M. HARMS.

ORIGIN, HISTORY AND DEVELOPMENT OF CALCULATING MACHINES

AND

THE ART OF PUNCHED HOLE ACCOUNTING

Calculating machines are mechanical contrivances designed to facilitate computations to relieve the calculator from the mental strain of his work and to insure much greater accuracy in results. Calculating machines exist in various forms and are now made in such perfection that all important business houses regard them as a necessity and many scientific computations would not be made if it were not for the aid of these machines.

The earliest known instrument of any importance is the Abacus. The Abacus is a simple device for indicating numbers in addition and subtraction. It was in common use among the ancient Greeks and Romans and is still to be seen in general use in the Far East.

The Chinese lay claim to the invention of the abacus. Its use by the Egyptians as early as 460 B. C. is definitely asserted by Herodotus. It was probably used by the Babylonians and certainly by the Greeks and Romans from whom it spread to all Europe. It has existed in various forms—the knotted strings, the sand board, the pebble tray, the counters and the frame of beads. The last form, which is still in use, is known as the Chinese Swan Pan, the Russian Stchoty, or the Japanese Soroban. The ordinary Swan Pan consists of a frame divided into two sections, holding several parallel rods, each containing several movable beads. In the Chinese Swan Pan, each bead on the bottom row in the right division represents one unit, and each on the bottom row of the left division represents five units. In the next higher row, the value of each bead is ten times as great and so on.

Charles Babbage of London, England, was probably the first individual to forecast the computation of arithmetical calculations by machinery. His first calculating machine, which he called a "difference" or "analytical engine" was built between the years 1820 and 1822. It operated, after the manner of the "Jacquard" loom, from holes punched in a card. The card used by Babbage contained as many holes punched in a vertical column as the number desired to record. For example, if it was desired to record a "6," six holes in one vertical column would be punched.

The original model of one of the three Babbage calculating machines was purchased from the inventor in 1858 by an American citizen for $100,000.00 and donated to the Dudley Observatory at Albany, N. Y.

Several improved and distinctive types of automatic, mechanical and electrical punching, counting, sorting, tabulating and printing machine have been developed by resourceful inventors since the days of Babbage, notable among whom was Dr. Herman Hollerith, the founder of the Tabulating Machine Company.

The Tabulating Machine Company, subsidiary of the International Business Machines Corporation, is the pioneer in the manufacture and application of Tabulating machines. At about the completion of the tenth United States Census (1880), Doctor Herman Hollerith, an engineer who had won early recognition as an exceptionally able and accomplished statistician, realized the need of mechanical addition for census tabulation. For this purpose, Doctor Hollerith developed a system which recorded descriptive data for each individual or each unit of inquiry, by punching holes in strips of paper and later, in cards, both of which controlled electrical mechanisms, in the form of accounting or adding devices, either singly or in desired combinations. The first practical utilization of this machine and the mechanisms devised for its application, was in the tabulation of mortality statistics in the City of Baltimore; and the machines were also used by the Bureau of Vital Statistics of New Jersey and by the Board of Health of New York City.

At the beginning of the organization for the Eleventh United States Census (1890), the Superintendent of Census appointed a commission of three of the most experienced statisticians in the United States to make a practical test of all systems of tabulation that might be offered for use in connection with that census. The report of this Commission (November 30, 1889) showed that three methods were offered in competition and thoroughly tested, the Commission reporting that the punching could be done more rapidly than by writing on slips, and that tabulating by machine was approximately eight times as rapid as by sorting slips, as well as being decidedly more accurate. As a result of this report, Dr. Hollerith was awarded a contract for furnishing the equipment for tabulating the returns for the Eleventh Census.

ORIGINAL KEY PUNCH

This machine had a perforated board, bearing letter or figure characters beside each hole, which corresponded with the same information appearing on the Tabulating Card. Over this key board swung an index finger whose movement, after the manner of a pantograph, was repeated in the rear. In the open space underneath the arm in which a card was inserted, was a split holder or receptacle resting over the bed of the Punch. When the index finger was pressed down in any of the holes in the front of the Punch, the corresponding hole was punched in the card.

FIRST POPULATION TABULATOR

After the cards were punched, they were tallied or counted on a Tabulator which was the forerunner of our present varied line of Accounting Machines. The cards fed into this machine by hand were placed on a hard rubber bed plate which was provided with suitable stops or guides in order to assure the cards taking their proper positions. The bed plates were formed with a series of holes or cups corresponding in size and number to all the holes which could be punched in a card. The need of providing a bed plate with the same number of holes as the number that could be punched in a card is naturally apparent as the location of the holes in a card would vary for each subject punched; therefore, in placing a punched card on the bed plate, there would always be corresponding holes underneath the card.

Each hole in the bed plate was, in reality, in the nature of a cup partially filled with mercury which, as is generally known, is a good electrical conductor. These mercury cups were all connected by individual wires with the adding mechanism of the Tabulator. Above the bed plate was a frame provided with a number of projecting spring-actuated contact points, each contact point conforming in position with the center of the corresponding mercury cup. When a card was placed face up on the bed plate, the handle was brought down by hand and these contact points or pins went through the punched holes into the mercury filled cups and formed circuits corresponding to the digit or location of the hole punched in each column on a card. Where no holes were punched, the pins were merely pressed upward and upon the release of the handle, due to the spring actuation, they went back to their normal position.

The circuits, which were formed wherever the cards were punched, as previously described, actuated electro-magnets which operated counters. To tabulate any of the facts recorded on cards, it was only necessary to connect binding posts for specific counters with the corresponding mercury cup connections, place the cards singly on the plate underneath the pin box, pull down the handle on the right hand side of the machine and the results for each card were added to the preceding ones, the accumulated total for all the cards showing directly on the counter connected. The number of facts thus recorded at any one operation was only limited by the number of counters used.

The original Tabulating Machine used by the Census Bureau, was supplied with a series of dial counters adding "one" for each card passing through the machine. Each counter on this machine was connected with an individual mercury cup for a specific class of information, in accordance with the location of the hole in the card.

Each Census Card was complete in itself. Amounts or sums were not added on this machine but a great number of individual classes of information was automatically separated into groups, dependent upon the location of the holes in the card, and accumulated on the various counters.

The speed of this machine was entirely dependent upon the operator and the rapidity with which cards were placed on the bed plate and the handle pulled down. An average speed of approximately 50 or 60 cards per minute was considered good.

FIRST COMMERCIAL TABULATOR

The use of Tabulating Machines on population statistics presented the need of other mechanical devices for compiling agricultural, manufacturing and similar classes of data which required the adding of quantities or amounts. To accomplish this, a so-called "Integrating Machine" was developed which would accumulate or add digits ranging from 1 to 9 in each column, the accumulating being determined by the location of the hole in the card. This machine in so far as the placing of the cards on the bed plate, the pulling down of the handle, the removing of the Tabulating Card and the placing thereon of a new card were concerned, followed the same method outlined for the Population Tabulator. Its operation was, likewise, electrical but it was considerably different in appearance.

As a result of the latter type of Tabulator, Punched Hole Accounting was adopted in railroad, insurance and commercial circles and has since developed into virtually all lines of commercial and industrial activity including Federal, State and Municipal Governments. Manufacturing and distributing concerns of national and international prominence use the art of Punched Hole Accounting for compiling the cost of goods manufactured, for distributing their sales and for determining profits by territories, classes of goods, salesmen, agencies, etc.

In general, the principle of Punched Hole Accounting is represented in practically every industry and Tabulating Machines are used wherever figure-facts are called upon to assist in directing the operations of a business.

The foregoing is a brief but accurate resume of the early development of Punched Hole Accounting.

SPECIMENS OF BASIC TABULATING CARDS

The mechanisms presented were those originally devised for use in the practice of Punched Hole Accounting, but the unit which has made the operation of these machines both practical and successful is the commercial Tabulating Card which was originally designed for 27 columns on the short cards and 37 columns on the long cards, and later, in order to increase the capacity of the card, the short card was increased to 34 columns and the long card to 45 columns. These latter cards are still used, the one containing 45 columns being of greater value on account of its almost unlimited capacity to meet all requirements. While the number of columns on the cards was changed to increase the recording capacity, the size of the cards, however, remained the same.

Please notice that these cards, are still used in the same sizes as originally adopted, indicating how well and on what a solid foundation of reason Doctor Hollerith's work was based, as after years of practical experience, we are still using the same size cards that were used in the early days with the hand machines when there were no precedents to follow and practice was built step by step, in establishing the principle of Punched Hole Accounting.

MOTORS AND GENERATORS

Customer Engineering Reference Manual

CONTENTS

INTERNATIONAL BUSINESS MACHINES CORPORATION

New York, New York

Printed in U. S. A.

Form 52-3280-0-1M-JCP-5-51

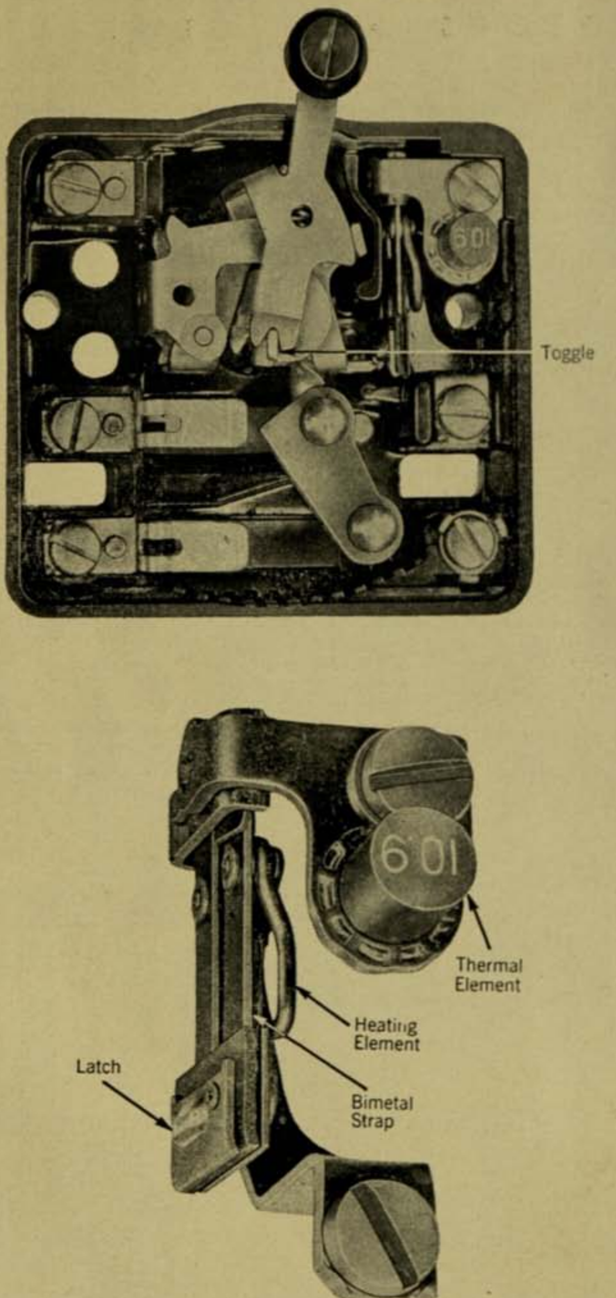


Figure 1. Sentinel Breaker Switch

MOTORS AND GENERATORS

GENERAL INFORMATION

Motors and generators play an important part in the operation of IBM Accounting Machines by providing independent operation for each machine unit. With the emphasis upon machines capable of independent operation, each machine is equipped with a drive motor and in many cases with a motor-generator set. Many sizes of fractional and full horsepower motors are used. These motors are furnished on all machines to conform with the voltage, frequency, and phase specifications.

To maintain these units properly, the customer engineer should concentrate his efforts primarily on the following items: starting switches, capacitors, commutators and brushes, and bearings. It is not practical for the customer engineer to undertake such jobs as rewinding an armature or field coil.

Sentinel Breaker Switch — Figure 1

All motors are protected by sentinel breaker switches. These switches differ from a standard toggle switch in that they automatically throw the switch to OFF or the open circuit position when an overload occurs.

The overload sensing element serves as a latch for the fulcrum of the toggle. This sensing element is made of two strips of metal bonded together. The two metals expand at different rates when heated and cause the bimetal strap to bend. The heating element is made of resistance wire and is mounted alongside the bimetal strap.

When the machine draws an overload for a time the bimetal strap becomes heated and bends, thus removing the latch from beneath the toggle fulcrum and allowing the switch to snap to the OFF or open circuit position by spring tension. The thermal elements are interchangeable and an element should be used which is rated slightly over the full load current of the motor that the switch controls. Some motors draw a much heavier current when starting than the rated current under full load. However, the starting current is drawn for such a short time that the sentinel breaker does not trip. If, however, the motor does not get up to speed within a short period of time, the sentinel breaker will trip and open the circuit. Sufficient time must be allowed for the thermal element to cool before the switch can be reset.

To restore the sentinel breaker switch to its operative position, move the lever to the extreme OFF position to relatch the toggle fulcrum. The switch may then be turned ON.

Thermal Fuses (Fusetrons)

For some types of loads, fuses do not provide satisfactory overload protection for the equipment. An example of this is motors. A ¼ horsepower motor which has a full load running current of about 5 amperes may require as much as 20 amperes starting current. A fuse rating of at least 15 amperes is required for starting. A 15 ampere fuse, however, would permit the motor to be seriously overloaded continuously without approaching the point where the fuse link melts. For protecting motors, then, some type of thermal fuse is desirable. This fuse will accommodate large overloads for short durations, but will blow at a small overload when subjected to it for a longer period. The construction of a thermal fuse is illustrated by Figure 2.

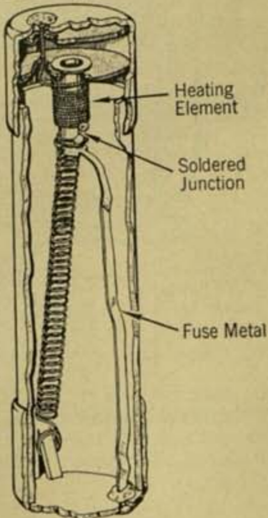
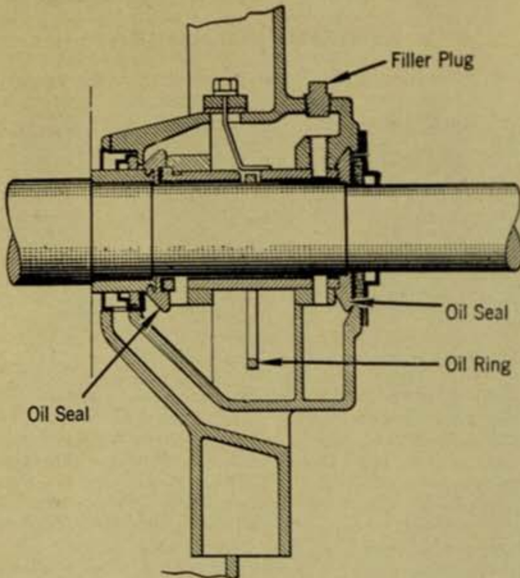
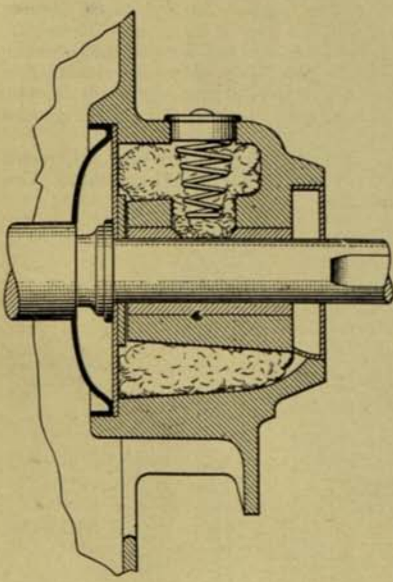


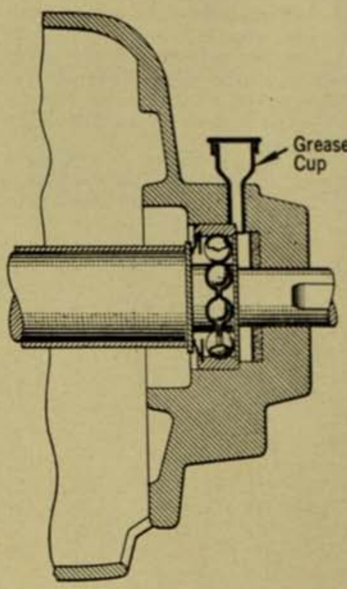
Figure 2. Thermal Fuse



Sealed sleeve bronze bearing



Wool packed bronze bearing



Ball bearing

Figure 3. Bearings

In case of a direct short circuit, the fuse link blows as in a common fuse, and when subjected to a steady overload the heater unit gradually heats the soldered junction until the spring pulls loose the fuse link, thus opening the circuit.

Bearings

Two general types of bearings are used in motors; ball bearings and bronze sleeve bearings, (Figures 3A, 3B and 3C). The ball bearings are pressed on the rotor shaft. If these bearings are kept properly lubricated, they should seldom require replacement. However, if it is necessary to replace a ball bearing, and if a press is available, the bearing may be replaced in the field.

The bronze sleeve bearings require line reaming. Since such facilities are not generally available, it is not advisable for the customer engineer to replace this type of bearing.

Lubrication

Proper lubrication and cleaning provide the best preventive maintenance. Lubrication is generally provided by one of two methods, either wool packed oil cups or grease cups.

Motors with ball bearings are provided with grease cups or removable bearing caps closed with pipe plugs. One full turn of each cup is recommended for each 2 to 6 months of normal operation eight hours per day. The manufacturer's notice on the motor will indicate what the period should be. The grease in the bearing caps equipped with pipe plugs (Figure 16) should be renewed every two years.

Motors with bronze sleeve bearings are provided with oil cups or ball closing type oil wells. Four drops of IBM lubricant 9 in each end bearing cup per month for machines under a normal eight-hour day operation is recommended. A little oil regularly each month is preferable to a larger amount at the end of a longer period. In any case a motor should never have more than 30 drops of oil in each bearing cup for each 1,000 hours of use.

Too much lubricant is as bad as too little. Excessive lubricant will travel along the rotor shaft and gather on the commutator or be thrown onto the starting switch or field windings. Grease and oil cause deterioration of the insulation and gather dust and dirt.

Most motors are equipped with a fan for ventilation and cooling. Air drawn through the motor by the fan contains particles of dust and dirt. This dust and dirt clings to those parts of the motor which are oily. The start switch and commutator are situated in a position to catch any excess lubricant from the shaft bearings and to collect the dust and dirt drawn in by the fan. Dirt on the starting switch points will cause failure to start. Dirt on the commutator may prevent the brushes from making contact with the commutator and thus prevent the motor from starting. Dirt may also short commutator segments together which will cause the motor to run slowly and overheat. Dust on the motor windings prevents proper ventilation and results in overheating. Overheating may cause breakdown of the insulation and result in short circuits which will burn out the winding.

Field Coils

The field coils of a D.C. motor up to ½ horsepower may be checked for continuity with a test light. Use D.C. and at least a 40 watt bulb. Remove the brushes and connect the test light leads to the field coil leads. If the lamp glows, the circuit is complete; if the lamp does not glow, the coil is open. To check motors larger than ½ horsepower, it is advisable to use an ohmmeter.

The field of an A.C. motor should be checked with an ohmmeter to detect an open field coil. Connect the ohmmeter across the field coil leads. If the ohmmeter shows a drop in the ohms value, the circuit is complete through the field. If the ohmmeter does not show a drop, the circuit is open.

Reversing Rotation

To change the rotation but not the polarity, it is necessary to reverse either the field or the armature leads. If both are reversed, the direction of rotation is not changed.

To change the rotation of a three-phase motor, reverse any two of the three wires at the junction box.

Heavy Duty Relays

All heavy duty relay armatures should operate freely. The points should be properly aligned and clean.

Excitation of D. C. Generators

When starting up, a generator may fail to excite itself. This may occur even when the generator operated perfectly during the preceding run. It will generally be found that this trouble is caused by a loose connection or break in the field circuit, by poor contact at the brushes due to a dirty commutator, or perhaps by a fault in the shunt resistor. Examine all connections; try a temporarily increased pressure on the brushes; check for an open circuit at the resistor; test for an open field coil with an ohmmeter.

If everything appears to be correct and the generator still fails to "build up," the cause may be lack of residual magnetism in the field poles. Shorting across the variable resistor in the shunt field will usually remagnetize the field. If this fails, however, connect a test light, plugged into D.C. in series with the F & L (common) leads. Use a 60-75 watt bulb in the test light. All generators used in IBM machines run counter-clockwise looking at the commutator end. Check for proper rotation.

A.C. MOTORS

Figure 4 shows the essential parts of an A.C. motor.

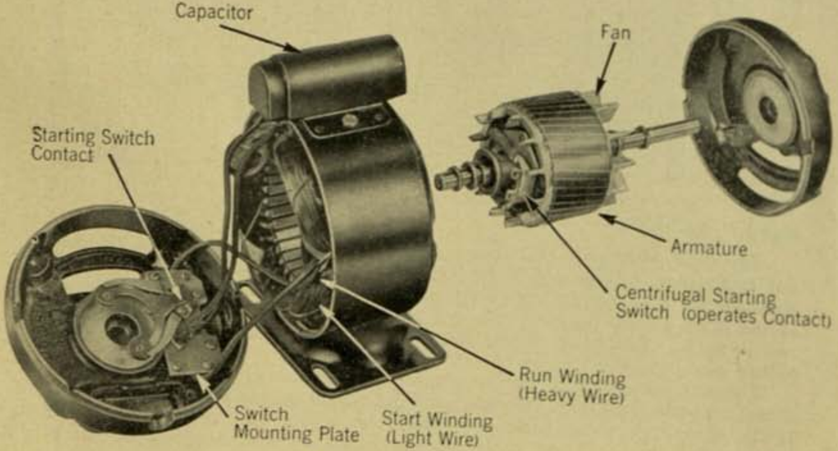


Figure 4. A. C. motor

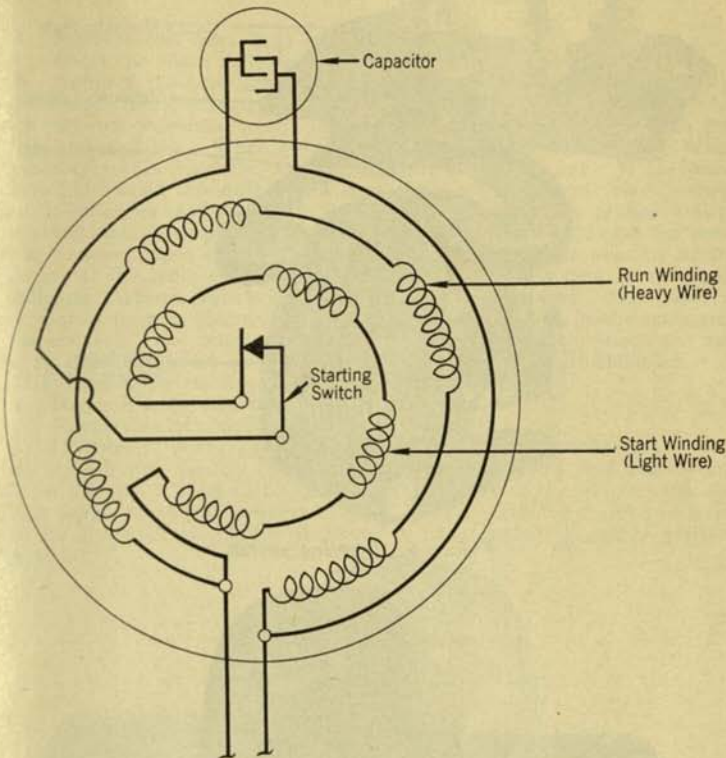


Figure 5. Schematic of A. C. motor

Starting Switches

A single winding on a single phase induction motor would exert no turning force on the rotor. Therefore, a secondary stator winding or a wound armature must be used to obtain the revolving magnetic field necessary to provide starting torque (Figure 5). When the speed of the motor reaches 70% to 80% of normal, this secondary winding which produces a false second phase is cut out of the circuit by a centrifugal starting switch and the motor runs on the single winding.

Most A.C. motors used on IBM equipment are of the capacitor or split phase type rather than the repulsion induction type which requires a wound armature.

The starting switch consists of a set of contact points and a throwout mechanism which operates by centrifugal force to open the points when the rotor approaches its rated speed (Figure 6).

The points of the starting switch may become dirty, may fail to close or fail to open. In the first two cases the motor will fail to start, while in the latter case the motor will run hot and eventually burn out the starting winding. The starting winding is a finer wire which is designed to carry a current for only a short time. The start switch may in some cases be visually checked without removing the end bells of the motor. On other motors it is necessary to check it with a test lamp or to remove the end bells.

To test the operation of a starting switch:

1. Test for power to the motor leads. If there are heavy duty relay points in the circuit, they must be held closed.
2. Remove the cover over the capacitor.

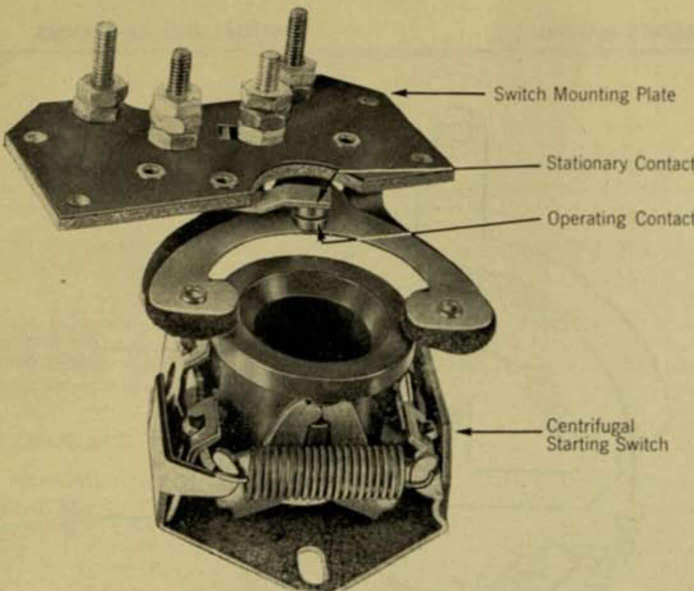


Figure 6. Starting switch

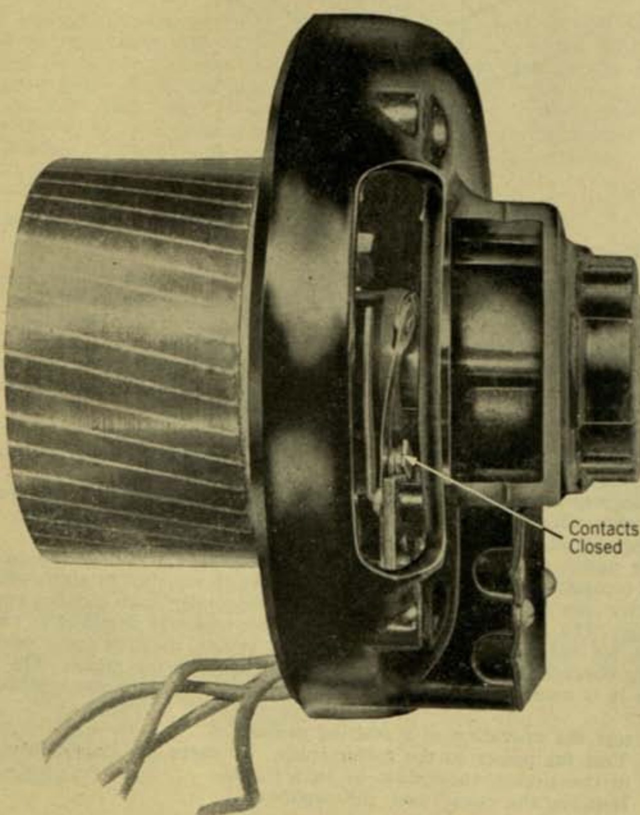


Figure 7. Starting contact (normal position)

3. Remove one wire from the starting capacitor.
4. Short the male terminals on the base of the test light together.
5. Connect the test light so that one lead is on the wire which was disconnected from the capacitor and the other lead is on the capacitor wire which remains connected to the motor. Turn on the main line switch and depress the start key. When the motor starts, the lamp should light. When the motor reaches operating speed, the light should go out. If the lamp fails to light when the start key is depressed and the motor relay is energized, it indicates that the points of the starting switch are probably dirty or sticking open. An open circuit in the start winding would give the same result; however, open coils occur much less frequently than starting switch failures. If the lamp continues to glow after the motor gets up to speed, it indicates that the switch is sticking and remains closed. The point in some motors may be cleaned and adjusted through a hole in the underside of the end bell. For other motors, it may be necessary to remove the end bells to clean the point or to adjust the switch operating mechanism.

If a starting switch must be replaced:

1. Remove both end bells and rotor.
2. Remove switch mounting plate.
3. Disconnect wires and remove defective switch mechanism.
4. Install new switch. Set switch end bell on table and place rotor shaft in bearing. Check to be sure that the fingers of the switch close the contact when in normal position (Figure 7) and allow the contact to open when the throwout mechanism is moved to its extended (running) position (Figure 8).

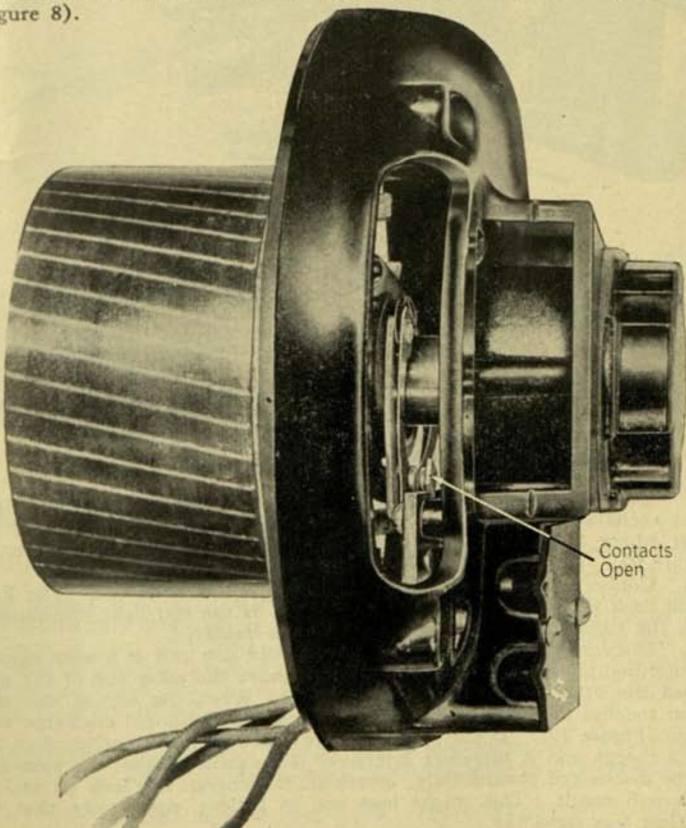


Figure 8. Starting switch (running position)

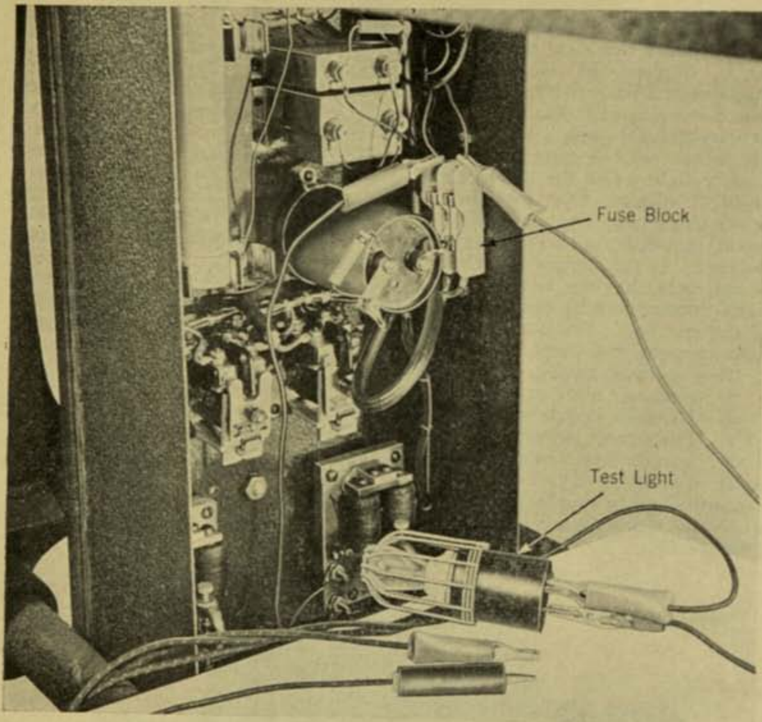


Figure 9. Source of 110V direct current

Testing a Capacitor

The capacitor type motor will fail to start if the capacitor (condenser) is defective. If the motor continues to run after the shaft is spun by hand in the direction of rotation with power on the motor, the difficulty is either in the capacitor or start winding. Caution: Remove the belts before turning the motor by hand with the power on. If the capacitor is defective, substituting another capacitor will remedy the difficulty. The capacitor puts the start winding 90° out of phase with the run winding to provide starting torque.

To test a capacitor, proceed as follows:

1. Disconnect the capacitor leads.
2. Connect the test light to a source of 110 volt D.C. (If 110 D.C. is not available from an outlet, it may be obtained at the fuse block of the sorter where 110 volt D.C. from the rectifier enters the sorting circuits (Figure 9).
3. Connect the test light leads to the capacitor terminals. The light should flash when the terminals are touched. If the test light continues to glow, the capacitor is shorted and should be replaced.
4. Disconnect the test light leads and hold one end of a wire against one terminal of the now charged capacitor; move the other end of the wire toward the other terminal of the capacitor. When the end of the wire almost touches the other terminal of the capacitor, it should discharge with an arc (Figure 10). If there is no arc, it indicates the capacitor does not take a charge and is therefore defective. It is assumed that the capacitor will be discharged immediately; otherwise, the charge will leak off and no spark will result. This might lead one to believe erroneously that the capacitor was defective.

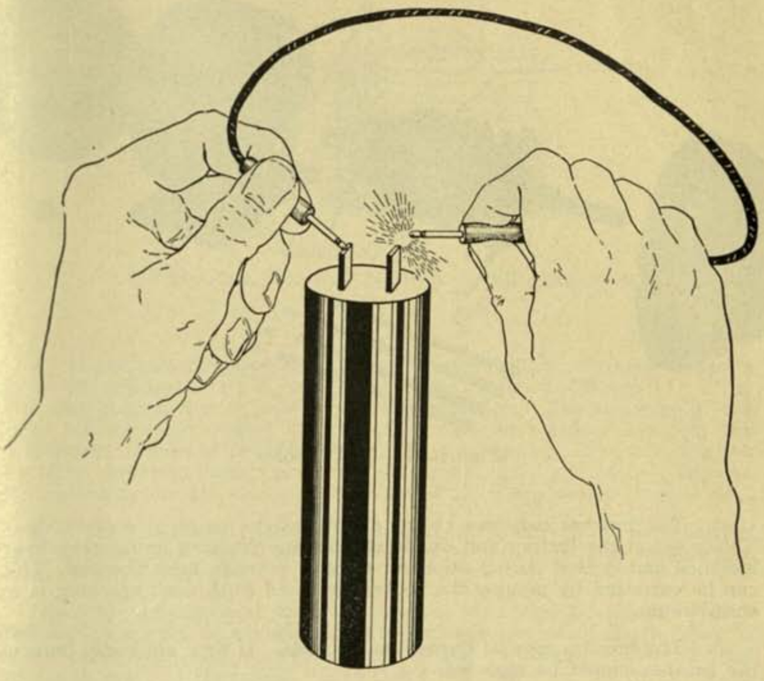


Figure 10. Discharging a capacitor

Two and Three-Phase Motors

Two- and three-phase motors have no capacitor or starting switch. The only care required is regular cleaning and lubrication.

The following section is devoted to additional information concerning specific machines for which additional removal procedures are required.

D.C. MOTORS

Commutators and Brushes

All D.C. motors and generators employ a wound armature, a commutator, and brushes (Figure 11). A commutator is perhaps the most important feature in a motor or generator as it is the most sensitive to abuse. For satisfactory operation, the brushes and commutator of a generator must be kept in good condition. Under proper operating conditions the commutator should run smoothly and true with a dark, glossy surface and without excessive heating. To keep these parts in good order, the main thing to guard against is excessive sparking at the brushes.

Sparking at the brushes may be due to various causes. These causes, some of which are listed below, apply to the motor as well as the generator.

1. The machine may be overloaded. The overload may be due to a ground and leak on the line, or a dead short-circuit which should cause the fuse to blow or the sentinel switch to trip.

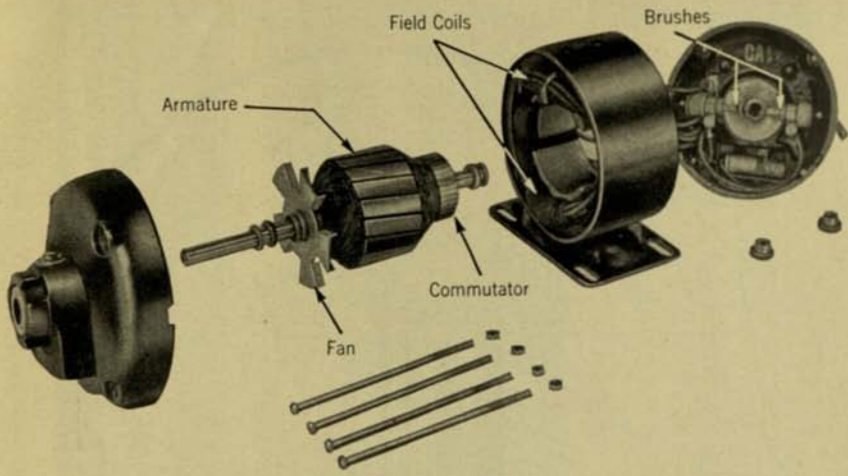


Figure 11. D. C. motor

2. The brushes may not be set exactly at the point of commutation. This is set at the factory and should not require changing unless they have loosened and shifted during shipment or have possibly been bumped. This can be corrected by moving the rocker back and forth until sparking is at a minimum.

3. The brushes may be burned on the ends. If they are badly burned, the brushes should be replaced.

4. The brushes may be sticking or wedged in the brush holder. The brushes should be kept free from binds and the brush holder should be kept clean of carbon dust and oily deposits. Before a new brush is inserted, it may be filed lightly to remove any roughness which might cause a brush to stick in the holder.

5. The brushes may not be fitted to the surface of the commutator. The brushes may be properly fitted to the commutator surface by the use of the brush seating stone. This stone is pressed lightly against the surface of the commutator until it powders slightly. It has abrasive qualities which cause the brushes to wear to conform to the surface of the commutator. When brushes are removed, mark the direction of the bevel and the position of the brush and be sure to replace the brushes in the same position and with the bevel in the same direction as it was before the brushes were removed.

6. The commutator may be rough, dirty, oily, or worn out. A commutator may be smoothed and cleaned with fine sandpaper (5-0 or finer). *Never* use emery cloth. Emery dust is a conductor and will cause shorts between the segments of the commutator. As one segment becomes shorted with another, the motor runs slower and hotter. For the same reason oil and dirt should be kept from between the segments of the commutator. If the space between the commutator segments becomes filled and dirt piles up on the surface of the commutator, the brushes will bounce. The commutator becomes blackened and low spots form from continual sparking. If the brushes wear a deep slot in the commutator, the brushes may bind on the sides of the slot and bouncing will result (Figure 12).

7. The carbon in the brushes may be unsuitable, making a change of brushes necessary.

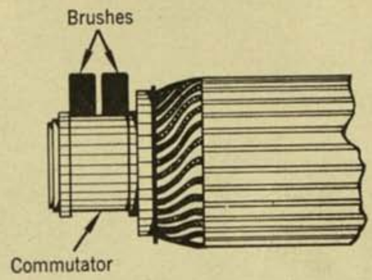


Figure 12. Brushes binding on commutator

8. If the mica insulation between the commutator segments projects above the segments, it will cause the brushes to spark (Figure 13). The mica should be undercut to eliminate this condition. The saw edge of the chute blade cleaner makes a satisfactory tool for cleaning between the commutator segments and for undercutting the mica. The commutator should be checked at least once every six months. It is advisable to remove the brushes before the armature is removed from any motor or generator.

9. Open circuits or loose connections in the armature. This condition may be recognized by a bright spark that appears to pass completely around the commutator.

There are two general kinds of sparking that can be readily distinguished. One kind of sparking, due to bad adjustment of the brushes, a short circuit, open circuit or ground in the armature, can be identified by the bluish color of the spark. This spark is small when the brushes are near the neutral plane, and increases in size and brilliancy as the brushes recede from the correct positions on the commutator.

Sparking due to a dirty commutator can be identified by the reddish color of the spark and a sputtering or hissing sound.

Armature

The easiest method of checking for an open armature coil is by observation. If an armature has an open coil, a bright blue spark will appear at the brush at the point where the open coil exists.

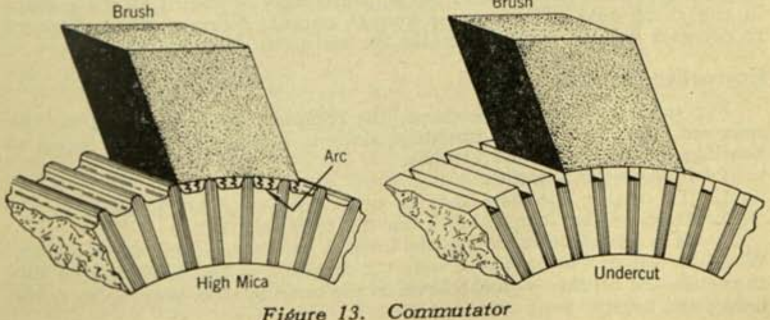


Figure 13. Commutator

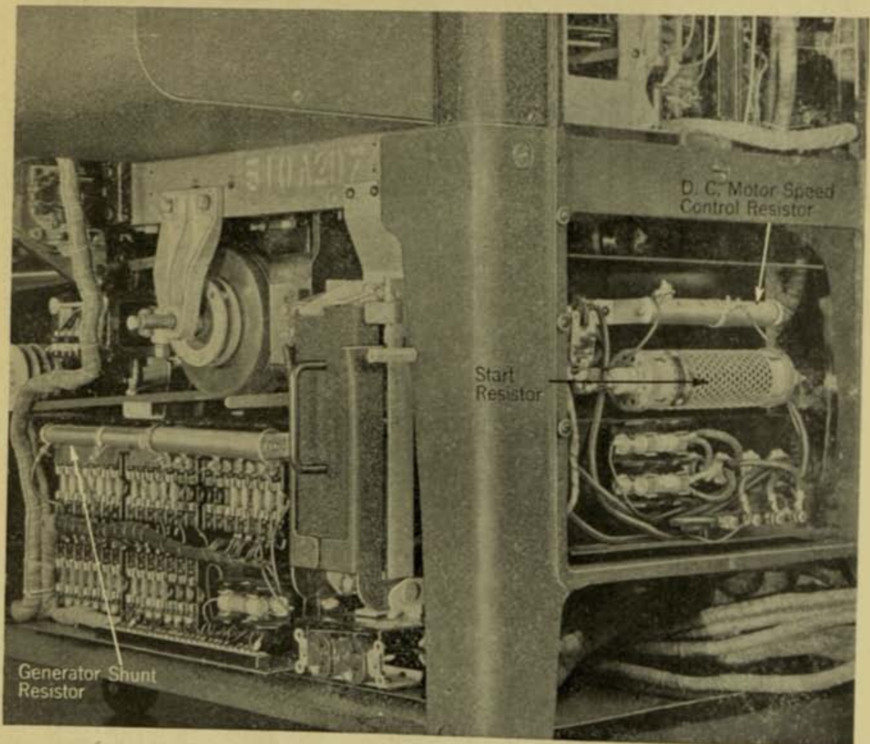


Figure 14. Control resistors

ALPHABETICAL ACCOUNTING MACHINE, TYPE 405

D.C. Generator

The generator on all *May 1st* or later machines is bolted to the underside of the upper base. The generator output is rated at 15 amperes at 40 volts. There are two models now in use, the Westinghouse and the Holtzer-Cabot.

Two sets of brushes are used in both models to assure good commutation.

The power supplied by the generator can only be as good as the motor which drives it. The output of the generator may be varied by the resistor in the shunt field. To increase voltage output, decrease the resistance; to decrease voltage output, increase the resistance (Figure 14).

Corrective Methods

For most corrective procedures, the complete generator need not be removed. Removal of the armature alone is sufficient to allow access to bearings, commutators and brushes.

To remove the armature:

1. To remove the belts and the belt tightener pulley bracket.
2. Remove the four screws from the front end bell.
3. It is advisable to remove the brushes before removing the armature. When the brushes are removed note the direction of the bevel and be sure to replace the brushes with the bevel in the same relative position as it was before the brushes were removed.

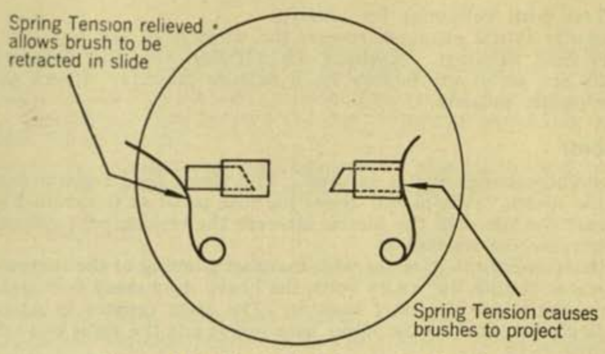


Figure 15. Replacing generator brushes

4. Pull the armature out from the front of the machine.
5. Remove the rear end bell; the brushes and grease cup are readily accessible for cleaning.
6. The old grease should be cleaned from the bearing and replaced with new IBM lubricant 21 approximately every two years. Fill the bearing housing approximately half full.
7. All carbon and dust should be cleaned from the entire generator with a brush and a cloth.

To replace the armature:

1. Be sure the brushes are removed from their slides or that the spring tension is relieved by placing a spring hook or rubber band beneath the brush tension spring. See that the brushes are pushed back in their slides; otherwise, the commutator will jam against the brushes and damage them (Figure 15).
2. Replace the rear end bell.
3. Check from front to be sure that all wires, brushes, etc., are out of the way of the armature, and that the brass shims are in the bearing housing.
4. Place the armature into the motor housing, being careful to align the bearing with the bearing housing.
5. Replace four screws in the front end bell.
6. Replace brushes in position.
7. Replace the belt tightener pulleys and belts.

If a direct short occurs across the generator, the load will be excessive. The motor will draw an extra heavy current and will cause the thermal element on the main line switch to trip.

Changing the Polarity of a Generator with a Self-Excited Field

At times it may be necessary to reverse the polarity of a generator to make it conform to the polarity of an auxiliary machine, as in the case of a Type 405 and a Gang Summary Punch designed for independent operation. The relays of both machines must operate with the same polarity to prevent short circuiting and blowing fuses.

1. Disconnect the F generator lead either at the shunt resistor in the fuse box or at the motor terminal plate.
2. If 110 volt D.C. is available, place a 40 watt bulb in the test lamp and connect to 110 D.C. Connect one lead of the test lamp to the F lead and touch the other momentarily to the L lead either at the bus in the fuse box or at the motor terminal plate.

If 110 D.C. is not available, connect one wire to each of the positive and negative sides of the 40 volt generator on another machine. These two wires may be connected momentarily to the F and L leads of the 405 generator. The A and F leads from the motor binding posts 7 and 8 are reversed from the notation on the blueprint. The F lead goes to the sliding contact and the A lead goes to the stationary contact.

3. Test with voltmeter for polarity.

If polarity is not changed, reverse the wires from the test light to the generator field windings. Recheck the polarity with the voltmeter. All generators are set at the factory for a definite polarity. Check the blueprint for proper polarity.

D.C. Motor

A one-horsepower motor is used. The shunt field resistor is used to control the speed. It is placed above the fuse panel as shown in Figure 14. To increase the speed of the motor, increase the resistance; to decrease the speed, decrease the resistance.

The start resistor is in series with the start winding of the motor. When the generator "builds up" to 24 volts, the heavy duty relay is energized and its points shunt out the start resistor. The start resistor is mounted on the binding post panel on the lower base just inside the right end relay gate (Figure 14).

The armature of the D.C. motor may be removed in the same manner as the armature of the generator is removed.

A.C. Motor

A one-horsepower motor is used on the Type 405. There is a capacitor in series with the start winding and a capacitor in series with the run winding of the Holtzer-Cabot motor. In this motor, the start capacitor is an electrolytic type of 378-420 mfd. capacity. The run capacitor is an oil type of 9 mfd. capacity.

The Westinghouse motor uses only a start capacitor.

AUTOMATIC REPRODUCING PUNCH, TYPE 513

Motor Generator Sets — Figure 16

The combination sets now in use are the Westinghouse and the Electric Specialty Company models.

The vertically mounted sets now in use are manufactured by Holtzer-Cabot, Westinghouse and Delco.

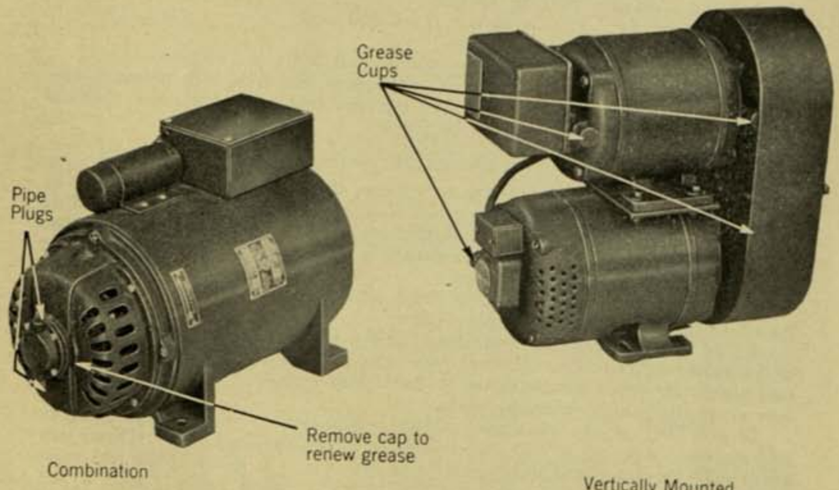


Figure 16. Motor generator sets

Lubrication

All motor generator sets on the 513 use ball bearings which require IBM lubricant 21. The bearings should be checked once every 6 months.

To check the Electric Specialty combination set, remove the four screws from the bearing cap and remove the cap. The cap should be approximately half full of grease.

To check the Westinghouse combination set, remove the end plug and check the bearing housing. It should also be at least half full of grease.

Corrective Methods

If the generator fails to provide the proper current, the following procedure may be followed:

1. Check the motor to see that it runs.
2. Check the variable resistor in the field circuit of the generator for an open circuit.
3. Check the brushes; see that they touch the commutator and have good tension.
4. Check the surface of the commutator for wear, dirt and oil.
5. If the generator fails to "build up" and everything appears to be correct, the cause may be lack of residual magnetism in the field poles. Shorting across the 50-ohm variable resistor will usually remagnetize the field. However, if this fails, connect a test light plugged into D.C. in series with the F and L (common) leads. Use a 60-75 watt bulb in the test light.

Standard 405 motors and generators are used in the vertically mounted models. The care of these is covered under Type 405 Motor and Generator care. If the motor fails to run, check the fusetrons in addition to the corrective methods given on page 14.

A direct short across the generator will cause the input circuit to open. This circuit may be controlled by a thermal element or fusetrons.

Drive Motor

The drive motor used is the same type of motor used for the sorter. However, the capacitor used on the A.C. motor is a larger one than that used on a sorter motor because the Type 513 is required to start so frequently. The windings on this motor are glass-insulated to withstand a greater heat generated by frequent starting.

AUTOMATIC MULTIPLIER, TYPE 601

A.C. Motor

The ½ horsepower motor, either A.C. or D.C., is used. The motor and generator are located beneath the upper base.

This motor runs counter-clockwise facing the end opposite the shaft.

The A.C. motor used previous to 1939 runs at 1640 R.P.M. The motor now in use runs at 1725 R.P.M. If the motor is changed from 1640 R.P.M. to 1725 R.P.M., the pulley must be changed.

D.C. Motor

The resistors between A_1 and F_1 in the shunt field are for speed control. An increase in resistance will increase the speed of the motor; a decrease in resistance will decrease the speed of the motor.

The capacitor across the motor brushes is provided for radio interference elimination.

Generator — Figure 17

This generator is designed to supply 78 volts A.C. and 48 volts D.C. There is a single common field winding and the two armatures are wound

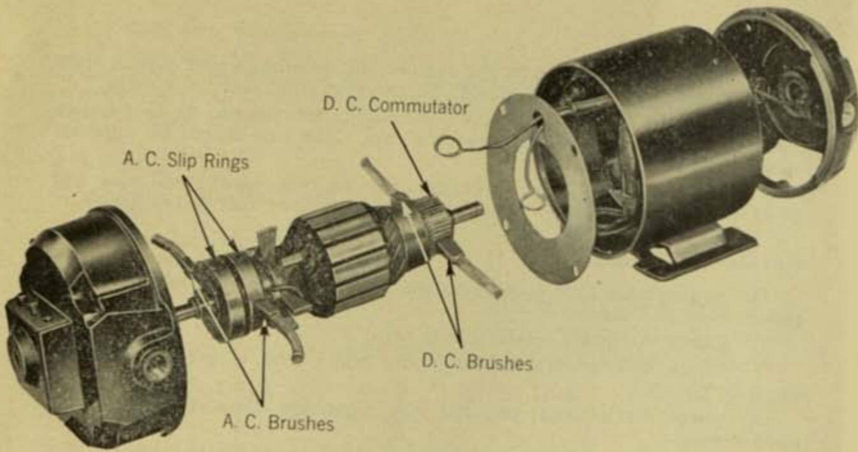


Figure 17. Generator—Type 601 Automatic Multiplier

on the same shaft, one for the A.C. and one for the D.C. There are three wires from the D.C. winding. The long white wire (*A-2*) is the common to both the armature and field coils. The red wire (*F*) is the field lead and the green wire (*G*) is the armature lead. In this machine the armature (*G*) and field (*F*) leads are both wired to the same side of the fuse.

Direct current supply for the control of the relays and punching mechanism in the machine is obtained from the commutator end of the generator, designated "D.C." on the wiring diagram.

Alternating current supply is obtained from slip rings located in the other end of the generator. This source of current supply is designated "A.C." on the wiring diagram.

The generator drive and gearing of the machine is arranged to provide for one complete A.C. wave per cycle point of machine operation. An A.C. wave is used for energizing all counter magnets, multiplying plate magnets, and column shift plate magnets. The circuit controls in each case are arranged to provide proper timing relation to the A.C. wave.

To time the generator to the machine:

1. With the two cap screws removed from the flexible generator coupling, set the machine at any numbered index line.
2. Turn the generator until the mark —/— (or red paint line) on the commutator is aligned with the pointer on the front (D.C.) end of the generator.
3. Find the two holes in the connector where the two cap screws will fit without turning the generator and insert the screws.
4. Turn the machine manually and check machine index lines with the paint or scratch mark on the generator. Check at 9, 5 and 1 on the index.
5. The second generator commutator mark —/—/— (or yellow paint line) is approximately 140° after the making point and is correct for current "lag" plus normal duration time. The breaking point must be used for timing purposes. Emitters and card brush circuit breakers should be timed to break at this yellow line.

The generator is designed to operate at 2400 R.P.M.

The D.C. from the generator serves to excite the single common field. Therefore, if for any reason the D.C. generator fails, the A.C. generator will fail also. However, it is possible to get D.C. without A.C.

The 2400 R.P.M. speed of this generator magnifies the tendency for brushes on the commutator (D.C.) to chatter. This cuts down the current in the field coils and affects both the A.C. and D.C. output.

The A.C. brushes are fitted with the curvature on the long face (Figure 17). The D.C. brush is fitted with the curvature on the short face.

Both sets of brushes must be removed before the armature is removed. If a short circuit appears across either the A.C. or D.C. line, it will cut both the A.C. and D.C. output to a negligible value.

ELECTRIC ACCOUNTING MACHINE, TYPE 285

All 110 volt Type 285 machines require a drive motor and a reset motor; 220 volt machines require a dynamotor in addition to the drive and reset motors.

All the motors used on a Type 285 require D.C.

Drive Motor

The drive motor must operate at two different speeds for list and non-list operations. This is accomplished by varying the resistance in the shunt field of the motor. When the resistance is increased, the speed of the motor is increased; when the resistance is decreased, the speed of the motor is decreased. The motor operates at approximately 900 R.P.M. on list speed and approximately 1700 R.P.M. on non-list speed.

The Dynamotor—Figure 18

The dynamotor is used to convert from 220 D.C. to 110 D.C. A single common field winding serves for both the motor and generator armatures. The dynamotor requires the same general care as D.C. motors and generators. Refer to the corrective methods summary chart for additional information.

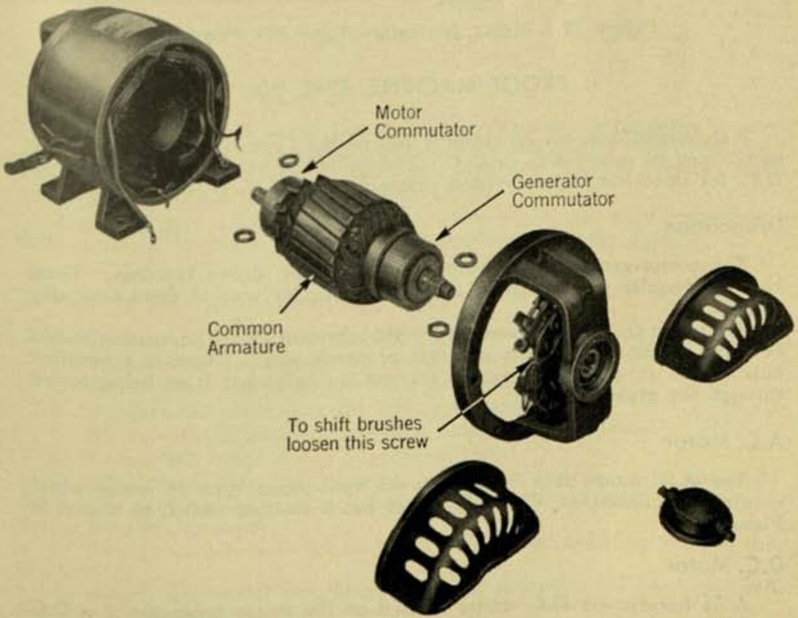


Figure 18. Dynamotor—Type 285 Electric Accounting Machine

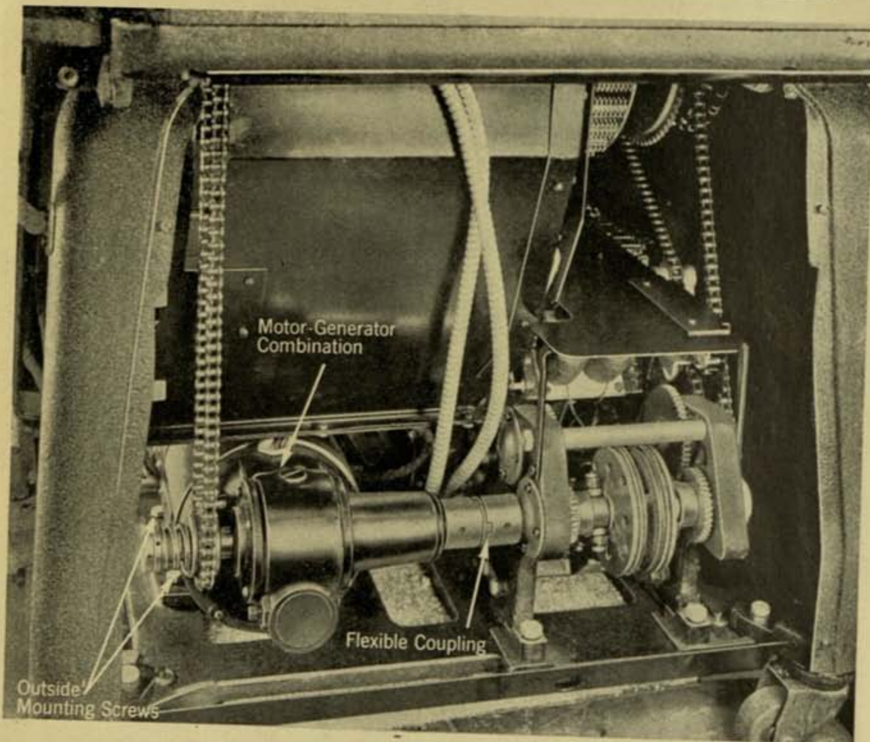


Figure 19. Motor generator—Type 801 Proof Machine

PROOF MACHINE, TYPE 801

A combination motor-generator is used on the Type 801 (Figure 19). The motor may be either A.C. or D.C. The generator produces 32 to 40 volts D.C. for operation of relays and solenoids.

Lubrication

The motor-generator is equipped with bronze sleeve bearings. These bearings require four drops of oil each month for normal eight-hour day usage.

The worm gear is lubricated with IBM lubricant 15. The housing should be filled to the level of the overflow or check plug. There is a breather hole in the top of the housing to prevent the lubricant from being forced through the grease seals.

A.C. Motor

The A.C. motor is a ¼ horsepower split-phase type of motor which requires no capacitor. The A.C. motor has a starting switch as shown in Figure 5.

D.C. Motor

A ¼ horsepower D.C. motor is used on the motor-generator of a D.C. machine.

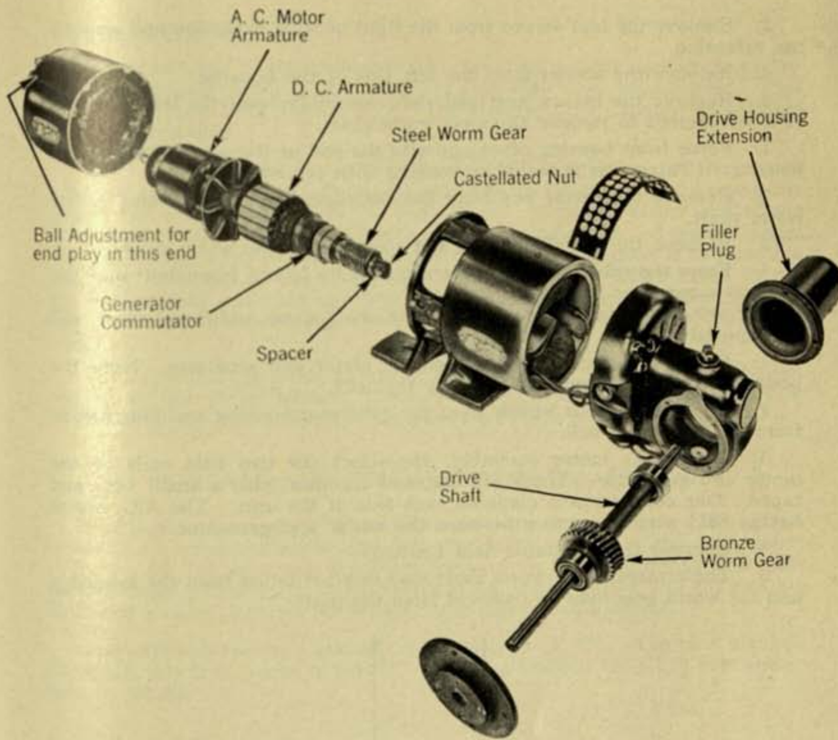


Figure 20. Drive mechanism—Type 801 Proof Machine

Drive Mechanism — Figure 20

The motor drives a worm and gear power unit which furnishes motive power to the machine. The lubrication of this worm gear is very important. There are three grease seals in the unit. If grease leakage becomes pronounced any or all of the seals may be replaced.

The worm gear is keyed to the shaft. This worm gear may be replaced most easily if the motor generator set is removed from the base.

To Remove the Motor Generator Combination

1. Loosen the two inside mounting screws.
2. Remove the two outside mounting screws.
3. Remove the two generator wires from the fuse block.
4. Remove the cover over the BX cable terminal box.
5. Remove the solderless connectors from the motor leads.
6. Loosen BX cable clamp at terminal box.
7. Slide motor generator assembly to the left far enough to disengage the flexible coupling and raise assembly to relieve tension from the chain so that it may be removed.
8. The motor generator set may now be removed from the front of the machine.

To remove the bronze gear after the motor generator has been removed from the machine.

1. Loosen screws and remove flexible coupling from shaft.

2. Remove the four screws from the right housing extension and remove the extension.

3. Remove the screws from the left side of the housing.

4. Remove the bronze gear and shaft assembly from the left.

If it is required to remove the steel worm gear:

1. Force front housing cover opposite the end of the worm shaft out of housing. (This cover is sealed to housing with cement.)

2. Remove the cotter key from the castellated nut on the end of the worm shaft.

3. Remove the castellated nut and spacer from the worm shaft.

4. From the side openings the worm may be forced from shaft and the key and worm gear removed.

To remove the motor generator armature shaft these additional steps will be required:

1. Remove the brushes from both the motor and generator. Note the position so that they may be properly replaced.

2. Remove the four screws from the generator housing and four screws from the motor end bell.

3. On a D.C. motor assembly, disconnect the two field coils of the motor and generator. These are fastened together with a small bolt and taped. One connection is made on each side of the unit. The A.C. motor has no field wire connection between the motor and generator.

4. Remove the generator field housing.

5. The armature and worm shaft may now be pulled from the assembly and the worm gear may be removed from the shaft.

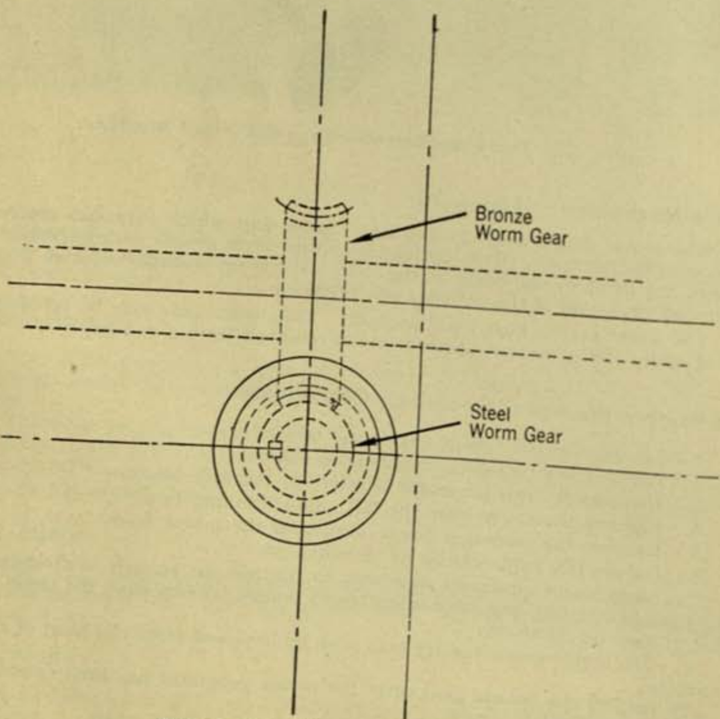


Figure 21. Alignment of drive gears

Armature End Play

In the end bell of the generator there is a ball bearing and screw adjustment by means of which the armature end play may be adjusted. This bearing requires IBM lubricant 21. The armature shaft should be adjusted for .003" end play.

When replacing the worm gear, be sure the center line of the bronze gear and the center line of the worm gear line up (Figure 21). These gears are placed at an angle of 90° to each other. Shims on either end of the worm shaft provide an adjustment to obtain this condition. A simple means of determining when the center lines of the gears are aligned is to assemble the unit as nearly in alignment as possible by sight. Then listen to the gears when they are running. The point at which the gears make the least noise provides the best alignment. This should be checked without the chain.

The drive shaft coupling should be so aligned that there is no perceptible wobble in the drive housing extension (Figure 20). This alignment is obtained by shimming beneath the motor generator.

PUNCHES AND VERIFIERS, TYPES 016, 031, 052

The punch motor is a 1/60 horsepower series-wound motor. The motor is rated as a universal motor; however, the armature used on the A.C. motor is wound for 100 volts and the armature used on the D.C. motor is wound for 110 volts. Therefore, a motor with a 100 volt armature will run fast on D.C. and a motor with a 110 volt armature will run slow on A.C.

The part number for a 100 volt A.C. motor is 167750. The part number for a 110 volt D.C. motor is 102437. The part number for a 110 volt armature is 280296.

Brushes and Commutators

The brushes and commutators will require the most attention. The brushes should be free in their holders and should make good contact with the commutator.

The brush caps should not be tightened excessively. Excessive tightening will result in breaking the caps.

There are two styles of brush caps for Westinghouse motors. One style has the threaded portion made of brass and the other style is made entirely of bakelite.

PRINTING PUNCHES, TYPES 034, 035, 036

Motor

A ¼ horsepower motor is now used on all printing punches. The ¼ horsepower motor replaces the 1/6 horsepower motor to eliminate overloading and overheating. This motor is the same type of motor as that which is used on the sorters and requires the same care for maintenance. The rotation is counter-clockwise facing the end opposite the shaft.

Generator

A 110 volt compound wound generator is used to supply current for the operation of all relays and solenoids in this machine. The output of the generator may be varied by the resistor in the shunt field.

To increase voltage output, decrease the resistance; to decrease the voltage output, increase the resistance.

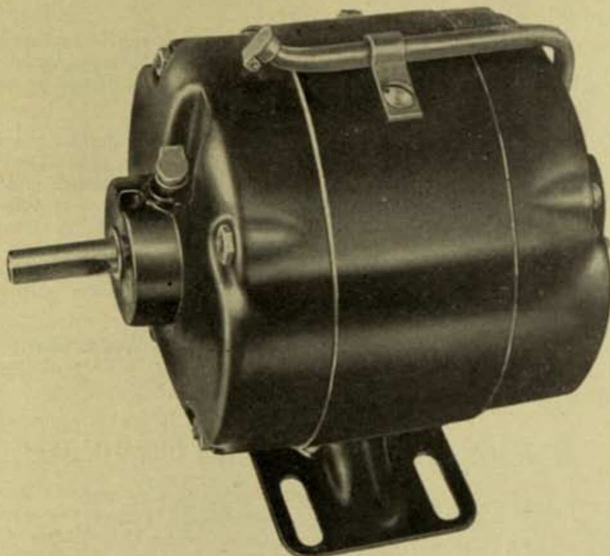


Figure 22. Fully enclosed motor

FACSIMILE POSTING MACHINE, TYPE 954

A 1/70 horsepower motor is used on a facsimile posting machine. This motor is fully enclosed to comply with Underwriters' specifications, and *only a fully enclosed motor can be used* (Figure 22).

The end bells must be removed when it is desired to make an inspection of any part of the motor.

COLLATOR, TYPE 077 and INTERPRETER, TYPE 552

Motors

The Type 077 and 552 machines use the same motors as the sorter. The rotation is counter-clockwise facing the end opposite the shaft. Corrective methods for these motors will be the same as those found under A.C. and D.C. motors.

Generators

Belt-driven generators are now being used on these machines.

There are two models of the belt-driven generator in use: the IBM generator, part number 192677, and the Westinghouse generator. The IBM generator shaft is ½" in diameter and the Westinghouse generator shaft is ⅝" in diameter. If generators are interchanged, the proper pulleys must also be supplied.

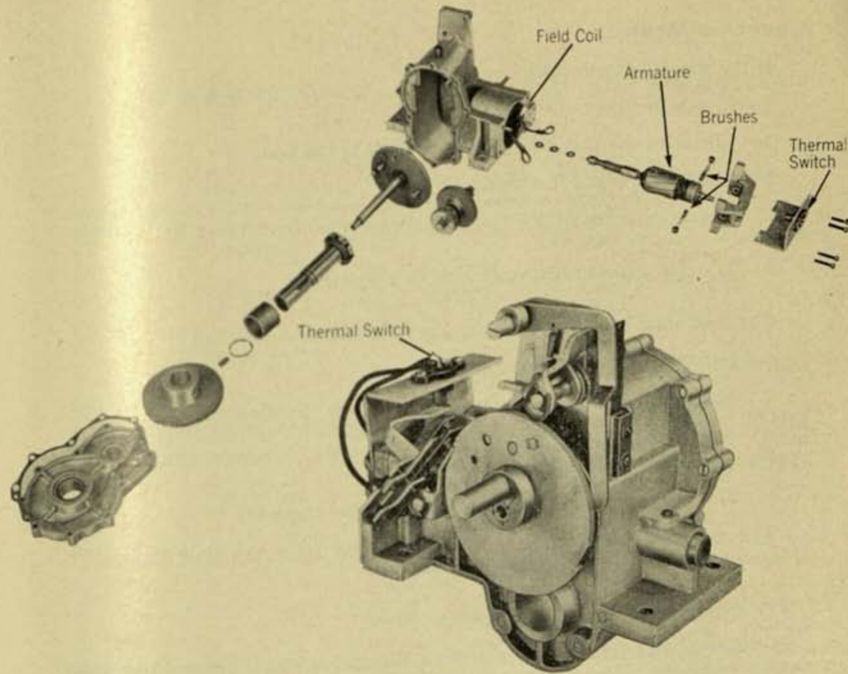


Figure 23. Drive motor—Type 805 Test Scoring Machine

TEST SCORING MACHINE, TYPE 805

A combination motor and drive housing is used on the test scoring machine (Figure 23). The motor is 1/10 horsepower universal type, with a rated speed of 7000 R.P.M. The motor is protected from overload by a thermal switch. This switch opens the circuit to the motor if the machine jams or the motor becomes excessively hot during operation.

Lubrication

The worm gear runs in a housing which contains IBM lubricant 9. The toggle drive gear in the top of the same housing is lubricated with IBM lubricant 21 packed around the shaft.

Corrective Methods

If the motor fails to start:

1. Check for power to the motor.

2. Check to see that the thermal switch is latched.

3. Check the motor brushes.

4. Check for binds in the operating mechanism by turning the armature by means of a screwdriver.

5. Test for an open field coil with an ohmmeter.

The field may be removed while the unit is in the machine:

1. Remove the motor brushes.

2. Remove the four screws from the rear bearing bracket. (The bracket is matched to the housing and doweled with the bearing in alignment. Be sure to replace the bracket so that the numbers stamped on it appear on the right side of the motor housing.)

3. The field may now be removed from the assembly.

The motor and drive unit must be removed from the base before the armature can be removed from the assembly.

To remove the motor and drive unit:

1. Loosen two screws, one in each of the collars which operate the paper shutter trip lever. These screws are just behind the platen, one on each end of the shaft just inside the base casting.

2. Remove the blue steel clip from the lower end of the motor key bell crank.

3. Pull shaft toward left end of machine.

4. Remove blue steel clip from the toggle pin and remove the toggle pin.

5. Remove the toggle link from the motor drive shaft. Caution: when replacing this unit, be sure the toggles are in the up position before raising the motor mounting bracket.

6. Remove the two rear batteries.

7. Remove the tubes from the item count chassis (tube and relay mounting plate).

8. Remove the two rear mounting screws from the item count chassis and pivot the chassis down about the two front screws.

9. Remove the four mounting screws and remove the motor and drive assembly.

To replace the motor:

1. Fasten motor to bracket with the four mounting screws.

2. Raise the motor mounting bracket and replace the two rear screws. Tighten the mounting screws very firmly.

3. Raise the item count chassis and replace the two rear screws.

4. Replace the motor key shaft and readjust the paper shutter trip levers.

5. Connect the motor key bell crank to the motor key shaft. Replace clip.

6. Replace the toggle link and toggle pin. Replace clip.

CORRECTIVE METHODS SUMMARY

TYPE	KIND OF FAILURE	PROBABLE CAUSE	CORRECTIVE METHODS
Capacitor and Split-phase	Fails to start	Thermal element in thermal overload switch burned out or switch tripped.	Reset switch or replace element.
Capacitor and Split-phase	Fails to start	Open circuit to motor.	Check with light for power to motor.
Capacitor and Split-phase	Motor hums but fails to start.	Defective capacitor.	Replace capacitor.
Capacitor and Split-phase	Motor hums but fails to start.	Points of starting switch not closed.	Clean and adjust starting switch.
Capacitor and Split-phase	Motor hums but fails to start.	Open circuit in start or run winding.	Remove end bell and check for broken wires. Check with test light for continuity. If open, return to Endicott.
Capacitor and Split-phase	Runs slowly and unevenly and heats excessively.	Starting switch not opening.	Check centrifugal throwout springs. Check contacts.
Capacitor and Split-phase	Runs slowly and unevenly and heats excessively.	Bearings gummed or worn.	Remove old lubricant. Clean shaft and bearing. Add new lubricant.
Capacitor and Split-phase	Runs slowly and unevenly and heats excessively.	Capacitor in run circuit open or shorted.	Replace capacitor.
D.C. and Universal	Fails to start.	Thermal element in thermal overload switch burned out or switch tripped.	Reset switch or replace element.
D.C. and Universal	Fails to start.	Open circuit to motor.	Check with test light for power to motor.
D.C. and Universal	Fails to start.	Brushes not making contact with commutator.	Check for sticking brushes and replace worn brushes.
D.C. and Universal	Fails to start.	Open circuit in field coil.	Remove end bell and check for broken wires. Check with test light for continuity. If open, return to Endicott.
D.C. and Universal	Runs slowly and overheats.	Dirty or rough commutator.	Clean and smooth with 5-0 sandpaper; if very rough turn down armature in lathe.
D.C. and Universal	Runs slowly and overheats.	Shorted commutator segments or high mica.	Clean between segments and undercut mica.
D.C. and Universal	Runs slowly and overheats.	Shorted windings on armature.	Return to Endicott.
Generators	Fails to "build up."	Open resistor in series with field coil.	Replace resistor.
Generators	Fails to "build up."	Open field coil.	Return to Endicott.
Generators	Voltage low.	Too much resistance in field.	Adjust variable resistor for lower resistance.
Generators	Voltage low.	Brushes not making good contact with commutator.	Check for sticking brushes and replace worn brushes.
Generators	Voltage low.	Commutator dirty or rough, or high resistance short between bars.	Undercut between commutator bars. Clean and smooth with 5-0 sandpaper, if very rough turn down armature in lathe.
Generators	Voltage low.	Short circuit on output.	Remove short.
Generators	Voltage low.	Short in armature windings.	Return to Endicott.
Generators	Voltage low.	Input voltage low on D.C.	Increase input voltage.

MOTOR AND GENERATOR SUMMARY

MACHINE TYPE NO.	A.C.—D.C.—UNIV	H.P.	MANUFACTURER	SHAFT SIZE	LUBRICANT
075, 080	A.C. D.C.	1/4	G. E. or Westinghouse	5/8"	9
405	A.C.	1	Westinghouse	3/4"	21
			Holtzer-Cabot	5/8"	21
	D.C.	1	Holtzer-Cabot	5/8"	21
	Gen.		Westinghouse	5/8"	21
			Holtzer-Cabot	5/8"	21
513	A.C.	1/4	G. E.	1/2"	9
	D.C.	1/4	G. E.	1/2"	9
	A.C. Combination	1	Westinghouse		21
			Elec. Spec.		21
	D.C. Combination	1	Elec. Spec.		21
601	A.C.	1/2	G. E.	3/4"	9
	D.C.	1/2	G. E.	3/4"	9
	Gen.		Westinghouse	1/2"	9
285	Drive-D.C.	1/8	G. E. or West.	5/8"	9
	Reset-D.C.	1/8 - 1/16	G. E.	1/2"	15
	Dynamotor		Elec. Spec. Co.		21
921	40 Volt D.C.	1/100	Robbins and Meyers	3/16"	9
	110 Volt D.C.				
801	A.C. Combination	1/4	Westinghouse or Robbins & Meyers		15
	D.C. Combination	1/4			15
016, 031	A.C.	1/60	G. E. and Westinghouse		9
	D.C.	1/60			9
034, 035 036	A.C.	1/4	G. E. or Westinghouse	5/8"	9
	D.C.				
	Gen.		G. E.	1/2"	9
954	A.C.	1/20	G. E.		9
	D.C.				
077, 552	A.C.	1/4	G. E. or Westinghouse	5/8"	9
	D.C.				
	Gen.		IBM	1/2"	9
			Westinghouse	5/8"	
805	A.C. or D.C.	1/10	Robbins & Meyers		9 & 21

METERS — TEST DEVICES

IBM
TRADE MARK

Customer Engineering Reference Manual

Meters and Test Devices

CONTENTS

New York, New York
Printed in U.S.A.
Form 22-8788-1

DEFINITIONS

A *coulomb* is a quantity of electricity equal to 6.24×10^{18} (6,240,000,000,000,000,000) electrons.

The *ampere* is the unit of measure for electric current intensity. If one ampere flows in a wire, one coulomb passes a cross section of the wire every second.

The *ohm* is the unit of measure of resistance to electric current. It is arbitrarily defined as the resistance of a standard column of mercury 106.3 centimeters long, weighing 14.4521 grams, at 32° Fahrenheit.

The *volt* is the unit of measure of electric force. One volt will force a current of one ampere through a resistance of one ohm.

The *farad* is the unit of capacitance. A one-farad condenser will store a charge of one coulomb when the potential difference of the plates is one volt.

The *henry* is the unit of inductance. An inductance of one henry will induce an electromotive force of one volt when the current through it varies at the rate of one ampere per second.

PREFIXES

To avoid the use of so many zeros when writing electrical quantities, the following prefixes are used; the most common prefixes are indicated by an asterisk:

Mega	=	1,000,000*
Kilo	=	1,000*
Hecto	=	100
Decka	=	10
Deci	=	0.1
Centi	=	0.01
Milli	=	0.001*
Micro	=	0.000001*

Example: 0.000005 ampere can be written "5 microamperes."

CAUTION ON THE USE OF AMMETERS

The Simpson Meter contains scales on which it is possible to read values of current directly. The meter movement is connected in parallel with a suitable shunt resistor, and the pointer moves a distance proportional to the voltage drop across the shunt resistor. In order to measure current, the meter is connected in series with the load, and all load current flows through the meter. Since virtually all of the load current flows through the shunt resistor, it is important that the meter dials are set properly before current is sent through the meter.

If a high current is sent through the ammeter circuit when a low-current, high-resistance shunt is in parallel with the meter, the shunt resistor and the meter coil may be atomized. Use EXTREME CAUTION on all current measurements, and when in doubt, start with the highest current scales.

METERS AND TEST DEVICES

THE IBM VOLT-OHM METER

THE earlier IBM machines, utilizing relatively simple circuits, could readily be tested by using the test light. With the advent of more complex machines, the test light has become inadequate. While the test light could be used to test continuity through a series of relay points, there was no provision for measuring, for example, the exact resistance of a relay coil or the voltage on the control grid of a vacuum tube. The comparatively high voltage used with the test light frequently caused damage to delicate circuit elements, and the customer engineer could receive a disagreeable shock from the probes.

To meet the need for an instrument to measure voltage, current and resistance, and yet be light and portable, the IBM volt-ohm meter was developed. The meter has provision for measuring DC or AC potentials from 0-300 volts and resistances from 0-2,000,000 ohms. When Ohm's law is used, currents may be calculated readily. The small battery voltage used in measuring resistance and checking continuity cannot damage circuit elements or shock personnel.

Use of the IBM Volt-Ohm Meter

The construction of the galvanometer movement and the design of the multiplier resistances used in the IBM volt-ohm meter will be considered in a later section of this manual. This section will deal entirely with the application of the meter to the testing of IBM equipment.

Three hubs, marked COMMON, VOLTS, and RESISTANCE, are provided on the meter case. These hubs will receive standard control panel wires or the tips of the test leads provided with the meter. The test leads are color-coded with red and black tips. The test leads should always be connected so that the black lead is connected to the common hub, and the red lead is connected to either the resistance or volts hubs. Connecting the leads in this manner is called *polarization of the leads,* and this system decreases the possibility of damage to the meter.

When the meter is to be used to measure voltage, the black lead is connected to the common hub, and the red lead is connected to the volts hub. The selector switch must be turned to the proper voltage range; the DC positions are used to measure direct current and the AC positions to measure alternating current. When direct current is measured, the red lead is always connected to the point of higher positive potential, while the black lead is connected to a lower potential point. Thus, current will always flow in one direction through the meter movement, causing the galvanometer movement to deflect upscale. Should the meter leads be reversed, the current would cause the meter to try to indicate downscale, and since no counterclockwise movement is possible below zero, the meter movement might be damaged. If the leads are properly connected to a voltage source, the galvanometer pointer will move a distance proportional to the voltage.

The setting of the selector switch determines which scale of the galvanometer should be read. When the selector switch is set to 50 volts, the top meter scale, calibrated from zero to 50 volts, is used. In Figure 1 a voltage is being measured that causes the pointer to be deflected halfway up the scale. Since full-scale deflection requires 50 volts, half-scale deflection indicates 25 volts; therefore, the magnitude of the voltage being measured is 25 volts. In Figure 2 half-scale deflection on the 150-volt range indicates that the measured voltage is 75 volts. Measuring a 150-volt supply will cause the pointer to move to half scale on the 300-volt range (Figure 3). The range should always be selected so that the measured voltage lies near the center of the scale, as the meter is more accurate in this range. The meter can be severely damaged if the leads are connected to high voltage while the selector switch is on a low range. For example, if the leads are connected to high voltage while the selector switch is on the 50-volt range, the meter would try to move past the upper end of the scale, and the delicate meter movement might be damaged. For this reason, the highest range (300 volts) should always be

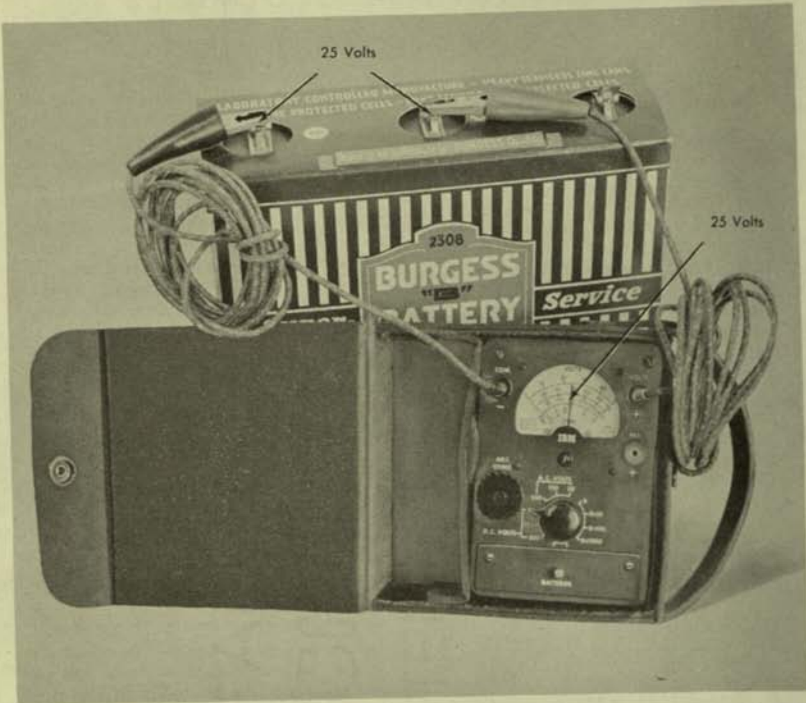


Figure 1. Voltage Measurement on the 50-Volt DC Scale

used first when an unknown voltage is being measured, and a lower scale may be adopted if the reading proves to be low enough to be read on the lower scale.

When AC voltages are measured, the same scale ranges are used, but the selector switch must be turned to the AC voltage positions. A full-wave rectifier is switched into the meter circuits on the AC ranges, and corrections are made for differences between the rectified AC and DC voltage that the meter normally measures. If a DC voltage is measured with the switch on the AC range, an incorrect reading will result. Theoretically, no reading should result if an attempt is made to measure AC voltages on the DC ranges, but it is possible to cause a slight deflection of the meter.

When the meter is to be used to measure resistance, the black lead remains connected to the common hub, and the red lead is connected to the resistance hub. The selector switch must be turned to one of the resistance ranges. A flashlight battery in the meter now supplies 1-3 volts to the leads, and when the leads are connected across a resistance, a small current will flow from the flashlight cells to the leads and resistance. This current will vary inversely with the resistance (the more resistance, the less current will flow), and the meter is caused to deflect a distance proportional to the current. Therefore, when the leads are shorted together (zero resistance), maximum current flows and maximum meter deflection occurs. Accordingly, the meter scale is calibrated backwards, with the zero end of the resistance scale at the right end of the meter, and the infinite resistance end of the scale at the left. Since the flashlight cell potential changes, a variable resistance marked ADJ OHMS is provided for calibrating the ohmmeter scales. This resistance adjusts the circuit so that a dead short reads zero ohms. When the meter is adjusted to read resistance, comparatively low resistances are connected in the internal meter circuits, and *extreme care should be taken to*

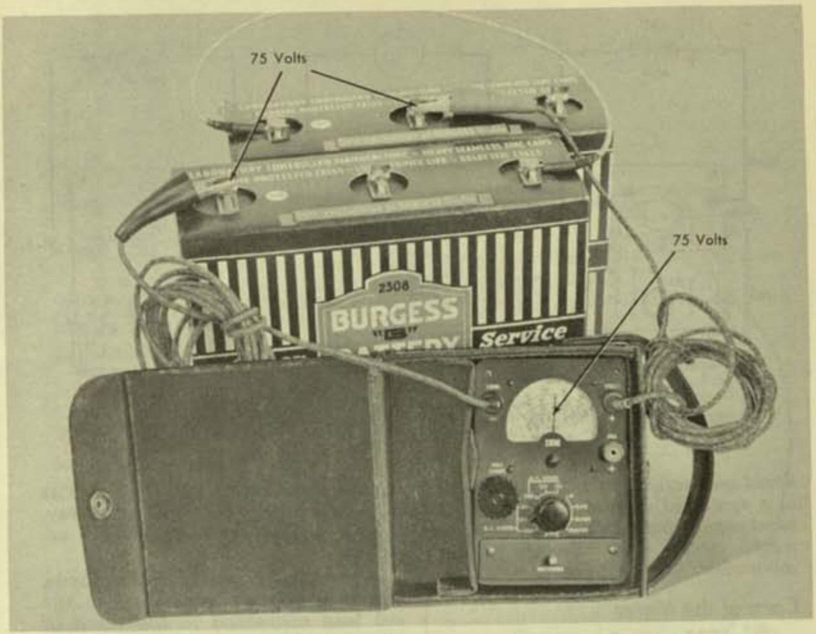


Figure 2. Voltage Measurement on the 150-Volt DC Scale

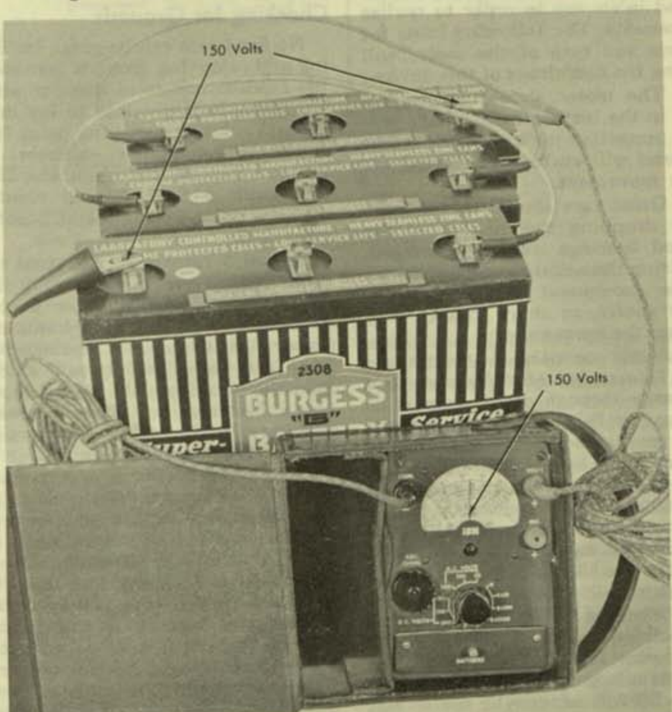


Figure 3. Voltage Measurement on the 300-Volt DC Scale

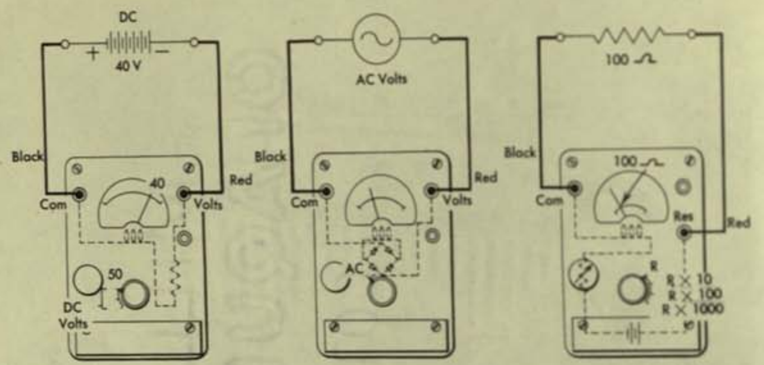


Figure 4. Electrical Measurements

avoid connecting the ohmmeter leads to a source of voltage. A moment of carelessness may burn out the ohmmeter circuit and ruin the meter movement. (See Figure 4.)

Care of the Meter

The IBM volt-ohm meter is a sensitive device, and care should be exercised in its use in order to realize full benefits. The following hints for the use and care of the meter will prolong the usefulness of this device:

1. The meter should always remain in the leather case, which provides protection for the plastic meter case and will cushion shocks to the meter movement.

2. Great care should be taken to avoid dropping the meter, as the jeweled bearings may be damaged, impairing the accuracy of the meter. If the movement sticks, tap the meter *gently,* as sharp knocks may damage the movement.

3. *Never connect the ohmmeter leads to a source of voltage* or to a resistance through which current is flowing, as this may burn out the meter resistances and harm the meter movement. When measuring the resistance of a circuit element, turn the machine OFF, and check across the power supply with the voltmeter, as a charged condenser can seriously damage the meter if discharged through the ohmmeter circuit.

4. When in doubt about the size of a voltage source, use the 300-volt range when connecting the instrument. If a large voltage is connected to the 50-volt range, the meter coil may be damaged, and sometimes the pointer may be bent by the suddenly applied force striking it against its full scale stop pin. Needless to say, it will never regain its former accuracy.

5. Always polarize the meter leads, and take voltage readings with the red lead connected to the point of higher positive potential.

Checking for Grounds

No fixed rule can be given for finding and removing grounds because of the random nature of these troubles. However, it is possible to lay down general rules as a starting point from which the customer engineer can proceed further. The ohmmeter is an invaluable aid in finding troubles where a point in the circuit becomes grounded.

Figure 5 illustrates a ground that is comparatively easy to find. The N/O strap of R62BL has become grounded to the machine frame of a Type 405. Disconnect the machine from the power supply and disconnect the wire from the power supply to the fuse common. This eliminates the possibility of back circuits. Switch the meter to the lowest resistance range, short circuit the common and resistance leads and adjust the ADJ OHMS control so the meter pointer reads zero ohms. Clip the black lead of the volt-ohm meter to the machine frame and connect the red lead to the fuse common. If a stable ground exists in the circuits, the meter pointer will be deflected. The circuit is traced from the meter battery through the adjustable resistor and the meter movement to the common hub, through the black wire to the machine frame, from the

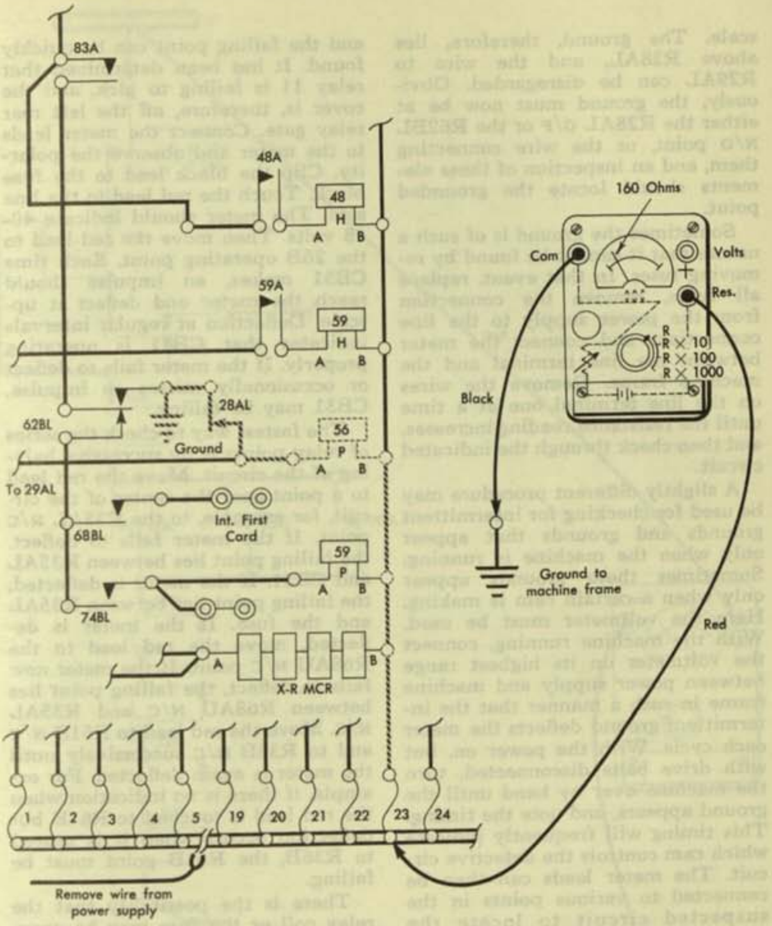


Figure 5. Finding a Stable Ground — Type 405 Circuit

grounded point of R62BL through R28AL N/C, R56P, fuse 23, fuse common, through the red wire to the meter battery. The meter indicates the external resistance in the circuit, 160 ohms in this case.

Because a ground exists on the machine, the procedure is to determine which circuit is grounded. Remove the fuses one at a time, simultaneously observing the meter. Obviously, nothing will change as fuses 1 through 22 are removed, but when fuse 23 is removed, the meter circuit is broken and the meter pointer drops to the high-resistance end of the scale. This shows that the ground is in the circuits protected by fuse 23.

Move the meter lead to the upper clip of fuse 23. The meter should again deflect to 160 ohms. Disconnect the B side of the XR multi-contact relay. No change in meter reading should result. Disconnect the B side of R59P. Again, there should be no change in meter reading. However, when the R56P circuit is opened, the meter circuit is opened, and the pointer drops to the high-resistance end of the scale. This shows that the ground is in the circuit above R56P. Move the red meter lead from fuse 23 to the R56P coil, connecting the lead on the A side of the coil. The 160-ohm coil is now removed from the circuit, and the meter should read virtually no resistance. Open the R28AL point and the meter pointer should drop to the high resistance end of the scale. The ground, therefore, lies above R28AL, and the wire to R29AL can be disregarded. Obviously, the ground must now be at either the R28AL O/P or the R62BL N/O point, or the wire connecting them, and an inspection of these elements should locate the grounded point.

Sometimes the ground is of such a nature that it cannot be found by removing fuses. In that event, replace all fuses, remove the connection from the power supply to the line connections and connect the meter between the line terminal and the machine frame. Remove the wires on the line terminal one at a time until the resistance reading increases, and then check through the indicated circuit.

A slightly different procedure may be used for checking for intermittent grounds and grounds that appear only when the machine is running. Sometimes these grounds appear only when a certain cam is making. Here the voltmeter must be used. With the machine running, connect the voltmeter on its highest range between power supply and machine frame in such a manner that the intermittent ground deflects the meter each cycle. With the power on, but with drive belts disconnected, turn the machine over by hand until the ground appears, and note the timing. This timing will frequently indicate which cam controls the defective circuit. The meter leads can then be connected to various points in the suspected circuit to locate the grounded element. Care should be taken to avoid leaving the circuit breakers closed for any length of time on such machines as the Types 402 and 602A, where coils or rectifiers may be damaged by overloads.

Checking Dynamic Continuity with the IBM Volt-Ohm Meter

Figure 6 shows the auto-start circuit on the Type 405. Relay 11 must be picked by CB31 to cause the card feed to function. The relay points in series condition the pick of relay 11 in order to prevent feeding a card at the wrong time. However, if one of the conditioning points should fail to make contact, the machine would continue to run but no cards would be fed.

With the machine running, a dynamic continuity check may be made and the failing point can be quickly found. It has been determined that relay 11 is failing to pick, and the cover is, therefore, off the left rear relay gate. Connect the meter leads to the meter and observe the polarity. Clip the black lead to the fuse block. Touch the red lead to the line side. The meter should indicate 40-48 volts. Then move the red lead to the 26B operating point. Each time CB31 makes, an impulse should reach the meter and deflect it upscale. Deflection at regular intervals indicates that CB31 is operating properly. If the meter fails to deflect or occasionally misses an impulse, CB31 may be failing.

The fastest way to check the series of relay points is by successive halving of the circuit. Move the red lead to a point near the center of the circuit, for example, to the R35AL N/C point. If the meter fails to deflect, the failing point lies between R35AL and CB31. If the meter is deflected, the failing point lies between R35AL and the fuse. If the meter is deflected, move the red lead to the R68AU N/C point. If the meter now fails to deflect, the failing point lies between R68AU N/C and R35AL N/C. Move the red lead to R61B N/C and to R36B N/C successively until the meter is again deflected. For example, if there is no indication when the red lead is touched to R61B but deflection occurs when it is moved to R36B, the R61B point must be failing.

There is the possibility that the relay coil or the fuse may be open. If the preceding test has eliminated all relay points, the fuse may be checked by moving the black lead to the point between the fuse and the relay coil. The red lead is connected to R22BL N/C. If no deflection occurs, the fuse is open. If deflection occurs, the relay coil is probably open. The relay coil may be checked with the ohmmeter as explained on page 59.

With practice, this entire procedure may be completed in a few minutes, saving the time required for checking the circuit elements one by one.

Testing Crystal Diode Rectifiers

Crystal diode rectifiers are finding wide application in the newer machines. Their purpose is to eliminate back circuits and to reduce the num-

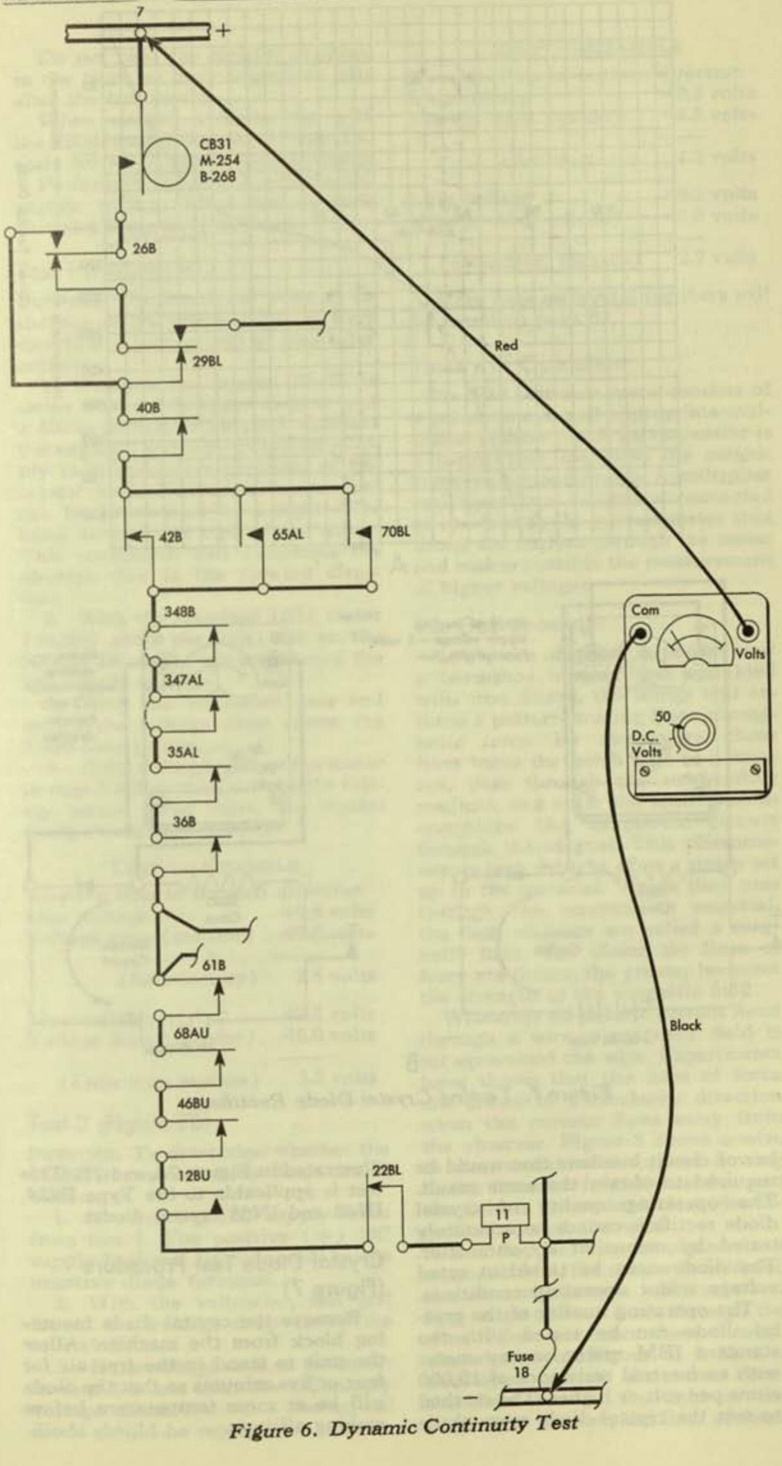


Figure 6. Dynamic Continuity Test

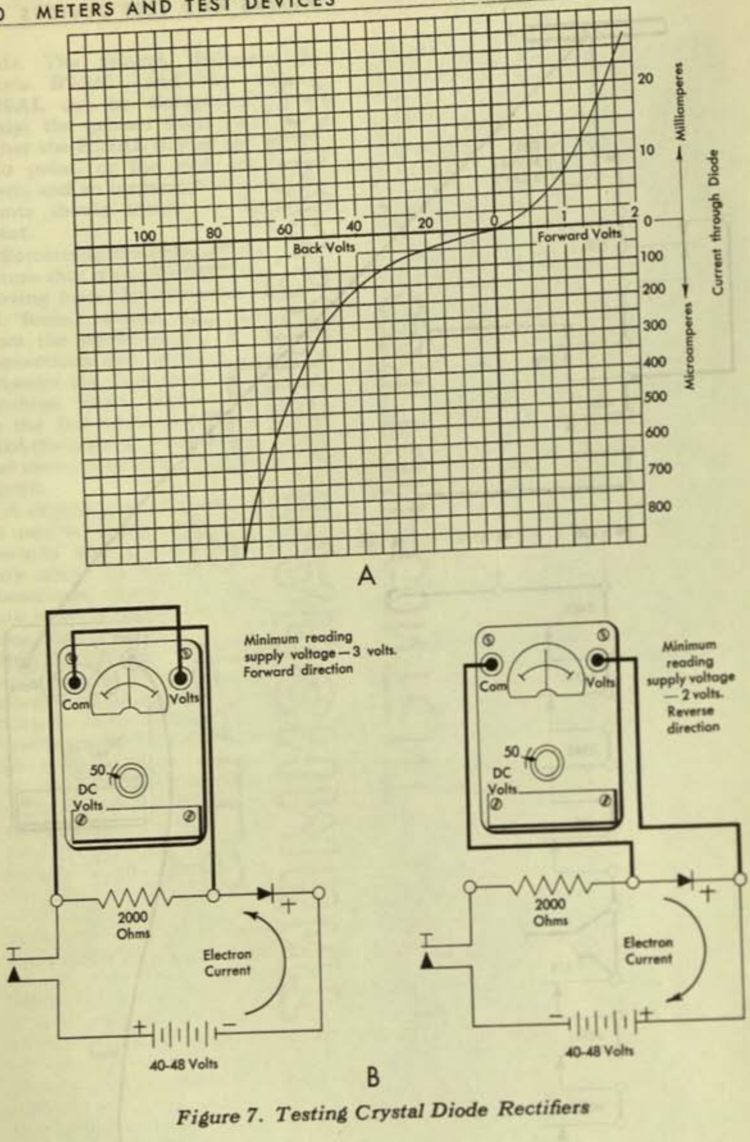


Figure 7. Testing Crystal Diode Rectifiers

ber of circuit breakers that would be required to obtain the same result. The operating quality of crystal diode rectifiers cannot be accurately tested by means of an ohmmeter. The diode must be tested at rated voltage under operating conditions.

The operating quality of the crystal diode can be tested with the standard IBM meter or any meter with an internal resistance of 10,000 ohms per volt or higher. The method to test the crystal diode correctly is illustrated in Figure 7A and 7B. This test is applicable to the Type IN34, IN48 and IN65 crystal diodes.

Crystal Diode Test Procedure (Figure 7)

Remove the crystal diode mounting block from the machine. Allow the unit to stand in the free air for four or five minutes so that the diode will be at room temperature before making all tests.

Do not hold the resistor or diode in the hand, as body resistance may alter the test results.

When making a diode test with the IBM meter, use the 50-volt DC scale for all of the voltage readings.

Perform tests 1 and 2 with the DC supply voltage from the machine that the diode is to be used.

Test 1 (Figure 7A)

PURPOSE: To determine whether resistance of the diode in the forward direction is low enough to pass rated current.

1. Connect the crystal diode in series with a 2,000-ohm resistor and a 40- to 50-volt DC supply. Connect the negative terminal of the DC supply to the negative terminal of the crystal diode. The negative terminal can be determined by a light color band around one end of the diode. This connection will determine the electron flow in the forward direction.

2. With the standard IBM meter (10,000 ohms per volt) set on the 50-volt DC scale, test and record the DC supply voltage.

3. With the voltmeter, test and record the voltage drop across the 2,000-ohm resistor.

4. If the voltage read on the meter in step 3 is less than the supply voltage minus three volts, the crystal diode should be replaced.

TEST 1—EXAMPLE

Electron flow in forward direction

Line voltage	49.5 volts
Voltage drop (resistor)	47.0 volts
(Satisfactory)	2.5 volts
Line voltage	49.5 volts
Voltage drop (resistor)	46.0 volts
(Defective; replace)	3.5 volts

Test 2 (Figure 7B)

PURPOSE: To determine whether the diode is a satisfactory back-circuit eliminator.

1. Reverse the DC supply leads from test 1. The positive (+) DC supply lead will be connected to the negative diode terminal.

2. With the voltmeter, test and record the voltage drop across the crystal diode.

3. If the voltage read on the meter in step 2 is less than the DC supply voltage minus two volts, the crystal diode should be replaced.

TEST 2—EXAMPLE

Electron flow in reverse direction

Line voltage	49.2 volts
Voltage drop (diode)	48.0 volts
(Satisfactory)	1.2 volts
Line voltage	49.2 volts
Voltage drop (diode)	46.5 volts
(Defective; replace)	2.7 volts

More data on crystal rectifiers will be found on page 67.

Theory of Operation

The IBM volt-ohm meter consists of a galvanometer and appropriate multiplier resistances. A galvanometer is a meter that measures the magnitude of electric currents. A multiplier resistance is a resistance connected in series with the galvanometer that limits the current through the meter and makes possible the measurement of higher voltages.

The Galvanometer

If a piece of paper is placed over a horseshoe magnet and sprinkled with iron filings, the filings will assume a pattern, tracing *lines of magnetic force*. By convention, these lines leave the north pole of a magnet, pass through the surrounding medium, and enter the south pole to complete the magnetic circuit through the magnet. This phenomenon is best thought of as a strain set up in the material. Where they pass through the surrounding material, the lines of force are called a magnetic field. The closer the lines of force are drawn, the greater becomes the strength of the magnetic field.

Whenever an electric current flows through a wire, a magnetic field is set up around the wire. Experiments have shown that the lines of force are drawn in a clockwise direction when the current flows away from the observer. Figure 8 shows a wire in cross-section with current flowing in the direction from the reader, and the field is drawn in a clockwise direction around the wire.

If a copper wire is placed in a magnetic field, the magnetic field and the wire will remain undisturbed as long as no current flows through the wire. When a current flows through the wire as in Figure 8, a field is developed around the wire. Since this field lies in the field of the permanent magnet, the lines of force

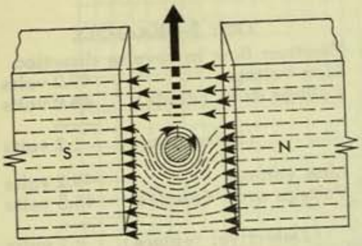


Figure 8. Flux Distribution Around a Wire Carrying a Current Through a Magnetic Field

of the two fields react with one another. The resultant field is strengthened under the wire and decreased above the wire. Since the lines of force try to take the shortest paths possible, the wire will tend to be forced upward. If the current is reversed, the lines of force around the wire are reversed, and the wire would tend to move downward.

If a loop of wire is pivoted in a magnetic field (Figure 9) when current flows through the wire, the sides of the loop will move in opposite directions, causing a turning force to be applied to the coil. The coil will

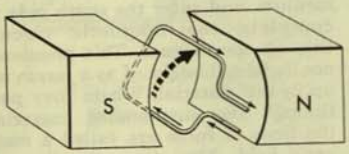


Figure 9. Basic Meter Principle

turn until it has reached the position shown as the position of maximum deflection in Figure 10. To gain sensitivity to small currents, the number of turns in the coil could be increased; two turns will develop twice as great a field and hence twice the turning force that one turn develops.

A French physicist, Jacques Arsène d'Arsonval (1851-1940), is accredited with the invention of the first moving coil current meter. An American, Edward Weston, developed this principle of meter design. The Weston galvanometer, which is the meter portion of the IBM meter, uses a coil pivoted in a permanent magnetic field. A hairspring is used to restore the coil when no current

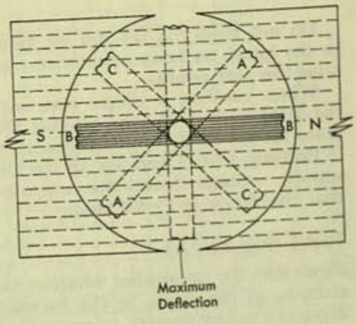


Figure 10. Galvanometer Movement

flows to a point that will be the zero position of the meter scale. The hairspring has essentially a constant modulus; if a force of one gram will stretch it a certain distance, two grams force will stretch it twice that distance. A screw is provided for setting the zero end of the scale mechanically. Attaching a pointer and scale completes the galvanometer assembly.

The force exerted on the coil can be increased by increasing the permanent magnetic field, the number of turns in the coil, or the current in the coil. The field strength and the number of turns are determined when the meter is manufactured; therefore, the force exerted on the coil is directly proportional to the current flowing through it. Since this force works against the hairspring, the pointer will move a distance proportional to the current.

Since the coil is turning in an essentially parallel field (Figure 10), it has a slightly different force exerted on it when at *A* and *C* than when at *B*, for at *B* it moves perpendicularly to the lines of force, while at *A* and *C* it moves obliquely to them. The field is irregular near its edges, which further changes the relation of the coil to the field. The most accurate portion of its travel occurs when the coil moves perpendicularly to the lines of force, and at that time the pointer is at the center part of the scale. Therefore, *the most accurate readings of the meter are those that fall on the center portion of the scale.*

The coil and pointer are mounted on a spindle, riding in jeweled bearings. The jewels are used to decrease spindle bearing friction and to increase meter accuracy. An iron core is placed inside the coil to further

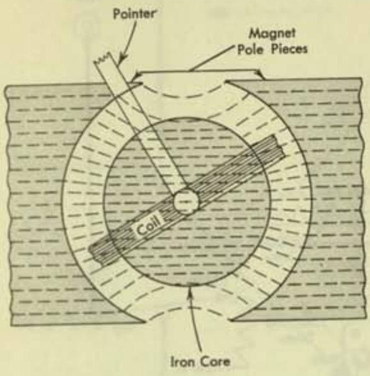


Figure 11. Improved Meter Movement

concentrate the magnetic field around the coil. Proper design of the core increases the accuracy of the end ranges of the meter by changing the magnetic field pattern (Figure 11) and causing the coil to cut the field at right angles for a greater part of its travel.

The Direct Current Voltmeter

In the following discussion of meter circuits, the theoretical values mentioned may vary slightly from the circuit elements found in a representative meter because of manufacturing tolerances. This discussion is not meant for meter repairs, but as a guide in using the meter.

The galvanometer has been designed to give full-scale deflection when a direct current of 100 microamperes (.000100 ampere) flows through the coil. The resistance of the coil is 1000 ohms. If connection were made directly to the coil ends, the voltage to give full-scale deflection is, by Ohm's law,

$$E = I \times R$$

$$E = .000100 \times 1000$$

$$E = .1 \text{ volt}$$

Since IBM machines operate at higher voltages, it is desirable to be able to increase the input voltage. If a full-scale reading is desired when the meter is connected to a 50-volt potential, a multiplier resistance R_1 may be connected in series with the meter coil:

$$R_{total} = \frac{E}{I}$$

$$1000 + R_1 = \frac{50 \text{ volts}}{.0001 \text{ ampere}}$$

$$1000 + R_1 = 500{,}000 \text{ ohms}$$

$$R_1 = 500{,}000 - 1000$$

$$R_1 = 499{,}000 \text{ ohms}$$

With a multiplier resistance of 499,000 ohms connected in series with the meter, full-scale deflection occurs when the meter leads are connected to a 50-volt source. A 499,000-ohm resistance is connected in series with the meter coil when the switch is set at 50 volts DC on the IBM meter.

The intermediate range of the DC voltmeter uses a full-scale reading of 150 volts. The series resistance for the multiplier must be:

$$1000 + R_2 = \frac{150 \text{ volts}}{.0001 \text{ ampere}}$$

$$1000 + R_2 = 1{,}500{,}000 \text{ ohms}$$

$$R_2 = 1{,}500{,}000 - 1000$$

$$R_2 = 1{,}499{,}000 \text{ ohms}$$

For the 300-volt range,

$$1000 + R_3 = \frac{300 \text{ volts}}{.0001 \text{ ampere}}$$

$$1000 + R_3 = 3{,}000{,}000 \text{ ohms}$$

$$R_3 = 3{,}000{,}000 - 1000$$

$$R_3 = 2{,}999{,}000 \text{ ohms}$$

The meter sensitivity is the ratio of the resistance of the meter and the series resistance to the voltage measured at full-scale deflection.

$$S = \frac{500{,}000 \text{ ohms}}{50 \text{ volts}}$$

$$= \frac{1{,}500{,}000 \text{ ohms}}{150 \text{ volts}}$$

$$= \frac{3{,}000{,}000 \text{ ohms}}{300 \text{ volts}}$$

$$= 10{,}000 \text{ ohms per volt}$$

This sensitivity rating holds for all three ranges of DC voltage. The sensitivity rating is important in cal-

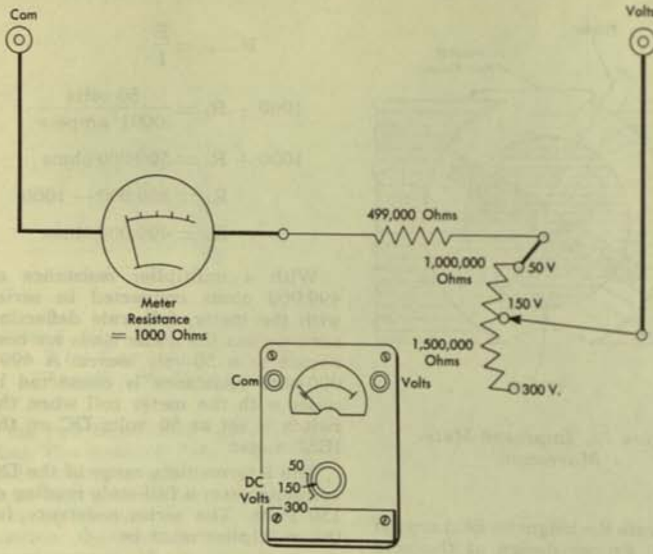


Figure 12. DC Voltmeter Schematic Diagram

culating the effect of the meter on the measured circuit.

Figure 12 gives the DC voltage measuring circuit, showing the method of successively coupling in multiplier resistances to obtain the desired multiplier.

The Alternating Current Voltmeter

It has been pointed out that a direct current will cause the meter coil to turn in the permanent magnetic field. If an alternating voltage is connected to the meter coil, the movement would be unable to follow the magnitude of the current because of the inertia of the coil, pointer, etc. The measurement of values of alternating current requires that several changes be made in the meter circuits.

First, the voltage must be rectified, or polarized, in one direction. A bridge rectifier is used, as it furnishes full-wave rectification. The current follows the arrows in Figure 13, and the meter is connected in the bridge so that the flow of electrons is always from *A* to *B*. If the input alternating voltage, when rectified, is assumed to follow a sine-wave pattern, the voltage will appear as in Figure 14.

An ideal rectifier would pass current freely in the forward direction but allow no current in the reverse direction. The copper oxide rectifiers used in the meter have a low forward resistance and a high reverse resistance, but some current can still flow in the reverse direction. This decreases the efficiency of rectification, and the voltage between points *A* and *B* (Figure 13) is decreased slightly by this effect. The rectifier in a new meter is about 91% efficient. In designing multiplier resistances for AC circuits this drop in voltage must be taken into consideration.

The rectified voltage starts at zero, rises to a peak value, and returns to zero twice for every cycle of input voltage. The distance of any point on the curve from the point on the base line directly under it represents the rectified voltage at that instant. If the distance of *every* point on the curve to the base line is measured and averaged, it is seen that

$$\frac{\text{Average voltage}}{\text{Peak voltage}} = .636 \text{ (a ratio)}.$$

The galvanometer mechanically averages the voltage, and moves a distance proportional to the *average* rectified voltage.

The designation "100 volts AC" represents an alternating voltage that would cause the same heating effect in a given resistor that a 100-

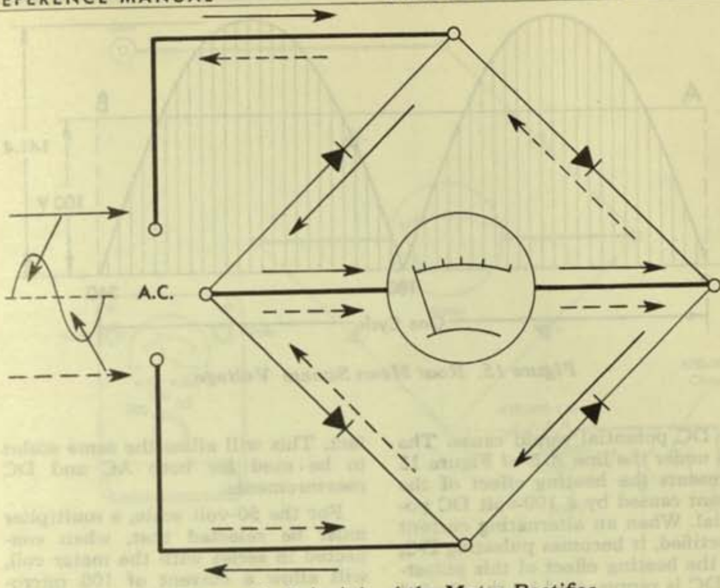


Figure 13. Principle of the Meter Rectifier

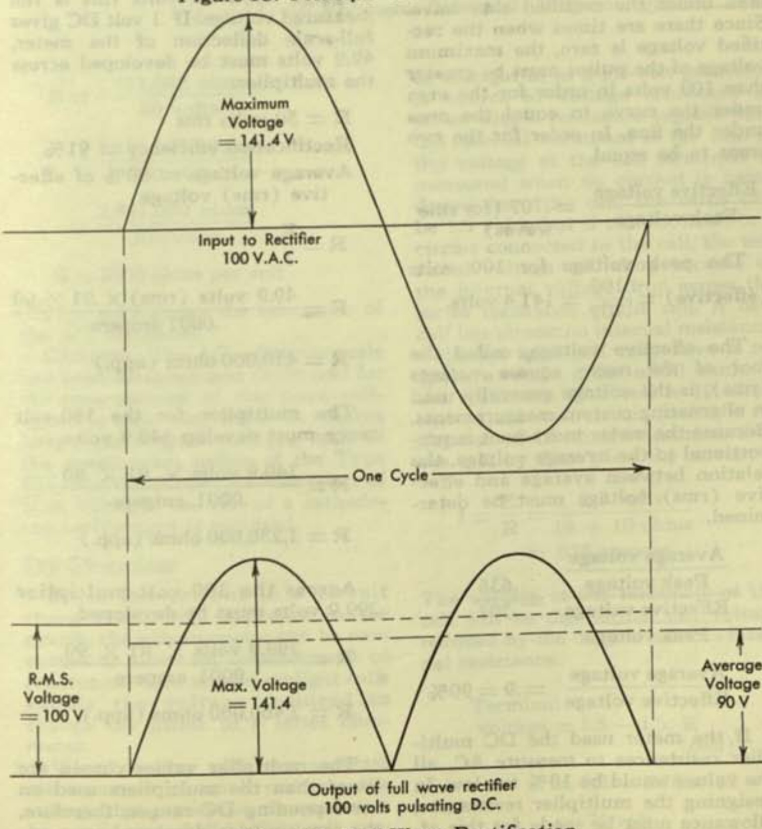


Figure 14. Full-Wave Rectification

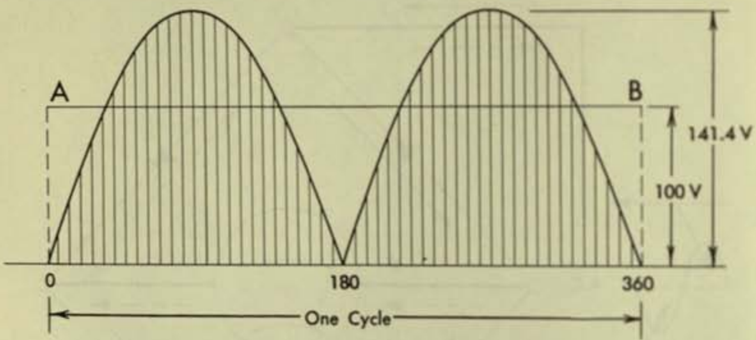


Figure 15. Root Mean Square Voltage

volt DC potential would cause. The area under the line *A-B* of Figure 15 represents the heating effect of the current caused by a 100-volt DC potential. When an alternating current is rectified, it becomes pulsating DC, and the heating effect of this pulsating DC is represented by the shaded area under the rectified sine wave. Since there are times when the rectified voltage is zero, the maximum voltage of the pulses must be greater than 100 volts in order for the area under the curve to equal the area under the line. In order for the two areas to be equal

$$\frac{\text{Effective voltage}}{\text{Peak voltage}} = .707 \text{ (for sine waves)}$$

The peak voltage for 100 volts (effective) $= \frac{100}{.707} = 141.4$ volts.

The effective voltage, called the *root of the mean square voltage* (rms), is the voltage generally used in alternating current measurements. Because the meter movement is proportional to the *average* voltage, the relation between average and effective (rms) voltage must be determined.

$$\frac{\dfrac{\text{Average voltage}}{\text{Peak voltage}}}{\dfrac{\text{Effective voltage}}{\text{Peak voltage}}} = \frac{.636}{.707}$$

$$\frac{\text{Average voltage}}{\text{Effective voltage}} = .9 = 90\%$$

If the meter used the DC multiplier resistances to measure AC, all the values would be 10% too low. In designing the multiplier resistances, allowance must be made for this effect. This will allow the same scales to be used for both AC and DC measurements.

For the 50-volt scale, a multiplier must be selected that, when connected in series with the meter coil, will allow a current of 100 microamperes when 50 volts rms is the measured voltage. If .1 volt DC gives full-scale deflection of the meter, 49.9 volts must be developed across the multiplier.

E = 50 volts rms
Rectification efficiency = 91%
Average voltage = 90% of effective (rms) voltage

$$R = \frac{E}{I}$$

$$R = \frac{49.9 \text{ volts (rms)} \times .91 \times .90}{.0001 \text{ ampere}}$$

$$R = 410{,}000 \text{ ohms (app.)}$$

The multiplier for the 150-volt range must develop 149.9 volts.

$$R = \frac{149.9 \text{ volts} \times .91 \times .90}{.0001 \text{ ampere}}$$

$$R = 1{,}230{,}000 \text{ ohms (app.)}$$

Across the 300-volt multiplier 299.9 volts must be developed.

$$R = \frac{299.9 \text{ volts} \times .91 \times .90}{.0001 \text{ ampere}}$$

$$R = 2{,}460{,}000 \text{ ohms (app.)}$$

The multiplier values chosen are lower than the multipliers used on corresponding DC ranges; therefore, the sensitivity is decreased.

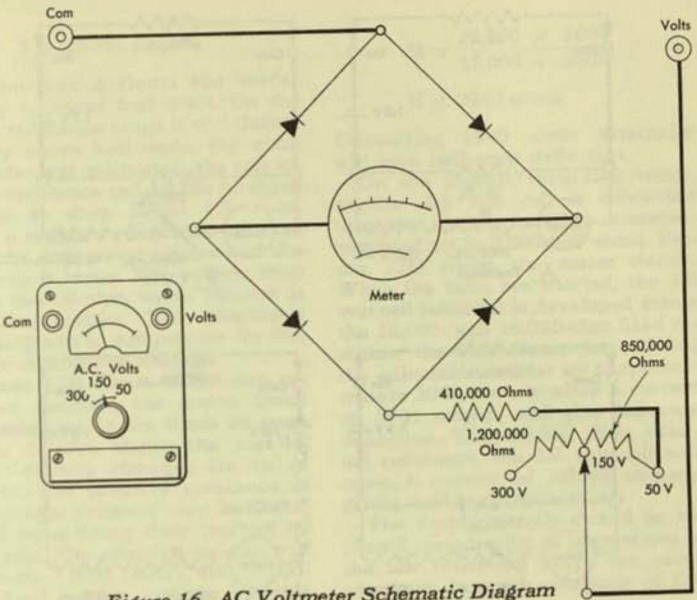


Figure 16. AC Voltmeter Schematic Diagram

$$S = \frac{411,000 \text{ ohms}}{50 \text{ volts}}$$

$$= \frac{1,231,000 \text{ ohms}}{150 \text{ volts}}$$

$$= \frac{2,461,000 \text{ ohms}}{300 \text{ volts}}$$

$$S = 8000 \text{ ohms per volt}$$

Figure 16 shows the schematic of the AC voltmeter.

CAUTION: The AC voltmeter scale has been designed and calibrated for the measurement of *sine wave* voltages. An error may occur in reading irregularly shaped voltages, such as the square-wave pulses of the Type 604. For the proper measurement of such voltages, the use of a cathode-ray oscilloscope is required.

The Ohmmeter

Since the current in a circuit changes with the resistance in the circuit, the galvanometer can be connected to allow for measurement of resistances. Two small flashlight cells supply the voltage required to change the meter to a series ohmmeter.

When dealing with the accurate measurement of small currents, the voltage that causes the currents must be considered. A flashlight cell may be thought of as a 1.5-volt generator or source of voltage connected in series with a resistance representing the internal resistance of the cell. If the voltage at the cell terminals is measured when no current is being drawn from the cell, the value will be 1.5 volts, but if current flows in a circuit connected to the cell, the terminal voltage will drop because of the internal voltage drop across the series resistance of the cell. A new cell has almost no internal resistance, while an aged cell may have a resistance of the order of 50 ohms. If the resistance of a cell is 10 ohms and an external circuit having a resistance of 10 ohms is connected to the cell, by Ohm's law the current is

$$I = \frac{E}{R} = \frac{1.5 \text{ volts}}{10 + 10 \text{ ohms}}$$

$$= .075 \text{ ampere}$$

The voltage at the terminals of the cell will be the normal cell voltage reduced by the drop across the internal resistance.

$$\text{Terminal voltage} = 1.5 - I \times R_{\text{(cell)}}$$

$$= 1.5 - .075 \times 10$$

$$= .75 \text{ volt}$$

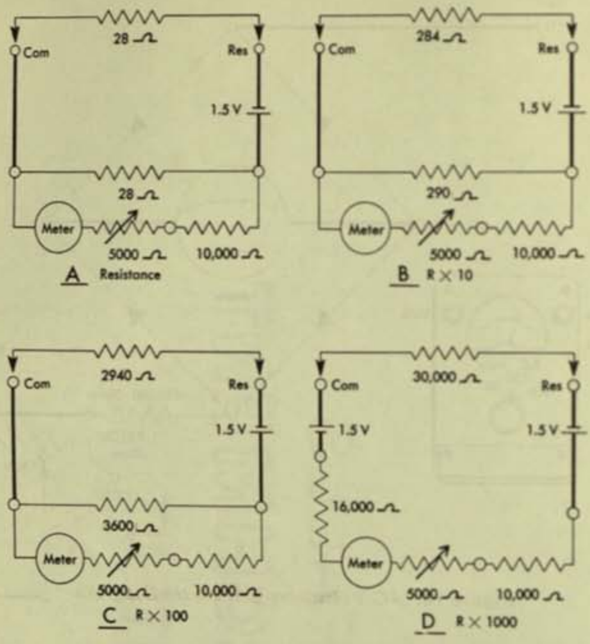


Figure 17. Ohmmeter Schematic Diagrams

Since the load on the meter cells changes on different scale ranges, the effect of battery internal resistance must be considered, especially on the low resistance ranges where more current is drawn.

Figure 17A shows the ohmmeter circuit when the selector switch is placed on the lowest resistance range (R). If a dead short is placed between the hubs marked common and resistance, the 1.5 volt cell potential is developed across the 28-ohm internal resistance and the meter circuit in parallel. This 1.5 volt potential appears across the 10,000-ohm fixed resistor, the 5000-ohm adjustable resistor and the 1000-ohmmeter coil. Since the current required to deflect the meter to full-scale is .0001 ampere, the variable resistance must be decreased to approximately 4,000 ohms, so the resistance of the meter circuit is

$$R = 10{,}000 \text{ (fixed)} + 4000 \text{ (variable)} + 1000 \text{ (meter)}$$

$$R = 15{,}000 \text{ ohms}$$

$$E = 1.5 \text{ volts}$$

Then, meter current $= \frac{E}{R}$

$$\text{Meter current} = \frac{1.5 \text{ volts}}{15{,}000 \text{ ohms}} = .0001 \text{ ampere}$$

The proper adjustment of the variable resistor thus causes the ohmmeter to read zero when a dead short is placed across the leads. This operation is called calibrating the ohmmeter.

If the short is now removed and a 28-ohm external resistor is connected between the common and resistance hubs, the 1.5 volt cell potential is developed across two 28-ohm resistors in series, and .75 volt is developed across each 28-ohm resistor. Since the resistance of the meter circuit is high, it may be neglected when in parallel with the 28-ohm internal resistor. The .75 volt developed across the 28-ohm internal resistor causes a current through the meter circuit of

$$I = \frac{E}{R}$$

$$I = \frac{.75 \text{ volt}}{15{,}000 \text{ ohms}}$$

$$I = .00005 \text{ ampere}$$

This current deflects the meter pointer to about half scale. On the lowest resistance range it will deflect slightly above half scale, for when the meter was calibrated, the cell internal resistance caused the terminal voltage to drop below 1.5 volts. When a resistance is placed between the hubs, less current flows and the cell drop is lower. The voltage drop across the 28-ohm meter resistor is therefore greater. The ohmmeter scale is drawn to compensate for this change in terminal voltage.

Figure 17B shows a 290-ohm resistance shunting the meter. Since this resistance is ten times as great as the 28-ohm shunt, the parallel meter circuit changes its value slightly. The effective resistance of two parallel resistors may be determined by dividing their product by their sum. The effective resistance of the meter (1000 ohms), the 10,000-ohm fixed resistor and the variable resistor of approximately 4000 ohms connected in parallel with a 290-ohm resistance is

$$R = \frac{15{,}000 \times 290}{15{,}000 + 290}$$

$$R = 284 \text{ ohms}$$

If a 284-ohm resistance is connected between the terminals, the voltage is divided equally between the external resistance and the meter and shunt combination, and again .75 volt will appear across the meter arm to give half-scale deflection.

Figure 17C shows a 3600-ohm resistor shunting the meter. The parallel resistance of meter and shunt is

$$R = \frac{15{,}000 \times 3600}{15{,}000 + 3600}$$

$$R = 2940 \text{ ohms}$$

Connecting 2940 ohms externally will give half-scale deflection.

On the highest resistance range, another 1.5 volt cell is connected into the circuit to allow measurements of up to 2,000,000 ohms. Figure 17D shows the meter circuit. When the hubs are shorted, the 3.0 volt cell potential is developed across the 10,000- and 16,000-ohm fixed resistors, the 1000-ohmmeter coil and the adjustable resistor set to approximately 3000 ohms to allow a current of .0001 ampere and give full-scale deflection. With 30,000 ohms external resistance, the 3.0 volt cell will cause a current of .00005 ampere, giving half-scale deflection.

The flashlight cells should be replaced periodically, as large errors in the low resistance range can occur when the internal resistance of the cells becomes excessive.

Current Measurement

The meter may be used to determine currents in DC circuits. If it is desired to measure the current through a relay coil, the resistance of the coil may be determined by using the ohmmeter. Disconnect one side of the coil to avoid the possibility of back circuits through the power supply. With the coil reconnected and the machine turned on, the voltage drop across the coil can be measured. Use Ohm's law to calculate the current through the coil.

Example: With the machine turned OFF, the relay coil of Figure 18 is measured on the $R \times 100$ scale.

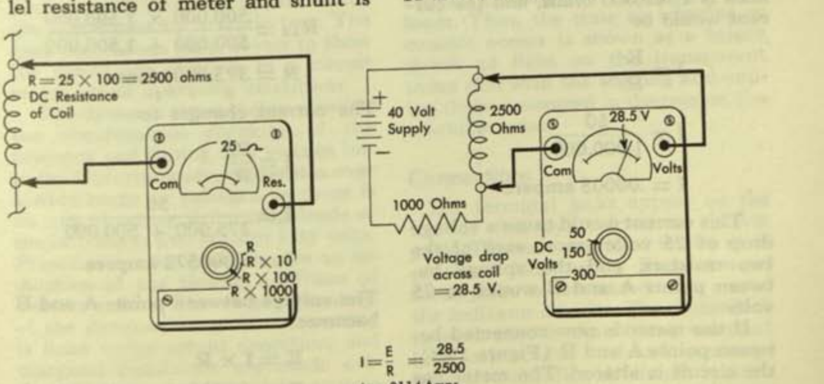


Figure 18. Current Measurements

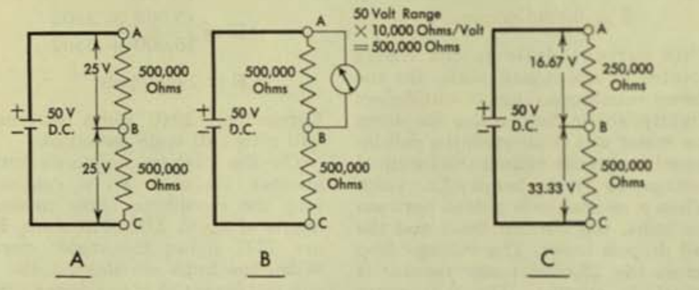


Figure 19. Error in Measurement Caused by Resistance of Voltmeter

The scale reading of 25 is multiplied by 100 to obtain the coil resistance of 2500 ohms. Then, with the machine ON, power is applied to the coil and the voltage drop across the coil is measured with the voltmeter. The current is obtained by dividing the voltage by the resistance. Where the relay is connected directly across the power supply, the power supply voltage may be read, but when the coil has a resistor in series with it, the voltage drop must be taken across the coil.

Effect of the Meter on the Circuit

In order for a voltage measurement to be taken by the meter, *current from the measured circuit must flow through the meter.* The fact that the meter alters the circuits should never be overlooked. Figure 19A shows a voltage divider network where a 50-volt DC power supply is connected across two 500,000-ohm resistors in series. The total resistance is 1,000,000 ohms, and the current would be

$$I = \frac{E}{R}$$

$$I = \frac{50}{1{,}000{,}000}$$

$$I = .00005 \text{ ampere}$$

This current would cause a voltage drop of 25 volts across each of the two resistors, and the voltage between points A and B would be 25 volts.

If the meter is now connected between points A and B (Figure 19B), the circuit is altered. The meter has a sensitivity of 10,000 ohms per volt, and is set on the 50-volt range; hence, its resistance is 500,000 ohms. Placing the meter in parallel with the 500,000-ohm resistor between A and B decreases the resistance between A and B to 250,000 ohms. More current flows in the circuit:

$$I = \frac{E}{R}$$

$$I = \frac{50}{750{,}000}$$

$$I = .0000667 \text{ ampere}$$

and the voltage between points A and B becomes

$$E = I \times R$$

$$E = .0000667 \times 250{,}000$$

$$E = 16.67$$

which is the value that the meter indicates.

If the meter is switched to the 150-volt scale, its resistance becomes 1,500,000 ohms. The resistance between points A and B is now

$$R_{AB} = \frac{500{,}000 \times 1{,}500{,}000}{500{,}000 + 1{,}500{,}000}$$

$$R = 375{,}000 \text{ ohms}$$

The current changes to

$$I = \frac{E}{R}$$

$$I = \frac{50}{375{,}000 + 500{,}000}$$

$$I = .0000572 \text{ ampere}$$

The voltage between points A and B becomes

$$E = I \times R$$

$$E = .0000572 \times 375{,}000$$

$$E = 21.4 \text{ volts}$$

which is still in error by slightly less than 15%.

If the meter is switched to the 300-volt range, a voltage reading of 23.2 volts will be read, which is in error by 7%. To correct this error, it is merely necessary to work backward through the preceding calculation. With the 50-volt range, the meter reads 16.67 volts across the 500,000-ohm resistor between A and B. On the 50-volt scale, the meter resistance is 50 × 10,000 (ohms per volt) or 500,000 ohms. Hence, R_{AB} = 250,000 ohms and R_{BC} = 500,000 ohms. Through these resistances in series the 50-volt potential causes a current of .0000667 ampere. If the meter is disconnected, the current would be .000050 ampere. Ohm's law may be put in proportional form and a solution obtained:

$$E = I \times R$$

$$\frac{E_1}{E_2} = \frac{I_1 \times R_1}{I_2 \times R_2}$$

$$E_1 = \frac{I_1 \times R_1}{I_2 \times R_2} \times E_2$$

$$E_1 = \frac{.00005 \quad \times 500{,}000}{.0000667 \times 250{,}000} \times 16.67$$

$$E_1 = 25 \text{ volts.}$$

THE DYNAMIC TIMER

THE fundamental concept of electric accounting machines is that arithmetical operations be accomplished by timed electrical impulses. The testing of circuits on IBM equipment, therefore, involves checking

1. The presence of a voltage impulse,
2. The time the voltage impulse is available,
3. The magnitude of the voltage impulse.

There is no testing device available that can simultaneously check these three things. The test light can only detect the presence or absence of an impulse. The volt-ohmmeter approaches the solution; when the machine is turned over manually, the presence, timing and magnitude of a voltage impulse are readily determined, but the reading is *static*. When the machine is run under power, conditions may appear which are not shown by a static test. The need then arises for a device to show the conditions existing in a circuit under actual operating conditions.

The dynamic timer makes possible the simultaneous checking of the presence and timing of a voltage impulse. Unfortunately, it operates over a wide range of voltages, so there is no way of telling if the magnitude of the impulse is five volts or fifty volts. Provision is also made to give an indication of the timing condition of contact points. The chief advantage of the dynamic timer is that testing is done under actual operation, and marginal conditions are made evident. Cases have arisen where sources of trouble have been detected by a few minutes' analysis with the timer after as much as two days' unsuccessful trouble shooting without benefit of the device.

Construction of the Dynamic Timer

The dynamic timer consists of a power pack assembly and a dynamic timer index. The dynamic timer index consists of a transparent index dial behind which two small neon bulbs revolve in synchronism with the machine index in the manner of a pointer on a conventional index dial. It is so timed that at any point of machine rotation the neon bulbs are behind the proper index timing on the transparent index dial.

The dynamic timer power pack assembly, IBM 454105, consists of a power supply and two vacuum tube amplifiers through which the neon bulbs are lighted. These bulbs glow for the duration of the impulse or contact connected to the proper test leads. Thus, the time an impulse or contact occurs is shown as a bright streak of light on the transparent index dial with the starting and ending times measured in degrees on the machine index.

Connections

Six terminal jacks appear on the top of the dynamic timer power pack. They are arranged in two rows of three jacks each. Each row of three jacks is associated with one of the indicator circuits. The center jack in each row is the COM (common) hub, color-coded *red* and is always used if the indicator circuit is used. The other two jacks are labeled CONT (contact) and COIL.

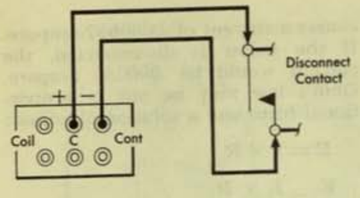


Figure 20. Contact Connection Used to Check Duration of Contact

Contact. Whenever a contact such as a relay point or circuit breaker is to be tested, the leads are connected so that the contact hub is shorted to the common hub whenever the machine contact closes (Figure 20). This causes a vacuum tube in the power pack to conduct and causes the neon lamp in the plate circuit to glow. *No external voltage is used on contact connection*—only the shorting action of the contact points. The neon lamp glows for the duration of time when the points are closed. *Machine power must be removed from the circuits being tested, and all condensers must be disconnected to prevent a false indication.*

Coil. Whenever the presence of a voltage impulse is to be tested, the coil connection is used. The timer is connected so that the test voltage is connected between the common and coil hubs with the positive lead connected to the (red) common jack. This positive injected voltage causes the tube to conduct, and the neon lamp glows during the time the impulse reaches the power pack. *If the injected voltage is of reverse polarity, the tube cannot conduct, and no indication will be given by the neon lamp* (Figure 21).

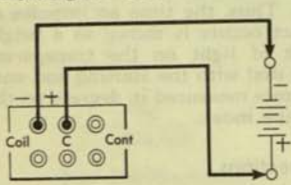


Figure 21. Coil Connection Used to Measure a Voltage or Voltage Drop

Applications

Figure 22 shows the connections made to measure the timing of any voltage impulses. In this diagram the circuit breaker impulses of a Type 402 are being checked. The common hub of the dynamic timer is connected to the circuit side of the circuit breakers, and the coil hub is connected to the fuse common. When the circuit breakers make, a voltage is injected into the timer, and the neon bulb glows. When properly timed, the circuit breakers cause indications that are aligned with the index markings.

The dynamic timer is being used to check a possible cause of machine failure on the Type 602A (Figure 23A). To add into the counters of this machine, the counters are started at 9 time and stopped with a card impulse. If a 9 is to be added, the start shot from the circuit breakers through C58 must reach the start magnet at the same time that the stop impulse from the circuit breakers reaches the stop magnet through a 9 hole in the card. If the brush which is reading the card has insufficient tension, or bounces, the stop impulse may be late or weak, resulting in the failure to add 9. In Figure 23B the inner neon lamp indicates the presence of a 9 time start impulse, but the outer lamp indicates a weak impulse to the stop magnet. Figure 23C shows the dynamic timer indication when the brush has been replaced.

In Figure 24 the dynamic timer is being used to check the lag in the pickup time of a relay coil. The impulse from a cam is connected to the relay pick coil, and the inner lamp of the dynamic timer is connected for coil indication. The outer lamp of the timer is connected for contact indication across one of the points of the relay. The delay from the time the relay is impulsed until its contacts close is thus shown in degrees on the timer index. The time in milliseconds can be computed, since the speed of the machine is known by the following formula:

$$\text{Pickup time in milliseconds} = \frac{\text{Degrees Lag} \times 1000}{\text{Mach. Cycles per Minute} \times 6}$$

Example: On the Type 602A a relay contact closes 5 degrees after the pick coil is energized.

$$\frac{5 \text{ Degrees} \times 1000}{200 \text{ Cycles per Min.} \times 6} = 4.17 \text{ Milliseconds}$$

Because the dynamic timer is extremely sensitive, the mere presence

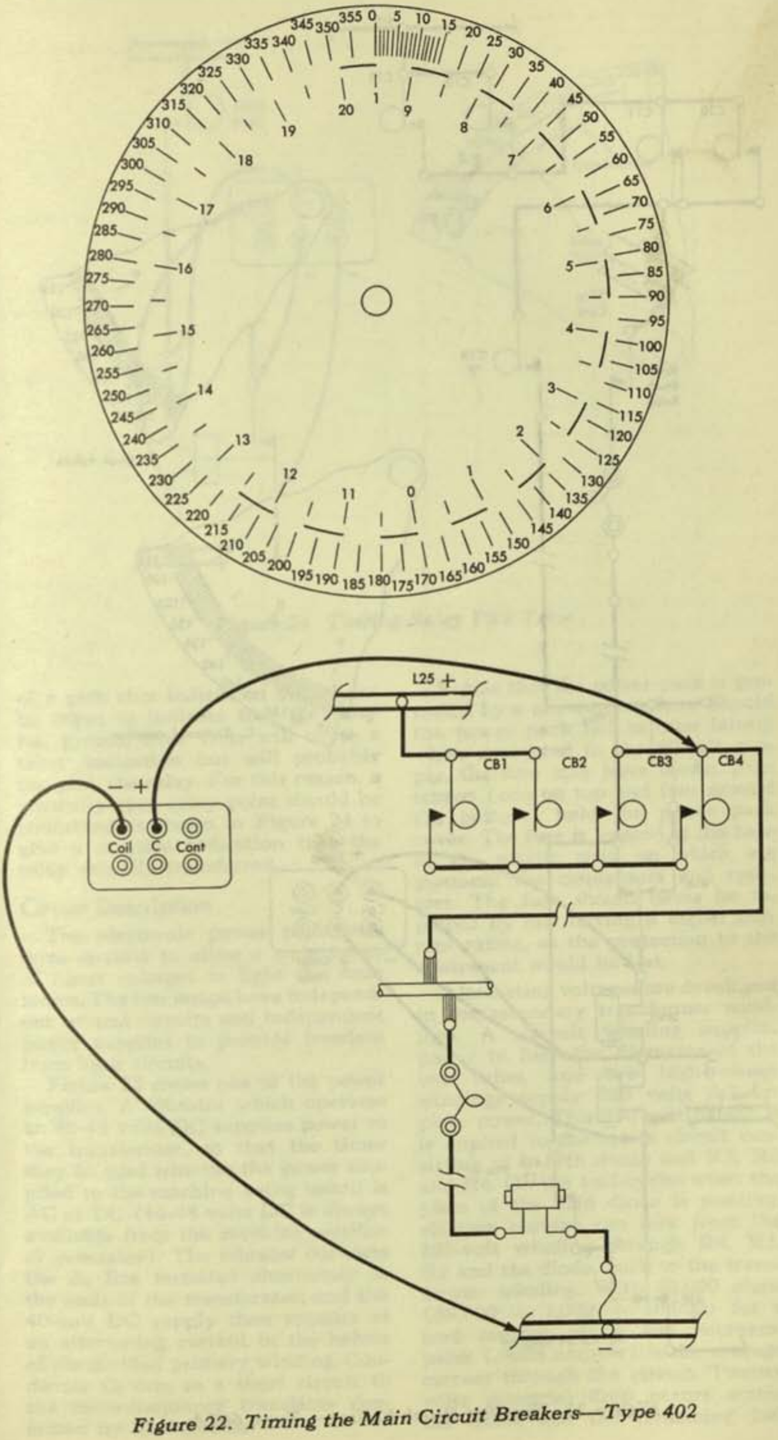


Figure 22. Timing the Main Circuit Breakers—Type 402

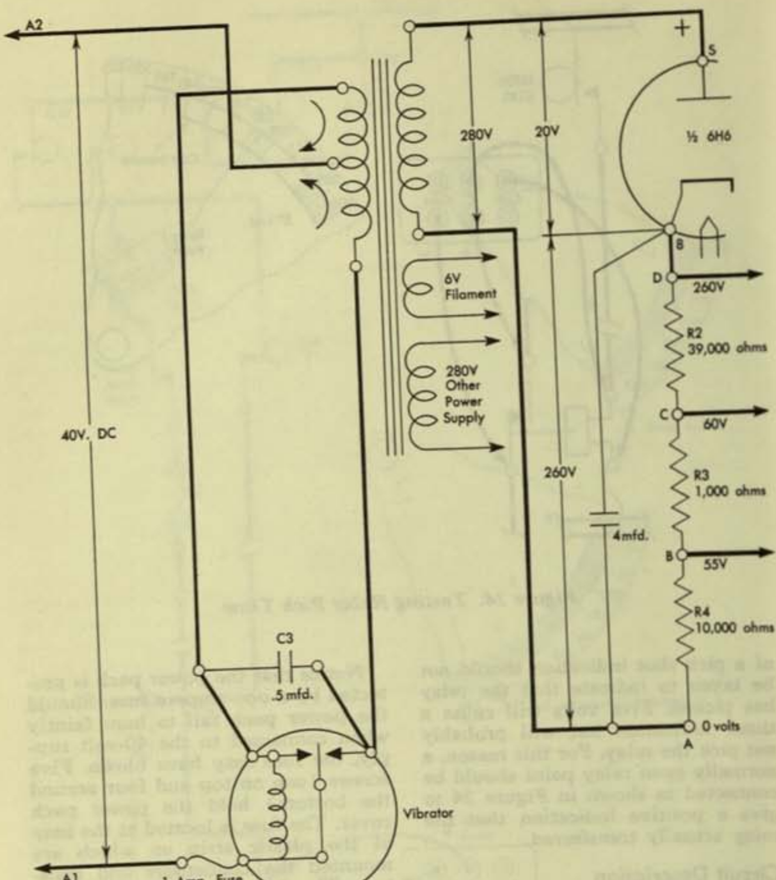


Figure 25. Dynamic Timer Power Supply

volts are developed across R2, R3 and R4. On the other half cycle, no current can flow because of the rectifying action of the diode, but the four-microfarad capacitor which has charged on the preceding half cycle now starts to discharge, maintaining current through R2, R3 and R4. Thus, a fairly constant DC voltage drop is maintained across R2, R3 and R4 through the whole AC cycle.

The values of R2, R3 and R4 are chosen so that the 260 volts are divided proportionately across them, providing zero reference volts at point *A*, approximately +55 volts at point *B*, +60 volts at point *C* and +260 volts at *D*. These voltages are available as long as the pack is connected to the machine, and for all practical purposes they do not change when the indicating circuits are used.

To simplify the discussion of the indicating circuits, the voltage drops across R2, R3 and R4 can be considered as 200, 5, and 55 volt batteries, respectively, connected in series. These are the voltages necessary to control the indicating circuit.

The Type 6SL7 vacuum tube consists of two triodes in a single evacuated envelope. One of these triodes is used to control each neon indicating bulb. Two facts about the behavior of a triode will make clear the functioning of this circuit.

1. When a tube conducts, there is a voltage drop across its load resistor

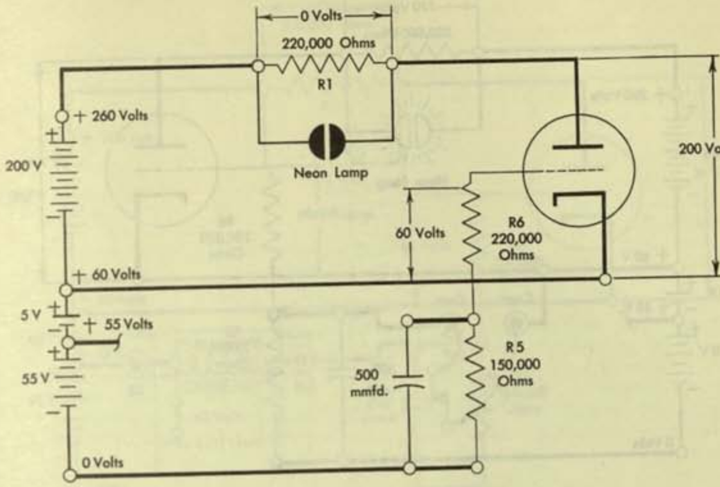


Figure 26. Basic Indicator Circuit

(R1 in Figure 30) determined by the current flowing through it in amperes.

2. A triode cannot conduct as long as the potential of the grid is sufficiently negative with respect to that of the cathode. If the grid potential is gradually made less negative with respect to the cathode, a point will be reached where the tube will start to conduct. This point is the "cut off" point. In this tube used in this circuit, it occurs when the grid is about three volts negative with respect to the cathode. In this discussion "negative" may mean "less positive"; that is, even if the grid were at +55 volts, the tube would not conduct if the cathode was at +60 volts, for even though the voltage values are plus, the grid is still five volts less positive than the cathode.

After the dynamic timer power pack is connected to an IBM machine, *time must be allowed for the tube cathodes to reach operating temperature* and for the Type 6H6 tube to rectify enough current to develop 260 volts across R2, R3 and R4. Figure 26 shows the conditions existing in one of the control circuits when the timer power pack has reached operating potential. The triode is connected in series with R1 across the 200-volt supply. The grid of the triode is connected through R5 and R6 to the zero potential end of the power supply, and since no grid current is flowing, the grid is 60 volts less positive (or more negative) than the cathode, which is connected to the 60-volt point of the supply. Under this condition, the triode cannot conduct. With no current flowing through the tube and R1, no voltage is developed across R1, and the neon lamp in parallel with R1 is dark. The entire 200-volt supply appears across the plate circuit of the triode.

In order to cause the neon lamp to glow, the triode must be made to conduct. Conduction is only possible when the grid voltage is positive or when not more than two volts negative with respect to the cathode. Two methods of causing conduction are provided:

1. For testing a *contact* with no external potential, the grid can be shorted to the cathode by the contact. With the grid at cathode potential, the tube will conduct.

2. In testing for the presence of an external voltage, the voltage can be injected on the grid in such a manner that the grid is driven positive, and the tube will conduct.

Figure 27 shows the connections for testing a contact. The clip leads are brought from the common and contact hubs to the terminals of the contact. Note that the contact must be disconnected from machine circuits. When the contact closes, a circuit is set up from the grid through R6, through the contact to the cathode. The 60-volt supply causes a

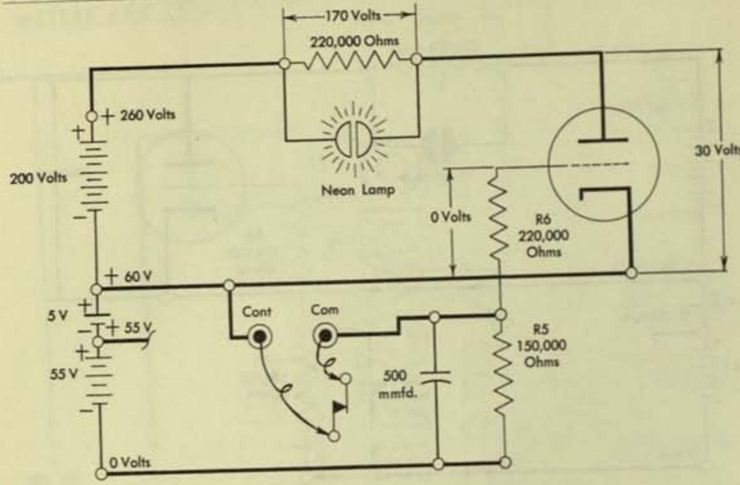


Figure 27. Contact Indication Circuit

current through R5, but this is limited to 0.4 milliampere. With the grid at cathode potential, the tube will conduct, and the 200-volt supply will now divide as indicated. Thirty volts are developed across the plate resistance of the tube, and 170 volts are developed across R1 and the neon lamp. The lamp glows, causing a streak of light to appear on the index for the duration of the time the contact is closed. As soon as the contact opens, the negative 60-volt potential returns to the grid, cutting off the triode.

For testing any external voltage, the connection is made as in Figure 28. The elements inside the broken line represent the 40-volt power supply and a magnet coil on an IBM machine. In Figure 28 the magnet is connected between coil and common hubs of the dynamic timer power pack, but the magnet is not energized, and, therefore, no voltage is developed across the magnet. The +55 volt potential is, therefore, applied through the magnet coil to the grid of the triode, and since the cathode is at a potential of +60 volts,

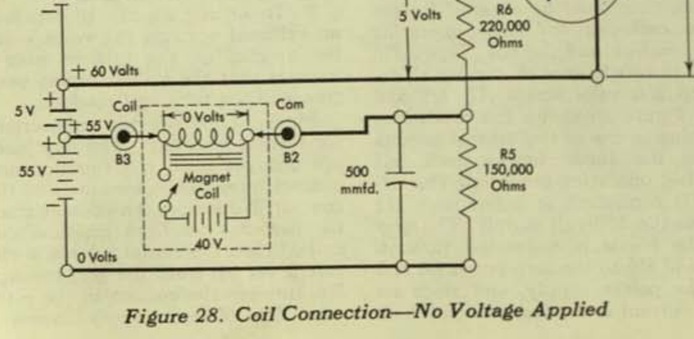


Figure 28. Coil Connection—No Voltage Applied

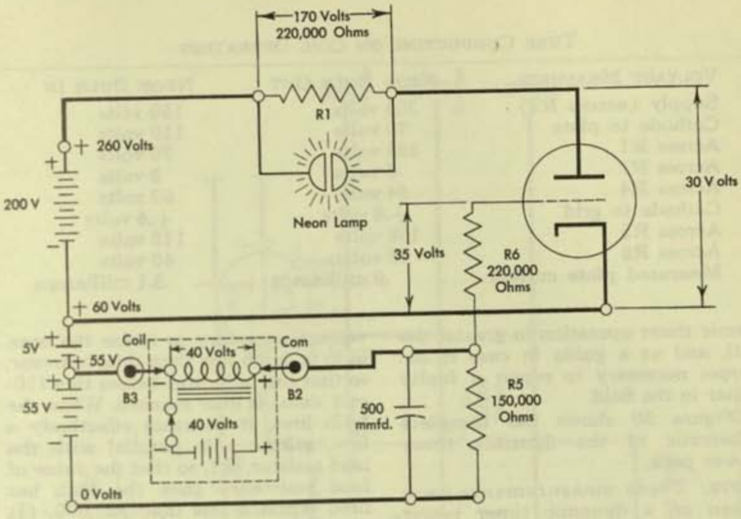


Figure 29. Coil Connection With Voltage Applied

the grid is five volts negative with respect to the cathode, and the tube cannot conduct. Therefore, the neon lamp is dark. In Figure 29 the magnet coil is energized by the machine power supply and 40 volts are developed across the magnet with the polarity shown. The 40-volt potential is injected in the triode grid circuit, resulting in a net voltage of +35 volts on the grid. The triode will now conduct, and the neon lamp will glow. With this connection, the dynamic timer index lamp glows only when voltage is applied across the magnet coil.

Notice the effect of reversing the elements inside the broken line. If the potential applied across the magnet coil were reversed, the polarity of the voltage developed across the magnet would be reversed, and the grid of the triode would be driven negative by a —45 (40 + 5) volt potential. The triode would never conduct under these conditions. It is important that the leads be properly connected when using the coil connection in order that the injected voltage can drive the tube into conduction, but no damage will result if the leads are reversed. The tube will start to conduct with a minus two-volt potential on the grid, and, therefore, the voltage injected into the circuit can be as little as three volts. However, as the characteristics of the triodes vary, not all triodes will conduct sufficiently to cause the neon bulb to glow, when only three volts are injected. All should cause an indication when five volts are injected.

Voltage and Current Data

The following chart of voltage and current values is furnished for those who may wish to analyze the dy-

VOLTAGE AND CURRENT CHART
TUBE CONDUCTING ON CONTACT OPERATION

VOLTAGE MEASURED	NEON BULB OUT	NEON BULB IN
Supply (across R2)	205 volts	190 volts
Cathode to plate	55 volts	125 volts
Across R1	150 volts	65 volts
Across R3	5 volts	6 volts
Across R4	55 volts	65 volts
Cathode to grid	—.4 volts	—.3 volts
Across R5	60 volts	71 volts
Across R6	—.4 volts	—.3 volts
Measured plate current	.8 milliamps	2.2 milliamps

TUBE CONDUCTING ON COIL OPERATION

VOLTAGE MEASURED	NEON BULB OUT	NEON BULB IN
Supply (across R2)	205 volts	180 volts
Cathode to plate	20 volts	110 volts
Across R1	185 volts	70 volts
Across R3	6 volts	8 volts
Across R4	54 volts	67 volts
Cathode to grid	+.8 volts	+.6 volts
Across R5	108 volts	115 volts
Across R6	48 volts	40 volts
Measured plate current	.9 milliamps	3.1 milliamps

namic timer operation in greater detail, and as a guide in case it becomes necessary to repair a faulty timer in the field.

Figure 30 shows the complete schematic of the dynamic timer power pack.

NOTE: These measurements were taken on a dynamic timer power pack connected to a Type 402 machine. All measurements were made with a Simpson 20,000 ohms per volt meter. The input to the power pack vibrator was 48 volts DC. The pulsating DC output of the vibrator measured approximately 100 volts with the meter set to measure AC. The AC output across the secondary of the transformer was 280 volts.

The following comments will help in interpreting the values given on the chart. A study of the chart shows that the voltage supplied to the 6SL7 plate circuit (voltage across R2) varies under different operating conditions. The value of this voltage depends partly on how heavily the 6SL7 is conducting. Tube current is returned to the cathode through R4 and R3, and the voltage drop across them depends partly on this cathode return current, as well as the bleeder current drawn by the 6H6 rectifier. Since the total available voltage across R4, R3 and R2 is 260, any increase in that across R4 and R3 will result in a similar decrease in that across R2. Thus, any change in the circuit which causes more or less current to be drawn from the cathode will be accompanied by a change in the supply voltage.

In the description in the preceding section on how the voltage necessary was developed across R1 to ionize the neon bulb, no consideration was given to the effect of the neon bulb on the circuit when it suddenly ionizes and conducts. Actually, the voltage across R1 only *tends* to rise to the 170-volt value. The minimum voltage necessary to ionize the neon bulb is much less than this, however, so that the bulb fires before this 170-volt value is ever reached. When the bulb fires, it becomes effectively a low resistance in parallel with the load resistor, R1, so that the value of load resistance once the bulb has fired is much less than 220,000. (It is actually of the order of 25,000 ohms). This sudden change in load resistance causes an increase in plate current from .8 milliamps to 2.2 milliamps with an accompanying decrease in supply voltage from 205 to 190 when operating on contact, and an even greater decrease on coil, since here the grid is slightly positive, and the tube is conducting more heavily.

In explaining how the voltage drop across the load resistor is produced, it was assumed that the tube had a resistance of 40,000 ohms, a value which was approximated from the tube curves.

In all of the above discussion, it should be remembered that the current, voltage and resistance values used represent approximate values. They were obtained by actual measurement from a dynamic timer power pack, but because of allowable variations in tubes, resistors and other circuit components *cannot* be regarded as exact values which should exist in all power packs. They should be regarded as representative of the approximate order of magnitude of the values which should exist in any power pack.

NOTE: On machines with permanently-mounted dynamic timers, the timer is fastened to a continuously-running shaft, and the timer index rotates once for each machine cycle. The carbon brushes that make contact with the rotating slip rings are subject to wear, and the carbon dust worn from the brushes may accumulate between the slip rings. Because

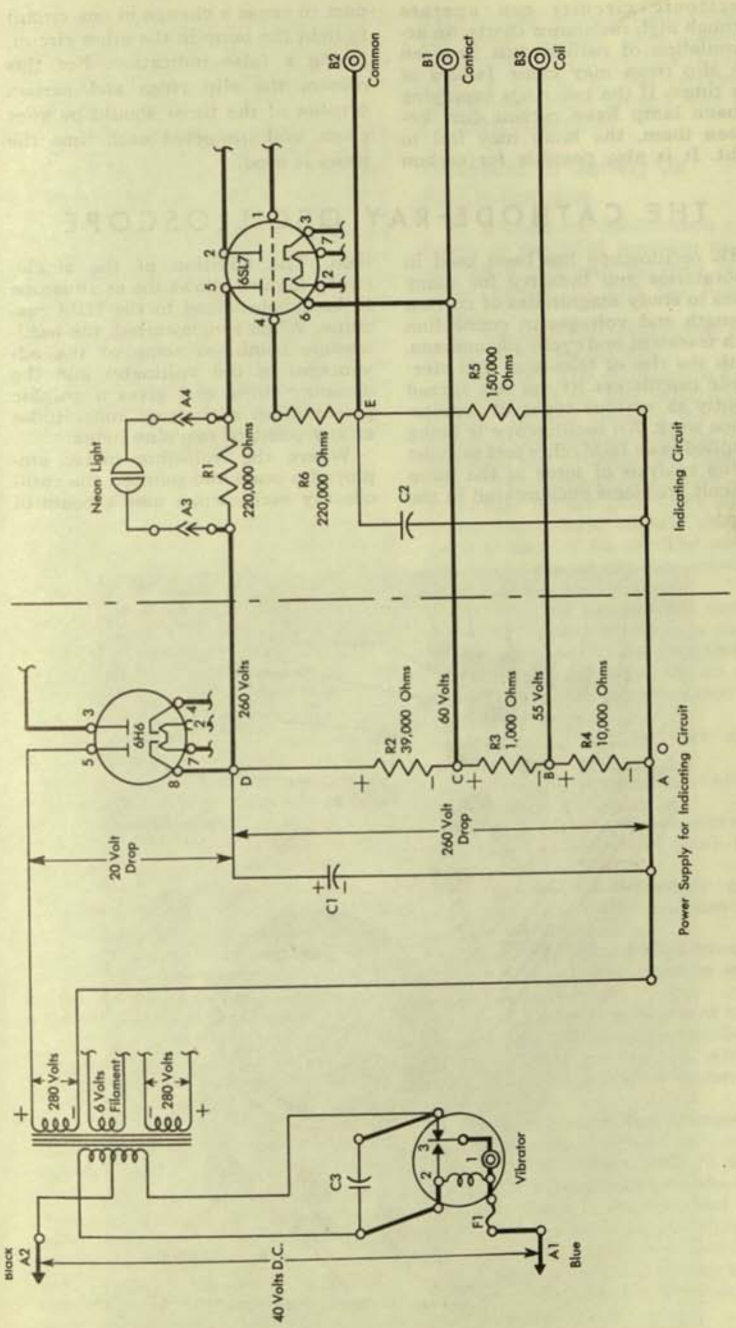


Figure 30. Dynamic Timer Power Supply Schematic Diagram

electronic circuits can operate through high resistance shorts, an accumulation of carbon dust between the slip rings may cause failure of the timer. If the two rings supplying a neon lamp have carbon dust between them, the lamp may fail to light. It is also possible for carbon dust to cause a change in one circuit to light the lamp in the other circuit, giving a false indication. For this reason, the slip rings and carbon brushes of the timer should be kept clean, and inspected each time the timer is used.

THE CATHODE-RAY OSCILLOSCOPE

THE oscilloscope has been used in laboratories and industry for many years to study magnitudes of current strength and voltages in connection with transient and cyclic phenomena. With the rise of television and electronic calculators its use has spread rapidly to various types of maintenance work. An oscilloscope is being supplied as an IBM office tool to assist in the analysis of some of the more difficult problems encountered in the field. The addition of the single-sweep feature allows the oscilloscope to be synchronized to the IBM machine. When synchronized, the oscilloscope combines some of the advantages of the voltmeter and the dynamic timer and gives a graphic presentation of voltage magnitudes at any point of machine index.

Where the volt-ohm meter employed a scale and pointer, the cathode-ray oscilloscope uses a beam of

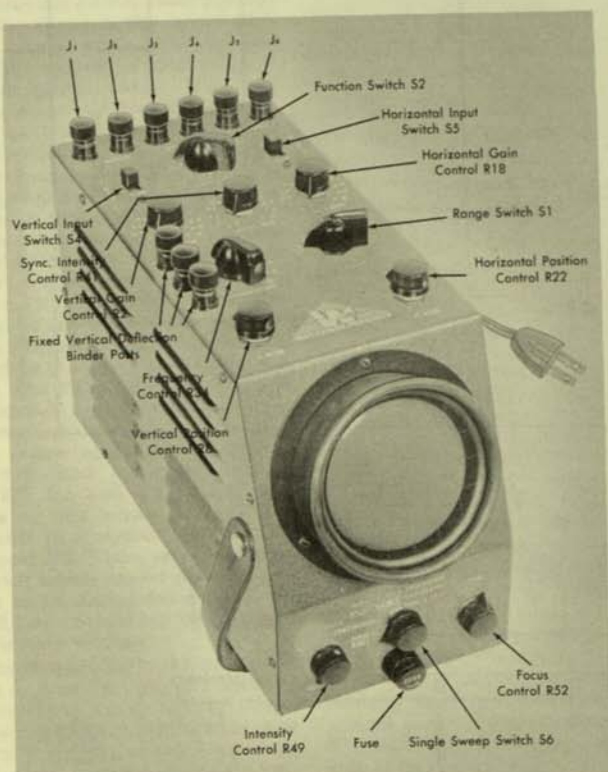


Figure 31. Waterman Oscilloscope

electrons. This beam originates at a cathode at the rear of the instrument and is focused to form a point of light where the beam strikes a fluorescent screen.

The electron beam passes between two pairs of deflection plates, and a voltage impressed on the deflection plates moves the electron beam from its position in the center of the luminescent screen. A voltage connected to the horizontal deflection plates will move the spot of light horizontally, while a voltage impressed on the vertical plates deflects it vertically. The volt-ohm meter has mechanical inertia and cannot follow instantaneous changes of voltage. The electron beam has virtually no inertia and can follow extremely rapid variations of voltage.

Applications

The cathode-ray oscilloscope is intended as an aid in the solution of the more difficult service problems where a marginal condition causes an occasional machine failure. It will be of greatest service on machines utilizing vacuum tubes, where a small, stray voltage reaches the grid of a tube, causing it to conduct. The chief advantage of the oscilloscope is its ability to show instantaneous values of current and voltage; a dynamic timer cannot follow the rapid variations which the oscilloscope can depict. The voltmeter and dynamic timer will generally serve on machines without vacuum tubes, but on occasions the oscilloscope may be needed to detect such conditions as:

1. Bouncing reading brushes
2. Bouncing cams
3. Bouncing relay points
4. Excessive surge voltages
5. Weak electronic tubes.

The usual procedure in using the oscilloscope is to connect the circuit to the IBM machine, first making certain that the power is off. Then turn the power on and adjust the oscilloscope for the best trace obtainable. The leads used to connect the oscilloscope to the machine will pick up stray electric fields, but the effect of this pickup can be minimized by connecting the binder post J3 to machine ground. At times it may be desirable to have other voltages connected to post J3, and in that case the oscilloscope can be connected to machine ground through a .5 microfarad capacitance, IBM part 100742. This capacitor by-passes the stray pickup without short-circuiting the power supply. Care should be taken when this procedure is used to avoid a shock, as the oscilloscope case and machine ground may be at different potentials.

Procedure for Setting Up the Oscilloscope

1. Ground the oscilloscope to the frame of the IBM machine by connecting a clip lead between oscilloscope binder J3 and the machine frame.

2. Connect the oscilloscope to the 110-volt AC power line.

CAUTION: The oscilloscope cannot be connected to any other voltage supply. Do not connect the oscilloscope to the power receptacle on any machine but 110-volt AC machines.

3. The oscilloscope ON-OFF switch is located on the INTENSITY control. Turn this control slightly clockwise until a click is heard. The electron tubes require about one minute to reach operating conditions.

4. Turn the HORIZONTAL and VERTICAL POSITION controls to a position midway in their range of rotation.

5. Turn the RANGE switch to its most counterclockwise position (3-15 cycles per second).

6. Rotate the SYNC/INT control counterclockwise to zero.

7. Set the HORIZONTAL GAIN control to about *8*.

8. Turn the SINGLE-SWEEP switch (centered under the screen) to the CONTINUOUS position.

9. Turn the INTENSITY control clockwise until the electron beam appears on the screen.

10. Adjust the FOCUS control to make the electron beam as sharply defined as possible.

11. Connect the source of voltage to be observed between oscilloscope binder posts J2 and J3, with the more positive potential connected to J2.

12. Attach the single-sweep contactor to the machine and connect the leads to binder posts J3 and J5. If a digit selector is available, a digit contact may be used instead of the contactor. The contacts should be adjusted to break just before the desired signal occurs. Turn the SINGLE-SWEEP switch to the SINGLE-SWEEP position.

13. Operate the machine and adjust the vertical gain control to cause the signal voltage to appear on the screen at a convenient amplitude.

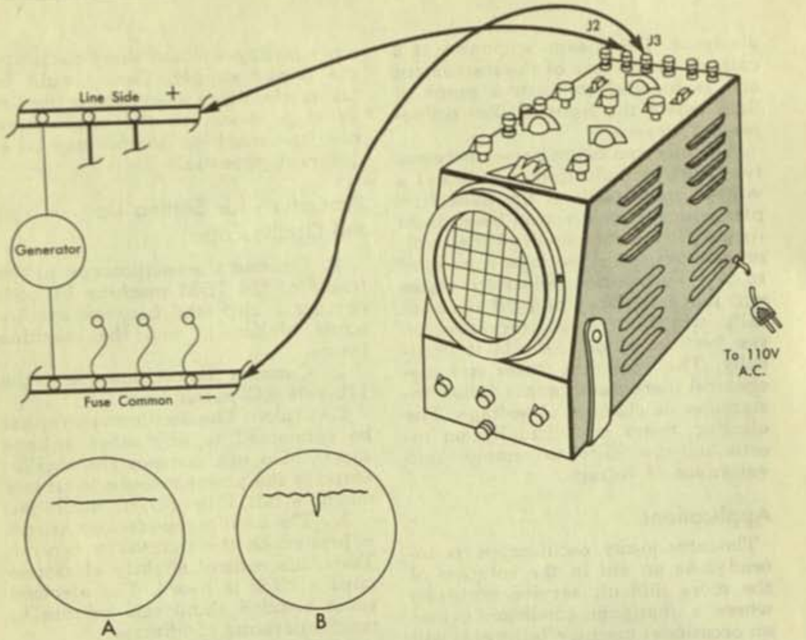


Figure 32. Checking Power Supply Ripple

The VERTICAL INPUT switch should be set to LOW.

14. The oscilloscope trace may be moved vertically by adjusting the VERTICAL POSITION control. Adjusting the HORIZONTAL POSITION control moves the trace laterally. The trace may be expanded or contracted by adjusting the HORIZONTAL GAIN CONTROL.

15. Where contact operation is to be observed and no voltage is present, the contact is arranged to short-circuit any two adjacent binder posts of the three fixed vertical deflection posts to the left of the FREQUENCY control.

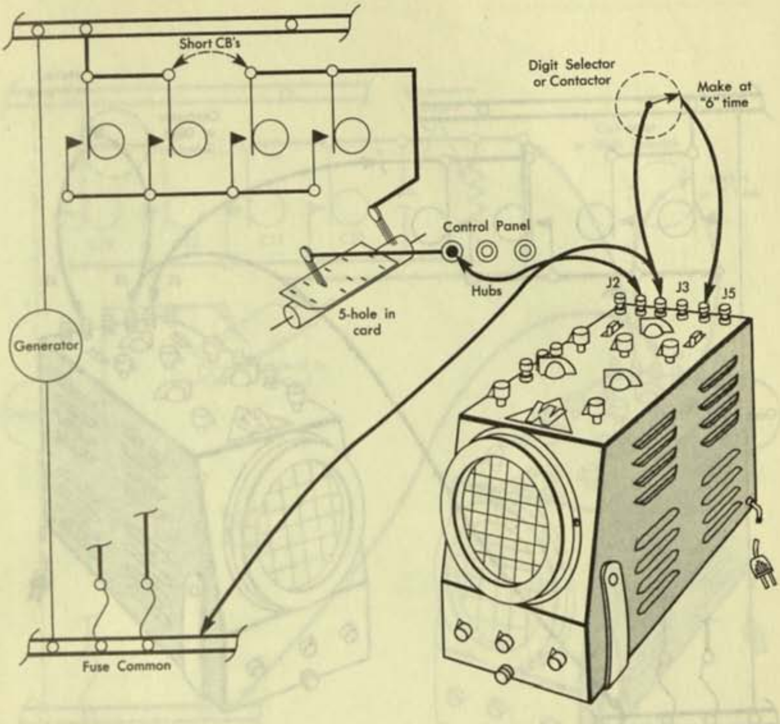
16. The FREQUENCY control is a fine adjustment on the RANGE switch. The RANGE switch setting indicates the range of sweep frequencies for which the FREQUENCY control can be adjusted.

17. On the Type 604 and the Card-Programmed Calculator a synchronizing voltage pulse is connected between binder posts J3 and J4. The SYNCHRONIZING INTENSITY control is then turned clockwise until the sweep synchronizes with the Type 604. The very minimum sync. voltage to lock the sweep should be used, as otherwise the linear time base may be distorted.

Voltage Fluctuations in Machine Power Supplies

Figure 32 shows the connections made in order to observe the fluctuations in the DC power supply. With the range switch set to position 2 (15-75 cps) and the sync. switch set to line, the frequency and sync. intensity controls are adjusted until any ripples or fluctuations appear to stand still. A good power supply should deflect the trace evenly as in Figure 32A. Sometimes a bouncing generator brush or an excessive load applied suddenly will cause a momentary drop in voltage as in Figure 32B. The excessive load may be due to a mechanical shock, such as a clutch latching, applying a sudden load to the motor, and, hence, the generator. It is also possible that building machinery such as elevators or power presses may cause sudden drops in line voltage.

On machines employing electronic tubes, the sudden drop in voltage may allow tubes to conduct, giving



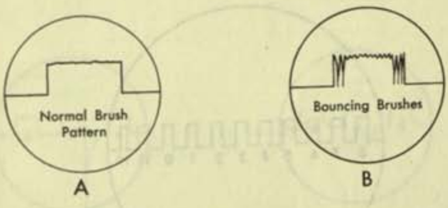


Figure 33. Checking for Bouncing Reading Brushes

a false reading on the Type 77, or causing an extra punch on the mark sensing reproducer. This test may help locate intermittent failures caused by surge voltages from the power supply.

Checking the Condition of Reading Brushes

The condition of the reading brushes on any machine may be checked by making the connections shown in Figure 33. The digit selector or contactor is connected between oscilloscope binder posts J3 and J5 in order to start the trace just before 5 time. At 5 time the brush makes through the hole in the card and causes the deflection of the beam for the duration of the brush. Figure 33A shows the normal oscilloscope pattern, while Figure 33B shows the pattern when the brush is bouncing due to insufficient tension.

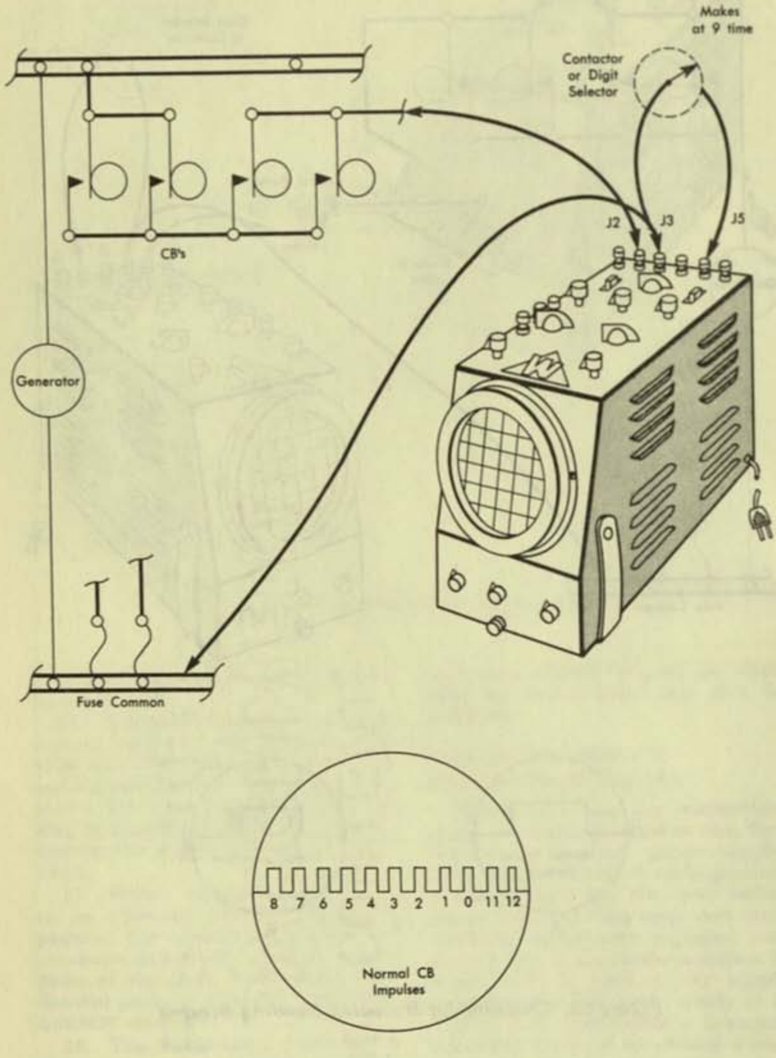


Figure 34. Circuit Breaker Impulses

Circuit Breaker Impulses

The pattern of CB impulses may be checked by connecting the oscilloscope as in Figure 34. Notice that the impulses seem crowded at the right-hand end of the trace because of the non-linearity of the sweep when used on single-sweep feature. To avoid this distortion, the impulse that is to be observed should be brought to the left end of the trace. This may be accomplished by adjusting the contactor or moving the digit selector to break just before the desired impulse.

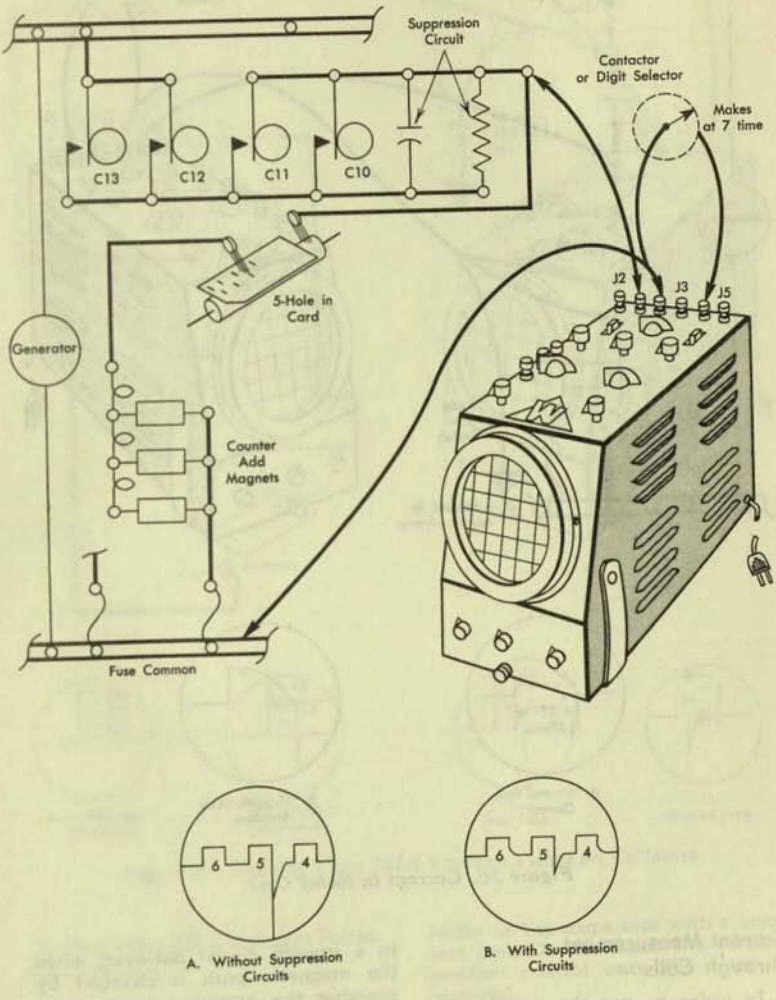


Figure 35. Counter Surge Voltages With and Without Arc Suppression

The effect of counter electromotive force caused by the collapse of the magnetic field around a coil is shown in Figure 35. The circuit breaker voltage impulse is disturbed by a large negative spike caused when the energizing voltage is removed from the coil. Figure 35B shows the same impulse after the addition of an arc-suppression network consisting of a condenser and resistor in parallel with the circuit breakers. Notice the change in the CB impulse wave-shape. This is due to the slow discharging of the condenser.

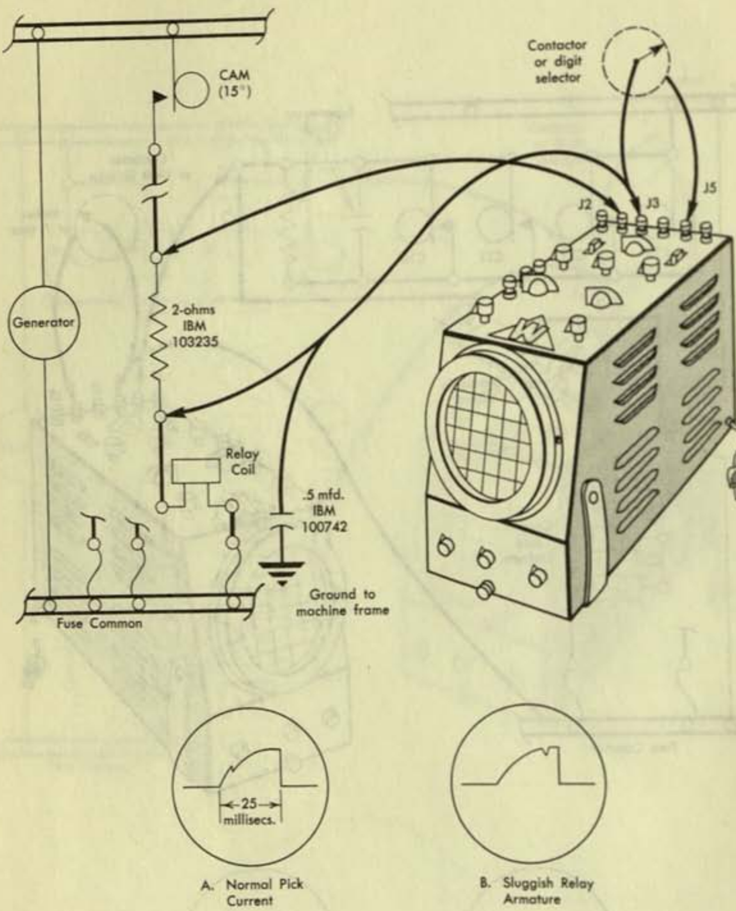


Figure 36. Current in Relay Coil

Current Measurement Through Coils

In order to use the oscilloscope to portray current through a circuit element, a voltage that is always proportional to the current must be supplied to the vertical amplifier. This voltage is obtained across a two-ohm resistor, IBM part 103235, connected in series with the circuit element. Figure 36 shows the pattern of the current caused by a 25-millisecond pick impulse to a relay coil. The notch in the curve is caused by the sealing of the armature. When voltage is applied to a coil, the current and magnetism tend to increase in a smooth curve; however, when the magnetic path is changed by pressing the armature against the core, a momentary change in current occurs. The change in the magnetic circuit is translated into a change in the electric circuit and causes a notch to appear in the curve. Figure 36A shows the normal pattern of current in a 12-position wire contact relay pick coil, while Figure 36B shows the pattern when the same type of relay has too much tension on the wire contacts. It requires 20 milliseconds to seal the armature and this condition might cause an occasional failure.

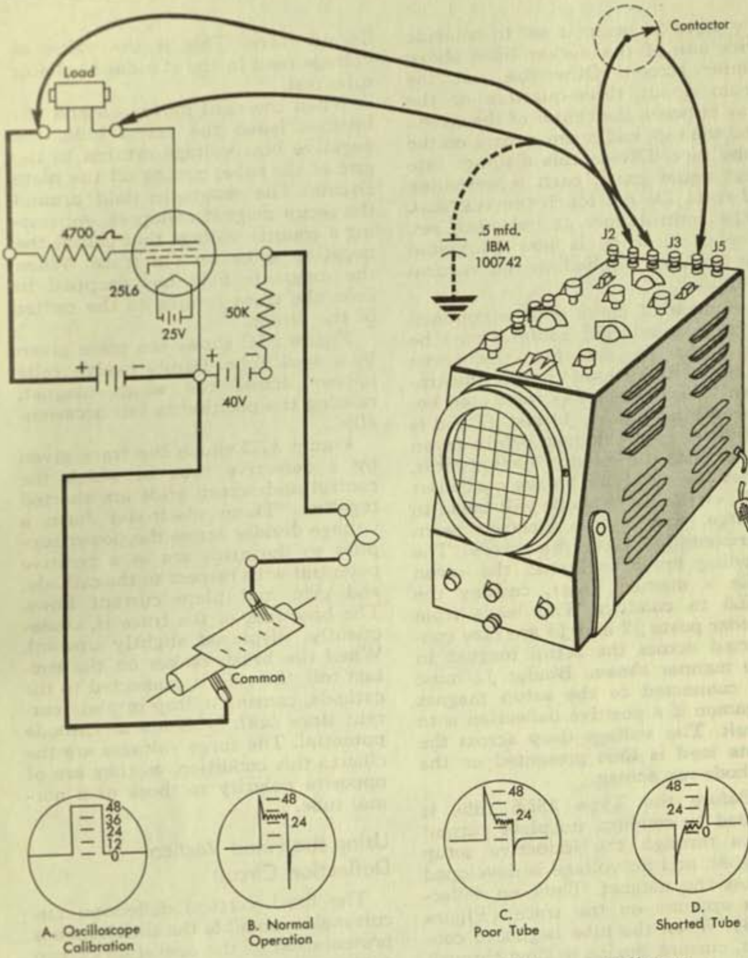


Figure 37. Testing Type 25L6 Vacuum Tubes on Collators

Testing Type 25L6 Vacuum Tubes on Collators

Figure 37 shows a setup for making a *dynamic* test on 25L6 vacuum tubes used on collators. For this application, the cathode-ray screen must be *calibrated* in voltage. To calibrate the screen, connect a control panel wire between binder posts J2 and J3 to assure that no induced voltage reaches the vertical amplifier. With the VERTICAL POSITION control, move the electron beam to the center of the screen. If the ruled plastic screen is available, the center line is used as a reference. It is sometimes preferable to draw a line directly on the scope face with a fountain pen. Do not touch the vertical position control once the trace is centered.

The jumper between binder posts J2 and J3 is now removed, and clip leads are connected to these binder posts. The output of the 48-volt supply is connected between posts J2 and J3, with post J2 connected to the positive side of the power supply. This will cause a deflection of the electron beam to a point above the center of the screen. Using the VERTICAL GAIN control, move the electron beam to a convenient position to represent 48 volts on the screen. If the ruled plastic screen is used, the electron beam is set to coincide with one of the darker lines above center screen. Otherwise, set the beam about three-quarters of the way between the center of the screen and the top, and make a mark on the tube face. Divide this distance into four equal parts, each representing 12 volts. Do not touch the VERTICAL GAIN control once it has been set. The oscilloscope is now calibrated for voltages applied to the vertical amplifier.

A deck of cards with a common digit in a selected column must be used. As an example, the seven punch will be used in this illustration. The contactor is connected between binder posts J3 and J5 and is adjusted to break just before seven time. With the collator feeding cards, when the contactor breaks, condenser C12 of the oscilloscope will begin to charge, moving the electron beam horizontally across the screen. The reading brush will read the seven hole a moment later, causing the 25L6 to conduct. The leads from binder posts J2 and J3 are now connected across the setup magnet in the manner shown. Binder J2 must be connected to the setup magnet common if a positive deflection is to result. The voltage drop across the plate load is thus presented on the cathode-ray screen.

Before the Type 25L6 tube is caused to conduct, no plate current flows through the inductive setup magnet, and no voltage is developed across the magnet. Thus, no deflection appears on the trace (Figure 37B). When the tube begins to conduct, current begins to flow through the magnet coil. Because the rate of change of current during this time is very high, the inductive reactance of the magnet coil is very high; consequently, the voltage developed across the combined reactance and resistance of the coil is very high. This voltage appears as the high positive spike on the oscilloscope trace. As the value of the current through the coil increases, the *rate of change* of this current decreases and the inductive reactance decreases. Thus, the voltage developed across the coil decreases to a final value determined by the DC resistance of the coil. When a good 25L6 is tested, the final value of voltage across the coil should be greater than 16 volts. Figure 37B shows a value of about 25 volts on the level portion of the deflected trace. This is the value of voltage read in the standard collator tube test.

When the card moves on and the brushes leave the seven hole, the negative bias voltage returns to the grid of the tube, cutting off the plate circuit. The magnetic field around the setup magnet collapses, generating a counter voltage that causes the negative spike on the trace. When the magnetic field has dropped to zero, the trace returns to the center of the screen.

Figure 37C shows the trace given by a weak tube. Barely twelve volts appear across the setup magnet, causing the position to fail occasionally.

Figure 37D shows the trace given by a defective tube in which the control and screen grids are shorted together. These electrodes form a voltage divider across the power supplies so the grids are at a positive potential with respect to the cathode, and grid and plate current flows. The base line of the trace is, consequently, displaced slightly upward. When the brush makes on the contact roll, the grid is connected to the cathode, causing a drop in plate current since *both* grids are at cathode potential. The surge voltages are the clue to this condition, as they are of opposite polarity to those of a normal tube.

Using the Fixed Vertical Deflection Circuit

The fixed vertical deflection circuit makes possible the simultaneous presentation of the operation of two contacts. In Figure 38 the circuit is being used to show brush and CB timing on a Type 405. The machine wires must be removed from CB's 1-4 and from the common brush on the contact roll. A digit selector is used to start the oscilloscope trace by connecting binder posts J3 and J5 momentarily at 6 time. A deck of cards with 5 holes in column 1 and column 80 must be prepared.

When the machine is operated, the digit selector will close the circuit between oscilloscope binder posts J3 and J5 at 6 time. Nine degrees later this circuit will be opened, and the sweep capacitor in the oscilloscope will begin to charge, moving the electron beam from left to right across the screen. Seven and one-half degrees later the first brush strands should make through the 5 hole in

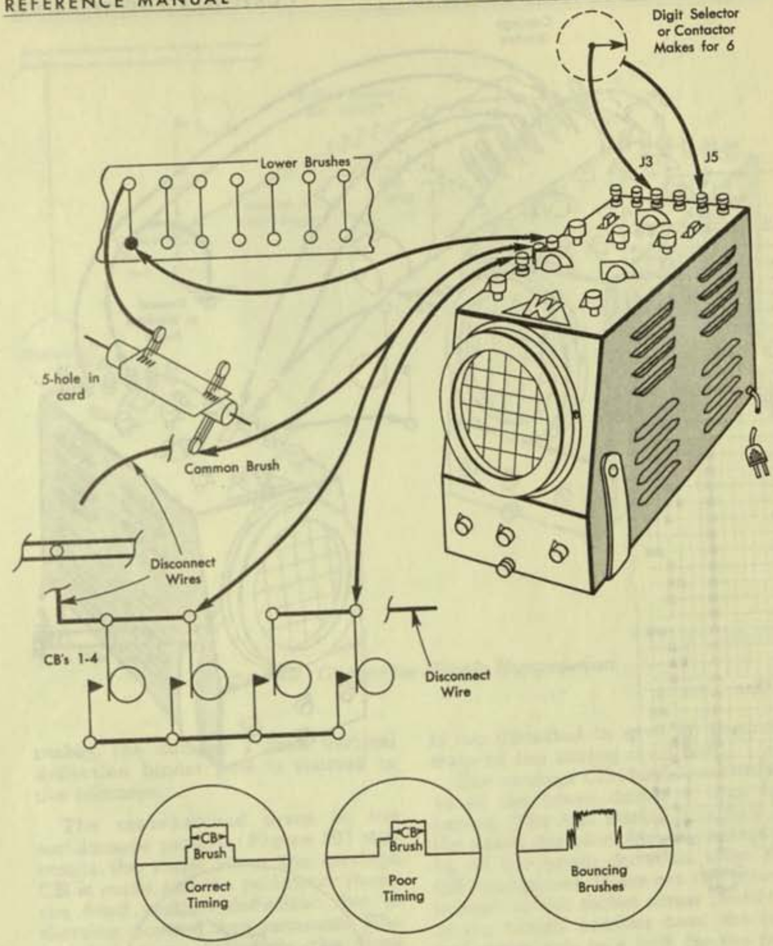


Figure 38. Brush and CB Timing

the card. The brush contact shorts binder post 1 to common and causes the oscilloscope trace to be raised about one-half inch. A moment later the circuit breakers will close, shorting binder post 2 to common and raising the trace another one-half inch. Nine degrees later the CB's will open, followed by the brush pulling out of the hole, which returns the trace to the base line. Check brushes at both ends of the card to make certain that the cards are feeding evenly.

Another interesting application using fixed vertical deflection and the single-sweep feature is shown in Figure 39. Here the oscilloscope is being used to check the condition of the carriage brushes and the carriage circuit breaker on the Type 923 Carriage. A tape is punched as shown to serve as the control unit. The wires must be removed from the carriage CB and brushes 1 through 4. Binder posts J3 and J5 are connected to carriage brushes 1 and 2, and J3 is connected to the frame of the Type 923 Carriage. This connection brings the chassis of the oscilloscope to the machine ground potential and reduces stray pickup. The fixed vertical deflection binder posts are connected with the common binder post connected to both the carriage CB and brush 3; and the other sides of these units are connected to binder posts J1 and J2.

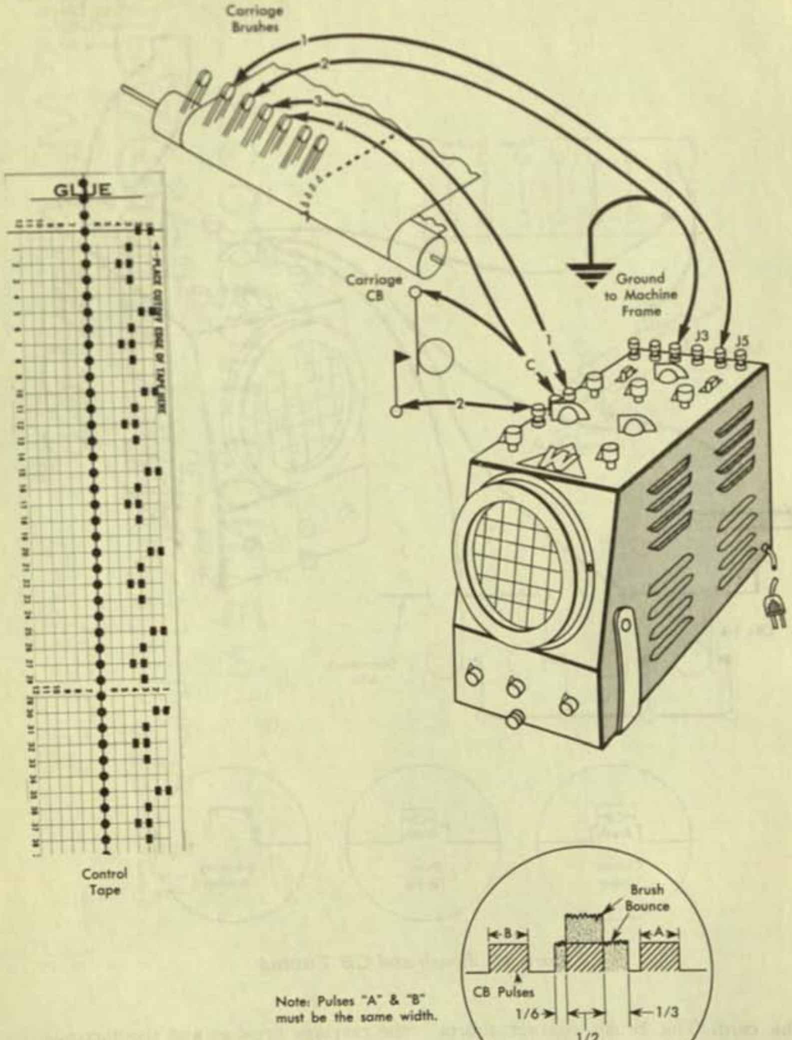


Figure 39. Checking Brush and CB—Type 923 Carriage

When the restoring button on the carriage is depressed, the carriage commutator will spin and carry the tape past the brushes. In the first line of the tape, brushes 1 and 2 will be connected through the tape and commutator, shorting J3 to J5 and discharging the sweep condenser. When the tape moves on, this connection is broken, and the sweep starts across the face of the tube. Channel 3 has three successive holes cut in it, and brush 3 will make immediately, staying made for three lines because the brushes overlap the separations between the holes. Channel 4 has one hole on the line with the middle hole in channel 3, so the pattern of brush 4 will be used as the test. When brush 4 makes, a circuit is established through brushes 3 and 4 to short the number 2 fixed vertical deflection binder post to the common. Each time the carriage CB

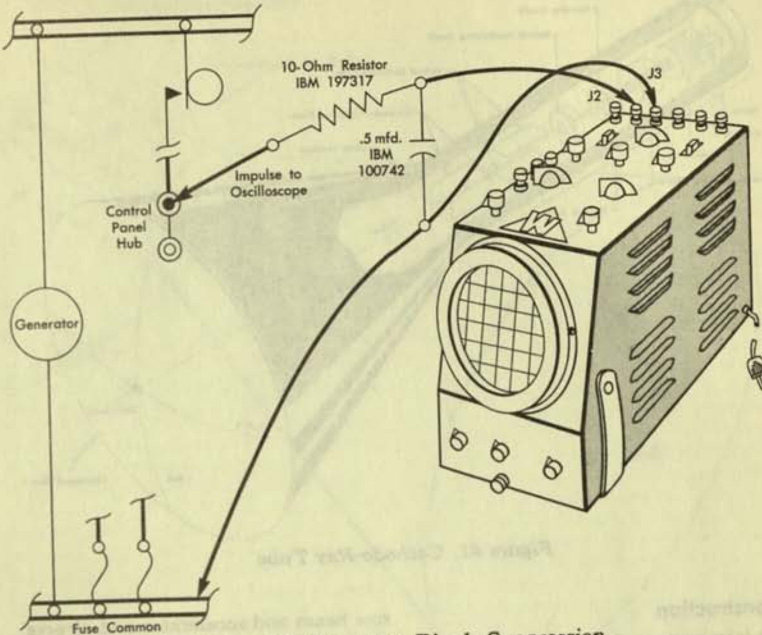


Figure 40. Generator Ripple Suppression

makes, the number 1 fixed vertical deflection binder post is shorted to the common.

The cross-hatched areas in the oscilloscope pattern (Figure 39) represent the times when the carriage CB is made, and the perimeter shows the fixed vertical deflection due to shorting posts 1 and common. The stippled area represents the time brush 4 makes contact with the commutator and is easily identified by a raggedness of trace due to brush bounce. The highest deflection occurs when both the brush and the carriage CB are made.

The range switch should be set to the lowest range, and the frequency switch set between 4 and 7. The horizontal gain control should be set to its maximum position. The platen clutch should be disengaged, and the high-speed interposer should be attracted manually before the restore button is depressed.

CAUTION: Do not allow the carriage to operate for too great a length of time under this condition, as the interposer magnets will be overheated. Make certain that the trace is linear: pulse A must be very nearly the same length as pulse B, or the sweep is too distorted to give an accurate trace of the timing condition.

The carriage CB should make after 1/6 of the brush duration time has passed. The CB duration is half of the brush duration, leaving a time of 1/3 of the brush duration after the CB has opened. There are two screws in each of the socket screw positions of the circuit breaker cam; the second screw acts as a lock for the first screw. Loosen the cam and adjust timing, if necessary.

Generator Ripple

Prior to May, 1950, all major IBM machines used motor-generator sets to supply DC power. Unfortunately, the generators supply DC voltage that has considerable ripple voltage superimposed on it, and the ripple voltage may interfere with the oscilloscope trace. A filter to decrease the effect of this ripple may be connected as shown in Figure 40. This filter will improve the oscilloscope trace by causing the ripple voltage to be developed in the resistance, while the signal voltage is developed across the capacitor and will, therefore, appear on the screen. However, the charging and discharging time of the capacitor will distort the oscilloscope trace slightly.

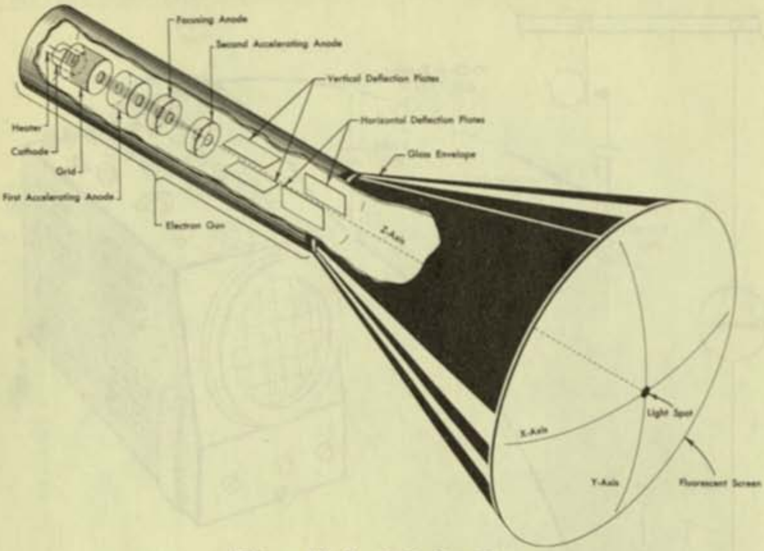


Figure 41. Cathode-Ray Tube

Construction

It is important that the construction of the oscilloscope be understood if it is to be applied effectively to the problems encountered. The oscilloscope consists of a cathode-ray tube, a power supply to develop voltages necessary for operation, two amplifiers, and a time base oscillator.

The heart of the oscilloscope is the cathode-ray tube, as it is upon the face of this tube that the pattern of the voltages under test will be observed. The cathode-ray tube is a long, evacuated, glass envelope, or tube, shaped as shown in Figure 41. At the small end of this tube is the *cathode,* which is a small button of material that emits electrons freely when heated by the heater filament. A system of positively charged electrodes forms the electrons into a narrow beam and accelerates and directs them to the screen of fluorescent material that covers the large end of the tube. Where the beam of electrons strikes the screen, a spot of visible light is produced. Focusing is accomplished by causing the electron beam to pass through a series of electrostatic fields of different intensity. An electron beam entering a field of rising potential is accelerated and concentrated in a manner comparable to the action of a converging lens on light rays. An electron beam entering a field of lowered potential tends to spread out. When the electrostatic fields are properly arranged, the electron beam can be focused in much the same manner that light rays are focused. Figure 42 shows how a decreasing and then an increasing field focuses the electrons

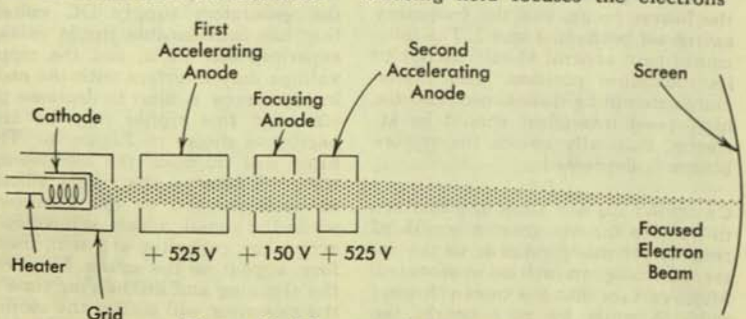


Figure 42. Electrostatic Focusing

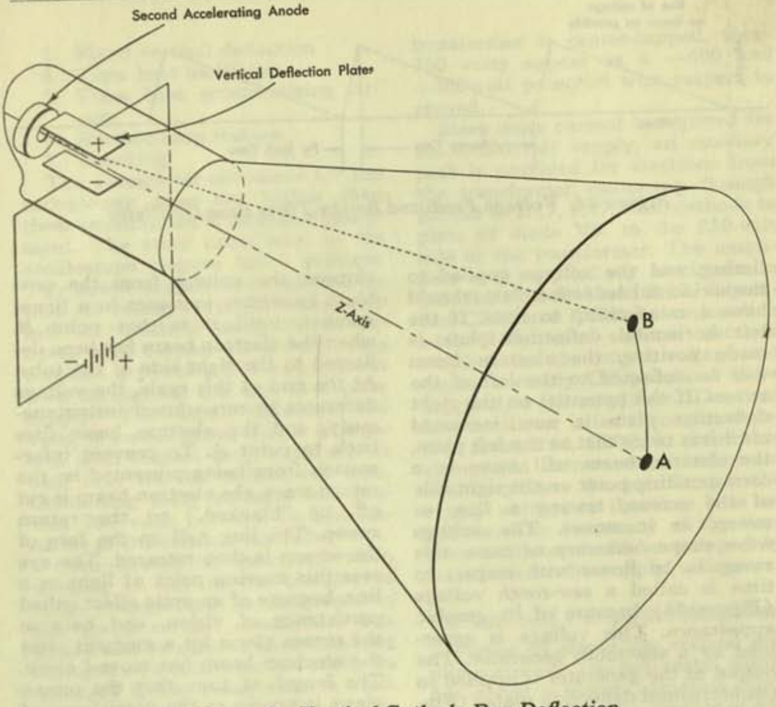


Figure 43. Vertical Cathode-Ray Deflection

into a pin point at the fluorescent screen.

This tiny spot of light must be deflected from its normal position in the center of the screen if it is to impart any information. The spot is caused by a stream of electrons, which are negatively charged particles. These negative particles are attracted by positively charged objects and repelled by objects with a negative charge. This principle called *electrostatic deflection* is used in the cathode-ray tube to deflect the electron beam from its central position on the screen. Two pairs of deflection plates allow the electron beam to be deflected along two axes. The vertical deflection plates move the beam vertically on the face of the screen. The vertical direction is sometimes called the Y axis. The horizontal deflection plates move the beam horizontally across the face of the screen, and this direction is sometimes called the X axis. When different potentials are applied to the deflection plates, the electron beam is deflected so that the luminous spot can be moved to any position on the face of the tube.

As the electrons speed between the two pairs of plates, the electron beam will be unaffected if no potential difference is applied to the plates. If the voltage on the upper plate is increased and the voltage on the lower plate is reduced (Figure 43), the electron beam will move upward. The deflection is proportional to the voltage difference of the plates; if 40 volts deflects the beam ½ inch, 80 volts would deflect it one inch. Therefore, it is possible to measure voltages by calibrating the cathode-ray screen and applying voltages to the vertical deflection plates.

In order to show the voltages appearing in a circuit over a period of time, the electron beam can be swept horizontally across the face of the tube at a fixed time rate, while voltage impulses are applied to the vertical deflection plates. To determine what type of voltage should be used on the horizontal plates, it is necessary to consider the problem to which the oscilloscope is being applied. In the application of the oscilloscope to most IBM machines it is desirable to show the amplitude of the pulse with respect to machine

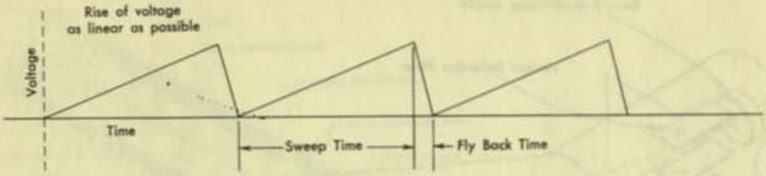


Figure 44. Voltage Produced by the Time Base Oscillator

timing, and the voltage applied to the horizontal deflection plates should have a relationship to time. If the left horizontal deflection plate is made positive, the electron beam will be deflected to the left of the screen. If the potential on the right deflection plate is now increased until it is twice that on the left plate, the electron beam will move to a corresponding point on the right side of the screen, tracing a line, or sweep, as it moves. The voltage wave shape necessary to cause this sweep to be linear with respect to time is called a *saw-tooth voltage* (Figure 44) because of its graphic appearance. This voltage is generated by a saw-tooth generator. The output of the generator is applied to the horizontal deflection plates (Figure 45). The voltage is zero at zero time, and the electron beam is at point *A* on the face of the tube because of *biasing* voltage. As time

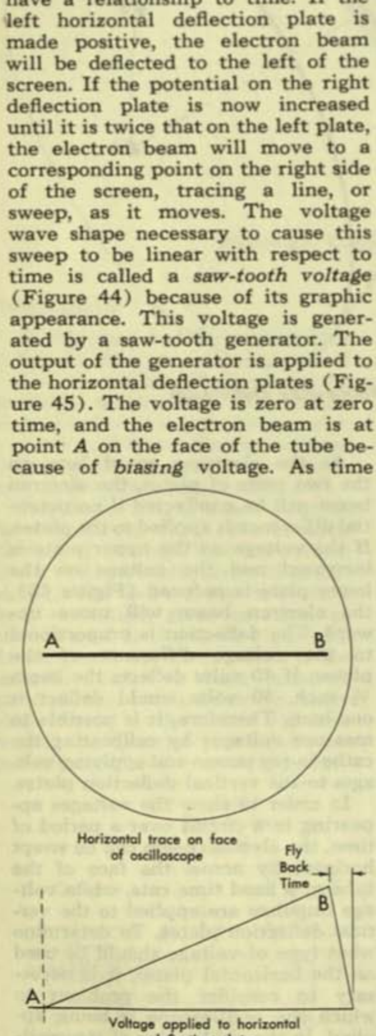


Figure 45. Linear Time Base Deflection

elapses, the voltage from the saw-tooth generator increases in a linear manner, until it reaches point *B*, when the electron beam has been deflected to the right side of the tube. At the end of this cycle, the voltage decreases to zero *almost* instantaneously, and the electron beam flies back to point *A*. To prevent information from being presented on the return trace, the electron beam is cut off, or "blanked," on the return sweep. The line A-B on the face of the screen is then retraced. The eye sees this moving point of light as a line, because of an optic effect called persistence of vision, and because the screen glows for a moment after the electron beam has moved away. The length of time that the screen glows is known as the *persistency* of the screen.

If the frequency of the time base generator is synchronized with the index of an IBM machine, the sweep will start from the left side of the screen as the machine index passes zero; the spot would be in the middle of the screen at 180 degrees, and it should be at the extreme right at 360 degrees. If this were possible, a complete index would have been developed along the time base. Since it is impossible to have the spot return instantaneously to the left end of the screen, this condition can only be approached. There will always be distortion of the time base at each end of the trace. For this reason it is advisable in most cases to adjust the time the sweep is started in order to cause the observed impulse to appear in the center of the screen.

Circuit Description

To simplify the discussion of the circuits in the oscilloscope, the diagram has been broken down into component circuits, which will be discussed individually in the following order:

1. Power supply
2. Vertical and horizontal amplifiers

3. Fixed vertical deflection
4. Time base oscillator
5. Time base synchronizing circuit
6. Single-sweep feature
7. Blanking

The voltage requirements for the cathode-ray tube are higher than those encountered in most test equipment. The other tubes used in the oscilloscope require lower voltages. Two power supplies are used in order that all voltages will be reasonably safe to personnel using the instrument with respect to ground. One supplies a positive 300 volts and is used throughout the unit as a plate supply. The other develops 400 volts, is connected so that it is negative with respect to ground, and is used only for the cathode-ray tube. Combining these voltages will provide 700 volts between certain elements of the cathode-ray tube.

Care should be exercised when working on any of the circuits, as these voltages can be dangerous to life under certain conditions. One should also be careful when checking voltages, as a voltmeter can easily be damaged if the wrong scale is used. High voltages appear at the binder posts on the terminal strip behind the cover plate on the rear of the oscilloscope. Connections at binder posts should only be changed when the oscilloscope is disconnected from the line.

Figure 46 shows a schematic diagram of the two-power supplies, the voltage divider network, and the points at which the voltages are applied to the cathode-ray tube.

When the switch on the intensity control is turned on, the primary winding of the power transformer is connected to the power line and a voltage is induced in the secondary having the rms (root mean square) values shown with respect to ground. The peak voltage between the ends of the transformer is equal to

$$(300 + 330) \times \sqrt{2} = 890 \text{ volts}$$

During the half-cycles that the secondary has the polarity indicated in parentheses, electrons can flow from the winding to diode $V6_2$ cathode to plate, through R49, R51, R52, R53, R47, R48, cathode to plate of diode $V6_1$, to the positive end of the winding. Because there are voltage drops in the diodes, about 700 volts are developed across the resistors. Because of the manner in which the transformer is center-tapped, these 700 volts appear as a −400 and +300-volt potential with respect to ground.

Since more current is required for the +300-volt supply, an auxiliary path is provided for electrons from the transformer center-tap through ground to R17, R47, R48, cathode to plate of diode $V6_1$ to the 330-volt side of the transformer. The amplifiers are supplied by a circuit in parallel with R47 and R17. Capacitors C20A and C20B, in conjunction with R48, form a filter network which filters the output voltage and causes a steady DC potential to be supplied to the amplifiers. The time base oscillator is fed through a separate filter, R44, C20C, in order that changes in current requirements of the amplifiers do not disturb the supply voltage to the time base oscillator. The frequency of the time base oscillator could be changed by variations in the supply voltage.

Vertical and Horizontal Amplifiers

Figure 47 shows the vertical amplifier circuit. The horizontal amplifier circuit is almost identical. Since the amplifier must be capable of amplifying direct, as well as alternating current potentials, a direct-coupled amplifier is used. This amplifier takes a single-ended input (one signal voltage with respect to ground) and amplifies and transforms it into a double-ended or push-pull output signal. A push-pull output signal consists of two voltages with respect to ground, 180 degrees out of phase with each other. The output signal is applied to the vertical deflection plates to move the electron beam above the base line. This circuit allows a wide range of frequencies to be observed without distortion and minimizes the effect of power supply variations.

Two vertical input binding posts are located on the left rear corner of the oscilloscope top. One is for alternating current; the other, for direct currents. Capacitor C1 in the alternating current input circuit isolates any direct-current component that might appear in the signal. Resistor R1, shunted by switch 4, the vertical input switch, determines the magnitude of the voltage applied to the amplifier. For many applications on IBM machines the vertical input switch (switch 4) will be set in the low position, shorting the 12-megohm resistor.

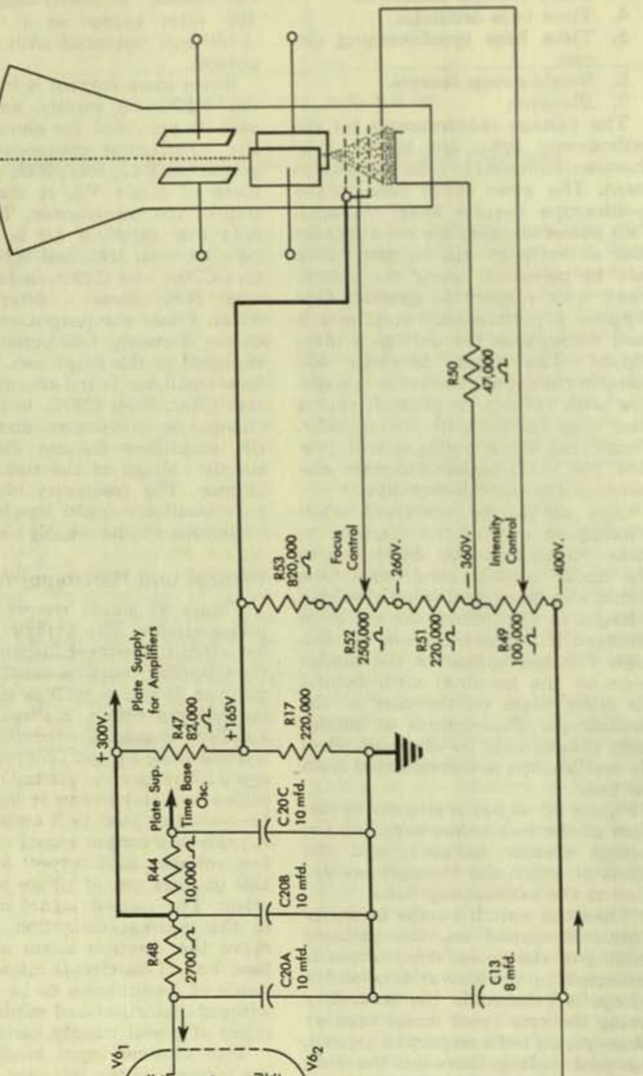


Figure 46. Oscilloscope Power Supply

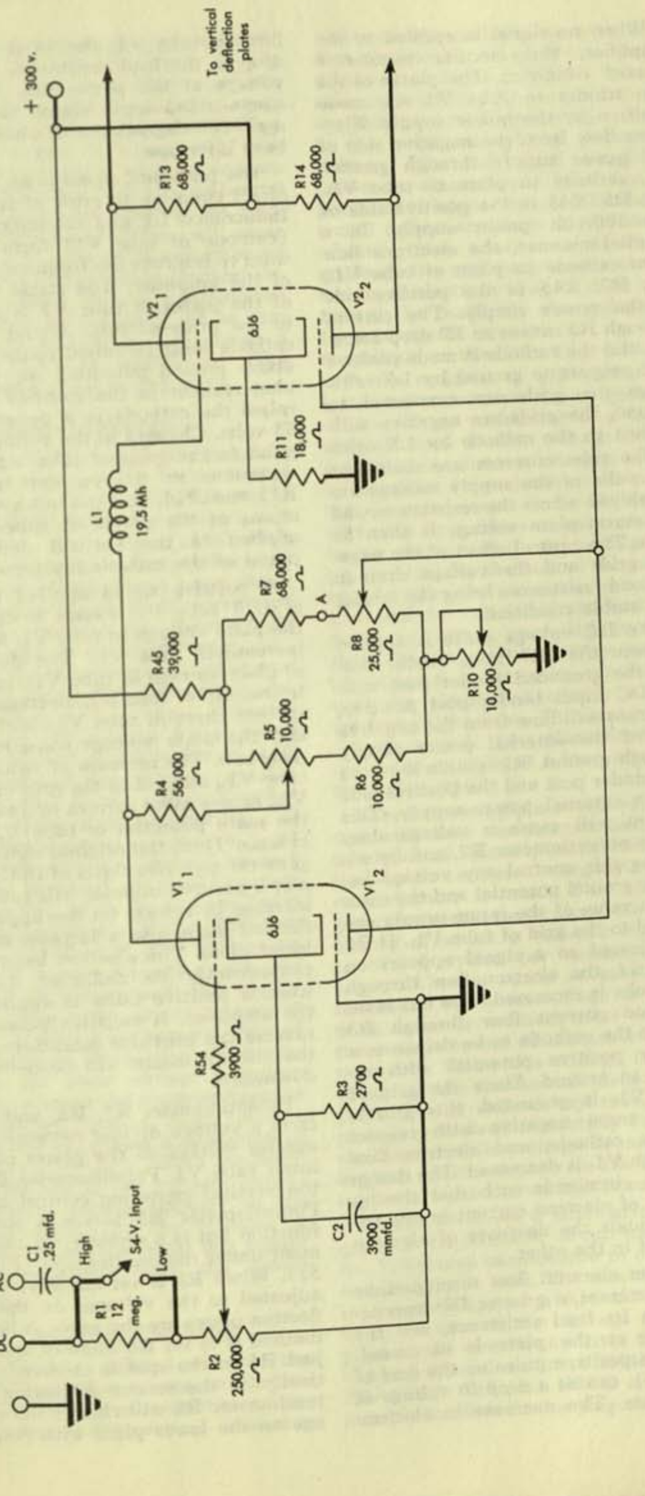


Figure 47. Vertical Amplifier

When no signal is applied to the amplifier, the circuits assume a "static" condition. The plates of the two triodes in tube V1 are made positive by the power supply. Electrons flow from the negative side of the power supply through ground, R3, cathode to plate of tube $V1_1$, R4, R5, R45 to the positive side of the 300-volt power supply. In a parallel manner, the electrons flow from cathode to plate of tube $V1_2$, R8, R7, R45 to the positive side of the power supply. The current through R3 causes an IR drop across R3, and the cathode is made positive with respect to ground by 1.5 volts. Since the grids are connected to ground, the grids are negative with respect to the cathode by 1.5 volts.

The tube currents are such that 250 volts of the supply voltage are developed across the resistances, and the static plate voltage is then 50 volts. The control effect of the negative grids and the voltage drop in the load resistances bring the triodes to a stable condition.

If a DC voltage pulse is applied between the DC input binder post and the grounded binder post with the DC input binder post positive, electrons will flow from the negative side of the external power supply through ground, R2, switch 4 to the DC binder post and the positive side of the external power supply. This current will cause a voltage drop across potentiometer R2, and by adjusting this control any voltage between ground potential and the maximum value of the input supply can be fed to the grid of tube $V1_1$. If R2 is adjusted so a signal appears on the grid, the electron flow through this tube is *increased*. The increased electron current flow through R3 causes the cathode to be driven to a higher positive potential with respect to ground. Since the grid of tube $V1_2$ is grounded, this grid is made more negative with respect to the cathode, and electron flow through $V1_2$ is decreased. The design of the circuits is such that the increase of electron current in one triode equals the decrease of electron current in the other.

When electron flow through tube $V1_1$ increases, a greater IR drop occurs in its load resistance, and the voltage at the plate is decreased. Thus, a positive pulse on the grid of tube $V1_1$ causes a *drop in voltage* at the plate. The decrease in electron flow in tube $V1_2$ decreases the IR drop in the load resistance, and the voltage at the plate rises. From a single-ended input signal two voltages, 180 degrees out of phase, have been developed.

The push-pull signal is applied by direct coupling to grids of tube V2. Inductance L1 and capacitance C2 (cathode of tube V1) form a network to improve the frequency range of the amplifier. The static voltage of the plates of tube V1 is applied to the grids of tube 2, and so the cathode must be raised considerably above ground potential. An 18,000-ohm resistor in the cathode circuit raises the cathode to a potential of 53 volts. Changes in the voltages applied to the grids of tube V2 cause variations in the current through R13 and R14, and the voltage variations at the plates of tube 2 are applied to the vertical deflection plates of the cathode-ray tube.

A positive signal applied to the grid of tube $V1_1$ causes a drop of the plate voltage in tube $V1_1$ and an increase in tube $V1_2$. The decrease in plate voltage in tube $V1_1$, applied to the grid of tube $V2_1$, decreases the current through tube $V2_1$, and R13, and the plate voltage consequently *increases*. The increase of voltage in tube $V1_2$, applied to the grid of tube $V2_2$, causes more current to flow, and the plate potential of tube $V2_2$ decreases. Thus, the original signal has gone through two shifts of 180° each, and a positive impulse will cause an increase in voltage on the upper deflection plate, also a decrease on the lower plate. The electron beam will consequently be deflected upward when a positive pulse is applied to the amplifier. A negative pulse will reverse the previous conditions, and the electron beam will be deflected downward.

Potentiometers R5, R8, and R10 form a voltage divider network that applies voltage to the plates of the input tube V1. Potentiometer R8 is the vertical centering control knob. Potentiometer R5 serves a similar function but is a screwdriver adjustment under the oscilloscope (Figure 53). When R8 is set midway, R5 is adjusted so the voltages on the deflection plates are the same. A better method is to set R8 midway and adjust R5 so the spot is centered vertically on the screen. Adjusting potentiometer R8 will change the voltage on the lower plate with respect to the voltage on the upper plate, moving the electron beam to any point on the screen. Potentiometers R23, R22 and R27 serve the same functions in the horizontal amplifier. Potentiometers R10 and R27 are called astigmatism controls and are adjusted so that with the horizontal and vertical gain controls set midway, a given input voltage will cause the same magnitude of deflection on either the horizontal or vertical deflection plates. This is accomplished in practice by adjusting R5 so that the potentials between terminals 3 and 4 behind the rear cover plate and ground average 165 volts.

Fixed Vertical Deflection

Since IBM machines generally operate at a single fixed voltage when the oscilloscope is connected to an IBM machine, the deflection is limited to the pattern of a single phenomenon. It is often desirable to check two simultaneous phenomena, and for that reason the *fixed vertical deflection* feature has been added. This circuit is also useful when testing machines having a DC generator for a power supply. Generators usually have a ripple voltage that disturbs the oscilloscope trace. When the fixed vertical deflection is used, the closing of any contact can give an indication on the screen. This has been accomplished by inserting two 3000-ohm resistors in series at point *A* (Figure 47). An external binding post is provided at each juncture (Figure 48). With the electron beam centered, when one of the 3000-ohm resistors is shorted, the voltage on the plate of tube $V1_2$ and on the grid of tube $V2_2$ is increased. This results in an increase of electron current in tube $V2_2$ with a consequent drop of plate voltage. Decreasing the potential on the lower vertical deflection plate will cause the electron beam to be deflected upward. Each resistor, when shorted, causes a deflection of about one-half inch. Since the binding posts are in the vertical centering circuit, voltage appears on the binding posts, and the contacts in the IBM machines under test should be disconnected from the power supply.

Linear Time Base Oscillator

It has been pointed out that the vertical amplifier causes an electrostatic difference of potential to appear between the vertical deflection plates of the cathode-ray tube, and that the stream of electrons, being negative, will be deflected toward the positive plate. The magnitude of the deflection is directly proportional to the magnitude of the deflecting voltage. The horizontal amplifier causes an electrostatic difference of potential to appear between the horizontal deflection plates of the cathode-ray tube, which are at right angles to the vertical plates, and the stream of electrons is again deflected toward the positively charged plate by a distance proportional to the magnitude of the deflecting voltage.

In the majority of applications it is desired to measure the magnitude of the voltage under test as a function of time. If the voltage being measured is connected to the vertical amplifier, its variations will cause the electron beam to be deflected vertically by a distance proportional to the magnitude of the voltage at any instant. On the face of the cathode-ray tube the trace can be measured and the voltage ascertained. In order to obtain any information about the *shape* of the voltage waves the electron beam must simultaneously be swept horizontally across the face of the tube. This horizontal deflection must take place linearly; the sweep must be at a fixed rate for the entire trace.

In order to supply a sweep voltage that will cause the electron beam to be deflected linearly with time, a time-base oscillator employing a multivibrator is used. This circuit generates a saw-tooth wave, the frequency of which is variable from 3 to 50,000 cycles per second. The saw-tooth wave starts at zero and builds up slowly in voltage until a peak value is reached, after which the voltage is cut off almost instantaneously. When this voltage is applied to the horizontal deflection plates of the cathode-ray tube, the trace is deflected horizontally during the time that the voltage is increasing and returns rapidly to the starting point when the voltage is cut off.

Figure 49 shows a schematic diagram of the oscillator circuit used in the Waterman oscilloscope to obtain the linear time base. The two triodes in the envelope of a 6J6 tube are used. As soon as the voltage is applied to the circuit, capacitor C12 is charged through resistors R34B and R37. Both C12 and R34B are adjustable to allow for varying the rate

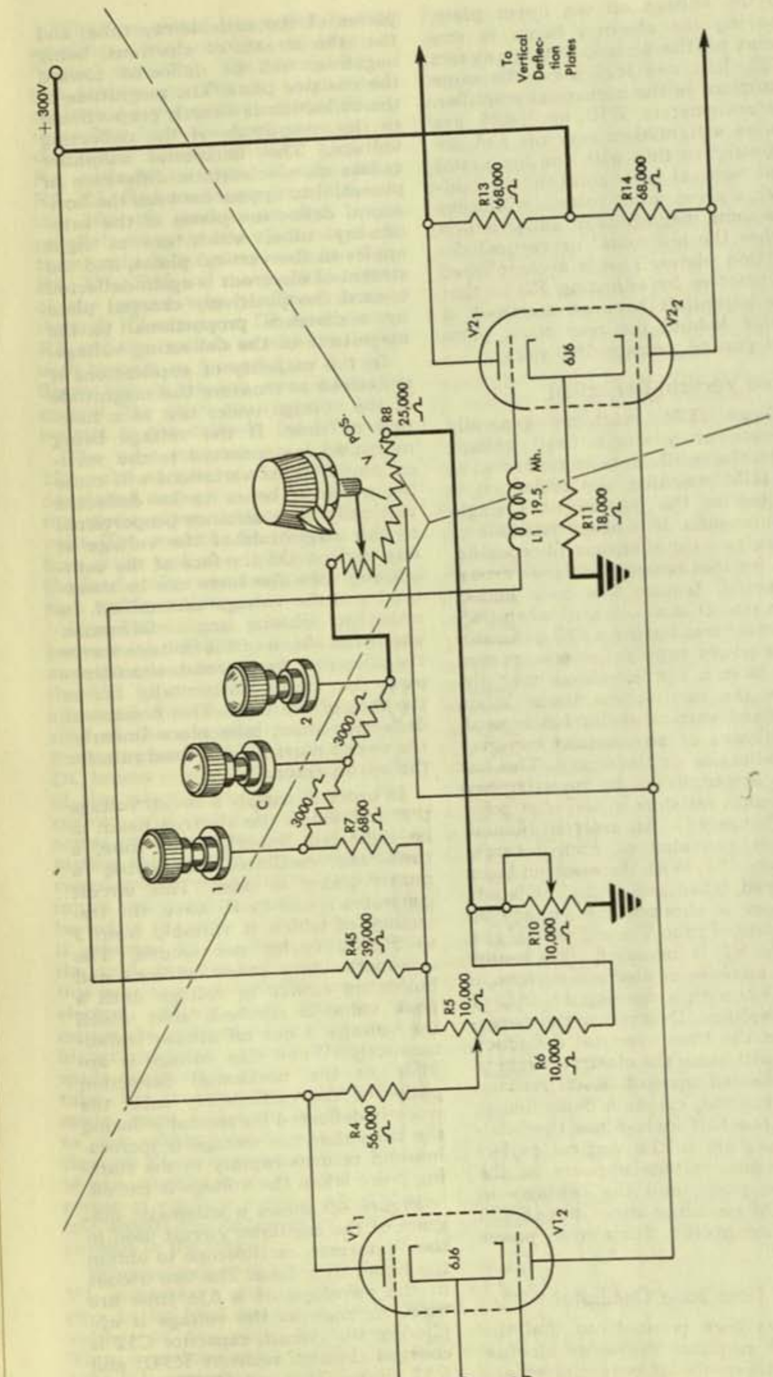


Figure 48. Fixed Vertical Deflection

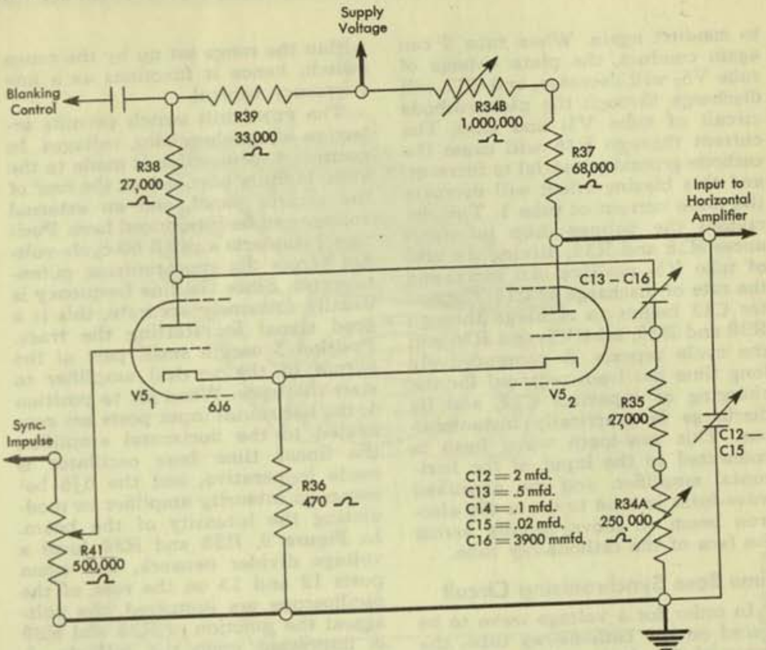


Figure 49. Time Base Oscillator

at which the capacitor charges. The rise of voltage across C12 is nearly linear with respect to time, since the voltage across C12 will only be allowed to rise to a small percentage of the applied voltage. When C12 has charged to a predetermined value, it is discharged through tube $V5_2$. The discharge time is much smaller than the charging time, and this gives a saw-tooth shape to the voltage across the capacitor. This voltage will be applied to the horizontal deflection plates of the cathode-ray tube.

To understand the operation of the multivibrator, assume that the triodes are heated, and that the supply voltage is now applied. Capacitor C13 begins to charge through R38 and R39, C13 and the grid-cathode resistance of tube $V5_2$, and the cathode resistance R36. This is possible because the grid of tube $V5_2$ is momentarily positive with respect to the cathode. Capacitor C13 is also charged through R39, R38, C13, R35, R34A; but R34A is so large that most of the charge will be developed through the tube. The charging current flowing through R38 and R39 causes a decrease in the plate voltage of tube 1. The charging current through R36 has made the cathode positive with respect to the grids, or the grids negative with respect to the cathode. The reduced plate voltage of the tube $V5_1$ and the biasing effect of the current through R36 immediately cuts off the plate current of tube $V5_1$. As the charge on capacitor C13 increases, the voltage applied to the plate of tube $V5_1$ will increase. At the same time, the charging current to C13 is decreased. A point is reached where tube $V5_1$ can conduct, but the instant a current is set up through the tube the plate voltage will tend to drop because of the current through R38 and R39. However, C13 is charged to a higher voltage, and the tube 1 current will be sustained momentarily by a reversal of current from C13. As C13 discharges, the grid of tube $V5_2$ is suddenly driven highly negative with respect to the cathode, completely cutting off the charging current to C13. Capacitor C12, which has remained essentially uncharged to this point because of the shunting effect of tube $V5_2$ and R36 in parallel with it, is now able to receive a charge through R34B and R37. Simultaneously, C13 is returning to the voltage that will allow tube $V5_2$

to conduct again. When tube 2 can again conduct, the plate voltage of tube $V5_2$ will decrease, and C12 will discharge through the plate-cathode circuit of tube $V5_2$ and R36. The current through R36 will cause the cathode-ground potential to increase, and this biasing effect will decrease the plate current of tube 1. This decreases the voltage drop in resistances R38 and R39, driving the grid of tube $V5_2$ positive and increasing the rate of discharge of C12. Capacitor C13 begins to recharge through R38 and R39, tube $V5_2$ and R36 and the cycle repeats. A comparatively long time has been required for the charging of capacitor C12, and its discharge is practically instantaneous. This saw-tooth wave form is connected to the input of the horizontal amplifier, and the amplified wave-form is used to cause the electron beam to move rapidly across the face of the cathode-ray tube.

Time Base Synchronizing Circuit

In order for a voltage wave to be traced on the cathode-ray tube, the sweep of the electron beam must be repeated, and the time base oscillator must be synchronized in some manner with the voltage wave in order to obtain a stationary pattern. In the Waterman oscilloscope the synchronizing voltage is applied across the potentiometer R41. Whenever a positive voltage impulse appears across the potentiometer the grid of tube $V5_1$ will be brought to a potential that will allow tube $V5_1$ to conduct, cutting off tube $V5_2$ and allowing C12 to start accumulating a charge. The rising voltage across C12 starts the sweep across the face of the cathode-ray tube. Thus, each pulse of synchronizing voltage can be used to start the electron beam on a sweep across the scope. It is important that the RANGE and FREQUENCY switches be set to the approximate frequency of the synchronizing voltage impulses. The RANGE switch couples in the proper capacitances for C12 and C13, and acts as a coarse frequency control.

Position 1—3-15 cycles per sec.
" 2—15-75 cycles per sec.
" 3—75-350 cycles per sec.
" 4—350-2000 cycles per sec.
" 5—2-10 kc.
" 6—10-50 kc.

The FREQUENCY knob adjusts the two resistors of R34 and allows selection of frequency to be made within the range set up by the range switch; hence it functions as a fine frequency control.

The FUNCTION switch permits selection of synchronizing voltages. In position 1, connection is made to the SYNC binding post jack at the rear of the control panel, and an external voltage can be introduced here. Position 2 connects a small 60-cycle voltage across the synchronizing potentiometer. Since the line frequency is usually extremely accurate, this is a good signal for starting the trace. Position 3 uses a small part of the output of the vertical amplifier to start the trace. When set to position 4, the horizontal input posts are connected to the horizontal amplifier, the linear time base oscillator is made inoperative, and the 6J6 becomes an intensity amplifier for modulating the intensity of the beam. In Figure 9, R38 and R39 form a voltage divider network, and when posts 12 and 13 on the rear of the oscilloscope are jumpered, the voltage at the junction of R38 and R39 is impressed upon the cathode. A positive signal will lower the cathode bias of the cathode-ray tube, and thus increase the number of electrons that go into the electron beam, increasing the intensity of the spot on the oscilloscope.

The Single-Sweep Feature

In adapting the oscilloscope to use on all IBM machines, the necessity of synchronizing the oscilloscope trace with the machine index becomes evident. If the oscilloscope trace is started at any fixed time on the machine index, any other index timing will appear a fixed distance from the beginning of the trace. For each machine cycle the electrical operation is presented on the screen, and any variation from normal is immediately evident.

The Waterman oscilloscope has been altered by the addition of a triple-pole, double-throw switch mounted directly beneath the oscilloscope face and electrically connected as shown in Figure 50. In this figure the switch has been thrown to the single-sweep position. Switch point $S6_3$ is opened to de-activate the multivibrator; no positive pulse can then reach the grid of tube $V5_2$ from the plate of tube $V5_1$. Capacitor C12 is charged from the supply voltage through R34B and R37. Switch point $S6_1$ sets up a circuit

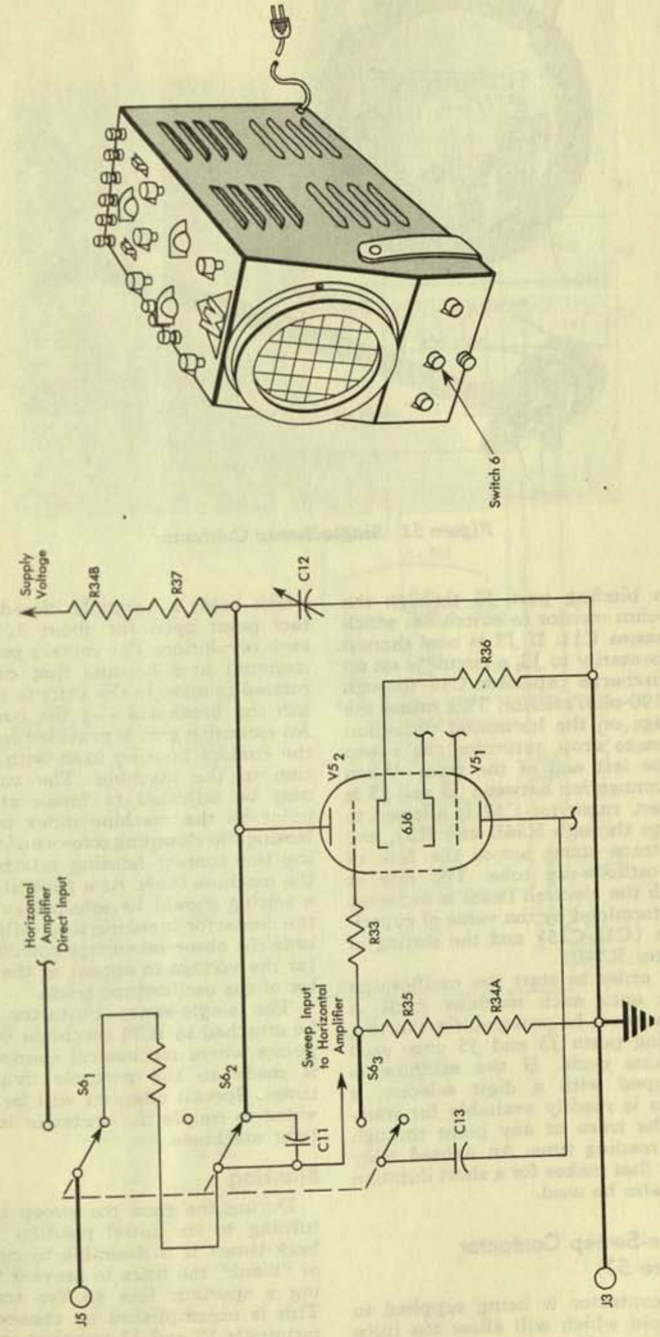


Figure 50. Single-Sweep Feature

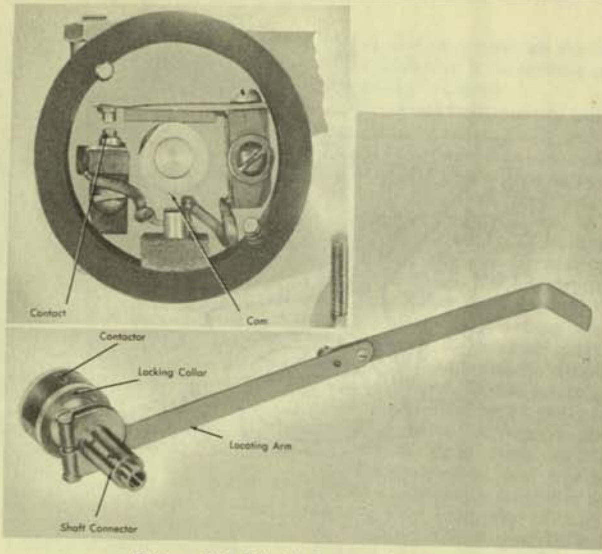


Figure 51. Single-Sweep Contactor

from binding post J5 through the 100-ohm resistor to switch $S6_2$ which by-passes C11. If J5 is now shorted momentarily to J3, a circuit is set up to discharge capacitor C12 through the 100-ohm resistor. This causes the voltage on the horizontal deflection plates to drop, returning the sweep to the left end of the trace. When the connection between J3 and J5 is broken, capacitor C12 is allowed to charge through R34B and R37, and the trace starts across the face of the cathode-ray tube. The rate at which the electron beam is deflected is determined by the value of capacitance (C12-C15) and the setting of resistor R34B.

In order to start the oscilloscope trace once each machine cycle, a means must be provided for shorting binding posts J3 and J5 once each machine cycle. If the machine is equipped with a digit selector, a means is readily available for starting the trace at any point through card reading time. An unused relay point that makes for a short duration may also be used.

Single-Sweep Contactor (Figure 51)

A contactor is being supplied to the field which will allow the trace to be started at any point of any cycle. The contactor consists of a shaft extension that carries a cam which holds a normally closed contact point open for about 320° of each revolution. The contact point is mounted in a housing that can be rotated relative to the shaft to establish the break time of the contact. An extension arm is provided to hold the contact housing fixed with relation to the machine. The contact may be adjusted to break at any point on the machine index by releasing the clamping screws and moving the contact housing relative to the machine shaft. As a general rule, a setting should be selected so that the contactor breaking time will precede the observed voltage sufficiently for the voltage to appear at the center of the oscilloscope trace.

The single-sweep contactor may be attached to IBM machines at the points where mechanical connection is made to the portable dynamic timer. Special adapters will be provided to couple the contactor to the later machines.

Blanking

During the time the sweep is returning to its initial position (fly-back time) it is desirable to cut off or "blank" the trace to prevent tracing a spurious line on the screen. This is accomplished by connecting terminals 12 and 13 together on the rear terminal board. During fly-back time the plate current of tube $V5_1$ (Figure 49) is decreased, and this

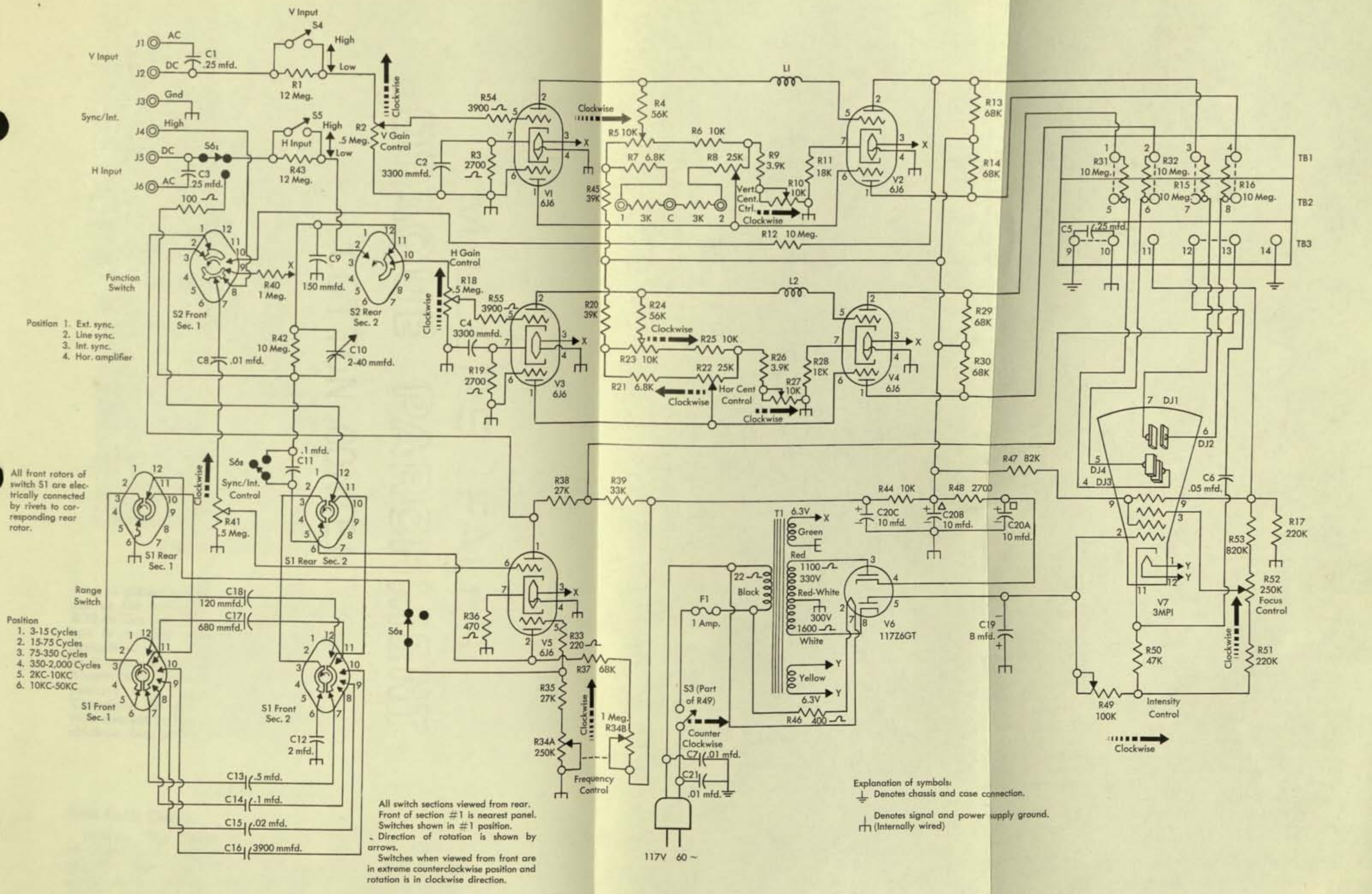


Figure 52. Complete Oscilloscope Wiring Diagram

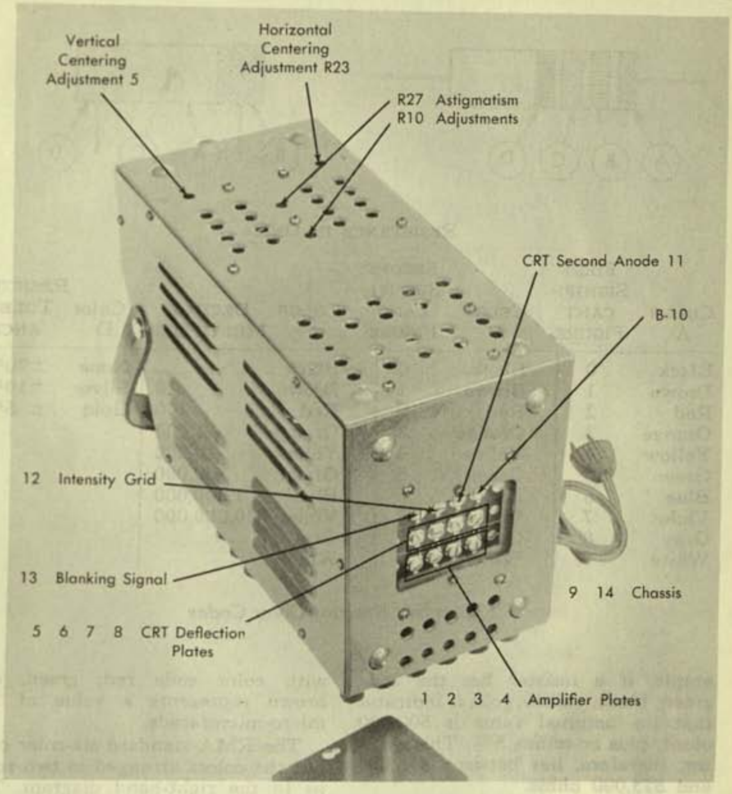


Figure 53. Oscilloscope Controls and Binder Posts

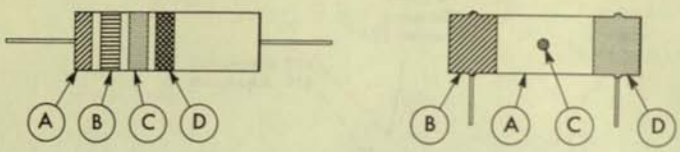
drop in plate current causes the voltage at the point between R38 and R39 to increase. This changing voltage is coupled through C6 to the cathode of the cathode-ray tube, and an increase in the positive direction momentarily drives the cathode more positive with respect to the grid. Therefore, the grid is more negative with respect to the cathode, and the electron flow is cut off. This occurs just as the beam is returning to its position at the left end of the screen, blanking the screen on the return trace. (See Figure 52.)

NOTE: The Waterman oscilloscope is shipped without the jumper between terminals 12 and 13. Disconnect the oscilloscope *from the line* before removing the rear cover plate to jumper these terminals.

COMPONENTS DATA

RMA Color Codes

Resistors. The Radio Manufacturers' Association (RMA), the American War Standard (AWS) and the Joint Army-Navy specifications (JAN) for color coding fixed composition resistors are identical. On axial lead composition resistors, four bands of color starting from the end give the resistance value. Radial lead resistors have their values given by color placed on the body, end, and dot, with the fourth color on the other end. In the illustration, Band A indicates the first significant figure in ohms, Band B indicates the second significant figure, Band C indicates the decimal multiplier, and Band D, if present, indicates tolerance in percent of nominal resistance. For ex-



RESISTANCE IN OHMS

COLOR A	FIRST SIGNIFICANT FIGURE	COLOR B	SECOND SIGNIFICANT FIGURE	COLOR C	DECIMAL MULTIPLIER	Color D	RESISTIVE TOLERANCE
Black	0	Black	0	Black	....	None	±20%
Brown	1	Brown	1	Brown	10	Silver	±10%
Red	2	Red	2	Red	100	Gold	± 5%
Orange	3	Orange	3	Orange	1,000		
Yellow	4	Yellow	4	Yellow	10,000		
Green	5	Green	5	Green	100,000		
Blue	6	Blue	6	Blue	1,000,000		
Violet	7	Violet	7	Violet	10,000,000		
Gray	8	Gray	8	Gray			
White	9	White	9	White			

Figure 54. Resistor Color Codes

ample, if a resistor has the code green, black, yellow, gold, it indicates that the nominal value is 500,000 ohms, plus or minus 5%. This resistor, therefore, lies between 475,000 and 525,000 ohms.

Fixed Capacitors (Figures 55A and B). The RMA standard three-dot color code shows the capacitance of fixed mica capacitors in much the same manner that resistance values are shown. In the left-hand diagram, dot *A* represents the first significant digit, dot *B* the second digit, and dot *D* the decimal multiplier. All the capacitance values are given in micro-microfarads. For example, a capacitor with color code red, green, and brown represents a value of 250 micro-microfarads.

The RMA standard six-color code has the colors arranged in two rows, as in the right-hand diagram. The upper row indicates the first *three* significant digits of the capacitor at *A, B,* and *C*. The decimal multiplier is at *D*. Dot *F* gives the voltage rating, and dot *E* the tolerance.

If dot *A* is black, white or silver, dots *B* and *C* give the significant digits, and the dot *D* the decimal multiplier.

Ceramic capacitors are marked as in Figure 55C.

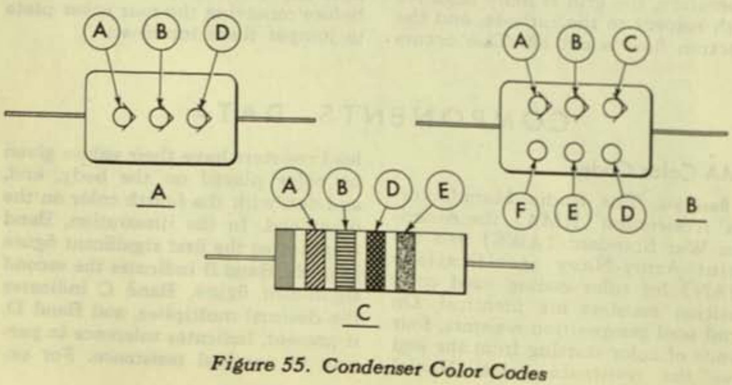


Figure 55. Condenser Color Codes

CAPACITANCE IN MICRO-MICROFARADS (MMF)

Color A	First Significant Figure	Color B	Second Significant Figure	Color C	Third Significant Figure
Black	0	Black	0	Black	0
Brown	1	Brown	1	Brown	1
Red	2	Red	2	Red	2
Orange	3	Orange	3	Orange	3
Yellow	4	Yellow	4	Yellow	4
Green	5	Green	5	Green	5
Blue	6	Blue	6	Blue	6
Violet	7	Violet	7	Violet	7
Gray	8	Gray	8	Gray	8
White	9	White	9	White	9
Gold					
Silver					
No Color					

Color D	Decimal Multiplier	Color E	Tolerance	Color F	DC Test Voltage
Black	--------	Black	20%	Black	--------
Brown	10	Brown	1%	Brown	100
Red	100	Red	2%	Red	200
Orange	1,000			Orange	300
Yellow	10,000			Yellow	400
Green	100,000	Green	5%	Green	500
Blue	1,000,000			Blue	600
Violet	10,000,000			Violet	700
Gray	--------			Gray	800
White	--------	White	10%	White	900
Gold	0.1	Gold	5%	Gold	1000
Silver	0.01	Silver	10%	Silver	2000
No Color	--------	No Color	20%	No Color	500

Resistance of IBM Coils

It is felt that a knowledge of approximate DC resistance values of IBM coils would be of value to the customer engineer where a partially shorted coil is suspected. A list of coils with nominal resistance values is appended. These coils are normally manufactured to within 10% of the nominal resistance value.

Coil No.	Resistance	Coil No.	Resistance
2310	133.00	13728	635.00
3811	50.00	15820	220.00
4162	200.00		
4440	1.30		
4817	14.00	20767	2.70
5552	.28	22862	365.00
6933	5.80	22987	27.50
9748	80.00	25980	23.00
		26476P	160.00
11241	140.00	26476H	455.00
11948	18.50		
12018	137.00	32375	11.00
12352	262.00	32376	42.00

Note: An asterisk indicates a tapped coil.

Coil No.	Resistance
32377	148.00
32378	595.00
32379	2600.00
36787	11.00
37698	5.40
37699	22.00
37700	98.00
37701	351.00
37702	1100.00
39021	65.00
39022	250.00
39023	900.00
39024	17.00
39025	26.00
39027	460.00
39028	1430.00
40825	12.00
40826	47.00
41244	1570.00
45194	40.00
46462	10.00
47228	6.00
47229P	24.00
47229H	24.00
47230P	96.00
47230H	96.00
47408	9.30
47409	35.00
47410	132.00
47411	515.00
47412	1975.00
47459	5.80
47460	22.50
47461	80.00
47462	315.00
47463	1020.00
51556	113.00
53289	3.00
55624	71.00
55625	266.00
55626	933.00
55991	48.00
55992	120.00
55993	780.00
55994	2490.00
56133	26.00
56135	417.00
56137	5500.00
56744	27.00
56745	110.00
57088	275.00
57135	150.00
57136	137.00
57137	574.00

Coil No.	Resistance
57234	120.00
57260	482.00
57375	170.00
57386	680.00
57429	8.20
58061	27.00
58373	14.00
58374	52.50
58375	250.00
58376	950.00
58377	3900.00
58530	220.00
58676	34.00
58677	206.00
58678	2200.00
58698	5.00
58768	280.00
58808	74.00
58880	108.00
59097	1.50
60546	350.00
60961	27.00
60962	110.00
60963	350.00
61546	24.00
61975	8000.00
61978	9.00
61979	42.00
61980	160.00
61981	880.00
62165	35.00
62828	92.00
62897	620.00
62960	3.20
63131	350.00
63133	590.00
63723	18.00
63809	2160.00
64613P	384.00
64613H	384.00
64615P	1536.00
64615H	1536.00
64618	190.00
64620	745.00
65217	26.00
65222	715.00
65244	100.00
66360	454.00
66453	1620.00
68045	10000.00
69465	6.50
70079	16.50
70080	74.00
70081	308.00

Coil No.	Resistance
70082	6350.00
70586	26.00
71102	4.50
71103	22.00
71104	32.00
71105	84.00
71106	388.00
71107	1200.00
71557	123.00
71559	2000.00
71575	17.00
71576	5.80
71577	4.70
71578	64.00
71579	80.00
71580	22.60
71581	318.00
71594	9.20
71850	31.00
71851	125.00
71852	500.00
71853	1960.00
71854	11500.00
71855	31.00
71856	125.00
71857	500.00
71858	1960.00
71859	11500.00
71981	8.60
71982	32.00
71983	120.00
71984	470.00
71985	2900.00
72156	10200.00
72635	.41
72636	2.96
72637	57.50
72638	380.00
72640	2000.00
72641	30.00
72642	117.00
72643	745.00
72644	3350.00
72645	7.60
72646	30.00
72647	124.00
72648	1197.00
72649	2000.00
72754	18.00
73390	32.00
73433	185.00
73434	19.00
73435	60.00
73662	9.50
73663	37.50
73664	155.00
73665	890.00
73666	3450.00

Coil No.	Resistance
73859	4.50*
73859	5.40*
73859	6.40*
75966	57.00
75967	209.00
75968	835.00
75969	3687.00
75970	12000.00
75992	80.00
75993	135.00
75994	215.00
75995	370.00
75996	550.00
75998	1500.00
76064	160.00*
76064	345.00*
76204	395.00
76414	36.00
76415	1400.00
76416	120.00
76417	80.00
76418	5600.00
76419	350.00
76427P	50.00
76427H	55.00
76428P	275.00
76428H	325.00
76429	4.70
76430P	5.00
76430H	5.80
76431P	21.00
76431H	22.50
76448P	22.50
76448H	24.00
76536	80.00
76584P	4.70
76584H	5.20
76585P	3.50
76585H	4.40
76586P	2.60
76586H	2.90
76587P	4.00
76587H	4.90
76588P	185.00
76588H	204.00
76589P	30.00
76589H	36.00
76590P	14.20
76590H	15.20
76591P	1.80
76591H	2.20
76592P	60.00
76592H	65.00
76593P	8.60
76593H	9.50
76594	22.60
76595	17.00
76596	5.80

Coil No.	Resistance	Coil No.	Resistance
76597	64.00	93940	6.60
76598	318.00	93941	250.00
76726	468.00	94506	18.00
77030	56.00	94507	70.00
77878	35.00	94508	257.00
77879	140.00	94509	1544.00
78557	520.00	95847	1975.00
78857	2100.00	95848	5.00
79281	7.80	95850	10.70
79349	7330.00	95851	2940.00
79351	2300.00	95861	8.30
79623	240.00	95862	2190.00
		95863	3.60
		95864	1510.00
80212	1035.00		
80213	3830.00		
80214	61.00	101745	50.00
80215	1666.00	102222	1100.00
80216	5150.00	103603	270.00
80217P	1750.00	103604	270.00
80217H	1800.00	103834	416.00
80218	6520.00	104859	235.00
80350	1650.00	105409	300.00
80953	300.00	106487	150.00
		106488	45.00
91764	65.00	106489	140.00
91765	1335.00	106562	12.50
91855	162.00	107557	205.00
91880	50.00	107559	216.00
92134	137.00	107566P	216.00
92135	224.00	107566H	578.00
92136	340.00	108389P	187.00
92622	3.90	108389H	618.00
92623	2190.00		
92624	2940.00		
92625	10.70	110109	75.00
92709	440.00	110437	16.00
92718	5.00	111240	2.80
92720	8.30	111280	19.00
92843	1760.00	111300	45.00
92844	1510.00	111310	80.00
93200	14.00	111320	110.00
93201	5.50	111330	176.00
93203	22.00	111350	482.00
93204	92.00	111360	706.00
93205	390.00	111370	1060.00
93286	36.00	111380	1900.00
93287	80.00	111390	2500.00
93288	92.00	111400	5100.00
93289	28.00	112412	1150.00
93290	80.00	112649	908.00
93291	36.00	113344	1050.00
93292	9.10	113573P	422.00
93293	16.70	113573H	1546.00
93294	37.00	115415	1050.00
93854	240.00	115649	1500.00
93855	780.00	116821	38.00
93938	43.00	117370	1060.00
93939	16.00	118013	166.00

Coil No.	Resistance
118904	600.00
121059	218.00
122181	500.00
122716P	109.00
122716H	452.00
122796	580.00
122811	5.50
123783	62.00
123784	24.00
123785	4.00
123931	70.00
125276P	396.00
125276H	396.00
126469	757.00
126470	238.00
127017	300.00
127154P	160.00
127154H	161.00
127447	157.00
128024	166.00
128297P	17.50
128297H	17.50
128322	224.00
128512	275.00
128911	600.00
129431	10.00
131030	75.00
131068	36.00
132000P	4.50
132000H	428.00
134085	1520.00
134094	1500.00*
134094	1500.00*
134208	2565.00
134466	71.00
134675	1300.00*
134675	1300.00*
134991	85.00
136847	80.00
136848	42.50
139816	71.00
141844	113.00
142095	118.00
143706	215.00
143939	1000.00
144211	118.00
144224	3.30
145216P	247.00
145216H	440.00
149067	370.00
149682	275.00
151058	16.00
151333	60.00
151368	127.50
152272P	15.00
152272H	422.00
153605	14.50
153607	150.00
155857	800.00
156063	640.00
156425	770.00
157345	170.00
157517	64.00
157925	3.00
157926	.60
158115	15.00
158203	1260.00
158445	11.00
158576	50.00
159326	1110.00
159581	575.00
159830	265.00
159832	1656.00
161293	121.00
166595	126.00
166733	176.00
166888	56.00
167424	153.00
170187P	1145.00
170187H	3200.00
170570	1040.00
172528	370.00
172814	36.00
172815	14.00
172816	130.00
172825	112.00
173430	641.00
175236P	111.00
175236H	1150.00
178554	4.90
178845	53.00
178969	195.00
179264	235.00
179265	22.50
180018	1030.00
180096	1735.00
180097	272.00
180307	97.00
180410	7.80
180411	8.60
180412	36.00
180413	41.00
180414	96.00
180430	16.60
180431	19.20

Coil No.	Resistance
180432	65.00
180433	78.00
180434	190.00
180847	1.10
182821	.40
184086	78.00
184362	135.00
184369P	170.00
184369H	155.00
184754	1225.00
185734	1730.00
186249P	430.00
186249H	440.00
186253	358.00
186255	500.00
186259	770.00
186260	238.00
186520	12500.00
186690	720.00
186693	560.00
186699	234.00
186707	332.00
186708	395.00
186871	75.00
186978	315.00
187394P	160.00
187394H	170.00
187655	200.00
188384	189.00
188850	330.00
189841	275.00
191225P	109.00
191225H	452.00
191338	780.00
191352	325.00
191397	12.00
192025	100.00
192279	1400.00
196563	46.00
196567	63.00
197702	68.00
197884	28.00
198725	270.00
198876	300.00
198881	720.00
198882	622.00
198883	395.00
198884P	624.00
198884H	622.00
198885P	622.00
198885H	695.00
198886P	395.00
198886H	411.00
198887P	624.00
198887H	1735.00
198888P	622.00
198888H	1080.00
198889P	395.00
198889H	825.00
202806	140.00
203097	164.00
204941	350.00
205439	170.00
205642	157.00
206361	270.00
207964	750.00
209704	72.60
211830	142.00
212461	19.00
212633	
212742	33.20
214222P	470.00
214222H	470.00
214550	120.00
219310	220.00
220277	280.00
222951	63.00
225766	277.00
226046	280.00
226303	196.00
226684	112.00
226698	300.00
226990	390.00
227626	2250.00
228079	1017.00
228567	910.00
228881P	445.00
228881H	1010.00
280225P	1215.00
280225H	1220.00
280827	220.00
281447	169.00
282743	115.00
282911P	650.00
282911H	770.00
282964P	153.00
282964H	430.00
283507P	1175.00
283507H	3900.00
287148	780.00
303450	90.00
306542	56.00
308417	300.00
455167	750.00

Varistors

A varistor is a circuit element that changes resistance under varying conditions. In most applications, resistors are designed to remain essentially constant for differing voltage and current conditions, but varistors are designed to change resistance under varying currents, voltages or temperatures. Varistors are classed as *symmetrical* varistors, *unsymmetrical* varistors and *thermistors*.

Symmetrical Varistors

The resistance of symmetrical varistors varies with the applied voltage. This type of varistor is used to limit surge currents. Silicon carbide is mixed with a ceramic binder and molded into discs. The discs are baked at high temperature in much the same manner that clay is fired in making dishes. Terminals are attached to the surfaces of the discs to complete the assembly. The material consists of resistive particles separated by thin insulating films of silicon dioxide. When a voltage is applied to a varistor of this type, the films break down and conduct as the voltage is raised. The higher the voltage, the larger the number of films that conduct. The insulating film reforms as soon as the voltage is removed. The completed circuit element has high resistance to low voltage but low resistance to high voltage. A varistor is applied across circuits where surge voltages occur. For example, on certain Type 405 machines, varistors of this type were applied across the plus and minus relay coils that caused excessive surge voltages when de-energized. The varistor exhibits high resistance to 40-volts, but essentially shunts the relay coil to provide a path for the currents induced when the coils are de-energized. This prevents the build-up of high surge voltages.

Unsymmetrical Varistors

Certain substances have the property of passing current freely in one direction, but limiting it severely in the opposite direction. These substances include copper oxide, copper sulfide and selenium, used in power rectifiers, and silicon and germanium crystals used in communications and computing equipment.

Selenium Rectifiers. Dry metallic rectifiers have several advantages over vacuum-tube diodes when used to change AC line voltages to the DC potentials required for IBM machines. They do not require a time delay for the cathode to heat, they can handle heavy current overloads, their life is much longer than that of a vacuum tube, and they can supply much higher currents than a thermionic vacuum tube power supply occupying the same space. When vacuum-tube rectifiers age the DC output decreases, and a time may come when the output is sufficiently low to cause an occasional failure in machine operation. The metallic rectifier output decreases so slowly that under normal conditions the rectifier far outlasts the life of the machine.

Several types of metallic rectifiers have been developed, but the *selenium* type is preferable because of its small size and weight for a given wattage output, its high efficiency and good voltage regulation.

The selenium dry disc rectifier is assembled from aluminum or steel discs coated on one side with a thin layer of selenium, which is a substance that chemically resembles sulphur. Over this thin coating is sprayed a layer of metallic alloy that makes even contact with the selenium. Between the selenium and the alloy a *barrier layer* is formed, which has the unique property of offering a low resistance to electrons flowing from alloy to selenium but a high

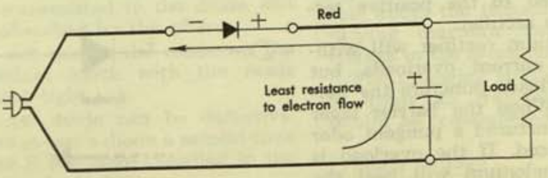


Figure 56. Half-Wave Metallic Rectifier Circuit

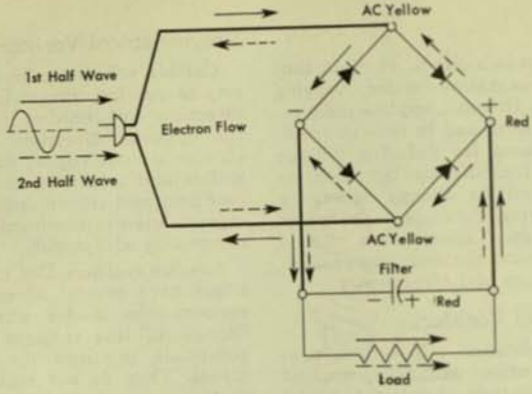


Figure 57. Half-Wave Metallic Rectifier Circuit

resistance to electron flow in the opposite direction. The selenium cell therefore acts in the same manner as a vacuum diode, with the alloy acting as a cathode and the selenium serving as an anode.

Each selenium cell is capable of withstanding a back voltage of 26 volts. If higher voltage is to be rectified the cells are connected in series. Seven such cells would be *required* to withstand the 161-volt peak voltage of nominal 110 volts AC, but more are used to give a safety factor.

The selenium rectifier is represented by the symbol shown in Figure 56. Note the direction of high resistance to electron flow. The terminal marked positive (+) is generally daubed with red paint.

Frequently it is desirable to use selenium rectifiers to accomplish full-wave rectification. The bridge circuit of Figure 57 is most commonly used. The terminals marked AC are daubed with yellow paint to indicate that they are connected to alternating current.

The electrolytic filter capacitors are connected in the manner indicated—with the red positive terminal connected to the positive terminal of the rectifier.

The selenium rectifier will withstand high current overloads, but voltage overloads puncture the barrier layer. When the barrier layer has been punctured a pungent odor will be noticed. If the overload is slight, the selenium will heal the puncture, but if a severe overload has occurred, the entire rectifier must be replaced.

Germanium Crystal Rectifiers. In the early days of radio development radio receiving sets used a detector made by clamping a small piece of metallic crystal in a small cup or receptacle. A flexible wire "cat whisker" was held in light contact with a "sensitive" spot on the crystal. This arrangement permitted electrons to

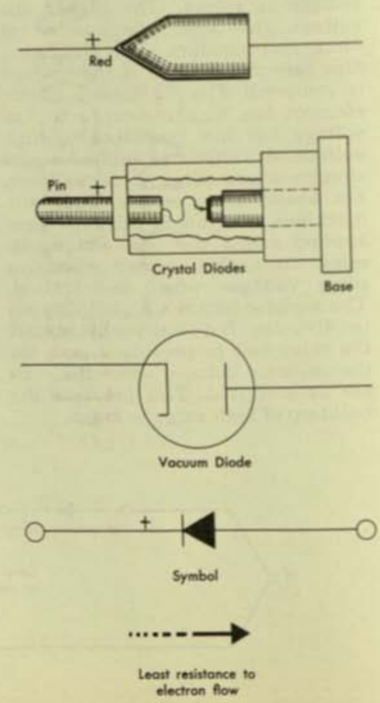


Figure 58. Rectifier Polarity

flow easily from the cat whisker, which was made of a metal having free electrons, to the crystal, but electrons were impeded in the reverse direction because the crystal had very few free electrons. Thus, rectification or detection of the incoming radio frequency voltage was accomplished. The development of the vacuum tube diode made crystal detectors obsolete in commercial radio sets; however, because the crystal diode rectifier is superior in certain respects to the vacuum-tube diode, especially in high-frequency circuits, considerable development has been made on this device.

The most widely used substance for crystal diodes is crystalline germanium. A germanium crystal is pressed into a holder and the exposed surface is then ground and polished to a bright finish. The crystal is assembled in its cartridge with a "cat whisker" of platinum or tungsten pressing lightly on the germanium surface. A high current is sent through the assembly momentarily to heat the cat whisker, and a weld is formed between the whisker and the crystal. The welded unit is mechanically stable, and does not require further adjustment.

A method of testing germanium diodes will be found on page 10.

Tips on Crystal Diodes

1. Do not pull on the diode leads. The unit is fragile and can be open circuited with excessive abuse.
2. Care should be exercised when soldering the diode in the terminal block. Excessive heat can be transmitted through the terminal leads to the crystal and cause damage. Only apply sufficient heat to melt the solder. Grip the lead between the body of the diode and the soldering point with a pair of pliers so that some of the heat that would normally be transmitted to the diode will be absorbed by the pliers.
3. Do not mount the diode on the terminal block with the reads pulled tight.
4. A new diode can be defective. Always test a diode a second time after it has been installed in the terminal block.
5. The life of a diode cannot be determined by testing, as the most common break occurs at the connection between the whisker and the crystal. A diode may be tested and will operate satisfactorily one minute, but it may become defective the next. Only after a satisfactory period of operation may the diode be considered stable.
6. A high temperature in an area around a diode can cause unsatisfactory results. Do not mount the diodes in a tight solid group. Leave some space for air circulation around each diode.
7. Crystal diodes have a very short "shelf life." Diodes that are in a machine, or kept in a tool bag and not used electrically will deteriorate very fast. Suggestion: Operate all diodes electrically once a week to keep them ready for use when required.

More information on crystal diodes will be found on page 9.

Thermistors

Thermistors are varistors that change electrical resistance with changes in temperature. They are usually used as resistance thermometers to measure temperature changes electrically. Substances such as uranium oxide and silver sulfide are melted and formed into beads. Platinum wires form the electrical connections to these beads. In the power supply of the Type 604 a thermistor is used to set up an accurate standard voltage against which a portion of the line voltage is compared. A change in line voltage changes the voltage drop across the thermistor and actuates a circuit to adjust the output voltage.

Transformers

A transformer is a device for changing the voltage of alternating current power. It consists of two or more windings around a soft iron core. Current in the *primary* winding induces a pulsating magnetic field about the transformer, and the varying magnetic field induces a voltage in the secondary windings.

The following rough working rule to apply to transformer voltages should be remembered.

$$\frac{\text{Primary voltage}}{\text{Secondary voltage}} = \frac{\text{Turns in primary winding}}{\text{Turns in secondary winding}}$$

The rule is useful in determining which taps of the power transformers on IBM machines should be selected. One type of IBM power transformer is shown in Figure 59. One side of the input AC line should be connected to the nominal line voltage (for example, 150 volts) binder post and the other side should be connected to *N*. With the IBM meter on the 50-volt DC scale, the DC voltage measured across the bleeder resistor should be 46 ± 2 volts. If the voltage is less than 44 volts, move the input wire from *N* to LOW. By decreasing the number of effective turns in the primary, the voltage induced in the secondary will be increased. If the output voltage must be lowered, the transformer tap labeled *H* is used. Increasing the number of effective turns in the primary reduces voltage induced in the secondary.

Figure 59B shows another IBM power transformer. This type has adjustable taps on both primary and secondary windings. The line voltage is normally connected between taps 1 and 3 on the primary winding. If the line voltage is higher than 117 volts, the DC output voltage will be greater than 48 volts. To remedy this condition, the live wire may be moved from tap 3 to tap 4, *increasing the number of turns in the primary* and reducing the secondary voltage. If the meter connected across the DC terminals still indicates above 48 volts, the secondary tap (*A* on the diagram) should be moved to include *fewer* turns. *Decreasing the number of turns in the secondary will reduce the output voltage.*

If the output voltage as measured by the meter is lower than 44 volts, the number of turns on the primary may be decreased, and the number of turns on the secondary may be increased.

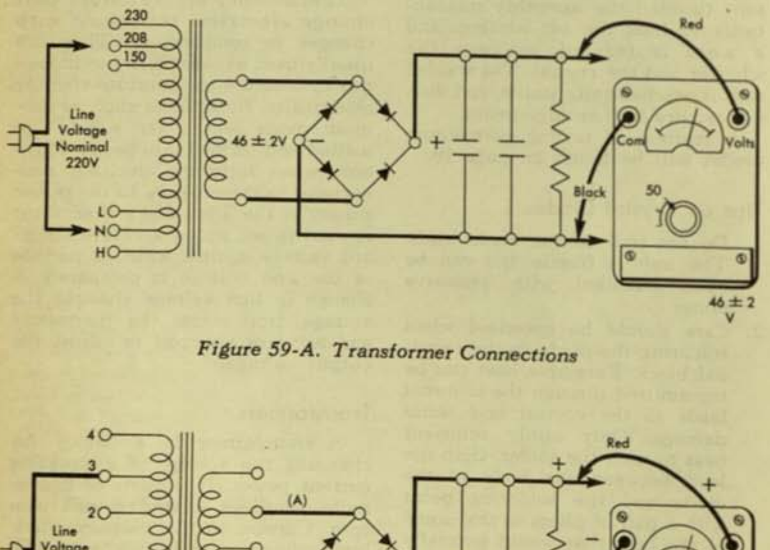


Figure 59-A. Transformer Connections

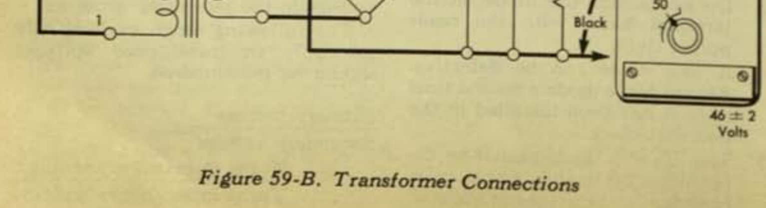


Figure 59-B. Transformer Connections

CIRCUIT BREAKERS

IBM

Circuit Breakers and Cam Contacts
Preventive Maintenance and Adjustments

CONTENTS

New York, New York
Printed in U.S.A.
Form 22-8885-0

Circuit Breakers and Cam Contacts

General

The proper inspection, lubrication and adjustment of circuit breakers and other electrical timing devices is becoming more important because of higher machine speeds and because of the use of circuit breakers in electronic circuits. The impulse duration has, in some cases, been reduced to a relatively short impulse with a very limited tolerance.

A high resistance short caused by dirt or carbonized oil between the circuit breakers may be the cause of intermittent failures in electronic circuits, while in a relay or magnet circuit this same short might not cause any trouble.

If the circuits are to perform their functions properly, it is imperative that the circuit breakers and cam contacts receive regular and thorough preventive maintenance.

When an adjustment is necessary, the circuit breakers should first be cleaned, inspected, and lubricated, using the procedure outlined for each type.

A complete row of circuit breakers with the wires attached can, in most cases, be loosened and moved out from the machine for easier cleaning and inspection. Take care that the wires are not stretched, broken, or pulled loose from the circuit breaker terminals. Do not allow circuit breaker assemblies to be supported only by the wires at any time.

Circuit breakers should be cleaned thoroughly using an authorized solvent to remove all old oil, grease and dirt. Be careful to clean the spaces between circuit breakers and to clean the insulating strips in the contact pile-ups.

Grasp each row of circuit breaker cams and attempt to rotate the shaft in one direction and then the other, checking the gear train for play. The only play that is allowable is caused by the normal wink between the gears. If the play seems to be excessive, check carefully to determine the cause.

When the contacts are timed, the end of the cam duration which has the degree given on the timing chart is to be accurately set. This may be either the make or the break time for the contact. A split-block adjustment is provided on the drive gear of most units to allow all the cams to be timed more closely than could be done by moving the drive gear one full tooth. The split block should be adjusted only if the majority of circuit breakers requires the same amount of change in timing.

Use a dynamic timer to check the make or break timing and the duration whenever it is possible to use one. Reference should be made to customer engineering manual *Meters and Test Devices* (Form 22-8788-1) for complete instructions concerning the use of the dynamic timer. The dynamic timer gives an accurate picture of the duration only. It does not show contact condition. An ohmmeter should be used to determine the quality of the circuit through the connecting wires and contact points. Machine power must be OFF when using a test light or an ohmmeter.

The screws holding the contact pile-ups, the brass jumpers, and the wire terminals should be checked for tightness.

The adjustments for each type of circuit breaker are listed in the order in which they should be made.

A new customer engineering reference manual, *Meters and Test Devices*, Form 22-8788-1 describes the method used to check circuit breaker impulses with an oscilloscope. If such a device is available, it can give an accurate picture of the circuit breaker impulse.

ROCKER ARM CIRCUIT BREAKER

Preventive Maintenance

Use an authorized solvent to clean cam surfaces of all old grease and dirt. Check to see that the cam is not loose, warped, or eccentric.

Cam rollers should be checked to see if they are loose or binding. Replace the rocker arm when the roller bearing is bad.

The rocker arm pivot should be checked to see if it is loose or binding. Replace the rocker arm when the pivot bushing is worn.

Circuit breakers should be cleaned with an authorized solvent. If the points are badly pitted, replace them. When it is necessary to use an abrasive on circuit breaker points, it is recommended that a folded strip of trimite paper be used. After cleaning with a solvent or with an abrasive, make certain that all particles have been removed from the contact surfaces. A good method to follow is to rub the surfaces with a finger and then to polish thoroughly with a burnishing tool.

A rocker arm is available that has a removable point. It is to be used in positions where frequent replacement of points is necessary. The part numbers of the arm and point are: contact breaker arm 198248; contact point (only) 198247; nut 27073; lock washer 6364; circuit breaker arm (only) 198275.

Check the screws holding the contact pile-ups for tightness.

Make certain that the contact surfaces are parallel and that they meet squarely.

If any of the rocker arms seem to have noticeably less spring tension than the others, replace them.

When any of the component parts of the circuit breaker assembly are replaced, the adjustments should be checked.

Lubrication

IBM 6

(1) The cam follower roller.

(2) The rocker arm pivot.

IBM 17

(1) A very light film on the cam surface.

(2) The cam follower roller (apply IBM 6 first).

Exercise caution in lubricating contact assemblies. Where the contact points are lower than the pivot point, too much lubricant should not be used, because it will run down the arm and may prevent the points from making contact.

Adjustments

1. Align the points so that the sides and faces are parallel (Figure 1).

2. The cam follower roller must be clear of the cam surface when the points are closed (Figure 1).

3. With the cam follower roller on the high surface of the cam, set the contact air gap with the adjustable contact point as specified on the electrical timing chart for the machine (Figure 2). On some older machines the correct air gap must be obtained from the customer engineering manual of instruction.

4. Loosen the setscrews in the circuit breaker cam (Figure 2), and turn the cam to obtain the proper timing as specified on the electrical timing chart for the machine. Use a dynamic timer whenever possible to check the timing of the circuit breaker contacts. Be sure to tighten the setscrews if they have been loosened.

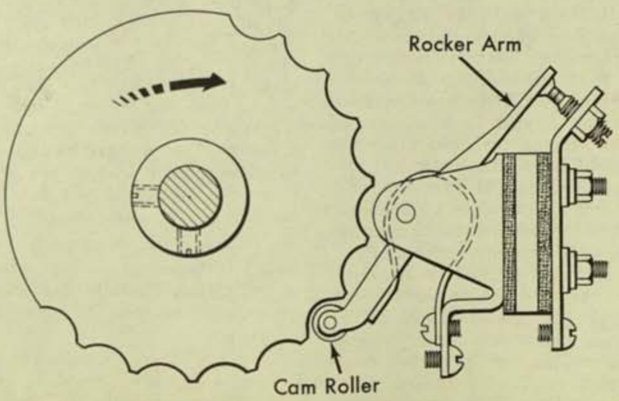


Figure 1. Rocker Arm Circuit Breaker Adjustments 1 and 2

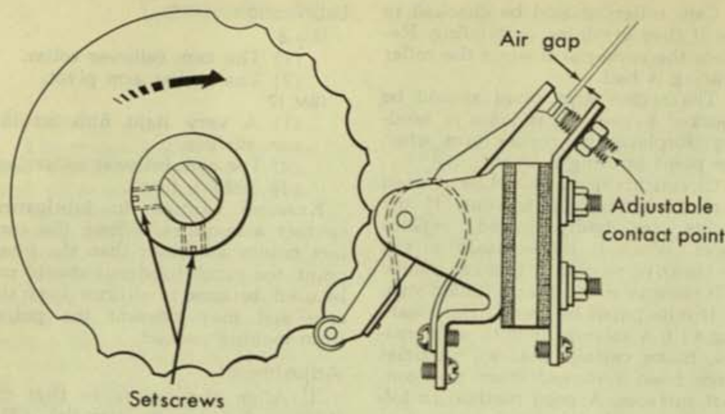


Figure 2. Rocker Arm Circuit Breaker Adjustments 3 and 4

PLUNGER CIRCUIT BREAKER

Preventive Maintenance

Inspect for a build-up of carbonized oil or other foreign material which could cause a short circuit between the contact straps. This accumulation will occur around the points and between the straps.

The plunger type circuit breakers cannot be properly cleaned in the machine. The complete contact bar assembly can usually be removed from the machine with the wires attached. These bars are not doweled, so it is necessary to use some means of determining that they are reinstalled in the same position from which they were removed. One method is to check the timing of a few cams on each end before the bar is removed. Then reinstall the bar so that these cams have the same timing that they formerly had.

When the circuit breaker assemblies are removed from the machine, they should be flushed out with an authorized solvent. Be very careful not to damage the wires and cables. The circuit breaker assemblies should never be supported by wires alone.

This cleaning procedure must be repeated periodically to reduce the possibilities of machine failure by minimizing the accumulation of dirt and carbon. The recommended maximum length of time between cleanings is six months. When compressed air is available, it should be used to blow the solvent out of the circuit breakers after cleaning.

A burnishing tool should be used to polish the circuit breaker points after they are cleaned. This will remove any particles or any film that is left by the cleaning process. A new burnishing tool, part 450567, is available. It can be used to burnish normally closed and normally open plunger type circuit breaker points.

Check the cable connections to the circuit breakers. Screws holding the brass jumpers and contact pile-ups should be tightened periodically. The taper plugs that plug into the circuit breaker contact block may become loose due to vibration or movement of the cable. They should be tightened using long nosed pliers.

Circuit breakers with badly pitted points or with worn plungers should be replaced as an assembly. It is not advisable to change component parts. The contact tension must be exact if the circuit breaker is to operate correctly, and this tension cannot be properly obtained by the customer engineer when he replaces the contacts. The plunger has a tendency to stick when it becomes worn. It is, therefore, better to replace the old contact with a new assembly.

Lubrication

Plunger and Latching Plunger Circuit Breakers.

IBM 6

(1) Place a small amount on the contact operating plunger. Never lubricate the plastic contact operating plunger of the roller cam follower circuit breaker.

(2) The pivot of the contact latch of the latching plunger circuit breaker.

IBM 9

(1) On the Type 602A and the Types 402-403 machines the Bijur lines to the felt cam wipers and bearings of the circuit breaker unit should be removed and plugged with the Bijur closure plug, part number 190278. This is done to reduce the amount of oil received by these units. Periodic light applications of IBM 9 on the felt cam wipers will be necessary.

(2) A small amount should be applied to the circuit breaker cam shaft bearings.

(3) Care must be exercised not to over-lubricate the circuit breaker units.

Plunger Circuit Breaker with Roller Cam Follower.

IBM 9

(1) Use sparingly on the roller arm pivot stud.

IBM 12

(1) One drop on each end of the roller shaft.

IBM 24

(1) Apply a light film to the cam surface.

The plastic contact operating plunger of the roller cam follower circuit breaker *should not be lubricated.*

Adjustments — Plunger Type

EITHER a normally open or a normally closed circuit breaker may be used to give the desired contact duration. If the contact duration is to be less than 180°, a normally open circuit breaker is used. The contact will be closed by the cam for the desired time. If the contact duration is to be greater than 180°, a normally closed circuit breaker is used. The contact will be opened by the cam for the number of degrees that the contacts should not be made.

Normally Open Circuit Breaker

1. The lower strap should be formed at point *A* to provide proper tension. (Figure 3). At the factory these straps are adjusted so that a force of 160 grams plus or minus 10 grams (approximately 6 oz.) applied at the tip of the lower strap will just close the points. This tension must be maintained accurately to prevent a bouncing condition.

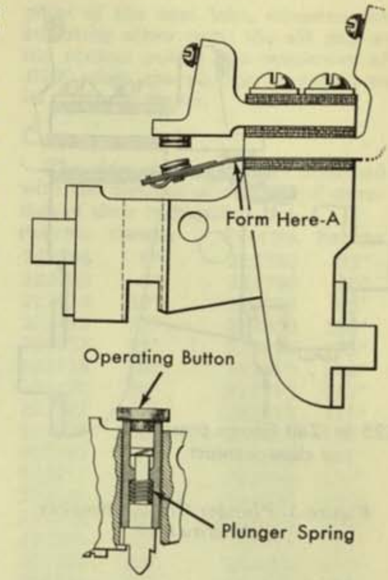


Figure 3. Plunger Circuit Breaker Adjustment 1

2. The upper contact support should be formed at point *B* (Figure 4) to provide a .015″ to .018″ clearance between the upper contact and the lower contact when in its normal position resting on the plunger. Before the upper contact is bent, the operating button is installed which gives the closest starting clearance. The white button 205740 is standard; the red button 186882 is .015″ shorter.

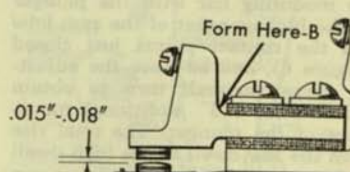


Figure 4. Plunger Circuit Breaker Adjustment 2

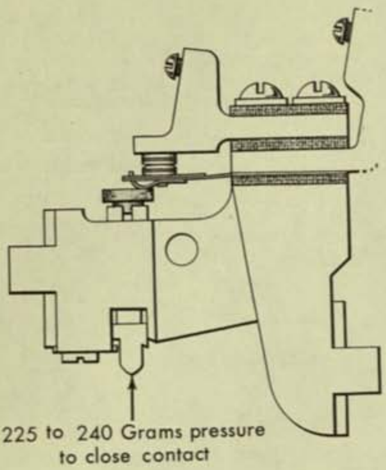


Figure 5. Plunger Circuit Breaker Adjustment 3

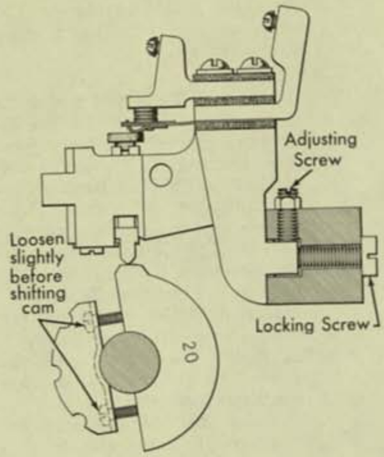


Figure 6. Plunger Circuit Breaker Adjustments 4 and 5

3. Check to be sure that the plunger does not bind (Figure 5). The design of the split bushing is such that the coil spring spreads the bushing to create a drag between the bushing and frame which increases the pressure required to close the contact from 160 grams (pressure required to close the contact) to 225 grams (approximately 8 oz.). This friction is used to dampen the rebound when the contact closes. Check to be sure that a maximum of 240 grams applied to the plunger closes the contact.

4. Locate the cam contact unit on the mounting bar with the plunger on the highest point of the cam lobe and the contact points just closed (Figure 6), and advance the adjusting screw one-half turn to obtain a .010" to .015" additional movement of the plunger. The total rise from the low dwell to the high dwell of the cam is .065". With the air gap set for .015" to .018" and the contact assembly correctly located on the mounting bar, the clearance between the cam plunger and the low dwell should not be greater than .018". This may be checked by inserting an .018" gauge between the low dwell of the cam and the plunger and observing any perceptible movement of the contact strap. This indicates that the additional travel of the plunger, after the contact is closed, will be sufficient to compress the plunger spring and provide good contact tension.

5. To adjust the make time of the contact, loosen the screws holding the cam to the shaft (Figure 6) until the cam is just snug on the shaft. Turn the machine to the index point corresponding with the make time of the cam. Move the cam on the shaft in the direction of rotation until the contact just closes. The machine may now be turned to a point where the cam holding screws can be tightened. The circuit breaker cam clamp is provided with notches and accurate adjustment of the cam may be obtained by tapping lightly against the notch with a screwdriver.

When the cam time duration is of a number of degrees not supplied by a standard cam, an additional adjustment must be made. It will be necessary to raise or lower the contact assembly until the desired condition is satisfied. Check the duration with a dynamic timer after the adjustment is changed. A contact which is dirty or is making with little tension may indicate proper duration on the dynamic timer, yet it may not be capable of carrying a heavier current load such as required to operate one or more relays. Be sure of the contact condition.

Normally Closed Circuit Breaker

The sides of the contact operating button of the normally closed circuit breaker have been cut away to prevent an accumulation of carbon and dirt at the contact points which causes the points to become shorted.

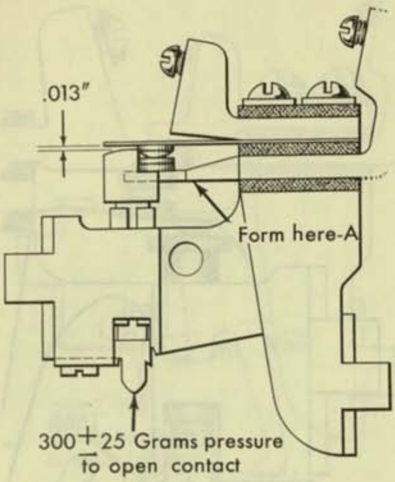


Figure 7. Normally Closed Plunger Circuit Breaker, Adjustments 1 and 2

1. The lower contact support should be formed at the point *A* (Figure 7) to provide a .013" clearance between the upper contact strap when it is in its normal position and the operating plunger.

2. A pressure of 300 grams plus or minus 25 grams (approximately 10.6 oz.) on the contact plunger (Figure 7) should be required to open the contact points.

3. Locate the cam contact unit on the mounting bar at its extreme limit of travel away from the cam (Figure 8). With the plunger on the highest point of the cam lobe, advance the adjusting screw until the air gap at the contact points is a minimum of .020" when the plunger is raised to its limit of travel.

Cams

The side of all cams are stamped with the number of degrees of duration of their high point.

Part No.	Degree	Part No.	Degree
222796	6°	222785	85°
222708	8°	222790	90°
222710	10°	222795	95°
222712	12°	222800	100°
222715	15°	222805	105°
222718	18°	222810	110°
222720	20°	222812	112°
222722	22°	222815	115°
222725	25°	222820	120°
222730	30°	222825	125°
222735	35°	222830	130°
222740	40°	222835	135°
222745	45°	222840	140°
222750	50°	222845	145°
222755	55°	222850	150°
222760	60°	222855	155°
222765	65°	222860	160°
222770	70°	222865	165°
222775	75°	222870	170°
222780	80°	222875	175°
		222880	180°

Where it is necessary to have closer tolerances than are available with powdered bronze cams, machined steel cams are used.

Adjustments — Latching Type

The latching plunger circuit breaker (Figure 9) makes it possible

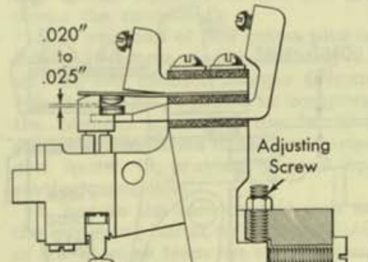


Figure 8. Normally Closed Plunger Circuit Breaker, Adjustment 3

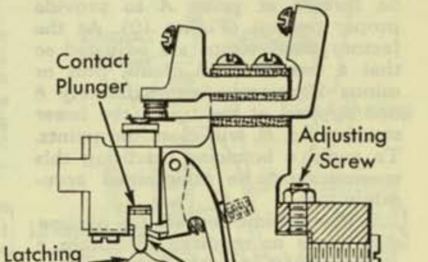


Figure 9. Latching Plunger Circuit Breaker

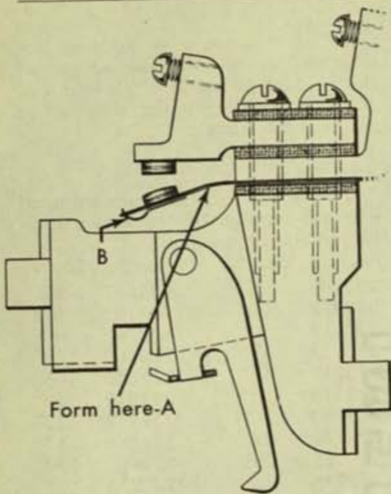


Figure 10. Latching Plunger Circuit Breaker, Adjustment 1

to obtain any desired duration of contact, ranging from a fraction of a cycle point to a complete cycle.

All contacts are closed by a lobe on a bronze cam which operates against the contact plunger and carries it beyond the latching point so that the latch arm may support the contact plunger. The unlatching cam may be adjusted to any position with respect to the periphery of the bronze cam. This cam strikes the latch arm and unlatches the contact plunger. In this manner the contact duration may be adjusted.

1. The lower contact strap should be formed at point *A* to provide proper tension (Figure 10). At the factory these straps are adjusted so that a force of 160 grams, plus or minus 10 grams, (approximately 6 oz.) applied at the tip of the lower strap, point *B*, will close the points. To avoid a bouncing condition this tension must be maintained accurately.

2. Place shims beneath the plunger stop plate as required to obtain a .040" to .050" travel of the plunger before latching up occurs (Figure 11). If the contact plunger is overlapped by the latch by an amount equal to the thickness of the latch metal, this should provide the .040" to .050" travel. When the latch arm is unlatched, a pressure of 45 grams plus or minus 5 grams, applied at the point where the unlatching cam operates against the latch arm should move the latch away from the plunger.

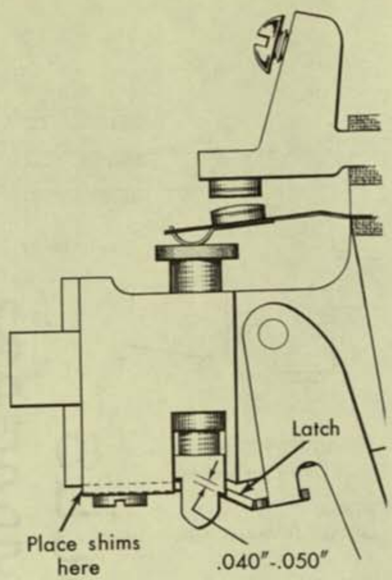


Figure 11. Latching Plunger Circuit Breaker, Adjustment 2

3. Place shims between the lower contact terminal block and the contact strap (Figure 12) to provide a .015" to .018" air gap between the contact points.

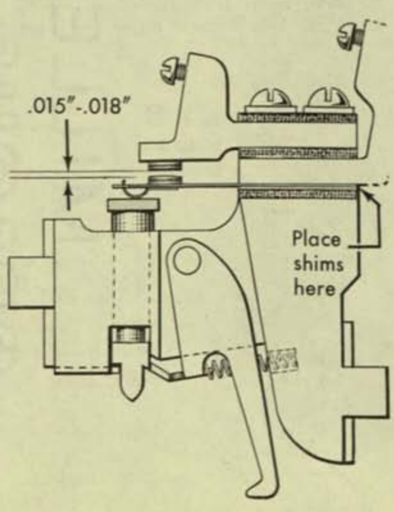


Figure 12. Latching Plunger Circuit Breaker, Adjustment 3

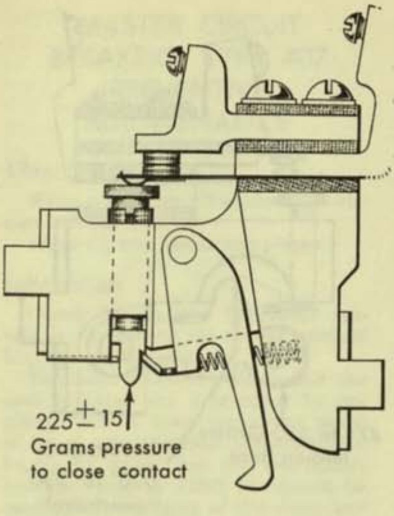


Figure 13. Latching Plunger Circuit Breaker, Adjustment 4

4. Check to be sure that the plunger does not bind (Figure 13). The design of the split bushing is such that the coil spring spreads the bushing to create a drag between the bushing and frame, increasing the pressure required to close the contact from 160 grams (pressure required to compress the spring) to 225 grams (approximately 8 oz.). This friction is used to dampen the rebound when the contact closes. Check to be sure that a maximum of 240 grams applied to the plunger closes the contact.

5. A pressure of 600 grams plus or minus 20 grams, (approximately 21 oz.) on the contact plunger (Figure 14) should be required to compress the plunger spring to the latching point. These values have been tested and found to provide a good operating condition.

6. Locate the cam contact unit on the mounting bar at its extreme limit of travel away from the cam (Figure 15), and with the plunger on the highest point of the cam lobe, advance the adjusting screw until the plunger latches; then advance the screw one-half turn additional to obtain a .010" to .015" movement of the plunger beyond the latch point. This will provide clearance between the low dwell of the cam and the plunger.

7. To adjust the make time of the contact, loosen the screws holding the cam to the shaft (Figure 15)

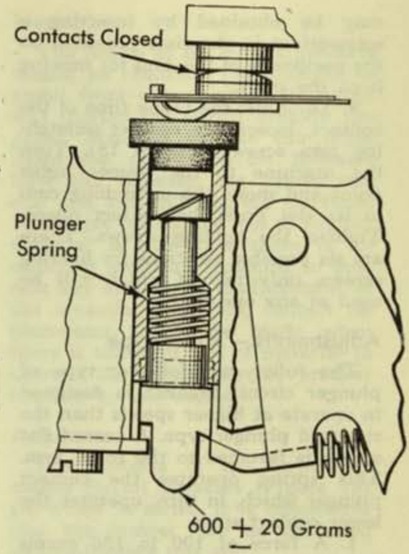


Figure 14. Latching Plunger Circuit Breaker, Adjustment 5

until the cam is just snug on the shaft. Turn the machine to the index point corresponding with the make time of the cam. Move the cam on the shaft in the direction of rotation until the contact just closes. The machine may now be turned to a point where the cam holding screws can be tightened. An accurate adjustment

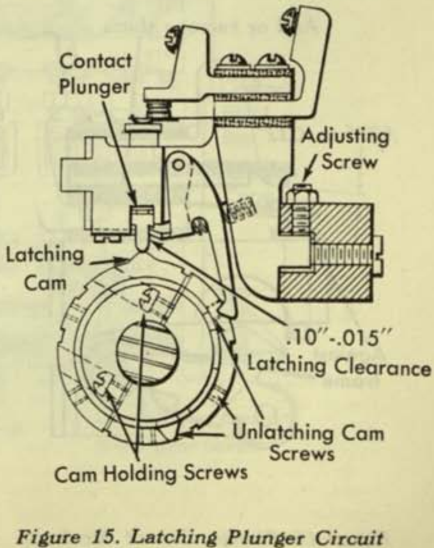


Figure 15. Latching Plunger Circuit Breaker, Adjustments 6, 7, and 8

may be obtained by inserting a screwdriver in the slots provided on the periphery of the cam for moving it on the shaft.

8. To adjust the break time of the contact, loosen the contact unlatching cam screws (Figure 15). Turn the machine to the proper index point and move the unlatching cam in its slot until the contact opens. Tighten the holding screws. There are six possible positions for holding screws, only two of which will be used at any one time.

Adjustments — Roller Type

The roller cam follower type of plunger circuit breaker is designed to operate at higher speeds than the standard plunger type. A curved flat spring is fastened to the roller arm. This spring operates the contact plunger which, in turn, operates the lower contact strap.

1. A force of 100 to 150 grams should be required to move the operating point to the point where it contacts the stationary point when measured at the end of the operating strap.

2. The contact air gap should be .027" to .032" when the plunger is resting against the frame (Figure 16). Add or remove shims to obtain this adjustment.

3. When measured at the roller, 475 to 550 grams should be required to close the contacts with a .020" to .030" overtravel (Figure 17).

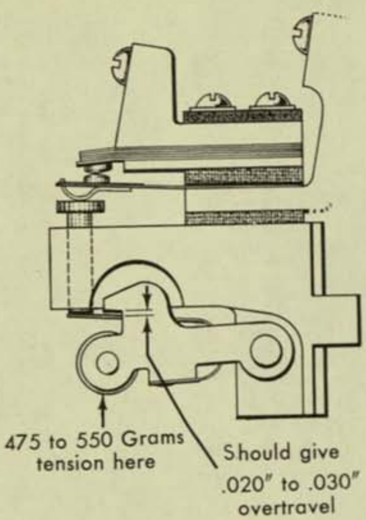


Figure 17. Plunger Circuit Breaker, Roller Cam Follower, Adjustment 3

4. With the circuit breaker assembly attached to the mounting bar by the holding screw (Figure 18), turn in on the adjustment screw to obtain a contact air gap of .017" to .022" when in the low dwell of the cam.

5. When positioning the dilecto cams, be careful not to tighten the cam holding screws too severely as their walls may crack.

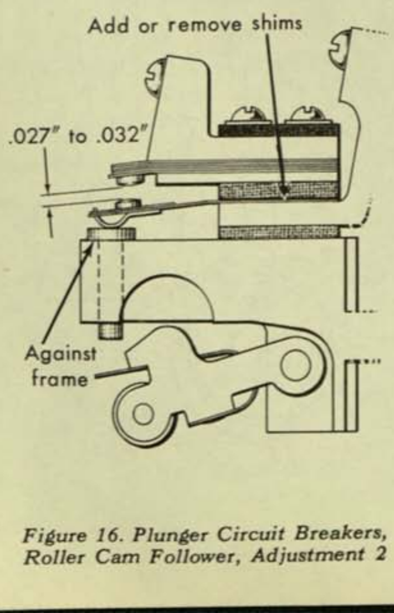


Figure 16. Plunger Circuit Breakers, Roller Cam Follower, Adjustment 2

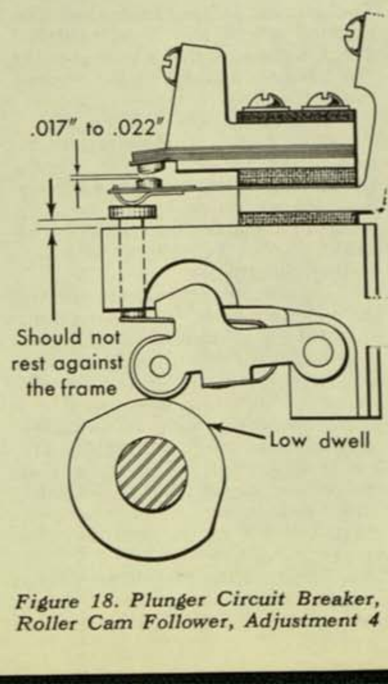


Figure 18. Plunger Circuit Breaker, Roller Cam Follower, Adjustment 4

MASTER CIRCUIT BREAKERS, TYPE 407 PREVENTIVE MAINTENANCE

Cleaning

Wipe away any oil around the circuit breaker points.

Wipe off the insulating plates.

Lubrication

Check to see that the Bijur system is furnishing oil to the contact bracket pivot point.

The cam follower rollers and the cam surfaces are lubricated by capillary action from the pivot point of the contact bracket assembly and by the oil vapor that fills the circuit breaker housing. IBM 17 should be used on the surfaces of the cams and rollers to supplement this means of lubrication.

3. A drop of IBM 9 should be applied to the roller bearings.

4. A small amount of IBM 21 should be applied to the point of sliding contact between the contact point bar and the contact cage.

Inspection

The timing of the circuit breakers should be checked. The transfer of metal from one point to the other will shorten the circuit breaker impulse. Machine failures can occur when the master circuit breakers have lost between one degree and one and one-half degrees duration. When this occurs, the loss of contact material is such that there is insufficient material remaining to warrant any attempt at readjustment of the contacts. Therefore, contact replacement should be made when there is sufficient loss of material to shorten the master circuit breaker impulse by one degree.

Adjustment

The contacts of the Type 407 master circuit breakers (Figure 19) are wired in series. It is imperative that the utmost care be exercised when adjusting this unit.

The following procedure should be followed when installing new contact points in the master circuit breakers:

1. Install the new contact points, four of part 203866 and two of part 203894.

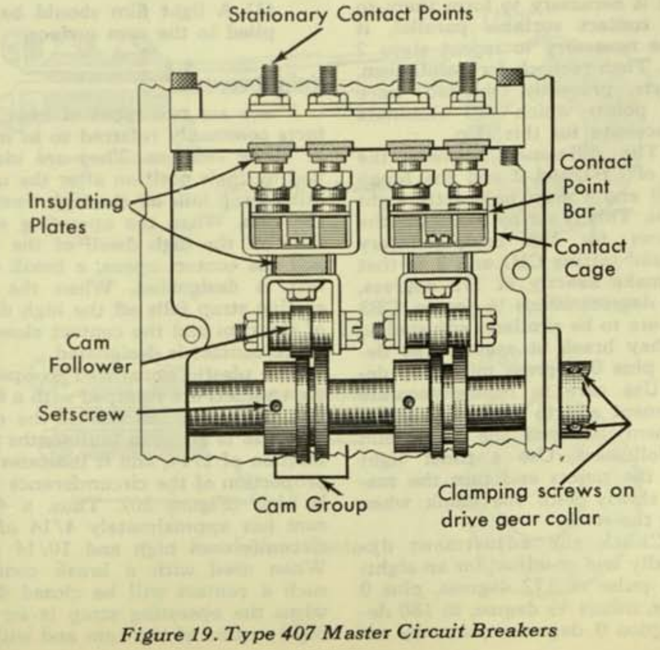


Figure 19. Type 407 Master Circuit Breakers

2. Connect the first dynamic timer light from CB1 to the common contact cage, and the second light from CB2 to the common contact cage. Turn the machine slowly, using the front crank, and adjust contacts 1 and 2 so that the timer lights make and break together and so that a duration of ten degrees is obtained. This is accomplished by varying the air gap by adjusting the stationary contacts. It is extremely important that the contacts make exactly together and break exactly together. To insure this condition, extreme care must be used and the machines must be cranked very slowly. The time of make and break with respect to the index time is not important at this time.

3. Connect timer light from CB3 and 4 to common contact cage as in step 2, adjust for ten degrees duration, and for the contacts to make and to break exactly together. As with CB1 and 2 it is necessary that extreme care be used to insure that the contacts make and break together as accurately as the adjustment can be made, and that the contacts have exactly a 10 degree duration.

4. If the contact points being adjusted have flat points, they must be carefully straightened so that all contact surfaces are exactly parallel. In the event flat contacts are used and it is necessary to form them to make contact surfaces parallel, it will be necessary to repeat steps 2 and 3. Then recheck for parallelism. Contacts presently shipped have round points which will eliminate the necessity for this step.

5. The difference between the make of CB1 and 2 and the break of CB3 and 4 must be exactly eight degrees. This is set by loosening the setscrews for the complimentary cams and setting CB1 and 2 so that they make exactly at 172 degrees, plus 0 degrees minus ½ degree. CB3 and 4 are to be similarly adjusted so that they break at exactly 180 degrees, plus 0 degrees minus ½ degree. Use care to insure accurate adjustment and to keep the correct alignment between the cams and cam followers. Use a timer light across the points and turn the machine slowly with the crank when timing the cams.

6. Check the adjustment dynamically and re-adjust for an eight-degree pulse at 172 degrees, plus 0 degrees, minus ½ degree, to 180 degrees, plus 0 degrees, minus ½ degree, if necessary. Check the impulse at the other cycle points. However, *slight variations* at other points on the index can be ignored as there will be some slight variation due to manufacturing tolerances on the lobes of the cams and the effect of the variable speed of the selector gear shaft.

SPRING STRAP CAM CONTACT

Preventive Maintenance

Clean the cam surfaces and contacts of all grease oil and dirt using an authorized solvent. When a point is badly burned, replace the contact strap assembly.

Check the contact points to see if they are loose in the strap. They can be tightened by peening the point.

Stone the points to a flat surface using a flexstone or trimite paper. After stoning or cleaning the contact points, they must be thoroughly polished with a burnishing tool.

Make certain that the contact surfaces are parallel and that they meet squarely. Check the screws in the contact pile up for tightness.

Lubrication

IBM 17

(1) A light film should be applied to the cam surface.

Adjustments

There are two types of cam contacts commonly referred to as *make* or *break* contacts. They are identified by their position after the operating strap falls off the high dwell of the cam. When the operating strap falls off the high dwell of the cam and the contact opens, a break contact is designated. When the operating strap falls off the high dwell of the cam and the contact closes, a make contact is designated.

The plastic cams used to operate the contacts are stamped with a fraction indicating the size of the cam. The size is given in fourteenths or a fraction of 1/14, and it indicates the proportion of the circumference that is high (Figure 20). Thus, a 4/14 cam has approximately 4/14 of its circumference high and 10/14 low. When used with a break contact, such a contact will be closed 4/14 when the operating strap is on the high portion of the cam and will be

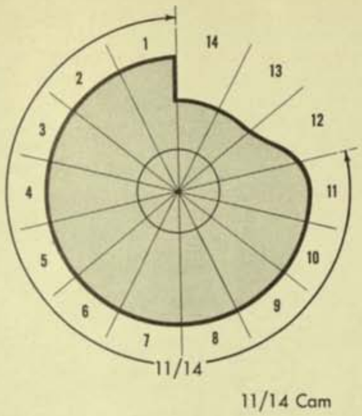


Figure 20. Contact Cam

open 10/14 when on the low dwell of the cam. If a make contact is used, the contact will be open for 4/14 and closed for 10/14 of the circumference of the cam. A make contact is open when the operating strap is on the high portion of the cam.

1. Align the contact points for full contact by loosening the contact mounting screws and shifting straps for proper alignment. Be sure the screws are tightened.

2. Adjust the make contact by bending the non-operating strap for an air gap of 1/32″ between points when the operating strap is on the high dwell of the cam (Figure 21). The operating strap should have sufficient tension to insure good contact when the points are closed.

3. Adjust the break contact by bending the non-operating contact support for 1/32″ rise of the non-operating strap off its support when the operating strap is on the high dwell of the cam (Figure 21). When the operating strap drops off the high dwell of the cam, there should be at least 1/16″ air gap between the points. There should not be too much tension on the operating strap. Too much tension will cause noisy operation and excessive wear on the cams.

4. Adjust the timing of the contacts by loosening the cam setscrews and shifting the cam on the shaft (Figure 21). The timing of the individual contact is obtained from the timing chart which accompanies the machine. Make contacts are timed for the making point (the point at which the contact strap falls off the high dwell of the cam). Break contacts are timed for the proper breaking point, according to the timing chart (the point at which the operating strap falls off the high dwell of the cam).

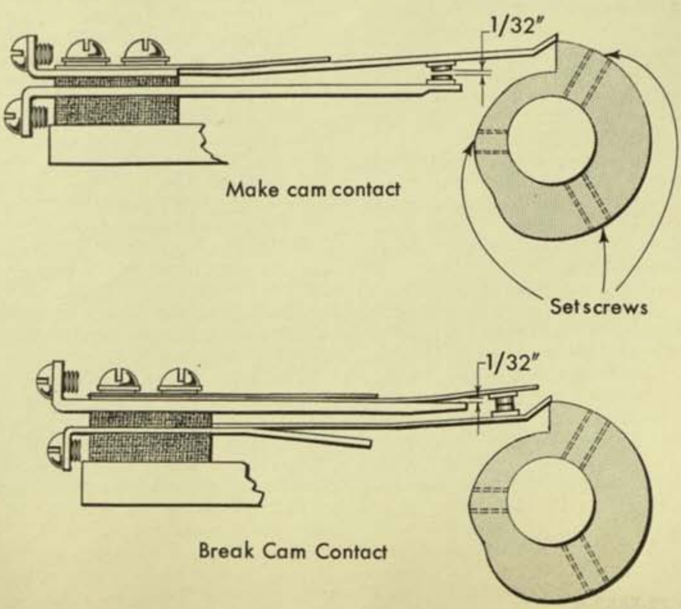


Figure 21

Form 22-8885-0

IBM CUSTOMER ENGINEERING

REFERENCE MANUAL

ELECTRONIC TUBE TESTER

CONTENTS

Printed in U.S.A.
Form 22-5644-0

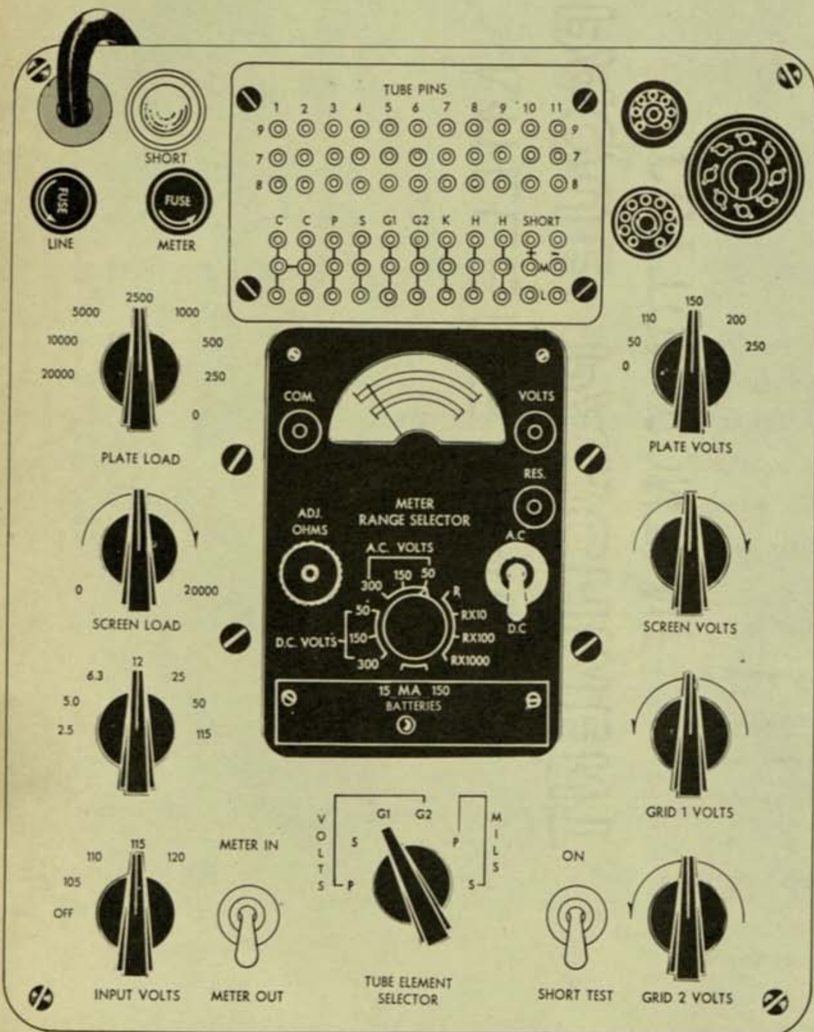


Figure 1. Electronic Tube Tester

ELECTRONIC TUBE TESTER

INTRODUCTION

THE IBM Electronic Tube Tester (Figure 1) is a portable unit designed to test the electronic tubes commonly used in IBM under load conditions which approximate the actual circuits in which the tube is used. The short test will detect short circuits of up to 2 megohms resistance between elements. The meter used in this tester has a 10,000 ohm/volt, 100 micro-ampere movement identical to the IBM Volt-Ohmmeter 450461 now in use. The tester is so set up that the meter can be used independently and if necessary be replaced by a standard IBM Volt-Ohmmeter.

A tube tester has the primary task of indicating a *bad* tube. A tube which fails any one of the specified tests may be rejected; however, tubes which pass all the specified tests satisfactorily can be proved good only by use in the machine.

Three basic tests are made on each tube:

1. Maximum plate current with zero volts on the control grid. For example, this tests the ability of the tube to conduct enough current to energize a selector unit magnet on the Type 077.
2. Control grid voltage required to cut off plate current. In the 077 application, this tests the ability of the tube to stop conduction as soon as the card brush circuit breakers open the reading circuit.
3. Presence of a short between any two elements of the tube.

Additional tests may be made for some tubes, but all tests bear a relationship to the actual circuit used, and the ability of the tube to function properly in that circuit.

When many tubes are to be checked, the tester should be set up and all tubes run through that portion of the test before changing the setup. If possible, the tester should be placed near the machine so that the tubes can be preheated with a minimum of lost time.

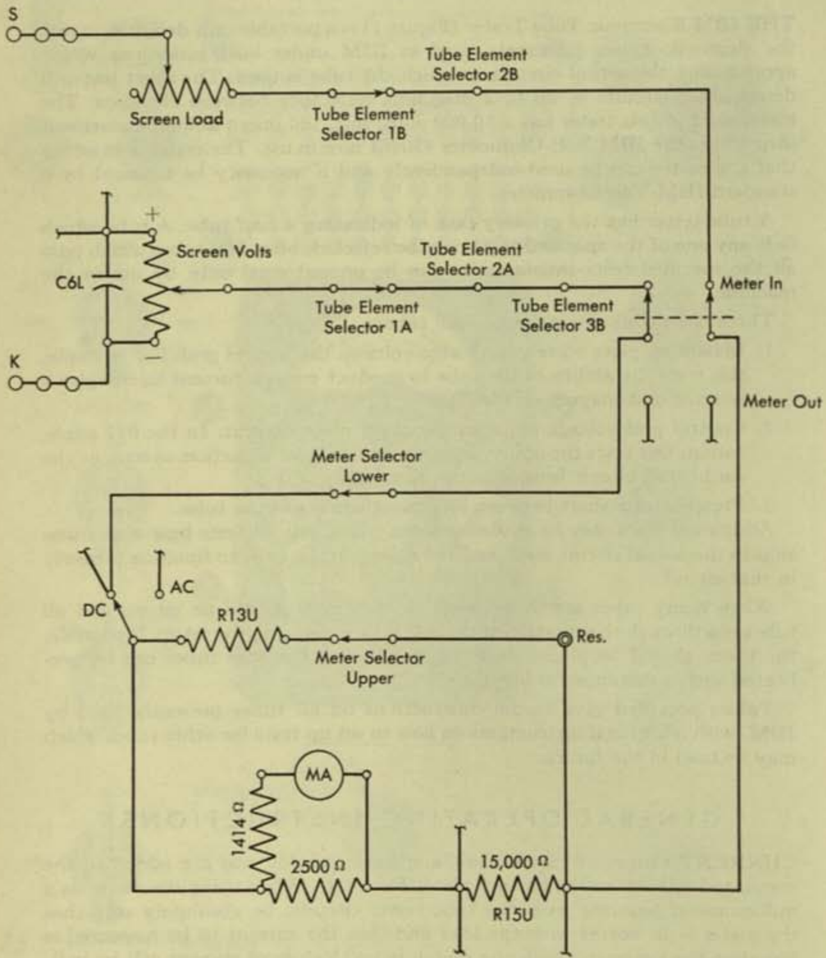
Tables provided give testing instructions on all tubes presently used by IBM, with additional instructions on how to set up tests for other tubes which may be used in the future.

GENERAL OPERATING INSTRUCTIONS

CURRENT ranges of 15 *ma* (milliamperes) and 150 *ma* are added to the meter and labeled on the battery plate (Figure 2). When using the meter as a milliammeter separate from the tube tester circuits, be absolutely sure that the meter is *in series* with the load and that the current to be measured is less than the range to which the switch is set. Values of current will be indicated on the volts scale of the meter face.

The tester is protected by a 3-amp. glass fuse, and the meter element is protected by a $\frac{1}{32}$-amp. glass fuse. Note that both of these are short fuses and cannot be replaced by the standard length glass fuse. The $\frac{1}{32}$-amp. fuse must be checked by an ohmmeter, not a test light. Good $\frac{1}{32}$-amp. fuses may have up to 200 ohms resistance.

This meter has two 1.5V pen-light size dry cells for use in the ohmmeter circuits. When using the tester as an ohmmeter, be sure that the power is off and the METER IN-METER OUT switch is set to METER OUT. When the dry cells are replaced, be sure the new ones are installed with the center terminals of the cells pointing toward the right.



Tube Element Selector Switch	S Mils
Screen Loads	5,000 Ω (25L6)
Screen Volts	150V (25L6)
Meter In-Out	Meter In
Meter Range Selector Switch	15 MA
AC-DC Switch	DC

Figure 2. Screen Current and Meter Circuit

On this instrument the title of each control is printed directly below the associated control knob or switch. An explanation of the controls follows.

Control Panel

The three top horizontal rows of 11 hubs each are labeled 9, 7 and 8 and connected to the correspondingly numbered pins of the 9-, 7- and 8-pin tube sockets just to the right of the panel (Figure 3). Note that the rows are labeled 9 (top), 7 (middle) and 8 (bottom). The guide pin at the center of the 9-pin noval socket is connected to hub 10 of the 9 row. The pins are numbered on the faces of the tube sockets in a counterclockwise direction from the key on the 8-pin octal socket or from the blank space on the 7- and 9-pin sockets. (Note: The tube manual shows the bottom of the socket; hence, the pins are numbered in the opposite direction.) The correspondingly numbered pins of each tube socket are not connected together because of patent limitations.

The three lower rows of hubs are connected to the tester circuits, with the exception of six hubs labeled C. These hubs are for use as a common bus where multiple-ended wires might be needed. The P hubs are connected through the plate load resistance to the plate volts supply. The S hubs are connected through the screen grid load resistance to the screen supply voltage. The G-1 hubs are connected through a current limiting resistance to the negative supply voltage. The G-2 hubs are also connected through a protective resistance to the negative supply voltage. (Note the terminology used with this instrument in respect to element designation: G-1 is the control grid; S is the screen grid for tetrodes and pentodes; G-2 is the other active grid in pentagrid tubes and some pentodes.) The K hubs are connected directly to the minus or zero side of the plate and screen supplies. The *two vertical rows* of H hubs (not common to each other) are connected directly to the tapped secondary of the filament transformer for AC heater power. The hubs labeled SHORT are explained with the SHORT-TEST switch.

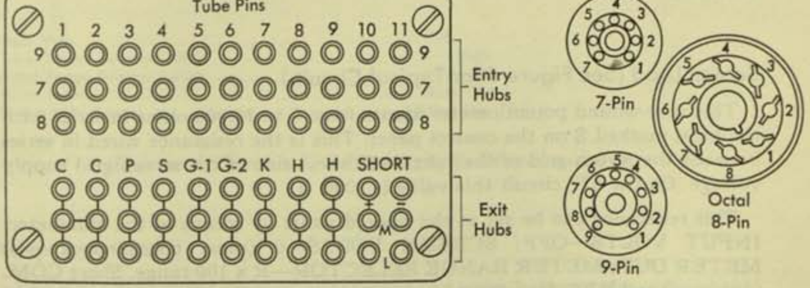


Figure 3. Control Panel and Tube Sockets

Tube Element Selector

This dial switch governs the internal connections of the meter to read the supply volts or tube element currents as indicated.

Meter In — Meter Out

In the METER OUT position, this toggle switch disconnects two of the meter leads to the internal wiring of the tube tester and connects them to the meter jacks so that the meter may then be used as a standard volt-ohmmeter. In the METER IN position, the meter is wired to the tube tester, under the control of the TUBE ELEMENT SELECTOR switch. Although the common meter jack is disconnected from the meter in this position, it is advisable to remove any test leads from the meter jacks while the meter is connected to the tester circuits.

Meter Range Selector

This rotary switch on the meter should be set on the proper range to read the voltage or current in question. When changing from voltage to current readings or vice versa the METER IN-METER OUT switch should be set to METER OUT until the TUBE ELEMENT SELECTOR switch and the METER RANGE SELECTOR switch are both positioned. When using the resistance ranges, be ***absolutely sure*** that the INPUT VOLTS switch is OFF.

Input Volts

This switch in the OFF position removes the 115V 50-60 cycle power from the unit. This switch is used to correct for variations of the existing line voltage. It controls filament, plate and screen supply volts.

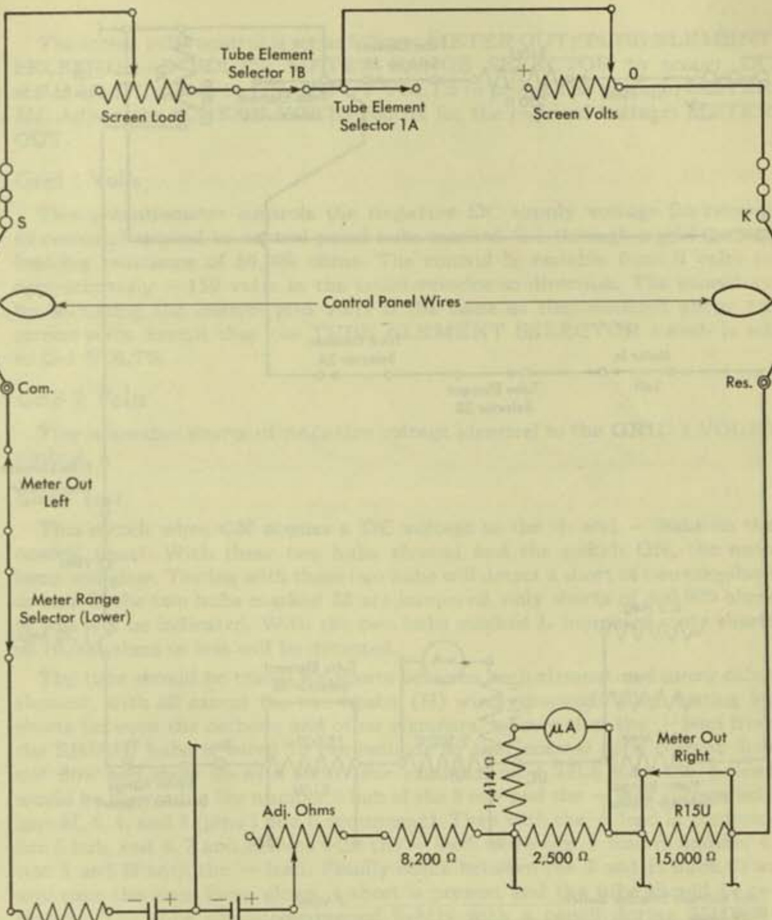
Filament Volts

This switch controls the voltage applied to the two heater (H) terminals on the control panel. Filament voltages for the most popular tube types are provided.

Screen Load (See Figure 4 for Typical Circuit)

This wire-wound potentiometer inserts from 0 to 20,000 ohms in series with the hubs marked S on the control panel. This is the resistance wired in series between the screen grid of the tube and the + side of the screen grid supply voltage. On the 077 circuit this value is 5000 Ω.

This resistance can be set at the desired value by means of the ohmmeter: INPUT VOLTS—OFF; SCREEN VOLTS—0 (max. counterclockwise); METER OUT; METER RANGE SELECTOR—R x 100 range. Short COM. (common) and RES. (resistance) jacks on the meter and turn the ADJ. OHMS control until the meter reads zero on the OHMS scale. Wire from the S and K hubs of the control panel to the COM. and RES. jacks of the meter, and adjust the SCREEN LOAD control for desired resistance; turning the control clockwise increases the resistance.

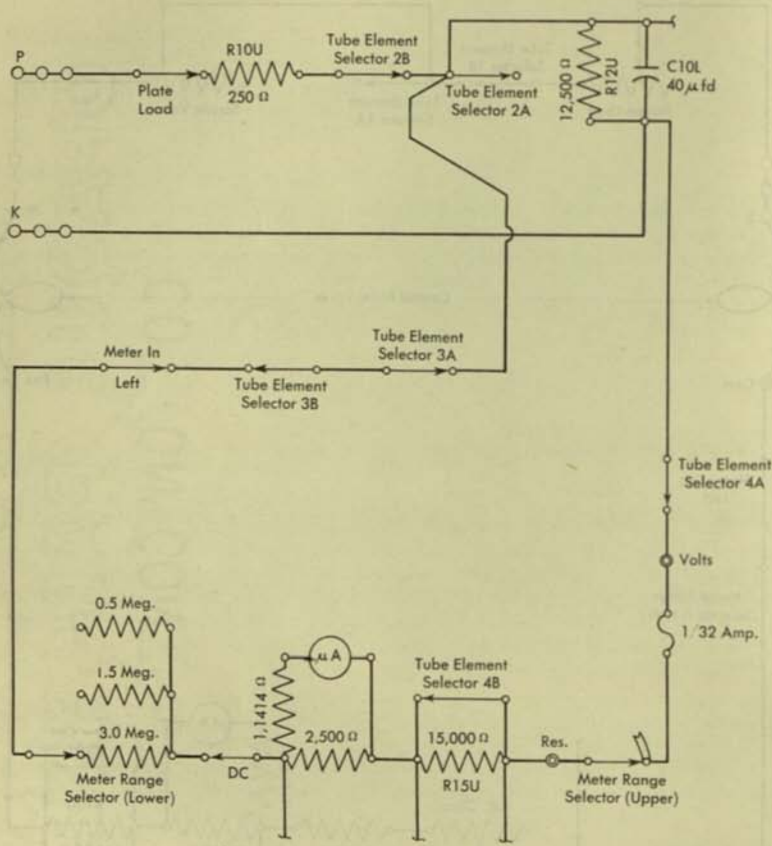


Input Volts	OFF
Tube Element Selector Switch	S — Volts
Meter Range Selector Switch	R × 1,000
Meter In-Out	Meter Out
Screen Volts Control	0 Volts (Max. ↶)

Figure 4. Screen Load Resistance Measurement

Plate Load

The plate load is the amount of resistance in series between the plate of the tube and the plate supply voltage; for instance, the selector magnet coil in the 077. The **PLATE LOAD** selector switch inserts the indicated resistance values (all 10-watt resistors) in series with the P hubs on the control panel.



Tube Element Selector Switch	P Volts
Plate Load	250 (25L6)
Meter Range Selector Switch	300V DC
Meter In-Out	Meter In
AC-DC Switch	DC

Figure 5. Plate Volts Supply and Meter Circuit

Plate Volts (See Figure 5 for Typical Circuit)

This selector switch controls the DC *supply* voltage that is applied through the plate load resistor to the control panel hubs marked P. The indicated approximate voltages are positive with respect to the cathode (K) hub.

Screen Volts

This potentiometer controls the DC *supply* voltage that is applied through the screen load resistor to the control panel hubs marked S. It is continously variable from 0 to approximately +150 volts on the clockwise direction.

The screen volts control is set as follows: METER OUT; TUBE ELEMENT SELECTOR—S VOLTS; METER RANGE SELECTOR to proper DC scale; AC-DC switch to DC; INPUT VOLTS to proper line voltage; METER IN. Adjust the SCREEN VOLTS control for the required voltage; METER OUT.

Grid 1 Volts

This potentiometer controls the *negative* DC supply voltage (in respect to cathode) applied to control panel hubs marked G-1 through a grid current limiting resistance of 50,000 ohms. The control is variable from 0 volts to approximately −150 volts in the counterclockwise direction. The procedure for adjusting the control grid volts is the same as that outlined above for screen volts, except that the TUBE ELEMENT SELECTOR switch is set to G-1 VOLTS.

Grid 2 Volts

This is another source of *negative* voltage identical to the GRID 1 VOLTS control.

Short Test

This switch when ON applies a DC voltage to the + and − hubs on the control panel. With these two hubs shorted and the switch ON, the neon lamp will glow. Testing with these two hubs will detect a short of two megohms or less. If the two hubs marked M are jumpered, only shorts of 300,000 ohms or less will be indicated. With the two hubs marked L jumpered, only shorts of 10,000 ohms or less will be detected.

The tube should be tested for shorts between each element and every other element, with all except the two heater (H) wires removed. When testing for shorts between the cathode and other elements, be sure that the + lead from the SHORT hubs is wired to the cathode so that normal tube current does not flow and show up as a short. For example, on a 25L6 tube the + lead would be inserted in the number 8 hub of the 8 row and the − lead successively into H, 5, 4, and 3 (pins 1 and 6 are unused). Then with the + lead in the number 5 hub, test 4, 3 and H hubs with the − lead. With the + lead in number 4, test 3 and H with the − lead. Finally check between the 3 and H hubs. If at any time the neon lamp glows, a short is present and the tube should be rejected. (The tube should be tapped lightly with a pencil during SHORT-TEST to show up shorts due to lint or other foreign material.) If desired, the M or L short test hubs may be jumpered to determine the approximate resistance of the short as explained above.

Long clip leads are provided with the tester in case the machine filament supply is used in testing tubes. If the machine filament (or heater) voltage differs considerably from the rated voltage, better results in tube testing may result in using the machine supply on tubes under test. The leads should be clipped to the filament connection pins of the socket from which the tube was taken. The other ends of the leads should be wired into the proper hubs of the tube element pin section of the control panel (pins 2 and 7 of the 8 row for the 25L6 tube). Do not, under any circumstances, connect these wires to the two heater (H) hubs in the EXIT section of the control panel, because these hubs are connected directly to the secondary of the filament transformer.

For standard tube types on which no instructions have been issued, the *RCA Receiving Tube Manual* will supply sufficient information. With knowledge of plate load resistance and the plate supply voltage, the plate current can be determined from the plate characteristic curves (Figure 6) in the following manner:

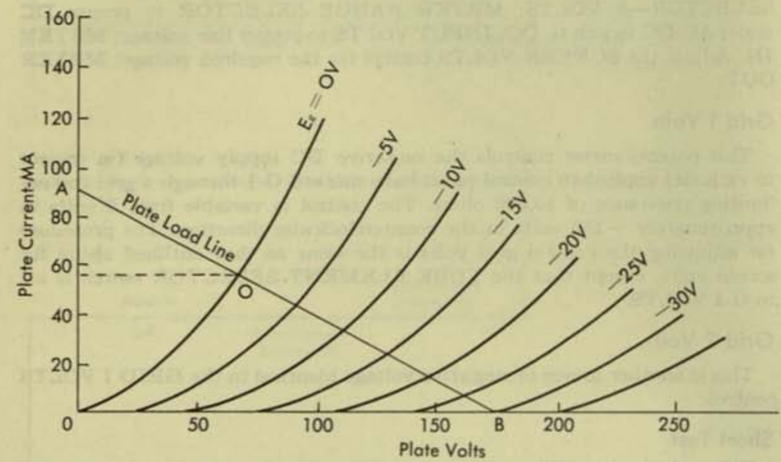
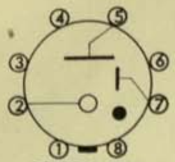


Figure 6. Plate Characteristic Curves

1. Point *A*, the maximum plate current possible with a given supply and load is $I = \frac{E}{R} = \frac{\text{Plate supply volts}}{\text{Plate load resistance}}$
2. Point *B* is the plate voltage at zero plate current, i.e. the plate supply voltage.
3. Connect points *A* and *B* to get the plate load line.
4. Plate current values for any grid bias values are fixed by the intersection of the load line and the particular grid bias curve. In this case point *O* is the intersection of the load line with the zero bias curve and represents the plate current through the tube under the given conditions.
5. With 150 volts on the plate, the grid voltage required to cut off plate current would be that grid bias curve which intersects point *B* at zero plate current.

TUBE TESTER PARTS LIST

PART NAME	NUMBER
3-amp. line fuse	454164
Selenium rectifier element, GE. 6RS5GH1	454165
Toggle switch (short test)	118463
Plugboard contact	166024
Tube socket (octal)	170589
Toggle switch (meter in-out)	171188
$\frac{1}{32}$-amp. meter fuse	171703
Fuse mounting posts	171704
Tube socket (7-pin)	198704
Test leads: Red	206046
Black	206047
50,000 ohm potentiometer (screen, G-1, G-2 volts)	213566
Meter	454108
Tube socket (9-pin)	454129
NE-51 neon bulb (short test)	454130
20,000 ohm wire-wound potentiometer (screen load)	454157

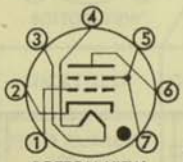


BOTTOM VIEW

		METER IN-OUT	PLUG #1 TO	2 (USE ROW 8)	3	4	5	6	7	8	FIL. VOLTS	SCREEN LOAD	PLATE LOAD	PLATE VOLTS	SCREEN VOLTS	G-1 VOLTS	G-2 VOLTS	SHORT TEST	TUBE ELEMENT SELECTOR	METER RANGE SELECTOR	METER IN-OUT	INPUT-VOLTS	GOOD TUBE IF
1	SHORT-TEST	Out										20,000 Ohms	1000 Ohms	150	Max.	Max.	Max.	On	P Volts	300 Volts D.C.	In	* 115	No lights [see Note (a)]
2A	STARTER ANODE TEST	Out		K			P		S			•	•	•	•	•	•	Off	•	•	Out	•	
2B		Turn SCREEN VOLTS control clockwise until tube fires.																					
2C		Out		•			•		•			•	•	•	As set in 2-B	•	•	•	S Volts	150 Volts D.C.	In	•	Within 70 to 90 Volts
3A	PLATE VOLTAGE DROP	Out		•			•		•			•	•	•	•	•	•	•	P Volts	•	Out	•	
3B		Out		•			•		•			Insert a wire from P hub to common hub of meter to read tube voltage drop.											Less than 81 Volts

*Tester is now set up to read PLATE VOLTS. Adjust INPUT VOLTS to bring plate voltage as near 150 volts as possible.

NOTE. (a) On this tube the neon bulb will light when short-test leads are inserted in pins 2 and 7. In a good tube a small glow spot will be seen on the starter-anode or cathode at the same time. Follow SHORT-TEST instructions on page 9.

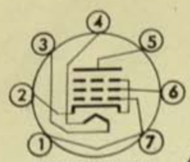


BOTTOM VIEW

		METER IN-OUT	PLUG #1 TO	2	3	4	5	6	7	FIL. VOLTS	SCREEN LOAD	PLATE LOAD	PLATE VOLTS	SCREEN VOLTS	G-1 VOLTS	G-2 VOLTS	SHORT TEST	TUBE ELEMENT SELECTOR	METER RANGE SELECTOR	METER IN-OUT	INPUT-VOLTS	GOOD TUBE IF
			USE ROW 7																			
1	SHORT-TEST	Out	/	/	H	H	/	/	/	6.3	0 Ohms	250 Ohms	50	Max.	Max.	Max.	On	P Mils	150 Mils D.C.	Out	115	No lights [see Note (a)]
2	PLATE CURRENT TEST	Out	G-1	K	H	H	S	P	/	•	•	•	•	•	Max.	•	Off	P Mils	150 Ma. D.C.	In	•	63 Ma. or more
3A	CONTROL	In	•	•	•	•	•	•	/	•	•	•	•	•	Max.	•	•	•	•	In	Off	/
3B	GRID CUT-OFF	Return INPUT VOLTS control to 115 volts. Turn G-1 volts control clockwise gradually until tube fires.																				
3C	TEST	Out	•	•	•	•	•	•	/	•	•	•	•	•	As set in 3-B	•	•	G-1 Volts	50 Volts D.C.	In	As set in 3-B	Less than 4 Volts

NOTE (a) Follow SHORT-TEST instructions on page 9.

2D21



BOTTOM VIEW

		METER IN-OUT	←PLUG #1 TO	2	3	4	5	6	7	FIL VOLTS	SCREEN LOAD (see page 6)	PLATE LOAD	PLATE VOLTS	SCREEN VOLTS	G-1 VOLTS	G-2 VOLTS	SHORT TEST	TUBE ELEMENT SELECTOR	METER RANGE SELECTOR	METER IN-OUT	INPUT-VOLTS	GOOD TUBE IF
1	SHORT-TEST	Out	/	/	H	H	/	/	/	6.3	470 Ohms	2500 Ohms	150	Max. ↷	Max. ↶	Max. ↶	On	P Volts	300 Volts D.C.	In	* 115	No lights [see Note (a)]
2	PLATE CURRENT TEST	Out	G-1	K	H	H	P	S	/	•	•	•	•	•	Max. ↷	•	Off	P Mils	150 Ma. D.C.	In	•	40 Ma. or more
3	SCREEN CURRENT TEST	In	•	•	•	•	•	•	/	•	•	•	•	•	•	•	•	S Mils	•	In	•	Less than 15 Ma.
4A	CONTROL GRID CUT-OFF TEST	In	•	•	•	•	•	•	/	•	•	•	•	•	•	•	•	P Mils	•	In	•	/
4B		Turn G-1 VOLTS control counterclockwise until meter reads between zero and first scale mark.																				
4C		Out	•	•	•	•	•	•	/	•	•	•	•	•	As set in 4-B	•	•	G-1 Volts	50 Volts D.C.	In	•	Less than 25 Volts

*Tester is now set up to read PLATE VOLTS. Adjust INPUT VOLTS to bring plate voltage as near 150 volts as possible.

NOTE (a) Follow SHORT-TEST instructions on page 9.

6AQ5

BOTTOM VIEW

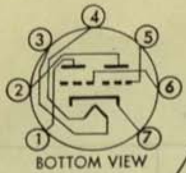
		METER IN-OUT	PLUG #1 TO	2	3	4	5	6	7	FIL. VOLTS	SCREEN LOAD (see page 6)	PLATE LOAD	PLATE VOLTS	G-1 VOLTS	G-2 VOLTS	SCREEN VOLTS (see page 8)	SHORT TEST	TUBE ELEMENT SELECTOR	METER RANGE SELECTOR	METER IN-OUT	INPUT-VOLTS	GOOD TUBE IF
1	SHORT-TEST	Out			H	H				6.3	470 Ohms	20,000 Ohms	150	Max. ↶	Max. ↶	Max. ↶	On	P Volts	300 Volts D.C.	In	* 115	No lights [see Note (a)]
2	PLATE CURRENT TEST	Out	G-1	K	H	H	P	S	G-2	″	″	″	″	Max. ↷	Max. ↷	75 Volts	Off	P Mils	15 Ma. D.C.	In	″	5 Ma. or more
3A	SECOND GRID CUT-OFF TEST	Out	″	″	″	″	″	″	″	″	″	″	″	″	Max. ↶	″	″	″	″	In	″	
3B		Turn G-2 VOLTS control clockwise until meter reads between zero and first scale mark.																				
3C		Out	″	″	″	″	″	″	″	″	″	″	″	″	As set in 3-B	″	″	G-2 Volts	50 Volts D.C.	In	″	Less than 25 Volts
4A	CONTROL GRID CUT-OFF TEST	Out	″	″	″	″	″	″	″	″	″	″	″	Max. ↶	Max. ↷	Reset to 75 Volts	″	P Mils	15 Ma. D.C.	In	″	
4B		Turn G-1 VOLTS control clockwise until meter reads between zero and first scale mark.																				
4C		Out	″	″	″	″	″	″	″	″	″	″	″	As set in 4-B	″	As set in 4-A	″	G-1 Volts	50 Volts D.C.	In	″	Less than 10 Volts

*Tester is now set up to read PLATE VOLTS. Adjust INPUT VOLTS to bring plate voltage as near 150 volts as possible.

NOTE (a) Follow SHORT-TEST instructions on page 9.

6BE6

(6B1000)



BOTTOM VIEW

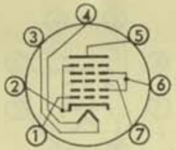
		METER IN-OUT	←PLUG #1 TO	2	3	4	5	6	7	FIL. VOLTS	SCREEN LOAD	PLATE LOAD	PLATE VOLTS	SCREEN VOLTS	G-1 VOLTS	G-2 VOLTS	SHORT TEST	TUBE ELEMENT SELECTOR	METER RANGE SELECTOR	METER IN-OUT	INPUT-VOLTS	GOOD TUBE IF
1	SHORT-TEST	Out			H	H				6.3		20,000 Ohms	150	Max.	Max.	Max.	On	P Volts	300 Volts D.C.	In	* 115	No lights [see Note (a)]
2	PLATE CURRENT TEST (SIDE 1)	Out	P		H	H		G-1	K	"		"	"	"	Max.	"	Off	P Mils	15 Ma. D.C.	In	"	4.5 Ma. or more
3A	CONTROL GRID CUT-OFF TEST (SIDE 1)	Turn G-1 VOLTS control counterclockwise until meter reads between zero and first scale mark.																				
3B		Out	"		"	"		"	"	"		"	"	"	As set in 3-A	"	"	G-1 Volts	50 Volts D.C.	In	"	Less than 10 Volts
4	PLATE CURRENT TEST (SIDE 2)	Out		P	H	H	G-1		K	"		"	"	"	Max.	"	"	P Mils	15 Ma. D.C.	In	"	4.5 Ma. or more [see Note (b)]
5A	CONTROL GRID CUT-OFF TEST (SIDE 2)	Turn G-1 VOLTS control counterclockwise until meter reads between zero and first scale mark.																				
5B		Out		"	"	"	"		"	"		"	"	"	As set in 5-A	"	"	G-1 Volts	50 Volts D.C.	In	"	Less than [see Note (b)]

*Tester is now set up to read PLATE VOLTS. Adjust INPUT VOLTS to bring plate voltage as near 150 volts as possible.

NOTES: (a) Follow SHORT-TEST instructions on page 9.

(b) If the tube is used in a trigger, the two sides must be balanced: plate current must be within 0.3 Ma. and control grid cut-off voltages must be within 1.5 volts.

6J6

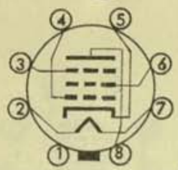


BOTTOM VIEW

		Meter In-Out	Plug #1 to	2	3	4	5	6	7	Fil. Volts	Screen Load (see page 6)	Plate Load	Plate Volts	G-1 Volts	G-2 Volts	Screen Volts (see page 8)	Short Test	Tube Element Selector	Meter Range Selector	Meter In-Out	Input-Volts	Good Tube If
1	SHORT-TEST	Out			H	H				6.3	470 Ohms	20,000 Ohms	150	Max. ↶	Max. ↶	Max. ↶	On	P Volts	300 Volts D.C.	In	* 115	No lights [see Note (a)]
2	PLATE CURRENT TEST	Out	G-1	K	H	H	P	S	G-2	•	•	•	•	Max. ↷	Max. ↷	75 Volts	Off	P Mils	15 Ma. D.C.	In	•	5 Ma. or more
3A	SECOND GRID CUT-OFF TEST	Out	•	•	•	•	•	•	•	•	•	•	•	•	Max. ↶	•	•	•	•	In	•	
3B		Turn G-2 VOLTS control clockwise until meter reads between zero and first scale mark.																				
3C		Out	•	•	•	•	•	•	•	•	•	•	•	•	As set in 3-B	•	•	G-2 Volts	50 Volts D.C.	In	•	Less than 10 Volts
4A	CONTROL GRID CUT-OFF TEST	Out	•	•	•	•	•	•	•	•	•	•	•	Max. ↶	Max. ↷	Reset to 75 Volts	•	P Mils	15 Ma. D.C.	In	•	
4B		Turn G-1 VOLTS control clockwise until meter reads between zero and first scale mark.																				
4C		Out	•	•	•	•	•	•	•	•	•	•	•	As set in 4-B	•	As set in 4-A	•	G-1 Volts	50 Volts D.C.	In	•	Less than 10 Volts

*Tester is now set up to read PLATE VOLTS. Adjust INPUT VOLTS to bring plate voltage as near 150 volts as possible.

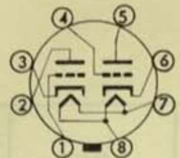
NOTE (a) Follow SHORT-TEST instructions on page 9.



		METER IN-OUT	PLUG #1 TO	2	3	4	5	6	7	8	FIL. VOLTS	SCREEN LOAD	PLATE LOAD	PLATE VOLTS	G-1 VOLTS	G-2 VOLTS	SCREEN VOLTS (see page 8)	SHORT TEST	TUBE ELEMENT SELECTOR	METER RANGE SELECTOR	METER IN-OUT	INPUT-VOLTS	GOOD TUBE IF
			USE ROW 8																				
1	SHORT-TEST	Out		H					H		6.3	0 Ohms	20,000 Ohms	150	Max.	Max.	Max.	On	P Volts	300 Volts D.C.	In	* 115	No lights [see Note (a)]
2	PLATE CURRENT TEST	Out		H	G-2	G-1	K	S	H	P	•	•	•	•	Max.	Max.	65 Volts	Off	P Mils	15 Ma. D.C.	In	•	5.7 Ma. or more
3A	CONTROL GRID CUT-OFF TEST	Out		•	•	•	•	•	•	•	•	•	•	•	Max.	•	Reset to 65 Volts	•	•	•	In	•	
3B		Turn G-1 VOLTS control clockwise until meter reads between zero and first scale mark.																					
3C		Out		•	•	•	•	•	•	•	•	•	•	•	As set in 3-B	•	•	•	G-1 Volts	50 Volts D.C.	In	•	Less than 20 Volts
4A	SUPPRESSOR GRID CUT-OFF TEST	Out		•	•	•	•	•	•	•	•	•	•	•	Max.	Max.	•	•	P Mils	15 Ma. D.C.	In	•	
4B		Turn G-2 VOLTS control clockwise until meter reads between zero and first scale mark.																					
4C		Out		•	•	•	•	•	•	•	•	•	•	•	•	As set in 4-B	•	•	G-2 Volts	50 Volts D.C.	In	•	Less than 40 Volts

*Tester is now set up to read PLATE VOLTS. Adjust INPUT VOLTS to bring plate voltage as near 150 volts as possible.

NOTE: (a) Follow SHORT-TEST instructions on page 9. On 6SK7 metal tubes, pin 1 is connected to the shield and should be short-tested.



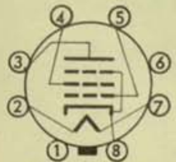
BOTTOM VIEW

		METER IN-OUT	PLUG #1 TO 1	2	3	4	5	6	7	8	FIL. VOLTS	SCREEN LOAD	PLATE LOAD	PLATE VOLTS	SCREEN VOLTS	G-1 VOLTS	G-2 VOLTS	SHORT TEST	TUBE ELEMENT SELECTOR	METER RANGE SELECTOR	METER IN-OUT	INPUT-VOLTS	GOOD TUBE IF
			USE ROW 8																				
1	SHORT-TEST	Out							H	H	12		20,000 Ohms	150	Max.	Max.	Max.	On	P Volts	300 Volts D.C.	In	* 115	No lights [see Note (a)]
2	PLATE CURRENT TEST (SIDE 1)	Out	G-1	P	K				H	H	•		•	•	•	Max.	•	Off	P Mils	15 Ma. D.C.	In	•	4.3 Ma. or more
3A	CONTROL GRID CUT-OFF TEST (SIDE 1)	Turn G-1 VOLTS control counterclockwise until meter just reads zero.																					
3B		Out	•	•	•				•	•	•		•	•	•	As set in 3-A	•	•	G-1 Volts	50 Volts D.C.	In	•	Less than 13 Volts
4	PLATE CURRENT TEST (SIDE 2)	Out				G-1	P	K	•	•	•		•	•	•	Max.	•	•	P Mils	15 Ma. D.C.	In	•	4.3 Ma. or [see Note (b)]
5A	CONTROL GRID CUT-OFF TEST (SIDE 2)	Turn G-1 VOLTS control counterclockwise until meter just reads zero.																					
5B		Out				•	•	•	•	•	•		•	•	•	As set in 5-A	•	•	G-1 Volts	50 Volts D.C.	In	•	Less than 13 Volts [see Note (b)]

*Tester is now set up to read PLATE VOLTS. Adjust INPUT VOLTS to bring plate voltage as near 150 volts as possible.

NOTES: (a) Follow SHORT-TEST instructions on page 9.

(b) If the tube is used in a trigger, the two sides must be balanced: plate current must be within 0.3 Ma. and control grid cut-off voltages must be within 1.5 volts.



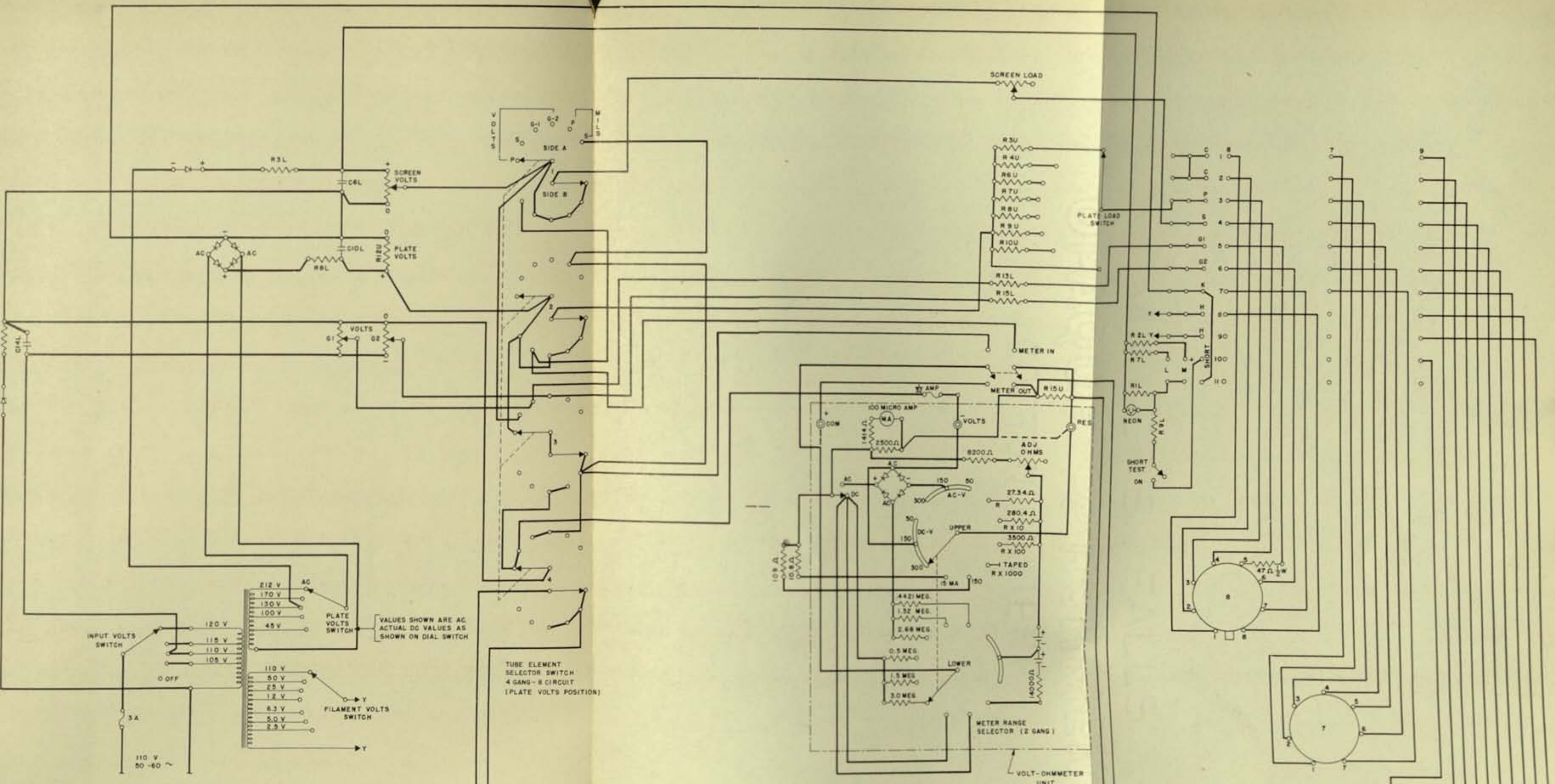
BOTTOM VIEW

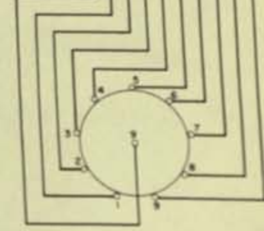
		METER IN-OUT	PLUG #1 TO	2	3	4	5	6	7	8	FIL. VOLTS	SCREEN LOAD (see page 6)	PLATE LOAD	PLATE VOLTS	SCREEN VOLTS	G-1 VOLTS	G-2 VOLTS	SHORT TEST	TUBE ELEMENT SELECTOR	METER RANGE SELECTOR	METER IN-OUT	INPUT-VOLTS	GOOD TUBE IF
				USE ROW 8																			
1	SHORT-TEST	Out	/	H	/	/	/	/	H	/	25	5000 Ohms	250 Ohms	150	Max. ↗	Max. ↖	Max. ↖	On	P Volts	300 Volts D.C.	In	* 115	No lights [see Note (a)]
2	PLATE CURRENT TEST	Out	/	H	P	S	G-1	/	H	K	"	"	"	"	"	Max. ↗	"	Off	P Mils	150 Ma. D.C.	In	"	80 Ma. or more [see Note (b)]
3	SCREEN CURRENT TEST	In	/	"	"	"	"	/	"	"	"	"	"	"	"	"	"	"	S Mils	"	In	"	Less than 15 Ma.
4A	CONTROL GRID CUT-OFF TEST	In	/	"	"	"	"	/	"	"	"	"	"	"	"	"	"	"	P Mils	"	In	"	/
4B		Turn G-1 VOLTS control counterclockwise until meter reads under 15 Ma. switch to 15 Ma. range and continue turning control until meter reads 2.1 Ma. for 077 use, 0.3 Ma. for all other applications.																					
4C		Out	/	"	"	"	"	/	"	"	"	"	"	"	"	As set in 4-B	"	"	G-1 Volts	50 Volts D.C.	In	"	Less than 30 Volts

*Tester is now set up to read PLATE VOLTS. Adjust INPUT VOLTS to bring plate voltage as near 150 volts as possible.

NOTE: (a) Follow SHORT-TEST instructions on page 9. On 25L6 metal tubes, pin 1 is internally connected to the shield and should be short-tested.

(b) 80 Ma. value for new tube, 66 Ma. minimum for used tube.





POS NO.	VALUE	POS. NO.	VALUE
1 U*	UNUSED	R1L	2 MEG-1/2 W
2U	UNUSED	R2L	300,000 Ω -1/2 W
3U	20,000 Ω - 5 W	R3L	47 Ω - 2 W
4U	10,000 Ω - 5 W	4L	UNUSED
5U	UNUSED	5L	UNUSED
6U	5,000 Ω -10 W	C6L	40 MFD - 300 V
7U	2,500 Ω -10 W	R7L	30,000 Ω - 1/2 W
8U	1,000 Ω -10 W	R8L	47 Ω - 2 W
9U	500 Ω - 10 W	R9L	20,000 Ω - 1/2 W
10U	250 Ω - 10 W	C10L	40 MFD - 300 V
11 U	UNUSED	11L	UNUSED
12U	12,500 Ω - 10 W	R12L	47 Ω - 2 W
13U	109 Ω ± 1%	R13L	50,000 Ω - 1/2 W
14U	10.8 Ω ± 1%	C14L	40 MFD - 300 V
15U	15,000 Ω ± 1%	R15L	50,000 Ω - 1/2 W

SCREEN LOAD POT. 20,000 Ω - W W
SCREEN VOLTS POT. 50,000 Ω
G1 & G2 VOLTS POT. 50,000 Ω

NOTE: U STANDS FOR UPPER MOUNTING PLATE
L STANDS FOR LOWER MOUNTING PLATE

NOTE
IF METER IS REPLACED BY NO. 450486 (IBM STANDARD VOLT-OHMMETER) CUT WIRES SHOWN IN DASH (- - -) LINES AND SPLICE TO POSITIONS SHOWN IN STANDARD WIRING.

454163

Form 22-5644-0

PREVENTIVE MAINTENANCE — General Section

CONTENTS

New York, New York
Printed in U.S.A.
Form 22-5689-1

PREVENTIVE MAINTENANCE

General Section

PREVENTIVE MAINTENANCE consists of three phases: cleaning, lubricating and inspecting. All members of the Customer Engineering Department should understand and adhere to the principle that intelligent and effective preventive maintenance is the foundation of quality customer engineering operations. Proper use of preventive maintenance will reduce peak load breakdowns and keep the machines in such condition that will permit the customer engineer to schedule his work and time efficiently.

Machine usage and conditions in the customer's office where the machine is located will determine the frequency with which this is necessary. Inspections should be made often enough to insure good operation of the machines, but unnecessary inspection of the machines is uneconomical and should be avoided. In some cases cleaning and lubricating is needed more frequently than inspecting. The customer engineer, knowing the general condition of his machines and the amount of use they receive, can best determine when each of the phases, cleaning, lubricating or inspecting, is required.

A preventive maintenance procedure is given for each machine. Since some units are subject to more wear than others, the customer engineer should follow the procedure for only those units which he feels necessary to cover at any given time. Rigid adherence to the procedures given here is not mandatory but rather they should serve as a guide. As each customer engineer gains experience, he will become more efficient in applying preventive maintenance procedures.

The instructions for preventive maintenance consist of two types of sections, a general section and a section designed for each specific machine. The general section should be placed in the front of the Customer Engineer's Reference Manual, and the specific sections should be placed with the adjustment section for each machine. In both sections the headings may be used as a general outline to follow, while the information under the headings will suggest means of accomplishment.

Call reports should carry code 08 for all preventive maintenance, except for repairs made as a result of the inspection. A separate call report coded 02 should be made on these repairs. Time involved in improving the external appearance of the machine should also be coded 08 but time involved in removing covers for refinishing should be entered under the appropriate code.

Under ordinary conditions the entire machine need not be inspected at one time. If only one unit of a machine is inspected at a time, the customer engineer will be in a position to return the machine to the customer quickly in the event of an emergency call. A chart should be kept showing when various units have been inspected. This will enable the customer engineer to make sure that all units receive periodic inspections.

No unit should be dismantled unless the customer engineer is reasonably sure that there are worn parts or that proper cleaning or lubricating can be accomplished only if the unit is dismantled. When making a repair on any unit, it is well to inspect the entire unit if the time is available.

Inspected machines or units should always be tested with test cards before being turned over to the customer. Shortening the duration of the CB's when testing a machine will bring to light potential intermittent troubles caused by insufficient margin of safety with the regular CB timing. This should be accomplished by advancing the break time rather than by retarding the make time.

Machines should be cleaned of dust and dirt frequently with particular attention to the feeds. Do not leave dust or dirt in the card lever or hopper contact. In brushing dust from the machine, care should be taken to deposit it into a waste basket or some other receptacle.

MACHINE APPEARANCE

EVERY CUSTOMER ENGINEER is charged with the responsibility of maintaining the machines in his territory in good mechanical condition and in FIRST-CLASS CONDITION WITH RESPECT TO APPEARANCE. The appearance of all machines should be checked frequently. If plated parts have become discolored or chipped, they should be replaced with newly plated parts. Machines should be checked to determine that painted surfaces are not chipped or scratched and that the porous surface of the paint has not become filled with dust, dirt or oil. Painted surfaces which have become filled with dust or oil may be renewed by the application of Isbell's Polish, Part No. 450419. This polish is a milky white liquid which is easily applied. Saturate a cloth with the liquid (just as you would when applying liquid wax) and rub it on the painted surface. It may be necessary to rub extremely dirty spots more vigorously. The surface should then be polished with a dry cloth. The frequency with which the Isbell's Polish need be applied will vary with the conditions in the customer's office. This will be best determined by each customer engineer consistent with the high level of appearance required by IBM.

When covers warrant refinishing, report to your field supervisor or manager of customer engineering so that proper steps may be taken in accordance with the present policy concerning refinishing covers.

The machines must be kept clean at all times. Upon the completion of a service call or inspection the machine must be checked, and any dirt or oil appearing on the machine covers must be removed. Isbell's Polish does a good job of drying an oily surface. Furthermore, a machine inspection shall include a thorough inspection of the machine to determine if any plated parts should be replaced or any covers need refinishing.

All covers should be properly attached to the machine with a full complement of cover screws or the appropriate fastening devices. All cover latches on the new type covers should be maintained in proper adjustment.

SAFETY

THERE IS but one approved way to work—THE SAFE WAY. The customer engineer shall at all times adhere to working methods and habits that are safe, not only for himself, but for others working with him or near him. Safety glasses must be worn when engaging in any activity which might conceivably result in an eye injury.

The customer engineer shall observe special precautions with respect to grounded machines. When machines are serviced or inspected, the power cord should be removed from the power receptacle whenever possible to prevent accidents. If it is necessary to have power on and the work is being done on machines that are on grounded circuits, the disconnect screw is to be removed for convenience and safety. However, it must be remembered that with the disconnect screw removed from ONE machine in an installation, a difference of potential may exist between that machine and all others in the group. Caution should be further exercised with the test light leads to prevent them from contacting a grounded machine when checking circuits of an ungrounded machine or when using a test light for any other purpose. When repairs are completed, the CUSTOMER ENGINEER IS RESPONSIBLE FOR REPLACING THE GROUND DISCONNECT SCREW, FOR IF IT IS NOT REPLACED, THE ENTIRE PROGRAM OF GROUNDING IS DEFEATED, AND AN INCREASED HAZARD RESULTS.

When servicing machines which are coupled with Summary Punches, it should be remembered that with the ground disconnect screw removed from either machine, the ground to the other machine will still be effective and, therefore, both machines will still be connected to ground as long as the cable between the machines is still intact.

On machines equipped with a 110-volt machine circuits such as the Collator, Type 89; Tube Collator, Type 77; Electric Accounting Machine, Type 285; etc., it is imperative to note that in order to prevent grounding the machine circuit, control panel wires must not be left hanging from the control panel. This procedure should be followed on all machines, and all operators should be instructed accordingly.

BASES

SENTINEL SWITCHES on all machines should occasionally be checked for loose wires and for wear on the contact points. A small amount of IBM #17 applied to the points will measurably increase the life of the switch.

STACKER POCKET tubes should be cleaned with a cloth saturated with cleaning fluid; they should not be oiled.

CONTROL PANEL contacts may be cleaned with a stiff wire brush. All spring connections should be checked for position and tension, using the gauge at least once every 2 years.

A LUBRICANT when applied in small amounts at the proper place will produce better results than an excess of the lubricant applied indiscriminately. Too much oil attracts dust and dirt, causing sluggish action and increased wear. The use of a pipe cleaner saturated with oil and applied to the spot desired is an efficient means of lubricating parts in confined areas that require only a light film of oil. Greases should never be heated to facilitate their application to our equipment. Heating may destroy the physical characteristics of the grease, and the danger from fire is enhanced.

MOTORS AND GENERATORS on all machines should be checked and lubricated at regular intervals. When lubricating, care should be taken not to get too much oil on bearings as it will saturate the windings and commutator. Brushes and commutators should be checked for wear, dirt and oil. Belt tension should be checked because too much tension will cause excessive wear on the rotor bearings and too little tension will cause slippage.

The link belt used on the Type 77 and the Type 552 machines must be tighter than the conventional "V" belt. As the link belt has a smaller area of contact with the pulley and a greater tendency to stretch, the tighter adjustment is necessary to prevent slippage. It is also necessary to avoid excessive tension of the link belts in order to minimize wear of the motor and pulley bearings. Therefore, when tightening a loose link belt, one link should be removed at a time until a half-inch movement of either side of the belt at the base of the machine results in a barely perceptible movement of the motor assembly. Sufficient links should be used when installing a new belt to permit the same adjustment procedure. The link belt should be placed on the Type 77 and the Type 552 machines so that the small ends of the links lead. This favors the small motor pulley and, on the Collator, decreases the possibility of interference between the front side of the link belt and the lower CR cam shaft, as the motor pulley will tend to push the links together. This will also decrease the possibility of interference between the belt and the slot in the Type 552 base.

TOGGLE SWITCHES on machines less than two years old or new switches installed on machines in the field should be lubricated to prolong their life. The possiblity of flushing foreign matter onto the blades in older switches makes it inadvisable to lubricate them. The use of IBM lubricant #6 is advised and only a small amount should be applied at the base of the toggle handle. Application once every three months should be sufficient.

COVER REMOVAL: It is suggested that only the covers over the unit being inspected be removed during inspection; then the machine can be covered quickly in case the customer engineer finds it necessary to leave that machine.

HORIZONTAL FEEDS

THE FEED gets as much or more use than any other part of a machine and for that reason requires more attention in cleaning, inspection *and lubrication. Particular care should be taken with preventive maintenance on the feed since the satisfactory operation of all of the rest of the machine depends upon how accurately the card is fed. MANY INTERMITTENT TROUBLES HAVE BEEN TRACED TO SLIGHT IRREGULARITIES IN THE FEED.*

1. CLEANING: All dust and dirt should be brushed out of the hoppers. Clean all dirt from around the roller throat and see that the roller turns freely. The feed knife slide assembly and slide guides should be removed to clean properly. On machines, such as the 77 and the 513, only one assembly should be removed at a time so that the remaining one can act as a guide to retime properly the one being cleaned. Also on these feeds be sure all dirt is removed from the gear teeth on the bottom of the feed knife slide and its rocker operating arm. Adjustment of the feed knife should be checked before replacing the feed knife slide assembly. Remove the hopper posts and clean all dirt from them, taking care not to lose any shims that may be used with them. Clean all dirt from feed roll surfaces and from the teeth of the feed roll drive gears as this will make the feed rolls bounce and result in crooked feedings. An easy way of cleaning dirt from the surface of the feed rolls is to hold the end of a card that has been dipped in IBM #6 lubricating oil and allow it to drag between two rolls while they are turning. This wiping action will take most of the dirt off the roll. When using this method on feed rolls just in front of brushes, be sure to remove brushes first, or do not let card move far enough in to damage the brushes. Be sure to brush all dust from the feed roll supporting brackets.

2. FEED KNIFE ADJUSTMENTS: If the feed knife holder is worn, it should be stoned to a flat surface before setting the knife. This may be done with an oil stone, or for faster cutting, a piece of Trimite Paper on a flat surface. The knife should be replaced if it is badly worn. However, if it is only slightly worn it may be stoned along with the block. Set the edge of the knife only about .001" or less above the block, and stone the two until there is no indication of where the block leaves off and the knife begins. Then proceed to set the knife to the proper adjustment. Always use a Go-No-Go gauge to set the knife—never a feeler gauge.

3. FEED KNIFE GUIDE SLIDES: These should have a minimum of play and no binds. After setting these, always turn the machine over by hand to check for binds before turning on the power.

4. EVEN FEEDING OF CARDS: This can easily be checked by placing a card through the throat, up to, but not in, the first feed rolls. Keeping the card from going into the feed rolls, turn the machine by hand until feed knives come up against the card when it is placed tight against the feed roll. If the knives are set to feed the card properly, they will both touch the edge of the card at the same time. If not adjusted correctly, set the machine with the first feed knife touching the card and bring the other knife up to the card by means of the knife holder adjusting screw.

5. HOPPER SIDE PLATES: Exact positioning of the plates depends upon the machine type, but they should be set so that with about 500 cards in the hopper; one card placed upright between the end of the 500 cards and the side plate will pull out easily, but two cards will have a drag.

6. ROLLER THROAT: The throat knife should be checked for wear at knife edge—the roller, for flat spots or wear on the pivot point. Either of these should be replaced, if worn. The roller throat should be checked for proper adjustment.

7. FEED ROLL TENSION: If any one of the feed rolls is eccentric, it will cause a difference in tension of the two ends and result in crooked feeding. This can be checked by holding two pieces of card in the feed rolls, one at each end of the roll, while the machine is running. If the feed rolls are true, the drag on both pieces of card will be the same.

8. TIMING OF FEED KNIVES: This varies with machine type and is covered under each machine.

9. HOPPER POSTS: These should be set so that the feed knife will come back .020"-.040" beyond the edge of the card.

BRUSH ASSEMBLIES

1. CLEANING: Clean all dust and dirt from entire brush assembly, paying particular attention to dirt between brush separators. Use the emery polishing stick, part number 450503 for cleaning all contact rolls.

2. BRUSH SEPARATORS for breaks; also look for burned or carbonized brush separators due to grounds or shorts.

3. BRUSHES for wear, bent or crossed strands, and tightness of individual brush clamps.

4. ⅛" PROJECTION on all but 77 and 552; the brushes should project about ⅛" above separators. To prevent wear of contact roll, stone edge of any new common brush before installing.

5. BRUSH ALIGNMENT TO SCRIBED LINE: Heel of brushes should be set on scribed line on brush separators to align brushes to center of contact roll.

6. BRUSHES EVENLY SPACED BETWEEN SEPARATORS: Use the brush bending tool for this. When installing a new set of brushes this spacing may be facilitated before installing the brush holder in the assembly by the following method: After tightening all of the individual brush clamps, place a card punched with one number in all 80 columns on top of the brush holder block and brush ferrules so that by looking through the holes in the card you can see the part of the brush ferrules that extend beyond the block. Align the card so that the ferrule on brush #1 is in the center of the hole in column #1 and fasten in this position with Scotch tape. The other 79 brush ferrules can then easily be aligned to their corresponding holes with the use of the brush bending tool.

7. BRUSH TRACKING: The hoppers must have been previously set correctly before making this check.

The following is a recommended procedure for accuracy and convenience:

(a) Punch a card in registration, preferably X and 8 alternately, or as a "Q" in alternate columns.

(b) Fold a piece of lightweight carbon paper, slightly shorter than twice the width of a card, over the leading edge of the card, creasing it well. The carbon surface must be toward the card, its non-folded edges toward the feed knives. The use of lightweight carbon will prevent making throat alterations.

(c) Insert the test card between a group of cards to obtain a more natural feeding condition.

(d) Feed cards through machine under power. When the carbon paper is removed from the test card, a perfect tracking of the brush can be seen as related to the card in registration.

8. BRUSH TIMING: Whenever possible, this should be checked with a dynamic timer, checking both CB's and brushes at the same time, Pre-punch a group of cards 1-3-5-7-9 in odd-numbered columns and 2-4-6-8 in even-numbered columns. Run all cards through under power, checking brushes on one dynamic timer circuit and CB's on the other to check overlap of brushes and CB's. When using the dynamic timer all 80 brushes should be checked one at a time. If no dynamic timer is available, timing of several brushes at each end of card should be checked by hand, using a test light and timing on a five hole.

CIRCUIT BREAKER CAMS

ALL CIRCUIT-BREAKER type cams should be checked for air gap and timing a month or two after installation of new machine, as these may change due to shrinkage of linen dilecto cams and insulators. Cam surfaces should be cleaned of all old dirt and re-lubricated with a thin film of IBM #17 before checking any other part. On all inspections, watch for indication that cam is warped or eccentric.

1. LOOSE DRIVE GEARS may be determined by rocking a row of cams and noting the amount of play.

2. WORN CAM FOLLOWERS AND PIVOT POINTS: Any contacts with worn parts should be replaced.

3. DIRTY, WORN OR LOOSE POINTS: Clean all dirty or worn points with flexstone. A piece of Trimite paper folded several times may be used as a flexstone. On many machines all points in one row may be cleaned at the same time by using a long strip of Trimite paper folded so that the Trimite side is out. Place this between the points of one row and draw it lengthwise several times through all of the points. To aid in inserting the paper, all of the points may be held open at once by means of a long rod. Each individual point should then be wiped with a clean cloth, and again with a clean finger to remove any filings or lint. Any points that are still dirty should be cleaned individually. Any badly pitted points should be replaced. Points should be adjusted for full contact by loosening the contact mounting screws and shifting straps.

4. AIR GAP: To facilitate adjusting the air gap on the CB and CF cam contacts, it is possible to approximate their air gap by counting the revolutions of the stationary contact screw.

If the specification for the contact being adjusted is for a .027"-.033" air gap, back off on the fixed point one complete turn. If contact specification is for .012"-.018" air gap, the screw should be backed off a half turn. As cams may become eccentric, a check should be made at several points of the cam periphery to insure that the best possible adjustment has been made. As the above is an approximation only, the air gap should be checked with feeler gauges at completion of the repair.

5. TIMING: Timing of contacts should be set for either make or break timing by shifting of cams on the shaft, not by changing air gap.

6. LUBRICATION: Exercise caution in lubricating contact assemblies on which the contact points are lower than the pivot points. If too much lubricant is used it will run down and prevent the points from making contact.

(a) Use IBM #6 on cam follower roller, followed by IBM #17.
(b) Use IBM #6 on cam contact pivot points.
(c) Put a very light film of IBM #17 on linen dilecto cam surfaces.

MAKE AND BREAK CAM CONTACTS

1. CLEAN: Cleaning fluid may be used to wash oil and grease from these points. Wipe points out afterward with a piece of card. Care must be taken that no lint or paper fiber is left in the points as this will prevent their making contact.

2. POINTS: Use flexstone to stone down any burnt points. Replace loose points. Points should be aligned to make full contact.

3. INSULATORS: Check tightness of support screws.

4. RISE OF STRAP: Break contact should have $\frac{1}{32}$" rise, and make contacts $\frac{1}{32}$" gap.

5. TIMING: Set according to timing chart.

CARD LEVER CONTACTS

1. WEAR OR BINDS ON OPERATING LEVER.
2. CLEAN AND ALIGN POINTS.
3. GOOD RISE WHEN MADE PLUS $\frac{1}{32}$" GAP WHEN BROKEN.
4. TIMING: If card lever is in a position where corner cuts will affect it, timing of both square and cut corners should be checked.

DUO RELAYS

I. Cleaning

Any relay that has accumulated dirt or oil should be washed with cleaning fluid. The core and residual may be cleaned by dipping a card in cleaning fluid and passing it between the core and residual while pressing on the armature.

II. Inspection

1. ARMATURE PIVOT: Check for freedom of movement of armature. All pivot points may be easily reached for lubrication by a pipe cleaner saturated with IBM #6 lubricant. Red rust will cause sluggish action. Any points found with red rust should be cleaned by removing armature, wiping off pivot rod and running the saturated pipe cleaner through the pivot holes in the armature. This will leave sufficient oil to lubricate pivot properly.

2. CORE should be firmly secured to the frame.

3. CONTACT PILE HOLDING SCREWS may become loose due to shrinkage of the linen dilecto separators.

4. POINTS: Line up points to make full contact. Points should be cleaned with a piece of clean card or burnishing tool, never with Trimite paper or flexstone.

III. Lubrication

Use IBM #6 on the following:

1. Armature pivot points.

Use IBM #17 on the following:

1. Very light film on the surface of the phenolic pad.

SUMMARY PUNCH AND DIGIT TYPE EMITTERS

1. WORN OR BURNT EMITTER SEGMENTS.

2. CENTERING OF EMITTER ON SHAFT: This can be checked by backing out one of the screws in the brush holder until it just touches the inside surface of the emitter. Turn machine over by hand, watching to see that the screw just touches all the way around.

3. BENT OR SHORT BRUSH STRANDS.

4. TRACKING OF BRUSHES.

5. TIMING OF BRUSHES: Check this at 0-5-9 time.

6. LUBRICATION: Very light film of Nujol mineral oil on inside surface.

BIJUR LUBRICATING SYSTEMS

AN ADEQUATE SUPPLY of oil should be maintained at all times. If any line has been disconnected at a junction point, be certain that oil is not prevented from flowing normally by an airlock. This may be prevented by operating the pump by hand (before reconnecting the tube) until oil flows out of it. When replacing a flow valve make sure that the arrow stamped on the valve is pointing in the direction of oil flow.

If conditions indicate that all bearings are receiving an insufficient supply of oil, inspect for:

1. Low level of oil in reservoir.

2. Broken, cracked or flattened tubes, or loose tubing connections. Wipe all tubes and connections and operate pump manually while watching for leaks.

3. Defective lubricator operation.

(a) Check oil level in lubricator and fill with IBM lubricant #9.

(b) Disconnect the tubing on the bottom of the pump, raise the piston part way and release. Oil should flow rapidly from the pump outlet. If there is little or no flow of oil and the piston remains in an elevated position, the filter disc is probably clogged. Remove the filter disc as follows:

1. Remove two mounting screws from Bijur lubricator.

2. Drain oil from the lubricator.

3. Raise the piston and block it 1/4" or more above its lowest position.

4. Remove the pump cylinder cap. Be sure to use a wrench to remove the cap, as placing a rod between the outlets and twisting will damage the die casting.

5. Lift out the piston seat plate and remove the filter disc. Should the filter disc be coated with dirt, replace it with a new one, if available (Part No. 173281); otherwise, wash the disc in carbon tetrachloride until it is clean before reassembly.

If there is an indication that only one bearing is receiving insufficient supply of oil, proceed as follows:

1. Inspect the tail tube for that bearing to determine that the nut is tightened sufficiently to prevent leaks, that the end of the tail tube is inserted in the bearing, and that the tube is not flattened or broken.

2. Remove the tail tube from the bearing and operate the lubricator two or three strokes; a drop of oil should appear at the end of the tube.

3. If no oil is delivered through the tube, disconnect the tail tube from the meter-unit and operate the lubricator manually. After two or three lubricator strokes, a drop of oil should be delivered through the meter-unit. If no oil appears, disconnect the meter-unit from the junction or junction bar and again operate the pump. Oil should flow freely from the junction bar. If oil flows from the junction or junction bar, but not from the meter-unit, replace the meter-unit. If oil does not flow from the junction or junction bar, inspect the feed tubes for breaks or leaks. If none is found, inspect the lubricator. After manually operating the pump for test purposes, wipe excessive oil from all line outlets.

MODEL 20 KEY PUNCH AND MANUAL VERIFIER

DESCRIPTION

This type of key punch is strictly mechanical and the punching of the card is a manual operation. This means that the operator has to exert pressure on the key to drive a punch through the card.

The information on an original record is transcribed to the tabulating card by means of the Key Punch. This machine has twelve punching keys, one for each punching position of a column. Ten are numbered from 0 to 9; the eleventh is marked "X" and punches directly above the O; it is used to record a detail and at times it is arranged to skip a field in which no information is to be punched. The twelfth has no distinguishing mark and punches in the position directly above the X. A key is also provided which, when depressed, advances the card one column at a time without punching a hole. An additional key, when depressed, releases the carriage for its return to the point where the card can be removed. The card is placed in the punching machine and is automatically advanced one column whenever a key is depressed, except where "X" is used to skip a field, in which case it advances to a predetermined point. A carriage stop is provided so that it is possible to begin punching at any column on the card.

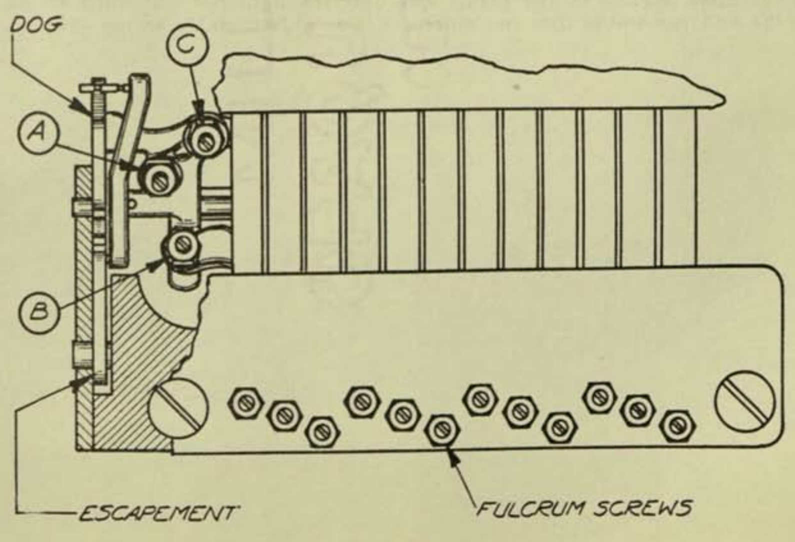
ADJUSTMENTS

Punches—Loosen the twelve fulcrum screw lock nuts (Fig. 1) and screw down on each fulcrum screw until the punch is visible below the stripper. Then back up each fulcrum screw until the tip of the punch is just level with the lower edge of the stripper. Then back each fulcrum screw 1/3 of a turn more and lock fast with the fulcrum screw nut, holding the fulcrum screw while locking. Care should be taken with this adjustment to make it as even as possible. A white paper or card back of the machine will bring the punches into a little clearer view.

Check to see that the rack does not escape before the punch leaves the card, also that the hole is punched before the rack escapes.

Rock Shaft—For the rock shaft adjustments refer to the standard rock shaft adjustments for all punching units.

Last Column Rack Stop—The last column rack stop is used to insure perfect registration of the punched hole in the last column (45th or 80th). The rack stop consists of a stud in a frame which is located in the center of the rack



guide assembly, and its movement is controlled by loosening its set screw and moving the eccentric stud either backward or forward until the perfect registration of the last column hole has been obtained by checking the hole on the registration gauge.

Adjusting Alignment or Registration of Punched Holes—To correct misalignment due to wear is very simple, an understanding of the functions of the different length dogs and escapements is all that is necessary. There are five dogs—10, 5, 6, 7, and 8. The dog marked "10" is the shortest. The one marked "5" is .005" longer. The next marked "6" is .005" longer. The one marked "7" is .005" longer and No. "8" is the longest being .020" longer than "10". These dogs control the alignment or registration of the punched holes.

When the machine is shipped from the factory the No. 5 dog is the regular equipment. As the machine wears it tends to allow the rack to move to the left. That is in the direction in which the rack moves when the machine is being operated. This throws the holes punched in the card to the right of their correct location. To overcome this put in a longer dog. The more wear or misalignment the longer the dog.

There are four escapements. No. 1 is the shortest and No. 4 the longest, being .005" longer than No. 1. The escapement should be of a length that will enter the rack freely when operating the keys. It should not strike on the top of the teeth in the rack or push the rack backward. A slight jump outward, about .003", that is to the left can be allowed as this will gradually disappear and the machine improve with use. It is usually necessary to slightly readjust the rock shaft adjusting screws after putting a different length of dog and escapement. When the wear is so great that the longest dog will not correct the adjustment the hole in the rock shaft bearing bracket will be found badly worn. By putting in a new bracket and using the proper dog the machine can be brought back to alignment or correct registration.

CLEANING AND OILING

It is important that the card bed be kept free from rust, dust and dirt. During the summer months or damp weather this surface should be wiped daily with an oily cloth. At other times, semi-monthly would suffice. The rack roller should be oiled semi-monthly. Keep the rack guide free from dirt, card punchings, etc., cleaning with carbon-tetrachloride if necessary. The punches must be oiled semi-monthly as follows: Insert a card in the machine and spread some oil from side to side across the surface of the same, push the carriage forward so the oiled portion is under the punches, then operate all the punches thru the oiled portion of the card. Use only the light non-gumming oil on this machine and remember that too much oil is as objectionable as too little.

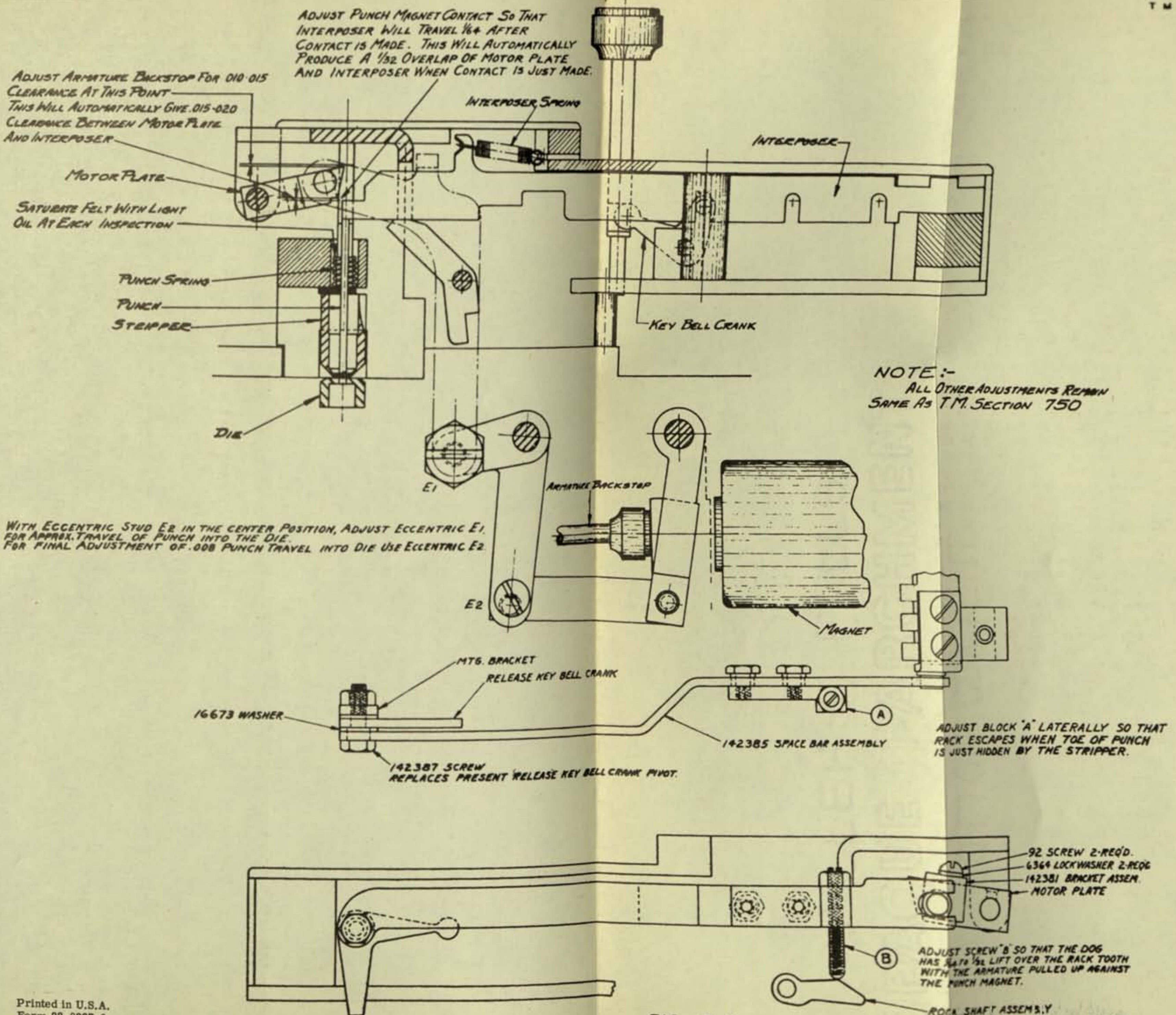

ADJUST PUNCH MAGNET CONTACT SO THAT INTERPOSER WILL TRAVEL 1/64 AFTER CONTACT IS MADE. THIS WILL AUTOMATICALLY PRODUCE A 1/32 OVERLAP OF MOTOR PLATE AND INTERPOSER WHEN CONTACT IS JUST MADE.
ADJUST ARMATURE BACKSTOP FOR .010-.015 CLEARANCE AT THIS POINT
THIS WILL AUTOMATICALLY GIVE .015-.020 CLEARANCE BETWEEN MOTOR PLATE AND INTERPOSER
INTERPOSER SPRING
INTERPOSER
MOTOR PLATE
SATURATE FELT WITH LIGHT OIL AT EACH INSPECTION
PUNCH SPRING
PUNCH
STRIPPER
KEY BELL CRANK
NOTE:- ALL OTHER ADJUSTMENTS REMAIN SAME AS T.M. SECTION 750
DIE
E1
ARMATURE BACKSTOP
WITH ECCENTRIC STUD E2 IN THE CENTER POSITION, ADJUST ECCENTRIC E1 FOR APPROX. TRAVEL OF PUNCH INTO THE DIE.
FOR FINAL ADJUSTMENT OF .008 PUNCH TRAVEL INTO DIE USE ECCENTRIC E2
E2
MAGNET
MTG. BRACKET
RELEASE KEY BELL CRANK
16673 WASHER
A
142385 SPACE BAR ASSEMBLY
ADJUST BLOCK "A" LATERALLY SO THAT RACK ESCAPES WHEN TOE OF PUNCH IS JUST HIDDEN BY THE STRIPPER.
142387 SCREW
REPLACES PRESENT RELEASE KEY BELL CRANK PIVOT.
92 SCREW 2-REQ'D.
6364 LOCKWASHER 2-REQ'D
142381 BRACKET ASSEM.
MOTOR PLATE
B
ADJUST SCREW "B" SO THAT THE DOG HAS 1/64 TO 1/32 LIFT OVER THE RACK TOOTH WITH THE ARMATURE PULLED UP AGAINST THE PUNCH MAGNET.
ROCK SHAFT ASSEMBLY

FIG. 2-A

EJECTOR MECHANISM

As the card rack moves into the last column punching position, the card is between the card gripper jaws which are held open when latched by the card gripper opener stud right. At this time the card retainer, left, operates against its release pin and the card is held in position by the positive card stop.

When the stacker magnet is energized, the card gripper latch releases the card grippers, which close, holding the card by action of a spring, also moving the stacker fingers to the right to clear the card while it is being ejected.

When the latch releases the card grippers, the stacker spring operates against a rack and through a train of gears, moving the card gripper assembly in an arc to the left until the card gripper opener stud left operates against a cam, opening the card gripper and releasing the card, which is guided into the card box by the return of the stacker fingers to their normal position.

As the stacker rack reaches the limit of its travel to the right, it operates a bell crank, closing the auto start ejector contact, which energizes the trip magnet, automatically starting a new card feed cycle.

As the card rack moves from the last column during the feed cycle, the stacker magnet circuit is opened allowing the card gripper latch and stacker fingers to return to their respective normal positions. The card feed rack near the end of the feeding stroke operates the stacker rack and the train of gears, returning the card gripper assembly to its normal latched position.

ADJUSTMENTS

A. Adjust Latch shaft adjusting screws so that the lower gripper jaw is level with the card bed when in latched position.

B. Adjust card gripper jaw opener stud right for clearance of .015" to .020" when latched.

C. Adjust card gripper opener stud left to open the gripper jaws .010" to .015" at center of stacker fingers.

D. Adjust spring stud so that stacker fingers will not strike stacker box with the stacker fingers in their normal position.

E. Adjust stop nuts so the card gripper jaws do not travel past the center of stacker fingers.

F. Adjust the stacker magnet assembly so the armature is square with the magnet cores and at right angles with the base.

G. Adjust latch tripper link with the stacker magnet armature in its attracted position so that the card gripper latch will clear the gripper jaw latching point at least 1/32". At the same time check to see that the stacker fingers clear the ejected card approximately ⅛" and do not touch the left end of the base.

H. Adjust the stacker armature backstop screw so there will be a clearance of .020" to .030" between the latch tripper link and the card gripper latch when the card grippers are latched and the armature is in its normal position.

I. The lower strap of the auto start contact should be depressed 1/32" off brass support when the gripper jaws are resting on the stop nuts of the card gripper jaws opener stud left.

J. Adjust the stacker plunger stud so the card gripper jaws latch and the dog drops into number ONE tooth **just before** the kickover pawl operates to disengage drive pawl from motor drive ratchet.

K. Adjust Dashpot barrel so the shaft is perfectly free when the gripper jaws are in their extreme left or right hand position.

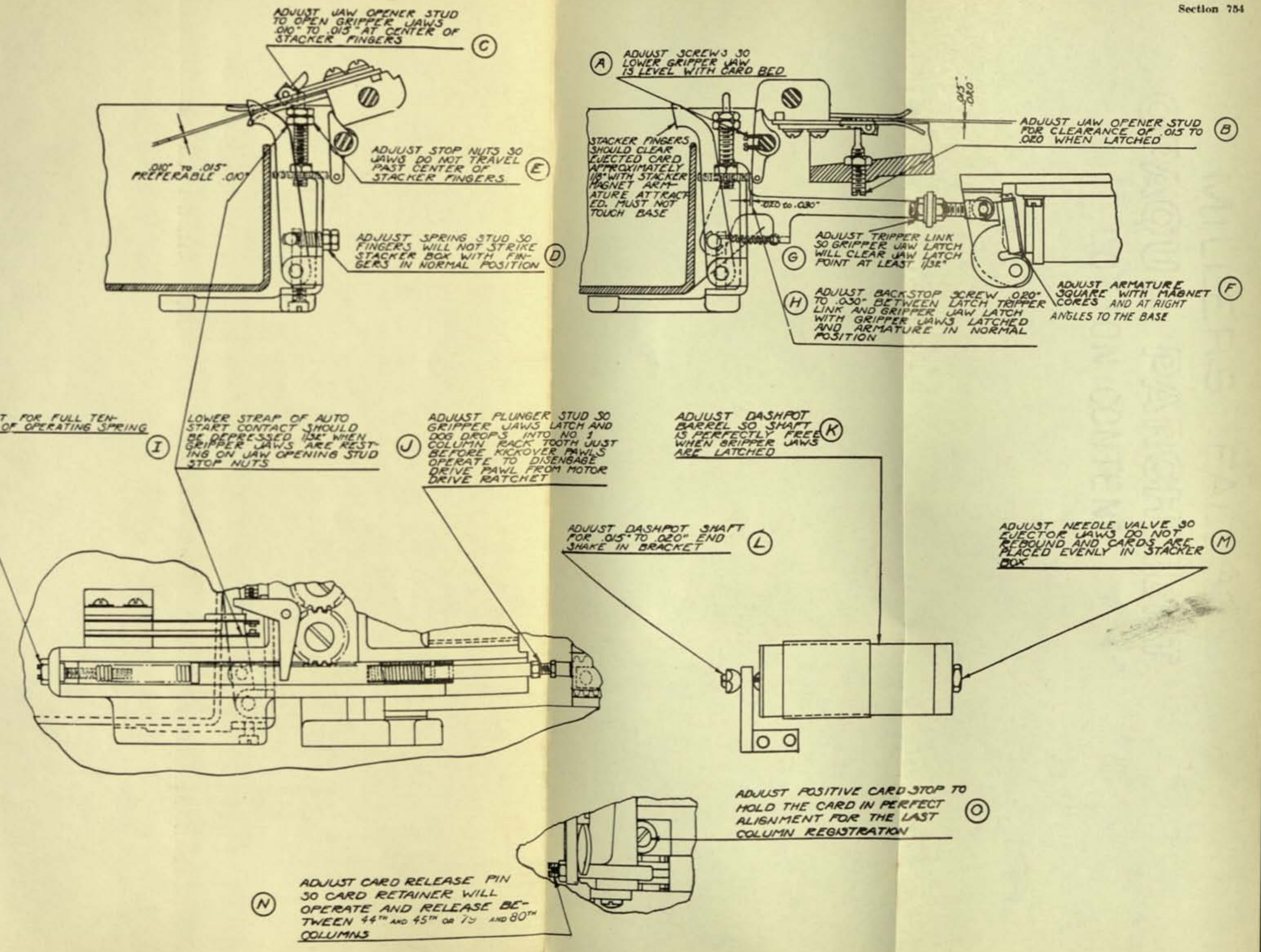
L. Adjust dashpot shaft for .015" to .020" end shake in bracket.

M. Adjust needle valve in right end of Dashpot so the Ejector jaws do not rebound and the cards are placed evenly in the stacker box.

N. Adjust card retainer release pin so the card retainer will operate and release between 44th or 79th and the 45th or 80th columns.

O. Adjust Positive card stop to hold the card in perfect alignment for the last column registration.

P. Adjust operating spring for full tension.


ADJUST JAW OPENER STUD TO OPEN GRIPPER JAWS .010" TO .015" AT CENTER OF STACKER FINGERS (C)
.010" TO .015" PREFERABLE .010"
ADJUST STOP NUTS SO JAWS DO NOT TRAVEL PAST CENTER OF STACKER FINGERS (E)
ADJUST SPRING STUD SO FINGERS WILL NOT STRIKE STACKER BOX WITH FINGERS IN NORMAL POSITION (D)
(A) ADJUST SCREWS SO LOWER GRIPPER JAW IS LEVEL WITH CARD BED
.015" .020"
ADJUST JAW OPENER STUD FOR CLEARANCE OF .015 TO .020 WHEN LATCHED (B)
STACKER FINGERS SHOULD CLEAR EJECTED CARD APPROXIMATELY 1/16" WITH STACKER MAGNET ARMATURE ATTRACTED. MUST NOT TOUCH BASE
.020 to .030"
ADJUST TRIPPER LINK SO GRIPPER JAW LATCH WILL CLEAR JAW LATCH POINT AT LEAST 1/32" (G)
ADJUST ARMATURE SQUARE WITH MAGNET CORES AND AT RIGHT ANGLES TO THE BASE (F)
(H) ADJUST BACKSTOP SCREW .020" TO .030" BETWEEN LATCH TRIPPER LINK AND GRIPPER JAW LATCH WITH GRIPPER JAWS LATCHED AND ARMATURE IN NORMAL POSITION
(P) ADJUST FOR FULL TENSION OF OPERATING SPRING
(I) LOWER STRAP OF AUTO START CONTACT SHOULD BE DEPRESSED 1/32" WHEN GRIPPER JAWS ARE RESTING ON JAW OPENING STUD STOP NUTS
(J) ADJUST PLUNGER STUD SO GRIPPER JAWS LATCH AND DOG DROPS INTO NO 1 COLUMN RACK TOOTH JUST BEFORE KICKOVER PAWLS OPERATE TO DISENGAGE DRIVE PAWL FROM MOTOR DRIVE RATCHET
ADJUST DASHPOT BARREL SO SHAFT IS PERFECTLY FREE WHEN GRIPPER JAWS ARE LATCHED (K)
ADJUST DASHPOT SHAFT FOR .015" TO .020" END SHAKE IN BRACKET (L)
ADJUST NEEDLE VALVE SO EJECTOR JAWS DO NOT REBOUND AND CARDS ARE PLACED EVENLY IN STACKER BOX (M)
ADJUST POSITIVE CARD STOP TO HOLD THE CARD IN PERFECT ALIGNMENT FOR THE LAST COLUMN REGISTRATION (O)
(N) ADJUST CARD RELEASE PIN SO CARD RETAINER WILL OPERATE AND RELEASE BETWEEN 44TH AND 45TH OR 79 AND 80TH COLUMNS

MOTOR DRIVE UNIT

The Motor Drive Unit as shown in figures 2 and 3 is operated by a 1/70 h.p. motor connected to a shaft and ratchet thru a fiber coupling, worm and spiral gear. The drive gear assembly is directly engaged with the card feed rack as shown at "B" Fig. 2.

When the trip magnet is energized, its armature is attracted and the armature bracket assembly "G" Fig. 2 operates against the kickover pawl pin on the kickover pawl, overthrowing the entire assembly, allowing the driving pawl "B" to engage with its ratchet "D" Fig. 1. At the time the kickover pawl assembly operates, the lower points of the latch contact "D" Fig. 3, are latched closed, completing the motor circuit until the end of the feeding cycle. During the feed cycle, the upper points of the latch contact are open, breaking the punch magnet, brush magnet, and duplicating circuits.

When the motor rotates, the entire pawl support and drive gear assembly Fig. 1, revolves, moving the card feed rack to the left, feeding a card into position to be punched in column one. The drive gear assembly is so timed with the card feed rack that as the rack reaches the end of its feeding stroke, the drive and kickover pawls operate against the stop bracket "G" Fig. 1, disengaging the drive pawl from the ratchet.

The pawl support drive gear assembly and card feed rack are returned to their normal position by the card feed rack return spring assembly "E" Fig. 3

Should any obstruction stop the card feed rack during its feed cycle, the drive gear assembly will be stopped, the ratchet will drive the pawl support against the tension of the safety trip springs "K" Fig. 3 until the drive and kickover pawls operate against the safety trip pin "R" Fig. 1, disengaging the drive pawl from the ratchet.

The complete motor drive unit assembly can be very readily removed from the machine by taking out the six mounting screws. Care should be exercised when replacing the unit to see that the knife switch connectors "G" Fig. 3, are not damaged, also that the drive gear assembly is properly timed with the card feed rack as shown at "B" Fig. 2.

ADJUSTMENTS

Timing of Motor Drive Unit to Machine—Spot marks are provided on the drive gear and the card feed rack "B" Fig. 2, to show where the rack and gear should be meshed when installing the motor drive unit.

Trip Magnet Armature Bracket Assembly ("G" Fig. 2)—With the card feed rack to the extreme right, adjust the trip magnet armature bracket assembly by means of four screws (two in each end of armature), so that when the armature is attracted and rests squarely against the cores, there will be a clearance of 1/32" between the bracket arm and kickover pawl pin, (when kickover arm assembly "L" is resting against its stop), as shown in Fig. 1.

Magnet Armature Stop Screw ("M" Fig. 3)—Adjust so there will be approximately 3/16" clearance between the armature bracket and kickover pawl pin, when armature is in de-energized position and kickover and driving pawl are dis-engaged from ratchet as shown in Fig. 2.

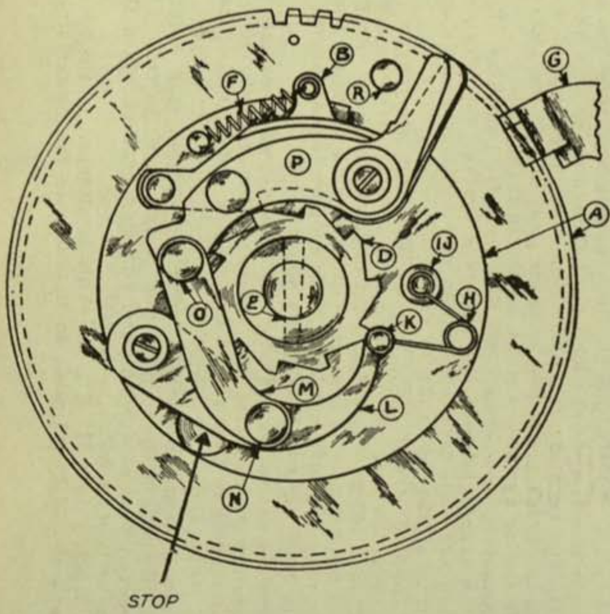
Contact Latch Assembly ("P" Fig. 3—With the trip magnet armature in attracted position, the contact operating arm should carry the center strap of contact 1/32" to 1/16" past latching point of latch assembly "P" Fig. 3. With center strap of contact latched and armature against its backstop, the lower strap of contact should have sufficient rise off its support to insure good contact and approximately 3/32" air gap between its upper points.

With armature against its backstop and center strap of contact unlatched, it should rest against the operating arm, and the upper strap should have sufficient rise off brass support to insure good contact and approximately 3/32" between lower points. (Fig. 3)

Driving Pawl Stop Bracket ("G" Fig. 1)—Adjust stop bracket with the driving pawl dis-engaged from the ratchet so there will be from 1/16" to 1/32" clearance between face of driving pawl and stop bracket, when the card feed rack is at the limit of its travel to the left.

Contact Latch Trip ("H" Fig. 3)—This is attached to the rear side of the drive gear and should be adjusted so it unlatches the center strap of contact

Printed in U.S.A.
Form 22-8445-0



PAWL SUPPORT & DRIVE GEAR ASSEMBLY COMPLETE #21668

A	SUPPORT & GEAR ASSEMBLY	20,201
B	PAWL ASSEMBLY	20107
C	KICKOVER PAWL ASSEMBLY (K,L,M,N,O,P)	21883
D	RATCHET	17,609
E	" PIN	3,916
F	PAWL SPRING	20321
G	STOP BRACKET	20,193
H	KICKOVER SPRING	102,465
I	" " PIN "REWORK"	102,468
J	" " PIN "LONG"	102,467
K	" " PIN "SHORT"	102,466
L	" " ARM ASSEMBLY	21875
M	" " " LINK	21721
N	" LINK RIVET "SHORT"	21814
O	" " " "LONG"	21815
P	" PAWL ASSEMBLY	20194
R	SAFETY TRIP PIN	17628

11/15/30

Fig. 1

A	CARD FEED GEAR HOUSING	17.661	E	CARD FEED RACK ASSEMBLY	18.719
B	" " " ASSEMBLY	19.859	F	TRIP MAGNET ARMATURE SHAFT	17.615
C	" " RACK GUARD-LEFT	18.533	G	" " BRACKET ASSEMBLY	18.721
D	" " " " -RIGHT	17.659	H	RETURN SPRING BRACKET	20.007

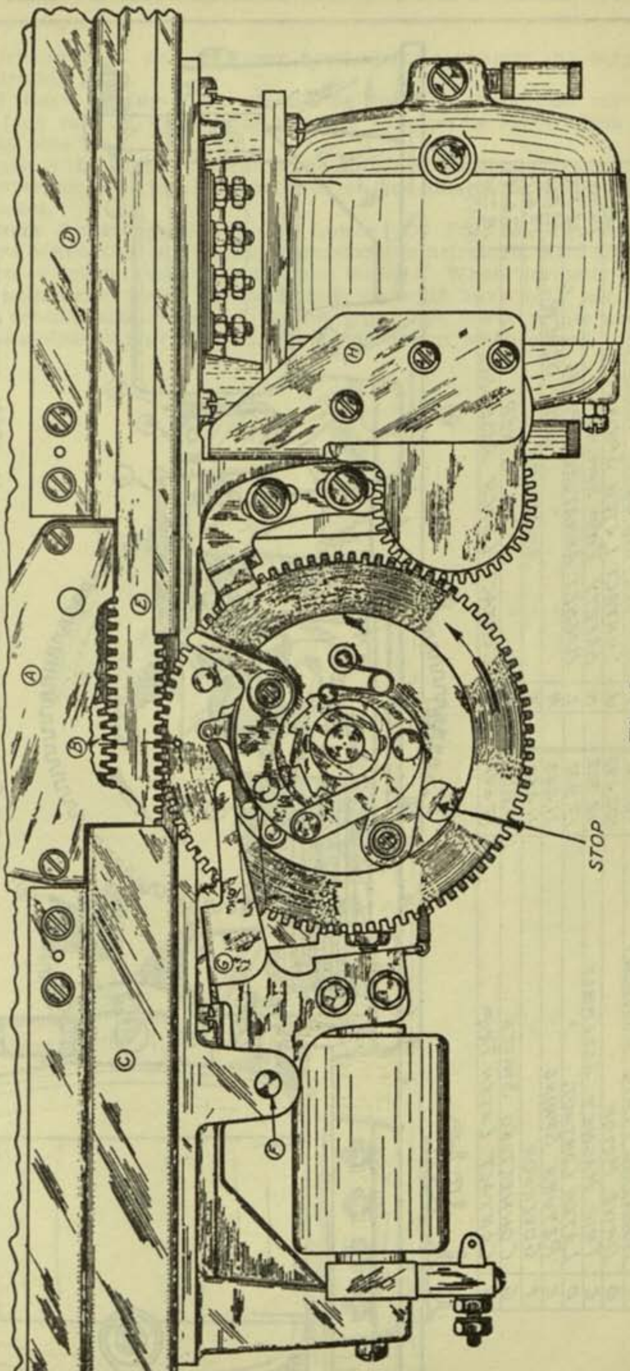
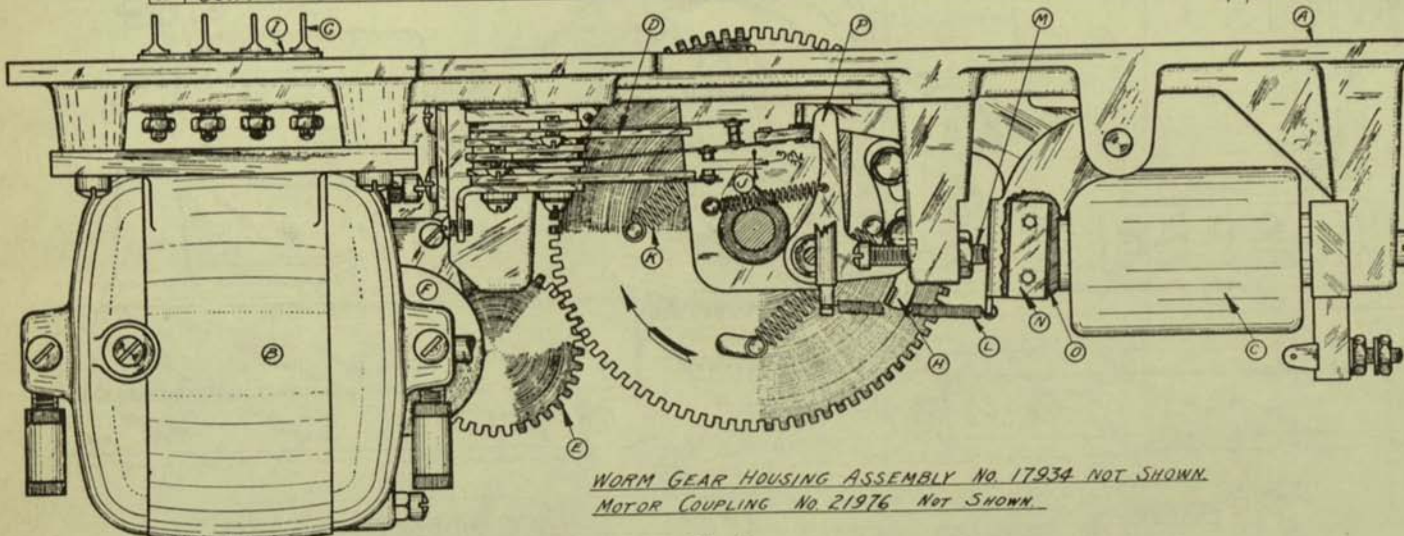


Fig. 2

MOTOR DRIVE UNIT COMPLETE ASSEMBLY No. 19095

A	MOUNTING PLATE ASSEMBLY	18,714	I	CONNECTING SWITCH INSULATION STRIP	14,868
B	DRIVE MOTOR	102,299	J	CONTACT LATCH SPRING	3,000
C	TRIP MAGNET ASSEMBLY	18,722	K	SAFETY TRIP SPRING	19,233
D	LATCH CONTACT "	17,941	L	MAGNET ARMATURE SPRING	13,507
E	RETURN SPRING "	21,543	M	" " STOP SCREW	18,865
F	GOVERNOR "	11,456	N	" ARMATURE	17,611
G	CONNECTING SWITCH	14,873	O	" " LINER	17,614
H	CONTACT LATCH TRIP	17,641	P	CONTACT LATCH ASSEMBLY	18,724

12/17/30



WORM GEAR HOUSING ASSEMBLY No. 17934 NOT SHOWN.
MOTOR COUPLING No. 21976 NOT SHOWN.

Fig. 3

1/16" before driving pawl and kickover pawl operate against the stop bracket to dis-engage driving pawl.

Card Feed Rack Spring—This should be installed with one turn tension with the card feed rack in its normal position, to extreme right. This spring is identified by the blue loop.

The governor is the same as used on the standard duplicator with the exception that the governor plate has been relieved on one side to facilitate adjustment of the stop bracket.

Latch Contact Assembly (Upper and Lower "D" Fig. 3)—The lower strap is latched closed when the trip magnet armature is attracted, and should have sufficient tension to insure good contact when latched. When normally unlatched and the upper points are closed, the lower points should have 3/32" air gap.

The upper contact should have 3/32" air gap when lower points are latched closed and have sufficient tension to insure good contact when closed.

PREVENTIVE MAINTENANCE

Type 016 Motor Drive Duplicating Punch

Type 031 Alphabetical Duplicating Punch

CONTENTS

New York, New York
Printed in U.S.A.
Form 22-5745-0

PREVENTIVE MAINTENANCE

Type 016 Motor Drive Duplicating Punch and Type 031 Alphabetical Duplicating Punch

PUNCH UNIT

THE MOTOR DRIVE UNIT should be removed to clean properly. Inspect and oil the punch unit. The punch can still be operated under power if a paper clip is bent so that it can be inserted into, and short together, knife switches 3 and 4.

I. Cleaning

As in the case of all other units, the punch should be thoroughly cleaned before oiling or adjusting. Carefully clean out all dirt, oil, etc., around the key stems to insure freedom of operation. Do not soak the keys with oil to overcome sluggish action. If the keys have become very sluggish, remove the key unit, completely disassemble, and wipe all parts with an oil-soaked cloth.

The rack should be thoroughly cleaned with a stiff brush and cleaning fluid.

II. Inspection

1. Linkage from Motor Plate to Punch Magnet Armature for wear at pivot points. Any parts showing excessive wear should be replaced.

2. Armature Pivot Shaft for wear and tightness.

3. Bell Crank Pivot Screw for tightness.

4. PM Contact for pitted points and adjustment. Replace individual straps if necessary.

5. "Slipping By". By this is meant the failure of the contact hook to engage the punch magnet contact on the second of two successive and rapid key depressions. If this condition occurs, it very probably indicates that the lower support of the contact must be bent upward slightly.

6. Motor Plate Linkage Adjustments
   (a) HEAVY DRAG ON TWO CARDS between PM armatures and cores with power on magnets.
   (b) PM ARMATURE BACKSTOP for .010"-.015" clearance between punch jacket and motor plate.
   (c) BELL CRANK ECCENTRIC SCREWS for proper travel of punch into die.
   (d) CIRCUIT BREAKER ARM for breaking PM contact just before armature reaches the limit of its travel.

7. Punch Travel. The following procedure may be used to check that the proper punch travel has been obtained:

   With four cards between the punch magnet armature and cores and power on the machine, the punches should cut through a card in the punch bed.

   With six cards between the armature and cores, the punches should not cut completely through a card and the punchings should be left sticking in the holes. If it is necessary to change the punch travel at this time, it should be done with the lower eccentric screw.

8. Die for wear by punching several holes with each punch. Ragged holes indicate wear and the corresponding punch should be replaced. Use oversize punches if necessary.

9. Dog and Escapement for wear and adjustment. The rise of the dog may easily be checked by shorting the PM contact with a screwdriver through the hole in the base.

10. Rack for wink and wear.

11. Skiplifter for wear. This will show up by a notch worn where it rides on the skip bar.

12. Governor. Remove and wash thoroughly with cleaning fluid. Lubricate the pivot point with a small amount of IBM 6.

13. Punching Registration

14. Auxiliary Keyboards. Check all the keys for ease of operation. It is essential to have the keys free of binds so that they may always be depressed their full travel to insure that their respective contacts will be fully made. This is particularly essential when a key operates a contact with double points.
    There should not be too much tension on the contact straps that operate against the contact bell cranks in order that all the keys may be operated fully with as little finger pressure as possible.

III. Lubrication

Do *not* lubricate the key unit other than to wipe parts with oiled cloth after cleaning.

IBM 6

(1) 4 rack rollers.
(2) Rock shaft spindle bearings.
(3) Dog and escapement pivots. It is permissible to put a small amount of IBM 6 on the rack if the short type dog is used. ***Never oil rack if the long style dog is used.***
(4) Card lever frame and hook pivots.
(5) Punches. These should be lubricated by punching through a card soaked with IBM 6. There is also a felt wick above the die that should be soaked with IBM 6.
(6) Interposer Locks. There are two holes provided in the key units to facilitate lubrication of the interposer interlocks. These two holes are located in the top plate over the interlocks and in line between the two right key plunger plate screws.
(7) Governor pivot points.

IBM 9

(1) Motor plate pivots.
(2) Punch magnet armature pivots.
(3) Toggle link spring wick.

IBM 17

(1) Toggle link pivots.

FEED UNIT

I. Cleaning

Clean all old dirt and grease from the unit. The governor should be removed and washed with cleaning fluid. The drive motor should be cleaned of all carbon.

II. Inspection

1. With drive unit off machine.
   (a) LATCH CONTACT for wear and adjustment. Replace any badly pitted points.
   (b) DRIVE MOTOR BRUSHES for wear.
   (c) GEAR HOUSING for wear and lubrication.

2. With drive unit on machine.
   (a) THROAT for wear and adjustment.
   (b) FEED KNIFE for wear and adjustment.

III. Lubrication

IBM 6

(1) Motor bearing—only a slight amount.
(2) Governor—only a slight amount.

(3) Rack spring gear pivots.
(4) Small amount on linen dilecto coupling between motor and gear housing.

IBM 9

(1) Feed rack gear shaft bearings.
(2) Drive pawl latch and pivot.

IBM 17

(1) Drive pawl ratchet.
(2) Light film on gear teeth.

IBM 21

(1) Gear housing.

STACKER UNIT

I. Cleaning

Clean all dust and dirt from unit. Dash pot should be removed and washed with cleaning fluid.

II. Inspection

1. Eject Gears for wear and tightness of pivot studs. The ejector stop lever must be removed to reach the locking screw for the center stud. To reach the locking screw for the lower stud, it is necessary only to raise the base to a vertical position. The screw will be found directly under the stud for the lower gear. These locking screws should be loosened before turning the gear studs and should always be tightened thoroughly when the studs are set to prevent the studs from loosening.

2. Eject Gripper Jaws for looseness on its shaft and for broken ears on the upper jaw. Also for proper jaw opening when latched and unlatched. While in the unlatched position, check for proper rise of the eject contact.
   Operate the feed rack by hand with the gripper jaws unlatched and see that the gripper jaws latch just before the main rack returns to column 1.
   This adjustment should again be checked under power when the motor drive unit is replaced.

3. Card Reversing Device for loose gears and freedom of action.

III. Lubrication

IBM 6

(1) Gripper jaw latch pivot.
(2) Eject gears.
(3) Eject jaw pivot shaft.
(4) Reversing finger shaft bearing.
(5) Card reversing drive shaft bearings.

DUPLICATING UNIT

I. Cleaning

Brush all dust and dirt from unit, paying particular attention to dust on and between brush separators. Clean contact roll with Trimite Paper.

II. Inspection

1. Floating Cam Contact for pitted points and adjustment.

2. Duplicating Brushes for wear, damage and projection.

3. Contact Roll for clearance to brush separator and for centering of brushes to roll. One method of determining whether the brushes are on the center line of the contact roll is:
   Place a piece of carbon paper cut to the size of a tabulating card in the master card bed, carbon side up.

Place two blank cards face up in the master card carrier on top of the carbon paper.

Set the card rack at approximately column 40 in the card and close the contact roll housing door. Tap the housing lightly with the handle of a screwdriver.

An examination of the card next to the carbon surface will show very clearly the imprint of the center line of the contact roll, as well as indicate the position of the scribed line on the brush guide by showing a fine line where no carbon was deposited, and surrounded by a black smudge approximately the size of a punched hole caused by that portion of the guide separating the brushes. The amount of carbon deposited on the card will show to which side the center of the contact roll is positioned.

The rear contact roll housing support bracket is adjustable and can be set to line up the one side of the contact roll with the scribed line on the brush separator. If the front side of the center line of the contact roll does not line up with the scribed line on the brush insulator, it will be necessary to scribe a new line and readjust the contact roll housing support bracket.

4. Duplicating Armature Levers for adjustment and freedom of operation. Any binds result in slow punching. Lift each lever slightly and see that it drops to normal because of its own weight.

5. Master Card Guides for proper registration. Be certain the card used for checking is in perfect registration.

III. Lubrication

IBM 6.

(1) Duplicating magnet levers at pivot points.
(2) Brush magnet armature assembly at pivot points.

TEST

COMPLETELY TEST the machine punching and duplicating all columns. The machine should duplicate with two cards in the master rack and punch through two cards at the same time.

IBM

Customer Engineering Reference Manual
Preventive Maintenance and Adjustments

CARD PUNCH, Type 24
PRINTING CARD PUNCH, Type 26

CONTENTS

Printed in U.S.A. March 15, 1952
Form 22-8941-0

CARD PUNCHES

Type 24, 26

THIS reference manual revises and condenses Type 24 and 26 adjustments previously published. Preventive servicing hints are included with each machine unit subdivision. In combining the pertinent C.E.I's with the current material from the 24-26 C. E. Manual of Instruction, new emphasis is established on servicing requirements.

Safety and Appearance

Clean machines command the most respect from those who use them. Card chips should be cleaned off reading boards and out of the tables. Keep the wiring diagram inside the left leg where oil cannot soil it.

Broken or chipped plastic guides should be either rounded off to a 1/8″ radius or replaced. The escape gearing cover should remain installed at all times when the machine is running. Be sure the belt guard is in place. Although the belts are covered from the front, one who follows dangerous practices can still place his fingers between the belts and pulleys from the rear. It is a safe practice to turn off the power when tilting the base. The escapement adjustment procedure using a meter is preferred to holding the escape wheel by hand, because some friction drives may develop exceedingly high torque.

Preventive Maintenance

Included in preventive maintenance is all of the work performed that will increase the usefulness of IBM equipment to our customers. Items falling into this category are: reduced calls, improved appearance, and increased machine life.

Pressed metal gears are being used on machines utilizing the Type 24 base. These parts, which are made from powdered iron with a bronze binder or from powdered bronze, are impregnated with lubricant. They can be identified by their dull finish and should not be stored in paper containers. With few exceptions under normal usage, they should not require additional lubricant for four years.

Noisy Machine

1. If the punch clutch is not lubricated according to schedule, it generates a metallic noise.
2. Nipping punch clutches can be determined by visual inspection. During auto-duplication, if the numbers on the punch index can be read, the clutch is nipping. A possible cause is excessive torque on the friction drive. If the escapement armature takes too long to pull out, the clutch is not impulsed early enough and will latch up. Dry punch clutches may produce a shrill squeal.
3. Relay cover rattles can be reduced by slightly curving the panel out at the center.
4. The belt guard becomes noisy if not properly installed. A loose drive belt may slap against the guard. Plastic guards cannot be formed. File away material above the mounting holes to bring the bottom out.
5. Excessive punch penetration or punches in need of oil may produce noise. See lubrication schedule.
6. Improper adjustment of the stacker bumpers may contribute to the noise level being high.
7. On the Type 26, excessive printing pressure is noise producing. With the phenolic platen there is very little embossing to indicate excessive pressure.
8. Old style friction drives may chatter and should be replaced with the new style drive with dry graphite alloy discs.
9. Loose program drums or loose screws in the forked arm should be eliminated.
10. On the Type 26, insufficient clearance (minimum .003″) between the washer in the end of the punch shaft and the eccentric drive link will cause the eccentric bearing to turn and throw out the suppression adjustment.

Polarity Trap Selenium Rectifiers

The rectifiers used have a current rating of only 5 ma. The meter should be used in place of the test light because the light draws upwards of 70 ma. In case the light must be used, short out the rectifiers first.

To check rectifier 2 (post 92 to 98) short across the program contact terminals 11 and 0. Upon depression of the release key, the card should release, but the punch clutch magnet should not energize until the 80th column.

BASE PREVENTIVE MAINTENANCE

Power Supply

Drive Motors. Motors of 1/12 HP have an external starting relay which picks up on 5.1 amperes and drops out on 4.35 amperes. The relay cover can be removed for inspection. The motor was oiled at the factory for a one year period based on normal usage of 40 hours per week. Motors of 1/20 HP have centrifugal starting switches.

Dynamotors. DC machines use dynamotors to convert DC to AC. The dynamotor output should be connected to the AC terminals. The DC line voltage should not be below 105 volts. The rectifier output (post 76 to 80) should show a voltage rise of about 25% above line input voltage. No figure for the dynamotor AC output is given; it cannot be measured accurately because of its harmonic content.

Rectifiers. A shorted selenium rectifier will produce a strong objectionable odor. A large variation in the voltages (AC) across the 4 sections of the rectifier usually indicates an open circuit in one section. Good rectifiers may have 20% variation in voltage among the legs.

Pulleys and Belts. Type 24 and 26 motors operate at the same speed. The Type 24 punch cam shaft pulley (p/n 227812) has an outside diameter of 2-7/32″ and rotates at 1200 rpm. The Type 26 punch pulley (p/n 228128) has an outside diameter of 2-3/8″ and rotates at 1080 rpm. Both belts and all other pulleys are identical for both machines.

Elongated motor mounting holes are used to adjust the motor belt tension for 1/4″ belt deflection midway between pulleys. The adjustable drive housing pulley is used to obtain the same tension on the punch drive belt. A tight belt throws extra load on the clutch and has caused noisy operation and failure of the clutch to latch up.

Tube Checking

Select the filament transformer tap for 22 to 25 volts across posts 6 and 9. Higher filament voltage shortens tube life. The plate voltage usually ranges between 130 and 160 volts. The negative bias supply should not be less than 40 volts. Exchanging tubes usually detects defective ones. Use a voltmeter test to locate defective tubes during inspection. With R3 de-energized and all tubes biased to cutoff, measure the voltage drop across each load. Connect one meter lead to post 80. The other lead can be touched successively to the P terminals on the tube chassis for the readings. Up to 5 volts drop is permissable. Replace any tubes whose leak current causes more than 5 volts drop across the load. Use only glass tubes because they have a longer filament life. Use caution when removing wires from the tube panel to prevent opening the moulded common on the chassis. Remove or insert wires with a slow rotating motion.

Die and Stripper

Type 24 Throat Clearance. When trouble occurs with cards having a tendency to bind in the throat, e.g., heavily handled original document cards, the clearance can be increased to .020″ to .026″. B/M 270617 provides for the change.

Cleaning and Oiling. A crayon or pencil deposit sometimes forms on the underside of the die and can cause a drag on the card resulting in off-registration punching. These deposits can be removed with a feeler gage.

A convenient method of lubricating the porous bronze punch guides is to multiple punch several columns of an oiled IBM card.

Punches. It is desirable to replace all punches in the same positions if they are removed. Avoid separating the die and stripper unnessarily as this can cause sticking punches. Excessive punch penetration or sticking punches can cause off-registration punching.

Chip Tubes and Flexible Shafts

Flexible Shafts. These shafts should be kept lightly greased. Avoid sharp kinks in the shaft.

Chip Tube Bearing. The chip agitator may bind if it has no end play at the rear bearing. If this condition exists, grind the face of the coupling on the flexible shaft for clearance. The agitator shaft shoulder should seat on the hub.

Chip Tubes. Clean all chips away before replacing the chip tube. The pressure roll bushing is porous bronze and oil impregnated. It should not require attention. The loose fit on its stud is intentional. A new assembly contains a horizontal adjustment for the pressure roll lever to make the pressure roll track properly and give correct punching registration.

Pressure Rails

It should not be necessary to put other than standard tensions on these rails. A bind on the card or incorrect pressure roll alignment may make it appear the rails are out of adjustment. The rails cannot be correctly adjusted without using a gram gage.

Pin Sensing Unit

Pin Bail Bearings. These bearings are lubricated by felt wicks which whiten as the oil is used up. Two holes to the wicks are accessible through the top of the pin sensing frame when the eject unit is removed.

Pin Bail Drive Link. The guide stud in the rear frame will wear rapidly unless it is kept lubricated. It may become necessary to readjust the link to compensate for wear.

Sensing Pin Contacts. Inspect the contacts for burning and clean out card particles and lint. One broken contact in a pair will cause erratic failure to read.

Sensing Pins. Check to make sure the pins operate separately. Pins sticking together cause reading failures by making it necessary for both pins to enter the hole. Clean out the accumulation of card dust around the card lever.

Eject Unit

Glaze on the continuously-running feed roll can be removed with carbon tetrachloride or a pencil eraser. Improper pressure roll arm tension will cause failure to register master cards.

Program Unit

Program Card Life. The program card should last for 10,000 or more card operations. The star wheels should form a glaze on the program card. Rough or worn star wheels should be replaced. Improper tension on the sensing arm shortens program card life.

Star Wheel Pivots. The star wheels must pivot freely. Check for oxide deposit on the pivots and for proper lubrication. The sensing arm lever must be free on its pivot shaft.

Program Drums. All drums should be interchangeable. Worn gripper cam shafts should be replaced.

Sensing Contacts. Service time on these contacts will be greatly reduced if the positive method for measuring their duration is followed as outlined in the adjustment section. Be sure the plastic safety cover is installed over the terminals.

Phenolic Mouldings. Avoid lubricating phenolic mouldings used for a bearing surface (release bail). Lubrication may cause them to freeze up.

Friction Drive and Escapement Gearing

Graphite Alloy Discs. These discs, which may be recognized by their adjustable spider springs, must be kept free of lubricants or they will lose their torque. The escapement gears should be kept almost dry. The alloy rings are pressed into the sides of the gear, and it is impractical to extract them. Keep card chips and other foreign matter out of the escapement gears and friction drive, as they may cause binds or increased torque that can result in escapement failures.

Gear Shaft Collars. All the gear shafts protruding through the gearing bracket must be pulled to their extreme forward position before tightening their collars. Be sure the unsealed bearings are capped.

Gearing Bracket. When removing the escape gearing bracket on machines after the DN suffix, it may be necessary to drive the locating pins through the base because of the close tolerance between the pins and the bracket.

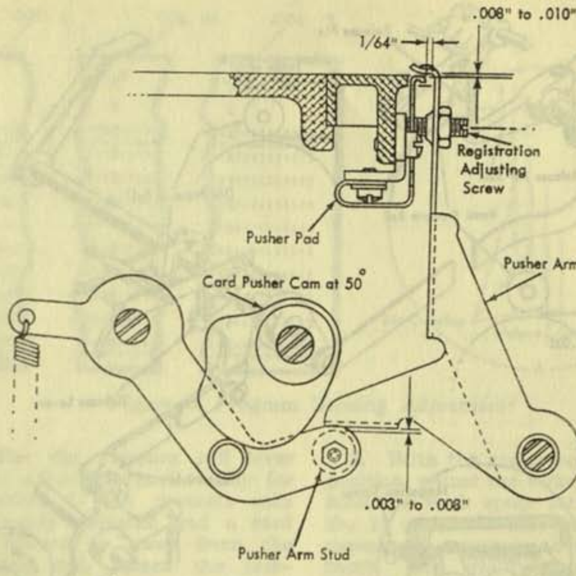


Figure 1. Card Registration Adjustment

Escapement Unit

Check the residual on the left-hand yoke end for wear. Incorrect torque on the friction drive may make the escapement armature slow to pull out. The escapement wheel must be kept free of lubricants. If the program drum is out of adjustment, it may cause the machine to space too far on a skip. Incorrect tension on the auxiliary armature spring may result in double spacing while punching. Care should be taken not to put sharp bends in this spring while forming.

BASE ADJUSTMENTS

Aluminum Base

Avoid tightening screws excessively in aluminum. Steel screws will strip aluminum threads easily.

Card Registration Adjustment (Figure 1)

1. Adjust the pusher pad for .008" to .010" clearance from the top of the pad to the pusher arm in the registering position (against its adjusting screw). Maintain 1/64" clearance from the side of the pad to the arm.

2. Back away the pusher arm stud to be sure it does not interfere with registration, then adjust the registration screw for correct registration.

3. With the card feed index standing at 50°, adjust the pusher arm stud for .003" to .008" clearance to the pusher arm.

Card Lever and Switch Adjustment (Figure 2)

1. The maximum load required to operate the switch should be 6 to 9 grams when measured at the center of the button. The newer style switch (stamped AC) should

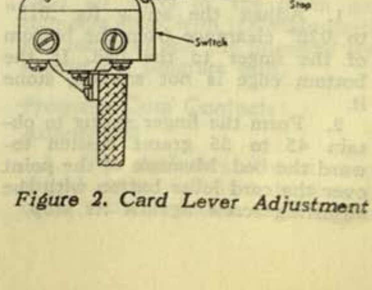


Figure 2. Card Lever Adjustment

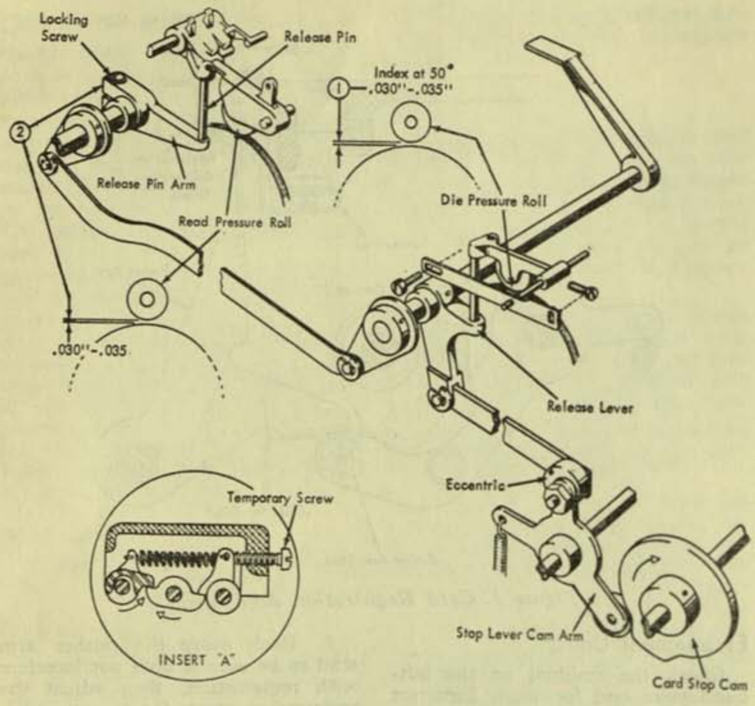


Figure 3. Pressure Roll Adjustments

make and break within a range of .030". The older style switch (stamped DC) should make and break within a range of .070".

2. Form the ear on the card lever to extend the button 3/32" above the base. The button must not bind on the base, and it must be impossible to slip a card under the button.

3. Position the switch to break on the upward motion of the button with .010" to .030" travel remaining.

Card Lever Pressure Finger Adjustment

1. Adjust the screw for .015" to .020" clearance from the bottom of the finger to the bed. If the bottom edge is not smooth, stone it.

2. Form the finger spring to obtain 45 to 55 grams tension toward the bed. Measure at the point over the card lever button with the adjusting screw against its stop.

Card Pusher Hood Plate Adjustment

The plate holds the second card in the detail bed and keeps it from interfering with the first card. It is formed for .015" to .020" clearance to the bed. Check with the pusher hood installed.

Pressure Roll Adjustment (Figure 3)

1. With the stop lever cam arm on the high dwell of the card stop cam (50° of CF index), adjust the eccentric in the arm for an opening of .030" to .035" between the die pressure roll and the larger feed roll.

2. With the stop lever cam arm still on the high dwell, insert a temporary 5-40 screw in the eject housing (insert A). Turn in on the screw until the read pressure roll is .030" to .035" off the larger feed roll. Loosen the locking screw in the release arm and take up the vertical play in the release pin. Remove the 5-40 screw.

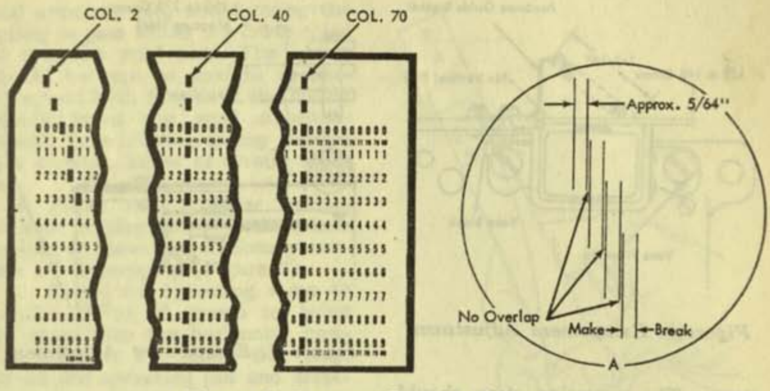


Figure 4. Program Sensing Adjustment

3. The die pressure roll lever shaft is adjustable horizontally for registration. If the pressure rails are properly adjusted and a card walks toward or away from the top guide rail, loosen the locking screw and position the shaft for correct feeding of the card.

Program Sensing Adjustment

1. The common contact plate is adjusted to require 45 to 55 grams to lift each star wheel off the program card when measured at the star wheel hub. Excessive tension on the short arms is relieved by a .022" cut from the common contact plate at those positions.
2. Position the contact moulding so that the sensing arm levers clear the aligner fingers of the program drum and the star wheels approach a column evenly.
3. Prepare a program card as indicated in Figure 4. Adjust each stationary contact for 3/8 turn additional travel after the contact makes while reading a hole. Use a meter to determine the make time accurately.
4. Register a blank card face down in the punch station. With the power off and a meter across the 12 position, mark the make and break time on the blank card progressively for each position as shown in Figure 4A. The duration marks should appear .070" to .085" apart (approximately 5/64"), with no overlap between positions. As much as 5/8 turn rise may be necessary for proper adjustment, but this amount should not be attempted without measuring the duration.
5. With the meter across the 12 position, adjust the forked arm (behind the back space ratchet) until the 12 contact breaks when the escapement armature overlaps 1/3 tooth. The multiple punches in column 40 and 70 are used to check the drum for eccentricity which should not vary more than .003". Gage by the relationship of the star wheel to the hole while standing in columns 1, 39, and 69.

Program Drum Interlock Arm Adjustment

1. This applies to machines having a split hub on the interlock arm. With the star wheels raised, rotate the arm on the serrated shaft to operate the switches with .015" travel remaining before the plunger bottoms.
2. Position the arm along the serrated shaft for a clearance of .015" to .020" to the back end of the drum when the star wheels are lowered. If the arm is pinned, it must be formed to obtain this adjustment. Avoid bending the release bail shaft.
3. Form the interlock arm toward the spindle to obtain a condition where the star wheels will clear all parts of the drum and clamping strip, with the drum partially removed and the interlock arm against the program card.

Program Cam Contacts Adjustment

1. The stationary contact straps should have sufficient tension to cause them to follow their support

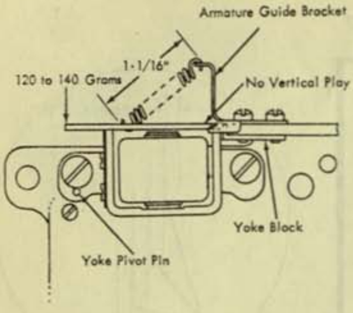


Figure 5. Escapement Adjustment

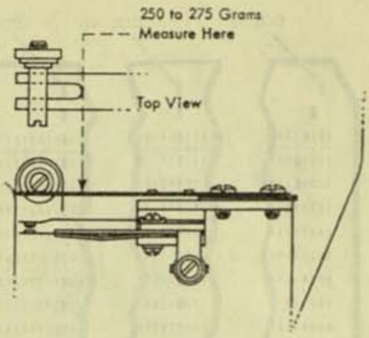


Figure 6. Escapement Adjustment

straps. The operating strap should be tensioned toward the N/C side with enough pressure to raise the stationary strap .020" to .030" off its support.

2. Set the contact levers on the high point of the cam (approximately column 84). Position the contact bracket for .020" to .030" rise of the N/O contact off its support. Form the N/C contact support for an air gap of .020" to .025".

3. Position the contact lever bracket laterally to time the number 1 contact. It should drop the escapement armature at column 88-1/6 to 88-1/3 (2/3 tooth before column 1).

Rotate the contact lever bracket to obtain a clearance of .010" to .020" between lever 2 and the pad on the contact strap when the levers are off the cam.

4. The break of contact 1 is critical. The above adjustments may have to be modified to meet the following timings with reference to program columns:

No. 1 make 80-1/3 to 80-2/3, break 88-1/6 to 88-1/3.

No. 2 N/C break 81-1/2 to 83, make 87-1/2 to 88-1/2.

Back Space Adjustment

Back spacing should maintain good registration over a group of 20 consecutive columns.

The actuating arm should be straight and free of binds so that its spring can return it to normal.

1. Position the back space ratchet by means of its three screws to cause a card to back space into column 1 and not column 88 of the program drum. Each back space should cause the escape wheel teeth to move 1-1/4 teeth past the end of the armature.

2. Position the back space switch to operate with 1/16" depression of the actuating arm.

Escapement Magnet Unit Adjustments

The adjustments are made with the unit removed from the base.

1. Remove the contact mounting bracket and slide the yoke block to the right until it seats firmly against its bracket (Figure 5).

2. Remove the vertical play from the armature pivot by rotating the magnet yoke about its pivot pin. The operating end of the armature must be free to move 1/8" without binding (Figure 5).

3. Form the armature guide bracket to require 120 to 140 grams to seal the armature, with the armature pin removed. A quick check can be made with the unit in the machine by measuring the 1-1/16" dimension as shown in Figure 5.

4. Form the auxiliary spring near its mounting bracket to exert 250 to 275 grams pressure against its stop stud when measured at the point shown in Figure 6. An approximate adjustment can be obtained by removing the stop stud

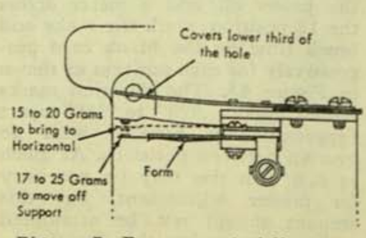


Figure 7. Escapement Adjustment

and armature pin, and forming the spring to pass across the lower third of the stop stud hole. The spring should be kept as straight as possible, and both fingers of the spring should leave the stud simultaneously. Loss of the spring tension is a common cause of erratic spacing.

5. Form the stiffener spring, without kinking, for 17 to 25 grams tension to move the stationary contact off its support (Figure 7).

6. Form the operating strap to require 15 to 20 grams to bring the strap into the horizontal position (Figure 7). After this step, attach the operating pin and armature stop. Attach the contact assembly to the main magnet bracket. If necessary, position the auxiliary armature spring and escape contact assembly to free the pin at all three points of contact.

7. With a .015″ gage between the armature and the yoke, position the contact mounting bracket to remove the vertical clearance of the operating pin shoulders at the armature and at the auxiliary spring. The pin must still be free of binds.

8. Form the stationary support to close the escapement contact with an .008″ gage between the armature and the yoke. Make this adjustment accurately by using a meter. When inserting the feeler gage, do not rest the gage against the armature spring loop. This would give a false adjustment.

9. Position the escape magnet assembly to allow the escapement wheel to rotate under power, with an .008″ gage between the armature and yoke and the magnet energized. With a .010″ gage the wheel should stop. In correct adjustment the armature may nip teeth but continue to rotate with an .008″ gage, and with a .010″ gage it may slip a few teeth before stopping.

Pressure Rails Adjustment

If the gram gage is held as shown in Figure 8, the eyes are free to watch the rail leave the card.

1. Tension the two pressure rails in the punch station to exert 23 to 27 grams pressure on a registered card. Check the above by the tension required to move the rail away from the card evenly. The blades of the gage must be held

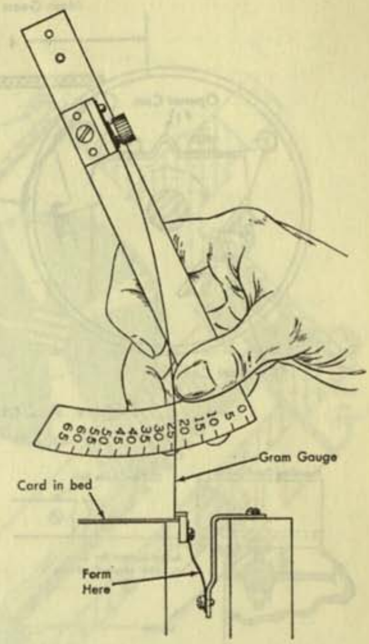


Figure 8. Pressure Rail Adjustment

squarely against the center of the lip on the rail. Adjust by forming the spring.

2. Adjust the two rails in the master card station to exert a force of 13 to 17 grams against a card in the bed. Measure the same as step 1. Machines having two screws in the plastic card bed also have adjustable rail brackets.

Stacker Unit Adjustment

1. With the card feed index latched at 0°, time in the stacker with the teeth which provide the closest measurement to 4-11/16″ from the upper cut in the stacker drum to the front edge of the base (Figure 9, step 1). It is advisable to measure this distance before removal of the unit to prevent changing other adjustments which might be affected because of a change in timing.

2. Register a card in the read station and space it about half-way through. Position the stacker bed plate for a clearance of .025″ to .030″ from the bottom of the card to the narrow rail on the bed plate (Figure 10, step 2).

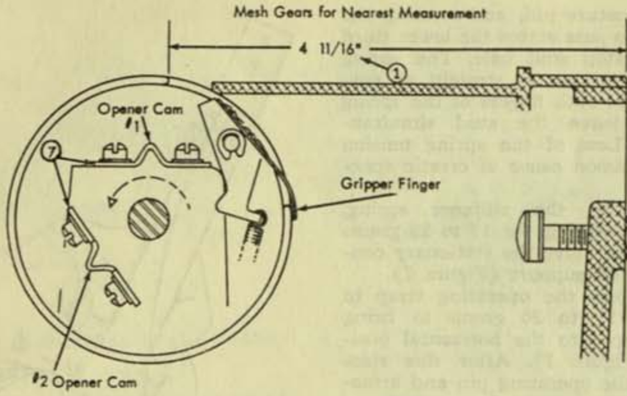


Figure 9. Stacker Adjustment

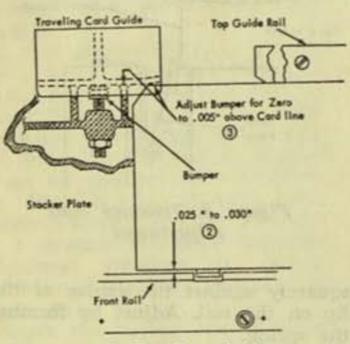


Figure 10. Stacker Adjustment

3. Adjust the traveling card guide bumper to put the vertical surface of the traveling card guide in line with the top rail and not more than .005″ above. This position can be determined by laying a straight edge (.0125″-.018″ thickness gage) along the edge of the top card rail and extending it into the stacker (Figure 10, step 3).

4. Adjust the lower bumper (Figure 15, step 4) to deaden the stacker noise. It must permit the traveling card guide to drop below the outer circumference of the two stacker drums.

5. Adjust the upper bumper to deaden noise and still maintain a

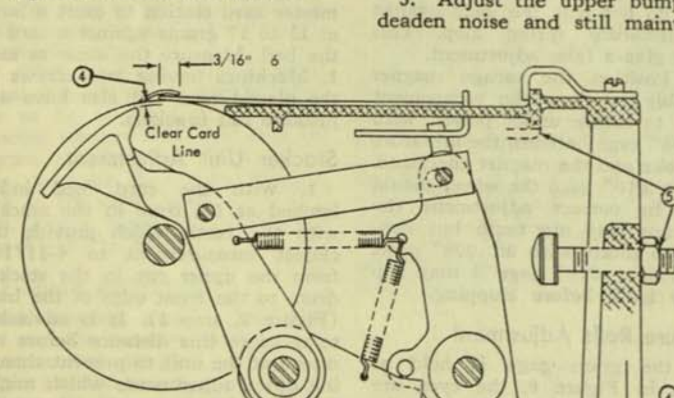


Figure 11. Stacker Adjustment

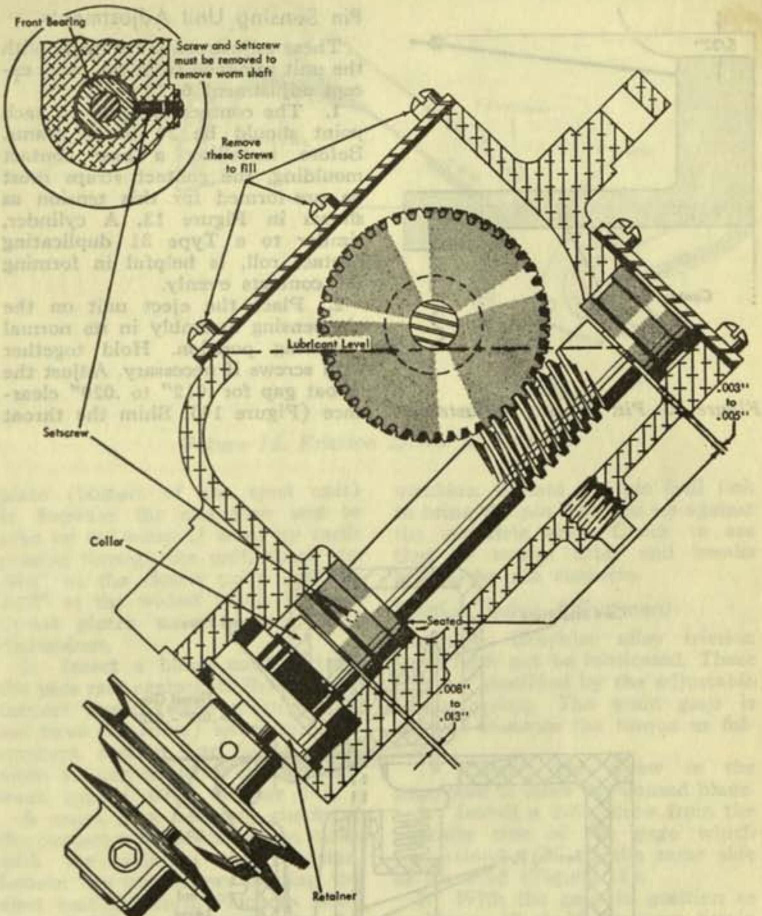


Figure 12. Reduction Drive Adjustment

clearance from the bottom edge of a card to the card pushers.

6. The grippers should overlap the card being stacked 3/16", and the cards should stack evenly without being damaged.

This operation must be checked under power with a partially filled hopper. An initial setting of the cams should cause the gripper finger blocks to contact the number 1 cams at 73° of the CF index. Adjust the number 2 cams to stack the cards without marking them (Figure 9, step 7).

The stacker cam mounted on the side of the stacker gear is held with three screws in elongated holes. A pilot hole in the gear and cam helps to set up the adjustment by locating the middle of the adjustment as a starting point. The unit depends upon card throw to operate properly.

Reduction Drive Adjustment

1. With the worm shaft removed from the housing, place the outer bearing on the shaft against the shoulder. Install the collar and lock it in place with .008" to .013" clearance to the bearing.

2. Keeping the outer bearing against the worm gear shoulder, insert the shaft in the housing and lock the front bearing in place with .003" to .005" end shake for the worm shaft (Figure 12). No timing is necessary to install the housing.

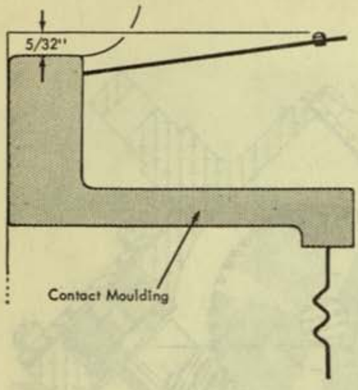


Figure 13. Pin Sensing Adjustment

Pin Sensing Unit Adjustments

These adjustments are made with the unit removed from the base, except adjustment 6.

1. The contact pressure on each point should be 20 to 30 grams. Before installing a new contact moulding, the contact straps must be pre-formed for this tension as shown in Figure 13. A cylinder, similar to a Type 31 duplicating contact roll, is helpful in forming the contacts evenly.

2. Place the eject unit on the pin sensing assembly in its normal operating position. Hold together with screws if necessary. Adjust the throat gap for .012" to .020" clearance (Figure 14). Shim the throat

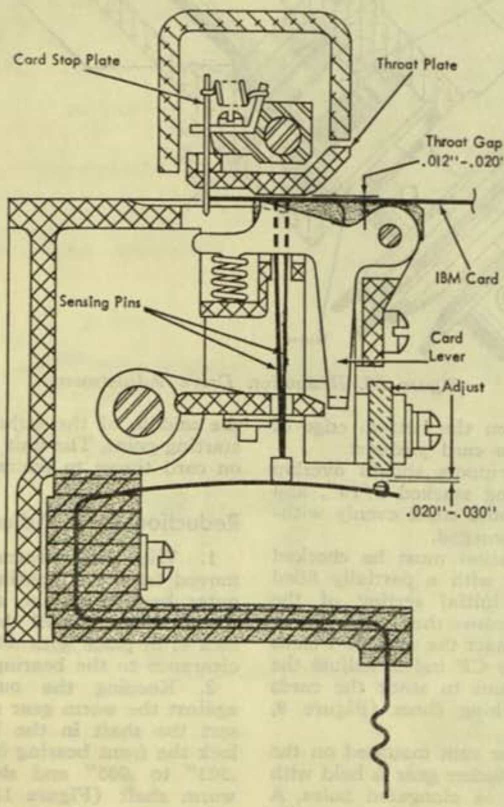


Figure 14. Pin Sensing Adjustment

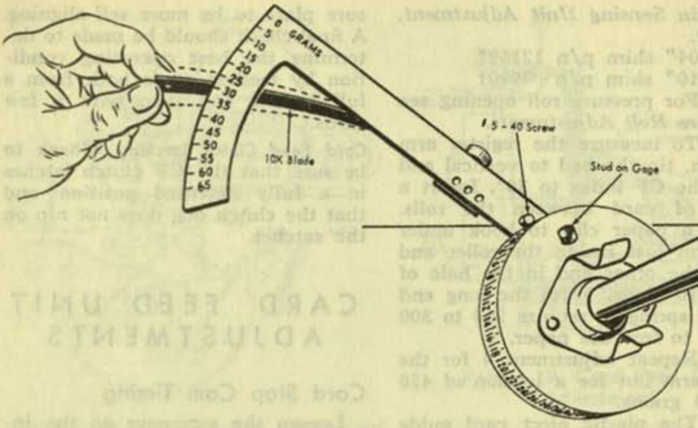


Figure 15. Friction Drive Adjustment

plate (bottom of the eject unit) to decrease the clearance and to take up for wear. If worn by cards passing through the unit, check the .012" at the closest point and the .020" at the widest point. Replace throat plates worn beyond these dimensions.

3. Insert a blank card and let the pins rest against it. Remove the contact cover (some machines do not have the cover) and adjust the common contact bar for a minimum air gap of .020" and a maximum gap of .030" (Figure 14).

A quick and accurate check of the contact adjustment can be made with the unit in the machine. Loosen the two screws holding the eject unit 1/4 turn. Place an .008" gage under the front edge of the eject unit and tighten the front screw to level the unit. All positions should duplicate correctly without picking up extraneous punching.

4. Normally it is unnecessary to alter the factory setting on the pin bail arm eccentric stop. If it becomes necessary, loosen the locking screw and adjust the eccentric to stop the pin bail arm when the sensing pins are retracted .010" to .015" below the surface of the separators. Tighten the locking screw (Figure 28).

5. Position the card lever to clear the pin bail by .005" to .010" when the pin bail arm is against its stop.

6. With the punch index at 345°, reinstall the unit in the machine. Extend the pin bail link to bring the pin bail arm up against the eccentric stop. Check to see that P5 makes after and breaks before the pin contacts.

Friction Drive Adjustment

CAUTION: Graphite alloy friction rings must not be lubricated. These may be identified by the adjustable spider spring. The gram gage is used to measure the torque as follows:

1. Remove the screw in the gage used to store the unused blade.

2. Install a 5-40 screw from the opposite side of the gage which will extend 1/2" on the same side as the stud (Figure 15).

3. With the gage in position as in Figure 15, hold the gage firmly while operating the space bar. When it is determined that the torque is not excessive for the gage range, increase the pressure on the blade until spacing stops. Read the gage. Adjust the spider spring for a reading 250 to 375 grams, resulting in 4 to 6 inch pounds torque. Avoid passing column 87 because the program cam contact levers will drop off the program cam and prevent back spacing.

Eject Unit Adjustments

1. Loosen the locking setscrew and adjust the pressure roll lever shaft to align the pressure roll with the feed roll and cause proper feeding through the read station.

2. Add or remove shims for a throat clearance of .012" to .020".

See *Pin Sensing Unit Adjustment*, step 2.

.004″ shim p/n 121397
.010″ shim p/n 49901

3. For pressure roll opening see *Pressure Roll Adjustments*.

4. To measure the register arm tension, tip the bed to vertical and turn the CF index to 30°. Insert a strip of card between the rolls. Form a paper clip to hook under the arm just inside the roller and hook the other end in the hole of the X10 blade. Form the long end of the spring to require 250 to 300 grams to free the paper.

5. Repeat adjustment 4 for the eject arm but for a tension of 450 to 500 grams.

6. The plastic eject card guide should clear the stacker plate by at least 1/64″. It can be raised by filing the eject casting slightly, or by shimming the right end of the guide. Forming the plastic is unsatisfactory because, even if heat is used, the plastic returns to normal.

For replacement eject units refer to CEI Memo 1398.

CARD FEED PREVENTIVE MAINTENANCE

Feed Clutch Armature Stop. On machines prior to 24-11696 PM and 26-10011 MM, the card feed armature stop post is of steel and must be insulated with cellulose acetate tape 700 which serves as a residual. This tape is recommended because of its durability. Machines built after these numbers, have posts of brass which are plated and look like the steel posts. The steel posts usually cause failure to auto-feed.

Card Feed Pusher Spring Tension. To improve feeding, the card feed pusher spring tension has been decreased. It should have 4 to 4-1/2 turns tension to its spring shaft when inserted from the rear instead of 5 or 6 turns as previously prescribed.

Last Card Feed Failures. In cases where the last card fails to feed out of the hopper, it is recommended that washer (p/n 22066) be added between the pusher casting and the pressure plate to permit the pressure plate to be more self-aligning. A final check should be made to determine the best operating condition by feeding cards both from a full hopper and then with a few cards.

Card Feed Clutch Latching. Check to be sure that the CF clutch latches in a fully detented position and that the clutch dog does not nip on the ratchet.

CARD FEED UNIT ADJUSTMENTS

Card Stop Cam Timing

Loosen the setscrews on the index shaft bevel gear. With the CF clutch latched, rotate the card stop cam to a point where the cam follower is at the approach, but is not up on the rise of the cam. Lock the setscrews. Check the timing by watching the eject and register arms to be sure they do not start downward again at the end of the CF cycle.

The beveled gears are spot marked at the factory to enable this timing to be regained after removal of the feed by simply lining up the spot marks.

Feed Clutch Adjustment

1. Form the armature spring to exert a tension of 100 to 120 grams in the direction of A, and 230 to 250 grams in the direction of B, as shown in Figure 16.

2. Adjust the magnet yoke mounting screws (Figure 16) for a clearance of .032″ to .036″ between

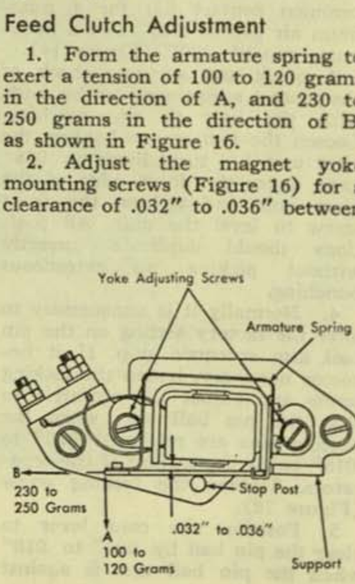


Figure 16. Feed Clutch Magnet Adjustment

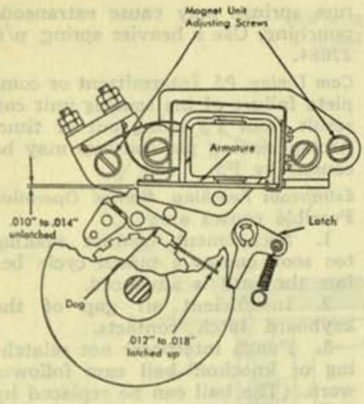


Figure 17. Feed Clutch Adjustment

the armature and the yoke at the operating end.

3. The CF magnet unit is positioned to satisfy the following conditions (Figure 17):

a. A clearance of .012″ to .018″ between the CF dog and ratchet with armature normal and the disc fully detented by the latch.

b. An unlatching clearance of .010″ to .014″ between the armature and the CF dog with the armature attracted.

Latch Magnet Adjustment (Figure 18)

1. With the contacts properly aligned against straight supports,

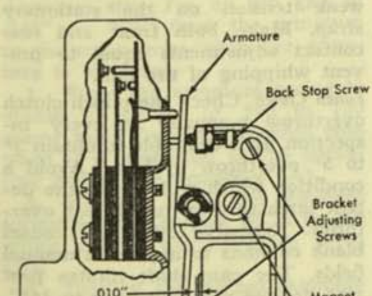


Figure 18. Latch Magnet Adjustment

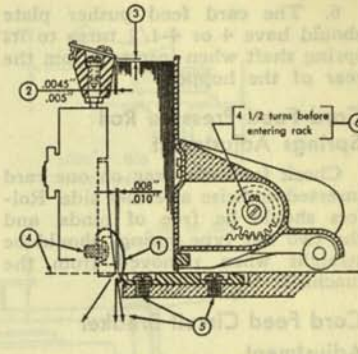


Figure 19. Card Feed Unit Adjustment

turn the armature backstop screw up until there is a 1/32″ rise from the contacts to their supports.

2. With a .010″ gage between the armature and the magnet core, position the magnet yoke so that the lower yoke strikes the armature. Tighten the screws.

3. Back off the backstop screw two full turns. This will provide approximately 3/64″ from a center line over the magnet yokes to the operating hook of the armature.

4. The assembly should be positioned to provide 3/64″ (7 IBM cards) from the latch armature to the ear on the CF cam follower arm.

5. There should be a latching clearance of .012″ to .017″ from the cam follower arm to the armature tip when the latch magnet is energized.

Hopper Adjustments (Figure 19)

1. Form the magazine springs to touch the feed bed.

2. Adjust the feed knives for a projection of .004″ to .0045″ with a go no-go gage.

3. With the CF latch armature engaged with the CF cam follower arm, adjust both feed knives evenly to give a .012″ to .017″ clearance from the feed knives to the top of the cards in the hopper.

4. Adjust the throat block to place the crown in direct line with the top edge of the throat knife.

5. Adjust the throat knife for an opening of .008″ to .010″. If the throat block is properly adjusted, an .008″ gage should pass freely in the three directions indicated, but a .010″ gage will not.

6. The card feed pusher plate should have 4 or 4-1/2 turns to its spring shaft when inserted from the rear of the hopper.

Card Feed Pressure Roll Springs Adjustment

Check for even drag on one card inserted endwise at either side. Rollers should be free of binds, and the two flat type springs should be straight when removed from the machine.

Card Feed Circuit Breaker Adjustment

1. Replace badly pitted or worn points.
2. Check for a worn operating arm roller.
3. Align points to make the sides and faces of the contacts parallel.
4. Adjust the stationary contact for an air gap of .020" to .025" on the high dwell of the cam.

Card Aligner Fingers Adjustment

The factory setting for the card aligner fingers is .020" to .040" motion ahead of the top card rail. This adjustment can be altered by adjusting the eccentric cam follower for a maximum forward travel of .055".

The card must snap off the fingers and into position along the top rail before punching. If this fails to happen, the first 15 columns may be in correct registration and the balance of the card off punched to the left. After adjusting the front pressure rail for 23 to 27 grams on a card registered in the detail bed, the aligner fingers can be formed in conjunction with the eccentric adjustment. Up to 10° backward angle should help the card snap off the fingers before it is gripped by the feed rolls.

PUNCH DRIVE PREVENTIVE MAINTENANCE

Interposer Magnet Armatures. Failure to punch 2's or 3's unless they occur consecutively may be caused by friction between the interposer and the armature. Apply IBM 22 at the latching surfaces. Weak armature springs may cause extraneous punching. Use a heavier spring, p/n 27084.

Cam Timing, P5. Intermittent or complete failure of the sensing unit can result from P5 being out of time. Arcing sensing pin contacts may be caused by P5.

Extraneous Punching, Manual Operation Possible causes are:

1. Escapement contact making too soon causes a punch cycle before the card is advanced.
2. Insufficient air gap of the keyboard latch contacts.
3. Punch interposer not relatching or knockoff bail cam follower worn. (The bail can be replaced by pulling all interposer armatures first.)
4. Guide comb and bumper too high, causing a blank column and a double punched column on duplication.
5. Wear at the latching points of the armatures. Armatures can be reversed, top row for bottom, thus using new surfaces of the armatures.
6 Improper adjustment resulting in failure to restore the interposers in the armature notches by 100° (by hand).

Interposer Bail Contacts. Insufficient air gap causes skipping columns while duplicating. Bouncing of the interposer bail contacts in conjunction with the escape contact can cause information to appear one column early as well as in the proper column. This is also caused by weak tension on the stationary strap. Make both front and rear contact adjustments equal to prevent whipping of the bail.

Punch Clutch. Check the punch clutch overthrow manually at every inspection. It is desirable to obtain 3° to 5° overthrow by hand. Avoid a condition which will permit the detent latch to drop in without overthrow. Excessive overthrow causes blank columns to appear in manual fields. The cam shaft rotates past zero degrees and rolls back to 345°. A dry clutch becomes noisy.

Punch Penetration. Excessive punch penetration can cause off gage punching by delaying the card during escapement.

Punch Drive Removal. To expedite removal and replacement of the unit, leave the screws in the front mounting plug attached to the base by a

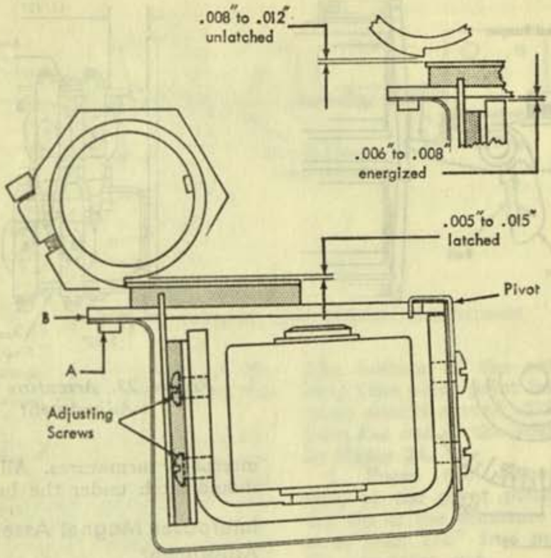


Figure 20. Punch Clutch Magnet

thread or two. Shake the drive unit to loosen the plug.

PUNCH DRIVE UNIT ADJUSTMENTS

Punch Clutch Magnet Adjustment (Figure 20)

1. Adjust the rubber mounted armature stop for an air gap of .006" to .008" from the armature to the outer yoke when the armature is attracted.

2. Form the armature spring to obtain a tension of 140 to 160 grams away from the magnet core when it is measured at the operating end of the armature (A).

3. Shape or adjust the armature spring to exert a force of 75 to 150 grams toward the armature pivot (B).

4. Position the magnet assembly against its support bracket to clear the step on the clutch sleeve by .008" to .012" when energized.

Punch Index Pointer Adjustment

With the punch clutch detent back against the punch clutch latch, set the punch index pointer to 345° ± 2°. Check to be certain that the pointer clears the index periphery.

Punch Clutch Spring and Collar Adjustment

1. Install the punch clutch collar against the side of the detent.

2. Grease the clutch spring and insert it under the collar against the shoulder on the shaft.

3. Place the sleeve over the clutch spring. Engage the stud inside the sleeve with the outer end of the clutch spring. Rotate the sleeve clockwise to expand the spring and install the pulley. Install the retaining collar, and when the pulley is properly located, the outer face of the collar will be flush with the end of the shaft.

4. With the clutch sleeve latched on the armature, uncoil the spring by means of the adjusting collar until it is tight within the sleeve. Rotate the punch index to 348° and lock the collar. When the index is turned by hand, there should be an overthrow of 3° to 5° past 345° to permit the detent to drop in.

Guide and Bumper Comb Adjustment

With the clutch latched, adjust the comb to make the bumper portion hold the punch operating arms down against the punch bail. There should be a minimum of .003"

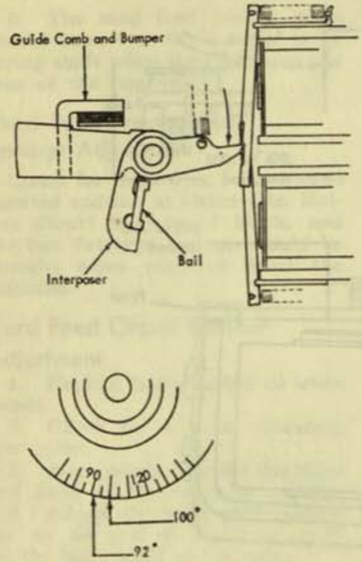


Figure 21. Interposer Relatching

clearance between the bottom of the bail and the interposers when the interposers are hooked under the bail. Check by placing the hand on the punch arms to take up any clearance between the top of the bail and the arms, then trip all

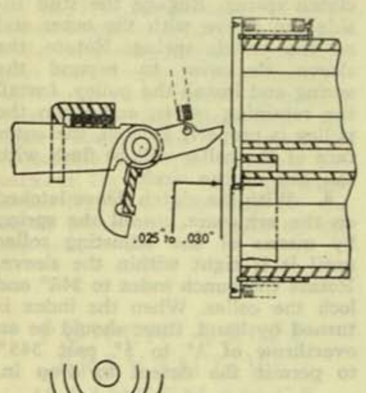


Figure 22. Armature Clearance Adjustment

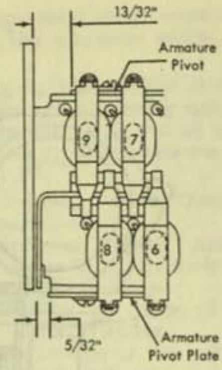


Figure 23. Armature Pivot Adjustment

interposer armatures. All positions should latch under the bail.

Interposer Magnet Assembly Adjustment

These adjustments are made with the unit removed.

1. Trip four interposers across the unit and position the unit vertically so that the interposers start to relatch in the armature notches at 92° and are all in their notches by 100° (Figure 21). The space interposer latching time will vary, but may not be later than 100°.
2. At 345° trip all the armatures and position the magnet unit for a clearance of .025″ to .030″ from the interposers to the attracted

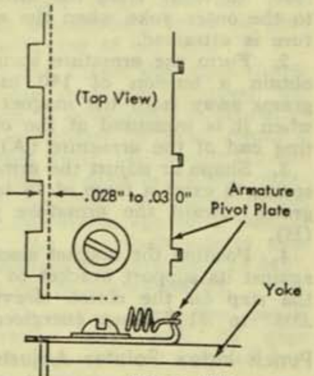


Figure 24. Armature Pivot Adjustment

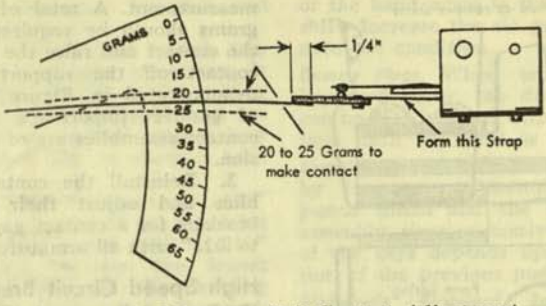


Figure 25. Interposer Bail Contact Adjustment

armatures as shown in Figure 22. The gap should be even across the entire unit.

3. Adjust the eccentric screw until the knockoff bail contacts the attracted armatures evenly at both ends of the unit between 13° and 20°. Where the eccentricity is insufficient, the adjustment may be obtained by pivoting the magnet unit about the armature latching point.

Interposer Magnet Unit Adjustments

When replacing coils, a little slack left in the wire leads will prevent the yokes from cutting through the insulation. All the Type 24 coils are of equal resistance. The 12, 11, 0 and space magnet coils on the Type 26 are the same as the Type 24 coils. All other Type 26 coils (p/n 228567) are of less resistance. The coils are held to the cores by cement (p/n 261096). The upper and lower armature pivot plates, as well as all armatures, are interchangeable.

1. Position the armature pivot strip as shown in Figure 23 to center the armatures over the cores. The bottom of the notch in the strip (the pivot point for the armature) should extend .028" to .030" from the end of the yoke, as shown in Figure 24.

2. Form the armature pivot strip at the pivot point by lifting the tip of the armature until there is at least 1/8" free movement to the operating end.

3. Form the armature to contact, within .005", the core and both yokes when attracted.

Interposer Bail Contact Adjustment

Master card bed plates having one screw can be removed by first pulling the top rail dowels. Standard dowels have a threaded top. Unthreaded pins are oversize. Do not interchange them. Plates held with two screws can be removed without disturbing the top rail.

1. With the contact assemblies removed, form the operating strap near the mounting to require 20 to 25 grams to close the contacts (Figure 25). Place the gram gage finger under the phenolic pad with 1/4" overlap when checking the adjustment.

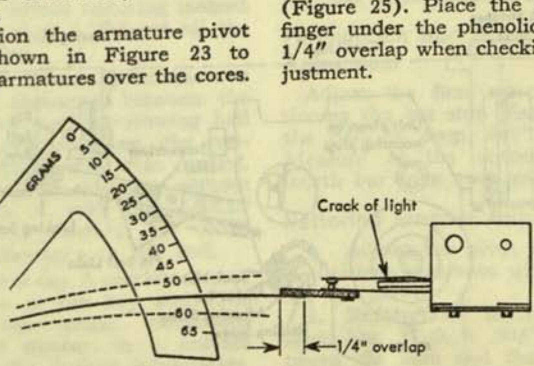


Figure 26. Interposer Bail Contact Adjustment

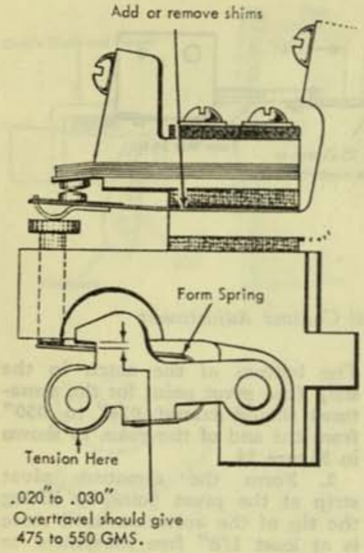


Figure 27. Circuit Breaker Adjustment

2. Form the stationary contact strap to require 30 to 35 grams to raise it off its support. The forming should be within the area of the support strap to reflect a true condition. One method of forming the contact strap is to insert a straightened paper clip between the strap and its support. Form the contact strap to obtain a point-to-point contact at the outer tip of the support strap. When properly adjusted, a crack of light will appear at the tip of the support strap during measurement. A total of 50 to 60 grams should be required to close the contact and raise the stationary contact off the support strap as demonstrated in Figure 26. It is of greatest importance that both contact assemblies are of equal tension.

3. Reinstall the contact assemblies and adjust their mounting brackets for a contact gap of .017" to .023" with all armatures restored.

High Speed Circuit Breaker (P Cam) Adjustment (Figure 27)

1. Form the operating strap to require 100 to 150 grams to close the contacts. Measure at the tip.
2. Add or remove shims to obtain .027" to .032" air gap with the assembly removed and the plunger seated against the frame.
3. Form the cam follower spring to require 475 to 550 grams pressure to close the contacts with .020" to .030" overtravel of the cam follower.
4. Adjust the circuit breaker assembly for .017" to .023" air gap with the cam on the low dwell. The plunger shoulder must be away from the frame.

Punch Penetration, Type 24 (Figure 28)

This method of adjustment eliminates partially punched holes during the setup process. The heel of the lowest punch must enter the die .015" to .020".

1. Loosen the following: support screws in the anchor bar, holding screws in the pin bail links, drive

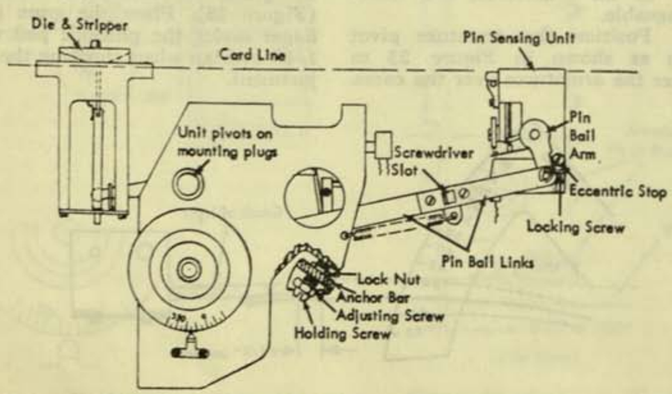


Figure 28. Punch Penetration Adjustment

unit adjusting screw lock nut, and holding screw.

2. At 345° (punch index), trip all punch interposer armatures. It can be done electrically by pulling R25 to open affected grids and using an interposer bail contact lead at the drive unit to energize each magnet.

3. With the index turned to 126° (punches up) turn in on the drive unit adjusting screw until a .010" gage passes between the lowest punch and the die. The holding screw must be tightened after each trial.

4. Remove the feeler gage and back off two complete turns on the adjusting screw. Tighten the lock nut.

5. Turn in the two support screws until they rest against the drive unit side frames, then lock their nuts. Extend the pin bail links. Additional travel, when needed, should not exceed 1/6 turn (.003") per step.

For *Punch Penetration, Type 26* see Type 26 Printing section.

KEYBOARD PREVENTIVE MAINTENANCE

Contact Air Gap. Insufficient air gap at the latch contacts can cause double punching to appear in a single column.

Latch Assemblies. Failure of a latch to restore may cause extraneous punching. Check the pivot on the latch assembly for a bind and oil it. See the revised restoring magnet adjustment, step 2. Do not oil the interlock discs.

Restoring Bail Contact. When there is a lack of clearance between the phenolic pad on the restoring bail and the operating strap, the contact will break earlier than desired. It may result in skipping, without punching an X, with the —SKIP key. Set the contacts for .002" minimum clearance to the pad.

Alphabetic Shift Key. A combination of the location of the key and close contacts can cause extraneous punches to appear in a column along with the desired information. It is attributed to operators striking the Alpha-shift key with the heel of the hand when in the numerical shift. Increase the air gap to eliminate the condition.

Dummy Plugs. When replacing the keyboard cover, the dummy plugs can be held in place with cellophane tape until the unit is assembled.

Sluggish Keyboard. This can be caused by improper adjustment of the punch clutch and the escapement assembly, since successive operation of the keys depends upon completion of the previous punch cycle.

Alphabetic Keyboard Bails. When working on these bails or the bail contacts, the use of cellulose acetate tape is recommended to hold the bails in place when the bail contacts are removed. A hole can be punched into the tape to remove any particular bail.

KEYBOARD ADJUSTMENTS (FIGURE 29)

Contact Bails Adjustment

Form all tabs on each contact bail for zero to .005" clearance to their associated operating ears on the permutation bar, with the permutation bars in the restored position.

Support Bar Guide Comb Adjustment

The support bar (which acts as a support for the latch pull bars and a guide comb for the permutation bars) should be parallel, within .008", of the interlock support bar upon which it is mounted.

Permutation Bar Travel Adjustment

Adjust the four setscrews positioning the bar stop plate to allow the bars to drop .042" to .048". Measure at the center and the fourth bar from each end.

Restoring Magnet Adjustment

1. Adjust the pivot bracket for a minimum clearance without binding the pivot.

2. Restore all latches on the latch bar. With a .003" gage between the core and the armature, position the magnet brackets evenly until the restoring bail meets the

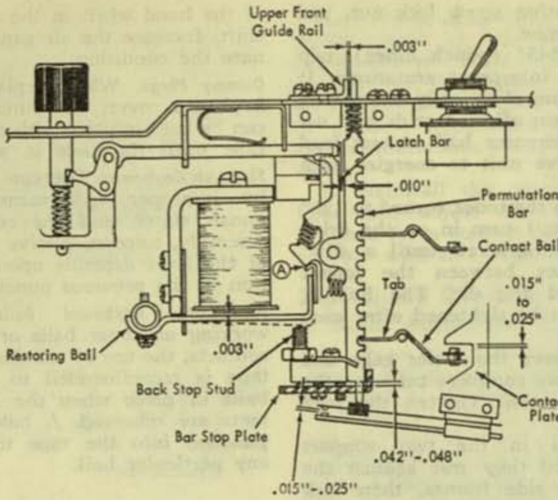


Figure 29. Keyboard Adjustment

lowest latches at *A*. This should result in .010″ maximum overtravel of the latching point with the gage removed.

3. With the magnet de-energized, adjust the two backstop studs for .002″ clearance between any tripped off latch and the restoring bail. Check at both ends and the middle.

Upper Permutation Support Adjustment

(Die cast supports are not adjustable.)

1. Position the switch mounting plate comb evenly across the unit for .010″ clearance between the permutation bars and the latch bar.

2. Position the upper front guide rail evenly for .005″ clearance to the permutation bars.

Key Unit Adjustment

Seventy to eighty grams tension should trip any key operating a latch assembly and interlock disc. Keys which do not operate latch assemblies should travel 5/32″ with 50 to 70 grams key pressure.

Keyboard Contacts Adjustment

1. *Bail Contacts.* Adjust the contact plates for .015″ to .025″ air gap with all the latch assemblies restored. It should require a minimum of 15 grams to break any closed bail contact. Form the contact straps to obtain the correct tension while maintaining the air gap.

2. *Latch Contacts.* Form the operating strap to require 17 to 24 grams of tension to close the contacts when measured at the pad of the operating strap. Pivot the contact assembly mounting bar to obtain .015″ to .025″ contact air gap across the unit. Stationary straps can be formed for individual air gaps. Be careful to keep the contact points lined up properly.

3. *Restoring Bail Contact.* Form the operating strap to require 50 to 60 grams to break the contacts. Adjust the contact bracket for a minimum clearance of .002″ between the operating contact strap and the phenolic pad on the restoring bail. This contact must break before the latch or bail contacts. It should break with a minimum air gap of .010″.

4. *Key Stem Contacts.* The N/O contacts should have a minimum of 1/32″ air gap and should close with a key depression of 1/16″ to 1/8″. The stationary contacts must be formed toward their support straps with 15 grams tension when measured at the contacts. It should require a minimum of 15 grams to break the numerical key contact when measured at the end of strap.

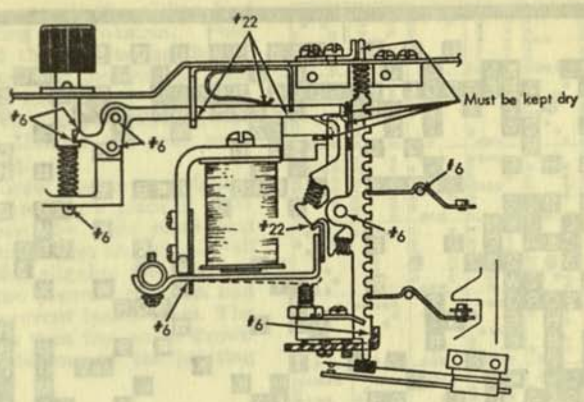


Figure 30. Keyboard Lubrication

PRINTING PREVENTIVE MAINTENANCE

Code Plate

Lubrication. Keep oil or grease away from the back of the code plate because it causes printing failures.

Missing Projections. Broken or missing projections can be determined easily if the code plate is in proper alignment. Each projection on the code plate is used for one specific character. A test of other characters will usually determine if it is a shifting error or bind. Make an overlay on Figure 31 with transparent paper, marking out the 35 home positions with circles. Shift the overlay the desired number of units and the character will appear inverted. The rows of projections can be counted for the exact projection in question.

Return Springs. Always make sure the two code plate return plungers are in place before running the machine. It might be possible to run the machine a short time without one plunger, but broken wires or code plate projections will result.

Test for Code Plate Alignment

1. Loosen the vertical (right-hand) fixed stop locking screw. While printing an R, back off on the adjusting screw until extra wires print. Mark the position of the screw slot and turn the screw in until failure occurs at the other extreme of the adjustment. Mark the position of the screw slot and turn it to the mid-point between the two marks. These marks indicate the critical limits of the adjustment and the mid-point represents the maximum safety factor. Tighten the locking screw.

2. Loosen the horizontal (left-hand) fixed stop locking screw. While printing 3's, back out on the adjusting screw slowly. If the code plate is in true vertical alignment with the rows of print wires, all the wires printing the 3 will drop out simultaneously because the code plate is being moved to its neutral position by the adjusting screw. If a corner of the number disappears first, remake the vertical shift adjustment using the aligning tools.

3. Repeat step 1 with the horizontal adjusting screw. An R is suggested because several extra wires are picked up at once, making the distortion of the R easy to detect. Tighten the locking screw.

Removal of the Code Plate

1. Remove the ribbon spools, leaving the ribbon under the die. Place the spools under the card lever pressure finger.

2. Transfer the vertical shift spring to the bellcrank to hold compression on the interposers.

3. Insert the aligning tool to keep the code plate in position until it is ready to be removed. This is necessary to prevent losing the pressure plungers and springs. Unscrew the flexible shaft gear (left-hand thread).

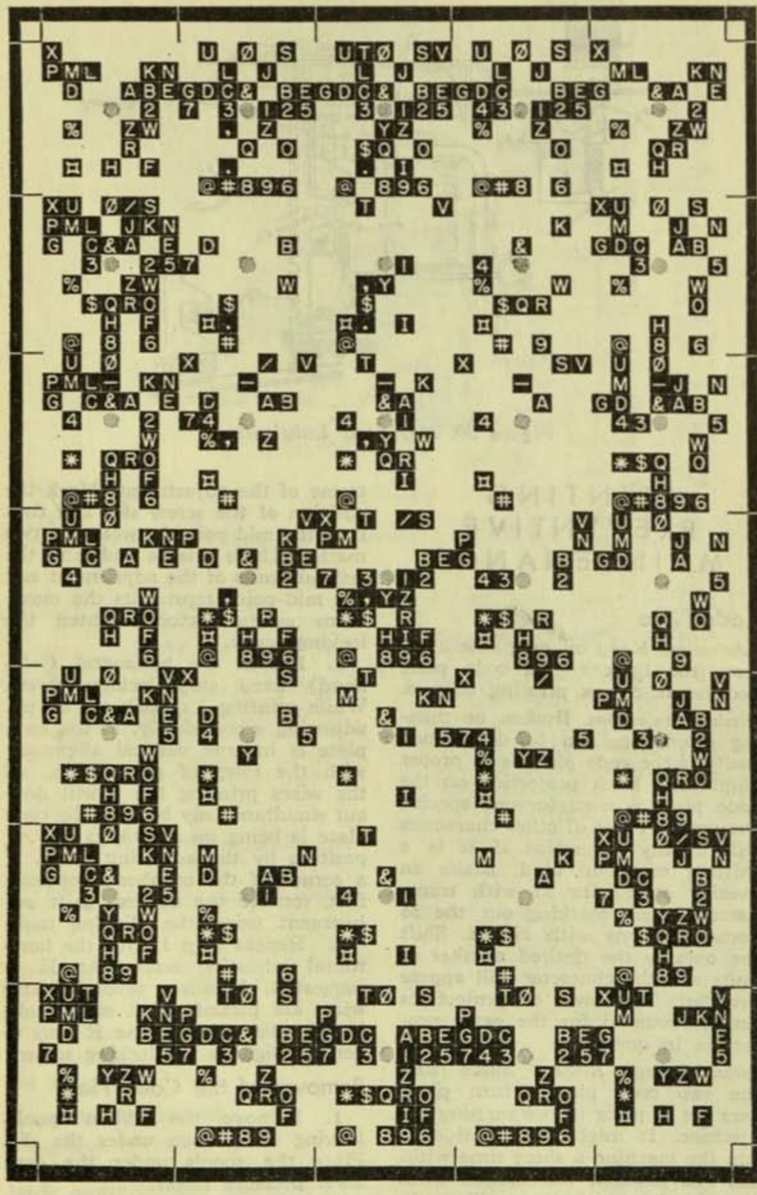


Figure 31. Code Plate Chart

4. Remove the chip tube to make it possible to lift the guide bushing out of the die with the print wires. Keep the bushing on the wires, with tape if necessary, to protect them.

5. Disconnect the print drive rod from the print arm. Remove the four screws holding the printing head to the base and lift the head off the guide pins.

6. Unhook the ribbon feed pawl

spring and separate the ribbon feed and printing mechanism. Four screws hold these units together.

7. Remove the two vertical shift plate pivot screws and move the plate out of engagement with the code plate. Unhook the code plate return spring.

8. Withdraw the upper aligning tool while inserting a piece of IBM card between the code plate and the wires to protect the wires. Pull out the lower aligning tool and remove the two pressure plungers and springs to prevent losing them. The code plate is then free to be drawn out of the bottom of the printing unit.

Print Wire Assembly

Print Wires. Wires do not require additional oiling.

Chip Tube Position. The housing helps position the wire guide closures. Exchanging or repositioning the chip tube may affect printing.

Replacement of Wires. Single wires can be replaced. Be sure the collar portion of the wire which extends through the guide plate is the same size as the one being replaced.

Replacement of Wire Guide Assembly. A precut set of 35 wires is not available because the wires are ground in a tool jig after assembly. If the units become troublesome or worn, replace the wire guide assembly.

Character Patterns. Figure 32 is supplied as a guide to the wires used for printing each character. It can be used to determine when extra wires are being picked up in printing.

Removal of the Wire Guide Assembly

Remove the code plate and proceed as follows:

1. Remove three horseshoe clips from one side of the unit (the two smallest clips and the one holding the print drive rod shaft). Pull out the three shafts that are freed (see Figure 36).

2. Remove the four screws holding the adjusting screw plate and pull the units apart.

Platen, Smudging, Printing Pressure

1. Avoid adjusting for printing pressure with a dry or worn ribbon.

2. A thin platen will require the print wires to extend farther into the card path than normal and cause smudging. Replace thin platens and check the platen and printing pressure adjustments. Remove any burrs from the platen.

3. A worn or undersize print cam will result in smudging cards. Replace defective cams.

4. Insufficient clearance between the eccentric drive link and the washer on the end of the shaft will place an extra load on the punch drive unit. It sometimes shows up by causing clutch latching failures.

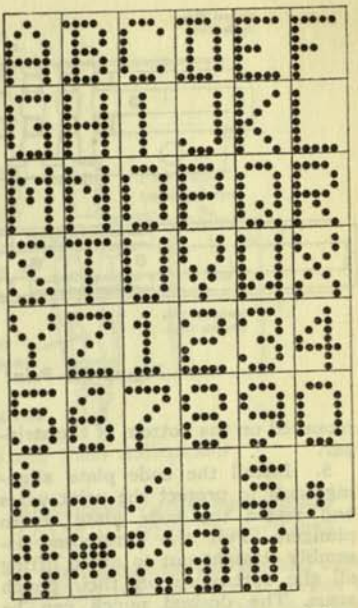


Figure 32. Character Impression Patterns

Removal of a Punch, Type 26

The quickest method is to remove the print interposer assembly.

1. Remove the nuts and springs from the 12 punch extensions. The springs are interchangeable.

2. Transfer the vertical shift spring from the shift plate to the eye in the bellcrank to keep the vertical shift interposers compressed.

3. Remove the horizontal shift spring. Compression must be held on the horizontal interposers by hand when shifting the unit.

4. Remove the three screws from the corners of the rectangular punch extension guide which is

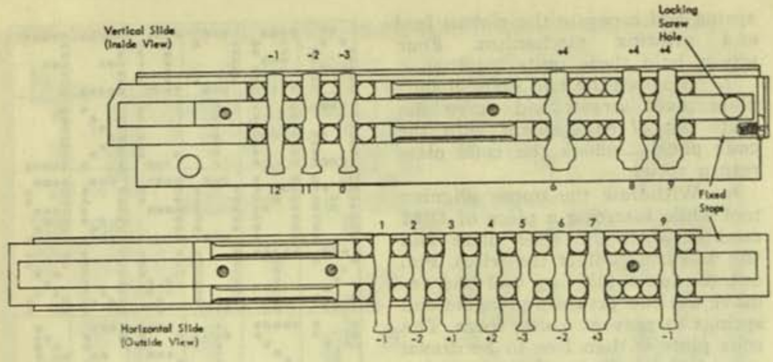


Figure 33. Print Interposer Assembly

mounted on the bottom of the stripper.

5. Install the code plate aligning tools to protect the print wires and retain the code plate return plungers. Pull the interposer assembly straight out to avoid lifting all the extensions off their punch arms. The desired punch can be removed by lifting its extension out of engagement with the associated punch arm.

6. A flat guide (.0125″ - .018″ thickness gage) is helpful in inserting a punch into the stripper. The highest point of the punch belongs toward the front of the machine and the head of the retaining pin belongs toward the retaining plate.

7. Slip the extension guide plate over the punch extensions to hold them located with respect to the interposer yokes.

8. Place the interposers in their lowest operating position while replacing the interposer unit on the extensions. A fillister screwhead placed between the 9 yoke and the frame will align the yokes with the punch extensions.

9. Install the 12 springs and nuts, turning the nuts up until they seat against the shoulder on the extensions.

CAUTION: Do not force the nut tightly against the shoulder because the extensions break off easily.

Electrical

Relay 31. Both pick and hold coils should be of equal resistances (625 ohms each). Relay 31 coils are in series with interposer magnets. When interchanged with relays of higher resistance, duplicating failures will result. Failure to duplicate only 8's and 9's is attributed to a relay with a high resistance hold coil being substituted for R31.

Fuses. All Type 26 machines operating on 115 V, 60 cycle, should be equipped with a 3.2 ampere fusetron p/n 107664.

Print Interposers

Figure 33 contains the location of the print interposers, rollers and slides. Each unit of cam action equals .020″ motion to its slide. A −1 cam has a .010″ cut from both sides of the interposer, resulting in .020″ motion. A +4 interposer moves the slide .080″. Use this chart as a guide to reassembly. The + or − values are now being etched on the interposer faces. (The ratio of motion of the slides to the code plate is 10 to 11.)

PRINTING ADJUSTMENTS

Punch Drive and Print Yoke Adjustment

There should be a clearance of .015″ to .020″ between the yokes and guides as shown in Figure 34. It is obtained by adjusting the punch drive unit. The clearance will result in the rollers contacting the print interposers a minimum of .015″ above the start of cam action. Because the clearance cannot be measured, it is obtained as described below.

1. Remove the belt guard and punch drive belt to take the load

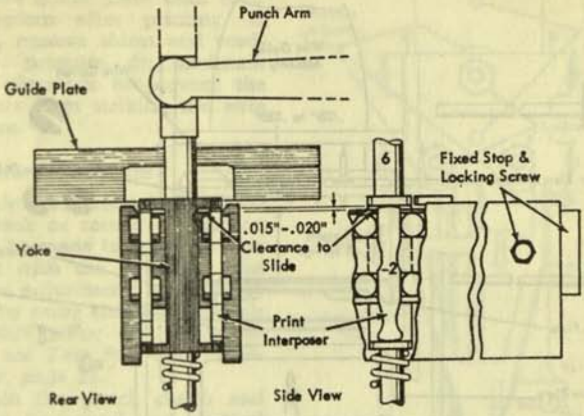


Figure 34. Punch Drive and Yoke Adjustment

off the drive unit.

2. Remove the cover from the punch extensions and remove the 12 nuts and springs to reduce the load on the punch extensions.

3. Remove the two screws from the pin bail drive link.

4. In the drive unit anchor bar, loosen the adjusting screw lock nut, the holding screw, and the two support screws. Unhook the print spring.

5. With the punch clutch latched, rotate the drive unit counterclockwise until the yokes can be felt to bottom on their inner guides. Turn the adjusting screw in until it touches the casting, then back off one full turn and tighten the lock nut. Tighten the holding screw. The two support screws should be turned in until they rest against the side frames. Reassemble the machine and test the punch penetration with standard codes.

6. Readjust the printing pressure.

Punch Penetration Type 26

Satisfactory punching should result from the preceding print yoke adjustment. If more penetration is required on machines with .012" to .015" throat gap, the yoke adjustment will have to be altered and the printing pressure adjustment remade. On machines with .020" to .026" throat gap, the penetration can be changed by its adjustable punches without affecting the yoke or printing pressure adjustments. See the following two items.

Additional Punch Penetration (.012" to .015" Throat Gap)

After loosening the pin bail drive link and the two support screws in the anchor bar, back out the drive unit adjusting screw 1/6 turn to a step. Turn in on the support screws and connect the bail link after each step and test the machine with standard codes. Each step will result in .004" more penetration. Do not exceed 1/2 turn over the yoke adjustment because the yokes will strike the extension guide plates.

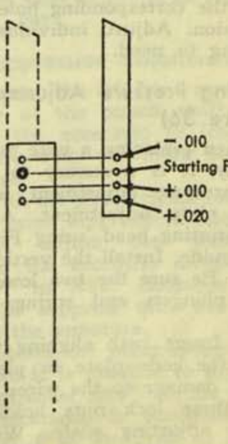


Figure 35. Adjustable Penetration - Type 26

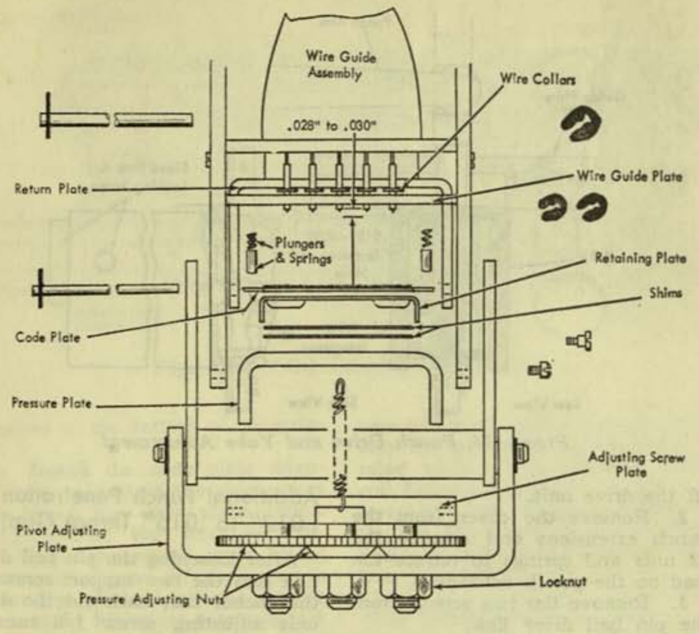


Figure 36. Code Plate Adjustment

Additional Punch Penetration (.020″ to .026″ Throat Gap)

These units contain adjustable punches which are assembled with the punch retaining pins in the second hole from the top. Each hole varies the punch penetration .010″ as shown in Figure 35. Always keep the hole in the punch associated with the corresponding hole in the extension. Adjust individually according to need.

Printing Pressure Adjustment (Figure 36)

When replacing a wire guide assembly, it is necessary to remake the pressure adjustment and the code plate adjustment. Assemble the printing head, using Figure 36 as a guide. Install the vertical shift plate. Be sure the two lower pressure plungers and springs are in place.

1. Insert both aligning tools to hold the code plate in place and avoid damage to the wires. Loosen the three lock nuts holding the pivot adjusting plate. With the tungsten bushing over the end of the wires, install the head on the stripper frame.

2. Connect the print drive rod and remove the aligning tools. Unscrew the three knurled adjusting nuts until the wire collars meet the guide plate.

3. Shim the code plate for a clearance of .028 to .030″ to the ends of the print wires (.003″ shim p/n 305243, .007″ shim p/n 228296). Use one .007″ shim instead of two .003″ shims.

4. Turn in evenly on the three knurled nuts, 1/4 turn at a time, until printing is obtained. Snug up the lock nuts after each step and operate the space bar to prevent damage to the wires. A practical test to show up uneven printing can be obtained by disengaging the ribbon feed pawl and printing an H until the printing grows faint. Too much printing pressure will make the machine noisy and cause marks to appear when spacing.

5. The print arm roller must be free to lift .010″ off the cam during print suppression to reduce noise and wear on the cam. Check for this clearance with the print spring removed. The lifting motion drives the wire collars .005″ closer

to the wire guide plate than their normal return after printing. If necessary, remove shims and readjust the pressure to maintain sufficient clearance to prevent the wire collars from striking the wire guide plate.

Code Plate Adjustment

The code plate must be adjusted for its blank or zero shift position and must be made to travel in true alignment with the rows of print wires. The adjustment is originally obtained by using the aligning tools (p/n 460028). For readjusting or checking see *Test For Code Plate Alignment, page 23.*

1. Latch the punch clutch and loosen the horizontal and vertical fixed stop locking screws. Back out a turn or two on both fixed stop adjusting screws (Figure 34).
2. Loosen the vertical shift guide locking screw and unhook both shift springs (Figure 37).
3. Shift the code plate until the aligning tools can be inserted through the guide holes in the back of the code plate and wire guide plate (Figure 37).
4. Center the aligning tools in their holes where they will move in and out freely and tighten the vertical shift guide locking screw.
5. Rehook the vertical shift spring. Turn in on the vertical fixed stop adjusting screw (the right-hand screw from the front of the machine) until the lower tool can be moved in and out freely.
6. Rehook the horizontal shift spring and adjust the horizontal screw as in step 5. Tighten both fixed stop locking screws. CAUTION: Remove both aligning tools before running the machine.

Print Suppression Magnet Adjustment

1. The armature should be flat within .005″.
2. Adjust and form the ears of the armature pivot so the armature lies flat against both yokes.
3. Form the ears of the armature return spring to extend out 1/16″ from the pivot, with the armature removed.
4. Adjust the armature retainer squarely for an air gap of .035″ to .037″ between the armature and the residual with the magnet de-

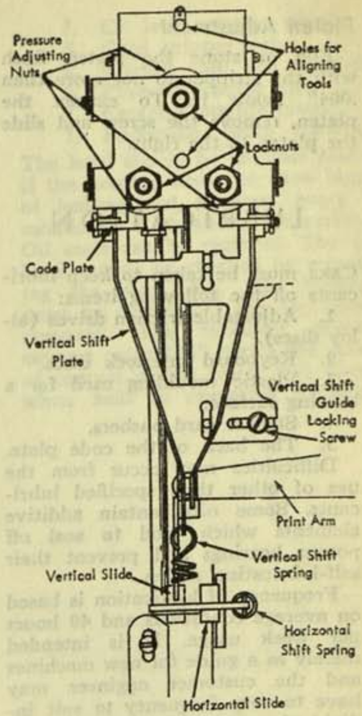


Figure 37. Code Plate Adjustment

energized. The sides of the retainer must not drag on the armature.

5. With the armature attracted, position the magnet bracket so that the armature contacts the suppress arm and the interposer block clears the sides of the print arm by .003″ to .005″.

Print Suppression Adjustment

1. Loosen the left-hand screw at the rear of the punch shaft and position the eccentric to line up its groove with the mark on the print cam.
2. With the punch clutch latched and the print suppression armature attracted, adjust the eccentric screw in the eccentric drive link for .024″ to .026″ clearance between the suppress arm and the block on the armature.
3. Unhook the print spring and make sure it is possible to lift the print arm roller .010″ off the cam. If the clearance is unobtainable, check step 5 of the *Printing Pressure* adjustment.

Platen Adjustment

File or stone the platen flush with the stripper to not more than .004" below it. To extract the platen, remove the screw and slide the platen to the right.

LUBRICATION

CARE must be taken to keep lubricants off the following items:

1. Adjustable friction drives (alloy discs).
2. Keyboard interlock discs.
3. Plastic moulding used for a bearing surface.
4. Stacker card pushers.
5. The back of the code plate.

Difficulties may occur from the use of other than specified lubricants. Some oils contain additive elements which tend to seal off porous bearings and prevent their self-lubricating action.

Frequency of lubrication is based on average conditions and 40 hours per week usage. It is intended merely as a guide for new machines and the customer engineer may have to vary frequency to suit individual machine requirements.

Lubrication Requirements

The number to the left of the item is a code number for the unit. To find each item necessary on the Punch Drive, for example, refer to each item labeled 2. The complete code number list follows:

1. Die and Stripper
2. Punch Drive
3. Eject and Pin Sense
4. Program
5. Card Feed
6. Stacker
7. Mechanical Drive
8. Print Unit

(For keyboard lubrication, see Figure 30, page 23.)

IBM 6

3 Month Period

1. Die and stripper. Punch an oiled card at least every 3 months.
2. Punch drive unit:
   a. Cam follower rollers.
   b. Circuit breaker rollers. Be sure they are free.
8. The print interposers, yokes and rollers. Tip punch bed to vertical and let oil run through the units.
8. Code plate linkage, not the code plate. There should be absolutely no lubricant between the back of the code plate and the shim retaining plate.
8. The print drive linkage on the printing head.
8. Print cam follower roller.
8. Eccentric bearing and eccentric screw in the suppression arm.

6 Month Period

2. Punch drive unit:
   a. Interposer pivots.
   b. Felt spacers.
3. Sensing pin bail shaft bearings. Saturate wicks. Remove the eject unit to make the oil holes accessible.
3. Sensing pin bail arm stud.
4. Star wheel pivots, oil sparingly. Wipe off excess.
5. CF circuit breaker rollers and pivots.

Yearly Period

1. Punch retaining pins.
3. Eject unit mechanism sparingly. Eject and register arm rollers. Keep oil off the continuously running rubber feed rolls.
5. Card feed knife linkage.
6. Stacker gripper block pivots.
7. Drive Motor.

IBM 22

3 Month Period

2. Punch clutch spring (grease fitting at least every 3 months). Wipe excess off sleeve and pulley. Where clutch becomes noisy, grease more often according to individual needs.
2. Knockoff bail cam follower. Lift off cam.
2. Sensing pin bail link guide stud.

6 Month Period

2. Punch interposers at latching points.
2. Punch bail bottom (film of grease).
5. CF steel pressure roller pivots.
8. Rear mounting plug grease fitting.
8. Print spring ends.

8. Print suppress armature at the yoke ends and on the interposer block.

8. Ribbon reverse mechanism.

Yearly Period

1. Flexible shaft.

1. Pressure roll release pin (ends).

1. Punch arm guide comb on the stripper.

2. Punch operating arm at the punch extensions.

3. Pressure roll release pin (ends).

4. Program cam.

5. Card feed clutch.

5. Card pusher stop cams and followers.

5. CF latch magnet pivot.

6. Card gripper cams.

6. Stacker cam and follower.

6. Phenolic stacker gear.

7. Escape armature pivot.

7. Reduction drive housing.

The level should be checked yearly if the housing does not show signs of leaking and at least every 6 months if oil shows on the surface. Oil seals can be replaced. The oil level cannot be checked by removing the pipe plug. The housing must be pulled and the top cover removed. The lubricant should cover a point 1/4" above the point of contact of the worm and wheel when held in operating position.

IBM CUSTOMER ENGINEERING REFERENCE MANUAL

PREVENTIVE MAINTENANCE

Alphabetical Printing Punch Type 036

CONTENTS

INTERNATIONAL BUSINESS MACHINES CORPORATION
New York, New York
Printed in U.S.A.
Form 22-5747-1

PREVENTIVE MAINTENANCE

Alphabetical Printing Punch, Type 036

CHARACTER OPERATING BAR MECHANISM

I. Cleaning

All dust and dirt should be brushed out of the keys and from other parts of the machine.

II. Inspection

1. **Punch Bails** should be free on their pivots with a minimum of end-shake. This can be adjusted by the pivot screws with lock nuts on the right-hand side frame. Be sure lock nuts are tightened.

2. **Operating Bar Stop** for wear and adjustment.

3. **Reamer Shaft** for nicked or worn flutes and proper speed. It is important that the proper speed be maintained on any printing punch. Increasing the speed of the reamer shaft will not necessarily speed up the operation; in fact, it may decrease the speed of operation and may be the cause of "galloping". The reason for this is that the time required for one reamer hook operation plus the unlatching of the next reamer hook may be just sufficient to permit a flute on the reamer shaft to go by if the reamer shaft is too fast. If this occurs, it is necessary for the newly unlatched reamer hook to "wait" for a flute, thus delaying the operation.

4. **Reamer Hooks** for wear and freedom of operation. The hook must be free on its pivot and must not bind in the comb.

5. **Key Lever Upper Stop** for wear and adjustment.

6. **Interlock Assembly** for freedom of operation and adjustment. The key interlock assembly may be the cause of sluggish or improper key operation. It should first be determined that the comb is clean and free of burrs or binds. If gummy, it may be washed with a cleaning fluid to which oil has been added and then the parts should be wiped with a clean, dry cloth. *Oil should never be put into the interlocks.* If any comb teeth are bent, they obviously will obstruct the free movement of the keys or the interlock discs. Any bent teeth should be straightened and the inside surface of the comb should be smoothed with a fine stone. It is well to run a flexstone between the teeth to remove burrs. The channel of the disc guide should likewise be free of burrs and binds.

7. **Star Wheel** for adjustment on both punching and spacing operation.

8. **Contacts.** Key interlock, punch bail, eject key and tab key for dirty points and proper adjustment.

9. **Tab and Eject Key Solenoids** for freedom of operation and proper adjustment.

III. Lubrication

Under no condition should oil ever be put into the key interlock assembly.

IBM 6

(1) Reamer hook pivots.

IBM 9

(1) Bail pivots.
(2) Oil cups in reamer shaft bearings.
(3) Operating bar guide combs, front and rear.

VACUUM PUMPS AND DRIVE HOUSING

I. Cleaning

All dust and dirt should be brushed from around unit. The pump solenoid plunger should operate freely. Wash it with cleaning fluid, if gummy.

II. Inspection

1. Control Valves (on early type machines only) for proper tabbing and for leaks.

   A check should be made to see that the rack will tab properly on a short skip (10 columns) on either end of the rack and should also be checked for a long skip on either end (approximately 40 columns). If it is found that the rack speed is too great on short skips, particularly on the column 1 end, it will be found that backing off the permanent by-pass valve adjusting screw will improve this condition. The backing off of this screw causes a reduction of the vacuum in the carriage cylinder while the rack is standing idle. Thus the carriage does not move at an excess speed at the beginning of a tab operation. This action is more prevalent when tabbing on the left end of the card due to the larger evacuated area in the right end of the cylinder.

   If sufficient speed cannot be obtained in either the forward or reverse movement of the carriage, it is likely that leakage is occurring in the system. The most common source of leakage is the by-pass valves which can be checked by disconnecting the tubing and shunting the by-pass valve casting by means of rubber tubing. When connected in this manner, excess speed of the rack should be obtained providing the pump is producing enough vacuum. It is seldom found that the pump will not produce sufficient vacuum, and it is therefore advisable to check thoroughly for leakage elsewhere before dismantling the pump.

2. Piston for sliding freely on shaft.

   Check to be certain that the piston slides freely in the cylinder with both ends of the tube open. This will indicate that there are no mechanical binds in the assembly.

   In a few instances trouble has been experienced because the plug in the center of the piston has moved to the right or left, closing one of the ports to the cylinder. If this trouble is present, it will be indicated by the fact that the cylinder does not slide freely on the tube when both ends of the tube are open. The "feel" of recoil due to compression in this case will distinguish it from mechanical friction or a bind. It will be necessary to replace the tube and cylinder if this condition occurs.

3. Oil Reservoir for proper oil level.

4. Drive Housing for wear and proper oil level.

III. Lubrication

IBM 15

(1) Oil pump drive housing.

IBM 16

(1) Oil reservoir should be not over one-half full when machine is running.

IBM 17

(1) Main drive shaft gear teeth.

IBM 21

(1) Ball bearing race behind drive pulley.

RACK CONTROL MECHANISM

I. Cleaning

The rack should be cleaned thoroughly with a stiff brush dipped in cleaning fluid. Any dust in the tab control assembly should be cleaned out.

II. Inspection

1. Racks for freedom of operation. Before attempting to make any adjustments of the rack, a check should be made to insure that both the main rack and the duplicating rack operate freely when moved by hand. These may be individually checked by raising the duplicating card bed.

2. Rebound Check Lock for wear and correct operation. The stop pin should hold the rebound check pawl in a vertical position when the back space lever is operated, or when the rebound check solenoid is operated.
   Remove the rebound check rod by taking off the nut on one end and sliding it out above the card hopper. Examine this rod for a smooth and polished finish. If it does not have this finish or shows any signs of wear or crookedness, it should be replaced.
   Remove the rebound check pawl. The edges of the hole should not be worn. They should be square and sharp but without burrs.
   After replacing these parts, a check should be made to see that the rack is positively locked against a reverse or rebound movement. Check further to be sure that the rack operates freely in a forward direction.
   When the solenoid plunger is fully attracted, the rebound check pawl should be just pulled up firmly against its stop pin.

3. Back Space Mechanism for proper operation.

4. Dog and Escapement Mechanism for wear and proper adjustment.

5. Tabulating Mechanism for freedom of operation and proper adjustment. Insert #6 tab stop in a predetermined column. With power on machine, hold rack and depress tab key, allowing the rack to move over slowly until the tab stop just touches to tab-break contact operating arm. At this time the dog lifter should allow the dog to drop in the proper tooth, with approximately 1/8" overlap. The dog lifter arm has to be bent to obtain this adjustment.

6. Tab Break Contact Operating Arm for freedom of operation.

7. Tab Break Contact for dirty points and proper adjustment. It should break with 1/32" air gap after the dog has dropped in the proper tooth in the rack and the rack has taken up the rest of the movement of the dog.

8. Tab Control Contact Assembly
   Check the contact operating levers to see that they do not bind. Be sure the screws which hold the contact assemblies are tight.
   The normally open contacts should have .022" air gap and the normally closed contacts must have good tension.
   Check with inserts 1 through 5 in tab rack and space the rack so that each insert operates the contacts. See that the N/O contacts are closed with good tension, and the N/C contacts are opened approximately .022".

9. Card Registration

10. First Column and 80th Column Contacts for dirty points and proper adjustment.

III. Lubrication

IBM 6

(1) Rack cylinder and piston.
(2) Dog and escapement mechanism pivots.

FEED, PUNCH AND PRINTING MECHANISM

I. Cleaning

All dust and dirt should be brushed from the feed and from around the roller throat. It is important that the feed knife block be clean and smooth in order to slide freely. The slide rods also must be smooth and should have a polished surface so that the knife slides freely and quickly. The solenoid plungers should operate freely. Wash them with cleaning fluid, if gummy.

Type should be brushed clean or cleaned with plastic type cleaner, part number 450528.

II. Inspection

1. Clutch Solenoid for freedom of operation and proper adjustments.

2. Pump Solenoid for freedom of operation and proper adjustments.

3. Feed Knife for proper adjustments.

4. Card Pusher Link for binds.

5. Roller Throat for proper adjustment.

6. Die and Guide Block Assembly for clearance between the top of the die and the type head. If this clearance is too small, the effect may be that the type heads strike on top of the die, causing it to collapse into the 12 hole. This may be due to the fact that the die is too high. If the top of the die is more than $\frac{1}{32}$" above the 12 hole, it should be filed down to $\frac{1}{32}$".

   To measure this distance, insert a card into punching position and punch a 12 hole. Using a small knife blade, scribe a fine line on the card even with the top of the die. The card can then be removed and the distance measured from the top of the hole to the line.

7. Punches for freedom of operation and proper travel. It is very important that all punches slide freely in the punch guide block and into the die. If it is necessary to stone the punches to free them, use the fine side of a clean, flat stone. Obviously, if too much stoning is done, the punched holes will be ragged. It should be possible to slide each punch into its place by hand and without binding until only the recessed driving portion of the punch projects from the rear of the guide block.

   The punch travel can readily be measured with a steel scale by putting a straight edge across the back casting of the machine and measuring from the straight edge to the rear of the punch. Measure the distance in the rest position. Then depress a key and turn the machine by hand until the tip of the punch just projects from the front of the guide block and measure again. The difference between the two measurements will indicate the amount of travel of the punch before projecting from the front of the punch guide block.

   The tip of the punch can readily be seen when it begins to project from the front of the guide block by sighting along the card line from near the feed knife and placing a white card or a light on the other side of the die.

8. Ribbon Spacing. Check operation of ribbon feed mechanism by manually operating machine. The ratchet operating pawls should have the same amount of travel after engaging their feed ratchets so that the two ratchets are operated the same distance. This can be observed from the rear of the machine by moving the carriage first to one end, then to the other. Check while operating the machine by hand. The ribbon feed operating fork should not bind at either end of the stroke.

9. Type for printing squarely and in registration.

10. Duplicating Mechanism
    - (a) DUPLICATING SOLENOIDS for freedom of operation and proper adjustment.
    - (b) BRUSHES for wear, damage and projection.

(c) CONTACT ROLL for clearance to brush separator and centering of brushes to roll. For a method of checking alignment of brushes to center of roll, see 016-031 section under Duplicating Unit.

(d) MASTER CARD CARRIERS for proper registration. Be certain the card used for checking is in perfect registration.

III. Lubrication

IBM 6

(1) The master rack guide bar. This should immediately be removed with a cloth so that only a very thin film remains to protect the rod from rusting. Excess oil at this point will eventually result in sluggish rack operation.
(2) Each punch where it enters the guides. However, the punches should be perfectly free before oiling.
(3) Duplicating brush holder assembly pivots.
(4) Ribbon spacing bell crank pivots.
(5) Ribbon spacing ratchet wheel pivots.
(6) Feed knife operating mechanism pivots.
(7) Roller throat.

IBM 9

(1) Pivots at the top and bottom of the punch connecting links as well as the striker arm bearings.
(2) Card feed drive shafts bearings.

IBM 17

(1) Card feed drive gears.

BASE

I. Cleaning

The entire base should be wiped down with a rag soaked in cleaning fluid. Any card punch chips should be brushed out of the machine. Any oil or dirt on the relay points should be washed out.

II. Inspection

1. Motor and Generator (see *General Section*)
2. Duo Relays (see *General Section*)
3. Sentinel Switch (see *General Section*)

IBM 6

(1) Oil cups of drive motor and generator.
(2) Pivot points of duo relays.

IBM 17

(1) Sentinel switch contact points.

IBM CUSTOMER ENGINEERING

REFERENCE MANUAL

PREVENTIVE MAINTENANCE

Verifier Type 055

CONTENTS

New York, New York
Printed in U.S.A.
Form 22-5748-0

PREVENTIVE MAINTENANCE

Verifier, Type 055

VERIFYING UNIT

I. Cleaning

The verifying unit should be thoroughly cleaned before oiling or inspecting. The rack should be cleaned with a stiff brush dipped in cleaning fluid.

II. Inspection

1. **Dog Carrier** for slight wink of rack when space solenoid is energized. Check this at several places on the rack, and be sure there is no backward movement of the rack.

2. **Skip Lifter** for wear and freedom of operation.

3. **Escapement** for $\frac{1}{64}$" clearance to rack. Check by latching up the release bar link and moving the rack back and forth. Also, check by raising the rack just enough to remove the up-and-down play. The escapement should not drag on the rack teeth.

4. **Sensing Pin Contacts** for air gap when not attracted, and for good rise when closed. Make sure that the points do not close if a blank column is under the pin.

   When the sensing magnet is energized and there is no card beneath the sensing pins, it is possible that all pins will not be pushed down far enough for the contact strap to make contact. Check with a card that has three successive holes in a column for those positions that do not operate when there is no card present. Both verifying and master units should be checked.

5. **Solenoids** for freedom of operation and proper adjustments.

6. **Dog** for wear and proper rise when space solenoid is attracted.

7. **Circuit Breaker Contact** for pitted points and proper adjustment.

8. **Card Notcher** should be approximately $\frac{1}{16}$" above the die before being attracted, and when energized, should be drawn into the die so that the upper edge of the notching punch is below the level of the card line; that is, there should be no interference to the card movement when the punch has gone its limit of travel.

9. **Pin Registration.** This can easily be checked by making use of a hole just above the thumb lever that is already tapped for an 8-32 screw. The procedure is as follows:
   (a) Punch a card with 12 through 9 in one column. Check registration of the holes with a card gauge.
   (b) Insert the card in the bed and push the rack to the column punched. Be sure the dog is seated properly.
   (c) Place an 8-32 screw in the above mentioned hole and screw it down until it binds on the master control bed casting. Take care not to tighten it too much so as not to warp the carriage.
   (d) The pin sensing unit may now be raised, and the 8-32 screw will hold the rack in position.
   (e) The card is now uncovered and held in position by 8-32 screw so that the card carriers, right and left, may be adjusted to center the holes in the card with the pin sensing holes in the card bed. Both verifying and master units should be checked.

10. **Key Boards.** Check all the keys for ease of operation. It is essential to have the keys free of binds so that they may always be depressed their full travel to insure that their respective contacts will be fully made. This is particularly essential when a key operates a contact with double points.

There should not be too much tension on the contact straps that operate against the contact bell cranks in order that all the keys may be operated fully with as little finger pressure as possible.

11. Relays (see *General Section—Duo Relays*)

III. Lubrication

Do not put oil on the sensing pins or the solenoid plungers.

IBM 6

(1) Dog carrier stud.
(2) Relay armature pivots.
(3) Card rack teeth (with short dog).

IBM 9

(1) Solenoid operating arm pivot.
(2) Release bar link guide screws.

IBM 17

(1) Light film on the surface of the phenolic pad on duo relays.

FEED UNIT

I. Cleaning

Clean all old dirt and grease from the unit. The governor should be removed and washed with cleaning fluid. The drive motor should be cleaned of all carbon.

II. Inspection

1. Motor Drive Clutch Pawl for proper unlatching and relatching on armature.

2. Feed Rack for proper feeding of cards. Check this by turning motor over by hand.

3. Main Rack for returning to column number one. This should also be checked by turning motor over by hand.
   The rack stop right should not act as a limit on the feed stroke since this will bind the motor drive unit and cause excessive bearing wear.

4. Stationary Throat for wear and adjustment.

5. Feed Knife for wear and adjustment.

6. Drive Motor Brushes for wear.

7. Eject Gripper Jaws for looseness on its shaft and for broken ears on the upper jaw and for proper jaw opening.

8. Card Reversing Device for loose gears and freedom of action.

III. Lubrication

IBM 6

(1) Card rack teeth (with short dog).
(2) Rack rollers.
(3) Motor.
(4) Rack spring assembly.
(5) Card reversing shaft bearings.

IBM 9

(1) Bearing points on motor drive unit.
(2) Feed rack gear shaft.
(3) Eject shaft.

IBM 17

(1) Card feed ratchet.

IBM 21

(1) Gear housing on motor drive unit.

TYPE 56

IBM
TRADE MARK

Customer Engineering Reference Manual

Preventive Maintenance and Adjustments

CARD VERIFIER
Type 56

CONTENTS

Form 22-6006-0

CARD VERIFIER
Type 56

THIS MANUAL condenses and revises Type 56 adjustments previously published. Preventive maintenance and servicing hints are included in each machine subdivision.

Most of the base adjustments of the Types 24-26 and 56 are identical. To conserve space in this manual, identical items are referred back to the Type 24-26 Reference Manual, form 22-8941-0. If a difference exists between adjustments, the Type 56 procedure is set forth here in its entirety.

The usefulness of IBM equipment is increased by an effective preventive maintenance program. Keeping machines abreast of current engineering changes is almost as important as cleaning and lubricating. These changes contribute to customer usage by improving machine features. Less service time and increased machine life result from the installation of improved parts.

BASE

Base adjustments to be found in the Type 24-26 reference manual are:

- Card lever and switch
- Card lever pressure finger
- Card pusher hood plate
- Pressure rolls
- Program sensing mechanism
- Program drum interlock arm
- Escapement magnet
- Friction drive
- Pressure rails
- Stacker unit
- Reduction drive
- Pin sensing unit
- Eject unit

Card Registration

Registration starts with moving the card from under the top rail and, for the detail card, continues until column 80 is processed and notched. From column 1 through column 80, registration on the verifier is not critical because the verifying pins can read the detail card throughout a variation in card placement of plus or minus .020″.

Feeding the card into the feed wheels then becomes most important. Cards should not be left under the top rail for long periods because they become curved and will not snap off the aligner fingers.

The most satisfactory operation of the aligner fingers is obtained when they travel .040″ or less ahead of the rail. Greater force than this merely throws the card into the front pressure rails. Keeping the left pressure rail in the detail station to its low limit of adjustment (23 grams to move away from the card) will also help snap the card off the aligner fingers.

Multiple punch a card in column 12. Adjust the card pusher arm in the same manner as the Type 24, using the scribed line in column 12 as a guide. The card should be registered so that the line on the verifying frame evenly divides the holes in column 12. The line can be used any time throughout verification for a check on registration. The card pusher pad should not grip the card and is adjusted the same as on the Type 24 punch.

Program Cam Contacts

This adjustment is affected by the forked arm adjustment and must be remade each time the forked arm is changed. If the column indicator dial has the program cam mounting screw head on the outside of the dial, the cam may be moved to compensate for the forked arm adjustment.

Although the timings are given in card columns, the adjustments are made and checked with the escape wheel teeth. Each tooth is as long as the width of a card column (.087″). The usual cause for skipping past column 81 is the adjustment of the 12 program contact.

1. The stationary contacts should have a minimum of 15 grams tension against their supports. The operating straps should be tensioned toward the N/C contact with enough tension to cause .005″ to .025″ rise. Avoid tension that would cause the operating strap to touch the support strap.

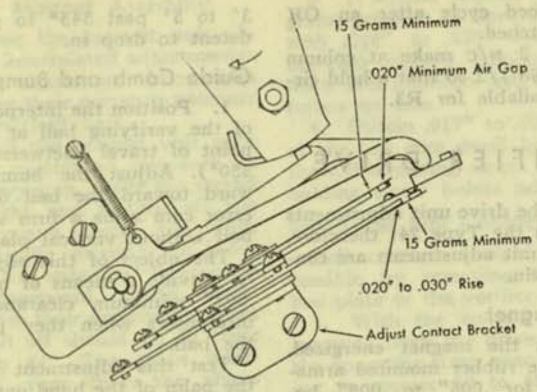


Figure 1. Program Cam Contact Adjustment

2. Set the contact levers on the high point of the cam (approximately column 84 as shown in Figure 1). Position the contact bracket for a make of the N/O points with .020" to .030" rise off the support. Form the N/C support for a minimum air gap of .020". Rotate the lever bracket to hold the levers 1/64" from the phenolic pads on the closest transfer strap. There should be a minimum of .020" air gap at the N/O contacts when the contact levers are off the cam. See that neither lever grounds out the rivet on the contact.

3. Turn the machine over by hand to column 88-1/3. Watch the escapement for a 1/3 tooth overlap of the armature on the tooth.

Position the contact lever bracket to cause cam contact lever 1 to drop off the cam. Rotate the contact lever bracket for the .010" to .020" clearance from the levers to the contact pads (Figure 2).

4. Refine the adjustments to meet the following conditions on the escape wheel teeth. All references are to program columns.

Number 1 N/O make at column 80-1/3 to 80-2/3 to pick R48 for the start of an OK notching cycle, or skip if the card was in error.

Number 1 N/O break at column 88-1/6 to 88-1/2 to drop out the escapement armature and stop the drum in column 1. This is a critical adjustment.

Number 2 N/C break at column 81-1/2 to 83 to drop out R3. If R3 drops early, the machine will lock in column 81. If the machine skips too far through a programmed skip to column 80, the machine will lock in column 82. R3 must hold until 180° of the OK notching cycle. The transfer number 2 points cause

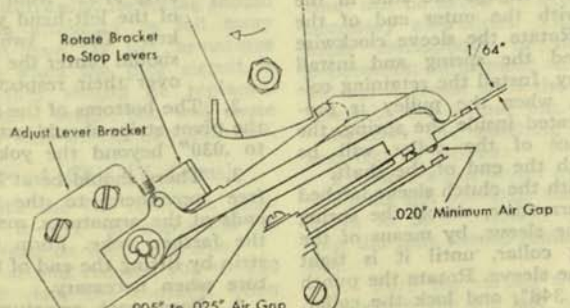


Figure 2. Program Cam Contact Bracket Adjustment

an auto feed cycle after an OK card is notched.

Number 2 N/C make at column 87-1/2 to 88-1/2 so that a hold circuit is available for R3.

VERIFIER DRIVE

MANY of the drive unit adjustments differ from the Type 24; therefore, all of the unit adjustments are contained herein.

Clutch Magnet

1. With the magnet energized, position the rubber mounted armature stop for .006" to .008" between the armature and outer yoke.

2. Form the armature spring to require a force of 140 to 160 grams to attract the armature, and to require 75 to 150 grams to move the armature away from its pivot. The keeper at the pivot end of the armature must not bind.

3. With the armature attracted, pivot the magnet about its support bracket to obtain an unlatching clearance of .008" to .012" to the step on the sleeve.

Index Pointer

With the clutch detent back against the detent latch, position the index pointer at 345° ± 2°. Be sure the indicator clears the index periphery.

Clutch Spring and Collar

1. Install the clutch adjusting collar against the side of the detent.

2. Lubricate the clutch spring, and insert it under the collar against the shoulder on the shaft. Avoid scratching or marring the spring.

3. Install the sleeve over the spring and engage the stud in the sleeve with the outer end of the spring. Rotate the sleeve clockwise to expand the spring and install the pulley. Install the retaining collar, and, when the pulley is properly located inside the spring, the outer face of the collar will be flush with the end of the shaft.

4. With the clutch sleeve latched on the armature, uncoil the spring within the sleeve, by means of the adjusting collar, until it is tight within the sleeve. Rotate the punch index to 348°, and lock the collar. When the index is turned by hand, there should be an overthrow of 3° to 5° past 345° to permit the detent to drop in.

Guide Comb and Bumper

1. Position the interposer section of the verifying bail at its highest point of travel (between 234° and 350°). Adjust the bumper downward toward the bail to give the error cam arms a firm seat on the bail without vertical play.

The object of this adjustment is to provide a means of maintaining .003" minimum clearance for the interposers when they pass under the bail.

Test this adjustment by placing the palm of the hand over all error cams while squeezing the verifying bail toward the error cam. Trip all magnet positions, and all the interposers should latch under the bail.

When installing new error cam arms and when the above adjustment is being made, there must be .003" minimum clearance as the interposer latches under the bail.

Interposer Magnet Unit

The Type 56 interposer magnet unit assembly, P/N 227784, is the same type of unit used for the Type 24 drive units. The difference in knockoff bail timing is accomplished by a different knockoff cam. All the coils in the assembly are of equal resistance (1800 ohms).

1. This adjustment is only required if an armature pivot strip is replaced. The two pivot strips are identical.
   a. Facing the armatures with the seven-coil side up, position the pivot strip 13/32" from its left end to the inside of the yoke bracket.
   b. Position the lower pivot strip 5/32" from the inside of the left-hand yoke bracket. These two settings should center the armatures over their respective cores.

2. The bottoms of the notches in the pivot strips should extend .028" to .030" beyond the yokes.

3. There should be at least 1/8" free movement to the operating ends of the armatures, measured to the farther yoke. Form the pivot strip by lifting the end of the armature when necessary.

4. Form each armature to contact its core and both yokes within .005".

Interposer Magnet Assembly

Positioning the magnet unit affects three interrelated adjustments: unlatching clearances; interposers relatching in their armature notches; and the knockoff bail.

1. Install the magnet unit with reasonable unlatching clearance as a preliminary step. Make the screws friction tight and restore all but four interposers across the unit. While manually rotating the index clockwise, the unlatched interposers in their downward motion should start to enter their armature notches at 73° and all should be in their notches by 84°. The space interposer will vary from the above but may not be later than 90°.

2. The heel of the latching end of interposers has been ground away to avoid contact with the opposite side of the notch in the armatures. The .025″ to .030″ clearance between the heel of a tripped interposer to the back of the armature no longer applies to all machines.

The actual unlatching clearance for the space interposer at the point of unlatching is .005″ minimum, with .008″ minimum clearance for all others. These clearances should result from adjusting the magnet unit for .040″ to .050″ armature travel with the interposers latched. Measure between the armature and yoke.

3. Adjust the eccentric screw in the knockoff bail to cause the bail to meet an attracted armature at both ends of the unit between 355° and 2°. If the eccentricity is insufficient, inspect the cam follower for wear. It may be necessary to pivot the entire magnet unit about the armature latching point to bring the bail closer to the armatures.

4. When an armature is attracted electrically, its spring should cause the armature to fall away from the core. If the armatures hang up when the pick circuit is broken, they should be replaced. The residual magnetism will cause excessive wear on the knockoff bail.

High Speed CB's (V Cams)

1. With the CB removed, shim for .027″ to .032″ air gap when the plunger rests on the CB frame.

2. It should require 100 to 150 grams to close the contacts when measured at the end of the operating point. Replace weak straps.

3. It should require 475 to 550 grams pressure to close the contacts with .020″ to .030″ overtravel of the cam follower. Replace weak or worn cam followers and be sure the rollers are free.

4. Obtain .017″ to .023″ air gap at the low cam dwell by means of the CB adjusting screw. Loosen the holding screw before adjusting.

Interposer Bail Contacts

Bail contact assemblies are accessible by removing the master bed plate or the verifier drive unit.

1. With the contact assemblies removed from the drive unit, form the operating strap near the mounting to require 20 to 25 grams to close the contacts. The gram gage blade and the phenolic pad should overlap 1/4″ when checking.

2. Form the stationary contact strap to require 30 to 35 grams to raise it off its support. The forming should be within the area of the support strap to reflect a true condition. Form the strap for a point to point contact at the outer tip of the support. When properly adjusted, a crack of light will appear at the tip of the support during measurement. A total of 50 to 60 grams should be required to close the contacts and raise the stationary strap off the support. It is necessary that both front and rear contact assemblies are adjusted within 5 grams of one another.

3. Reinstall the contact assemblies and adjust their mounting brackets for an air gap of .017″ to .023″ with all armatures restored.

Verifier Drive Unit Timing Test

Test the timing of the drive unit before readjustment. Sometimes only a slight change is necessary to correct a condition, and considerable time will be saved by avoiding unnecessary alterations. This adjustment corresponds to the punch penetration adjustment on the Type 24 and is made with the adjusting screw in the anchor bar.

Remove the notching assembly and test as follows:

1. Hold a flat object over all the verifying pin openings and turn the index to 50°. Remove the object and the pins should remain latched out.

2. Turn the verifier shaft slowly and watch for the last pin to pop up between 180° and 195°. If the

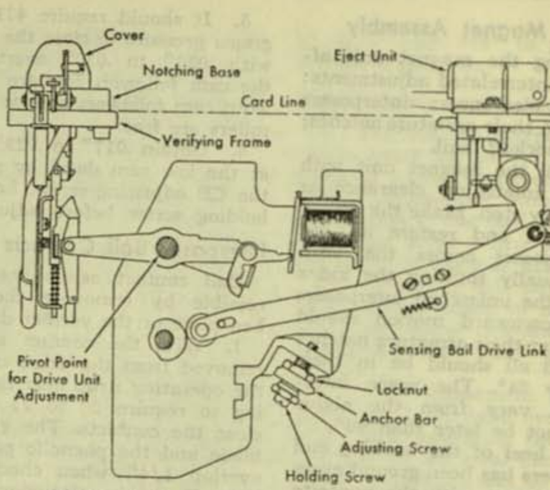


Figure 3. Drive Unit Adjustment, Rear View

machine does not meet these timings, remake the anchor bar adjustment.

Verifier Drive Unit Anchor Bar

When the preceding test shows that the drive unit must be retimed, or when a new verifier drive unit is installed, the following procedure is recommended:

1. Remove the notching base (assembly above the bed at the verifying station).
2. Loosen the sensing-bail drive-link screws.
3. Loosen the two support screws in the anchor bar.

At this point, the lock nut and holding screws can be loosened and small adjustments made with the adjusting screw to obtain the correct timing (Figure 3). Remake the notch drive link adjustment, tighten the drive unit support screws lightly, and extend the bail drive links.

If a new unit is being installed, continue with step 4, etc.

4. After installing the unit and the anchor bar, back off the adjusting screw about two turns.
5. Hold a flat object over the verifying pins while turning the machine by hand to about 70° of the verifier index. Remove the flat object and the pins should stay latched down.
6. Turn the index to 190° and hold it there. Turn in on the adjusting screw until the last pin has snapped up; then tighten the holding screw. Turn the machine through a cycle, again latching out the pins to be sure the adjustment has not changed. Remake the notch drive link adjustment, tighten the two support screws lightly against the side frames, and extend the bail drive links. Tighten the adjusting screw lock nut to avoid readjustment if the drive unit is removed.

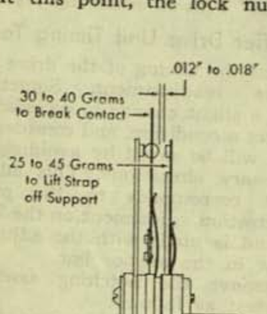


Figure 4. Error Contact Adjustment

Error Contact Assembly

1. Form the operating point support spring to require 30 to 40 grams to break the N/C contacts. Measure at the arrow shown in Figure 4.

2. Form the stiffener spring to require 25 to 45 grams to lift the N/O contact off its support.

The two steel contact straps and the center stiffener spring can be removed or lined up by loosening the holding screws in that area.

VERIFYING FRAME

Verifying Frame Removal

It is advisable to insert a blank card between the verifying frame and the notching base when handling the unit. If this precaution is not taken, the bottom of the pin drivers will leave the guide, and considerable time will be lost replacing them.

The verifying pin latches must pivot freely on the pin drivers. Set all the latches on the second step of the pin latch stop (Figure 5) to hold the drivers in their guides for the next step. Position the retainer for a clearance of .002″ to the closest pin drivers. The drivers must not bind.

When reinstalling the verifying frame, be sure the pin latches are straight up and down. It is possible to bump the lands on the pin drivers and pull them low enough to allow them to slip under the pin latch guide. If this should happen, those positions will not verify. Be sure to check this condition before replacing the bed plate.

Always place a blank card in the verifying position before removing the verifying frame to keep the pin drivers from rising out of their lower guide.

1. Turn the verifier index to 100° for the maximum rise of the verifying bail to clear the pin drivers.

2. Remove the following: eject unit, pressure rail covers, master bed plate, and the notch drive link from its cam follower arm.

3. Hold the notching base on the verifying frame and extract the four mounting screws. Keep the card in place and swing the bottom of the frame to the right to clear the bail. Lift the units out of the base. Lift out the eject pins, which are interchangeable.

When reversing the procedure to install the verifying frame, place a blank card between the units to keep the pin drivers in place. The

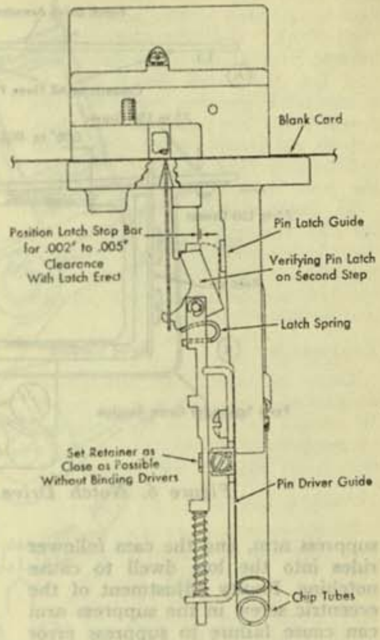


Figure 5. Verifying Frame Adjustment

chip tubes must be tight against the bottom of the dies to avoid chip jams. Close the top loop of the plunger spring to make it stay on the plunger. When replacing the plastic card bed, keep the right end as close to the top rail as possible to prevent cards from catching.

NOTCHING

Notching punches and dies have the same limitations that any other dies and strippers have. The punches are selected to fit; therefore, they are not interchangeable. Machines prior to the AP suffix contain punches .141″ in diameter which are obsolete. To date, .109″ punches are being used, of which the OK punch is offset. Parts are not stocked for the large punch styles. If replacements are needed for the large punches and linkage, the entire notching base and verifying frame (308654) should be replaced.

Notch Drive Magnet

Energizing the notch drive magnet eliminates the action of the

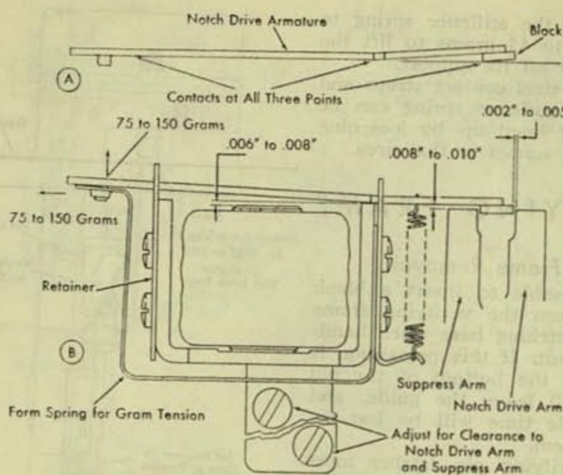


Figure 6. Notch Drive Magnet Adjustment

suppress arm, and the cam follower rides into the low dwell to cause notching. Faulty adjustment of the eccentric screw in the suppress arm can cause failure to suppress error notching or can prevent error notching when notching is desired. The eccentric screw (228369) is the same as the part used on the Type 26.

1. Form the notch drive armature so that a straight edge will contact the three points shown in Figure 6A.
2. The armature should be free to move across the yokes and must not bind in the armature retainer. Lubricate the pivot point of the armature where it slides on the lower yoke with IBM 22.
3. There should be .006" to .008" air gap at the core with the armature attracted. If it is necessary to shim the core, use .003" steel shims (305271).
4. Position the armature retainer on the yoke opposite the interposer block for maximum armature travel without binds.
5. Position the entire magnet bracket for a clearance of .008" to .010" between the armature at rest and the end of the suppress arm; at the same time there must be a clearance of .003" to .005" between the interposer block on the armature and the inside cut of the notch drive arm (Figure 6B). Every time the drive unit is readjusted at the anchor bar, this step must be checked. It may be necessary to move the suppress arm to perform step 5.

Notch Suppression

The high side of the eccentric bushing on the back end of the verifier cam shaft contains a groove which should line up with the mark near the center of the low dwell of the notch drive cam. The left-hand threaded screw in the end of the shaft must be loosened to position the bushing.

Trip the verifier clutch and turn the drive unit index to 245° (Figure 7). Adjust the eccentric screw in the suppress arm for .010" to .012" clearance to the interposer block on the armature.

When loosening or tightening the screw in the end of the shaft, take precaution to avoid damaging the clutch spring on the other end of the shaft. Each time the drive unit is readjusted by the screw in the anchor bar, this adjustment must be checked.

Last Column Notch Solenoid

Round embosses or OK punches in the middle of the card are caused by a worn punch interposer bar or the solenoid plunger travels may be off. The punch usually appears about 3 columns to the right of the column that should have been error notched.

1. It is necessary to remove the notching base cover to adjust the solenoid. The position of the

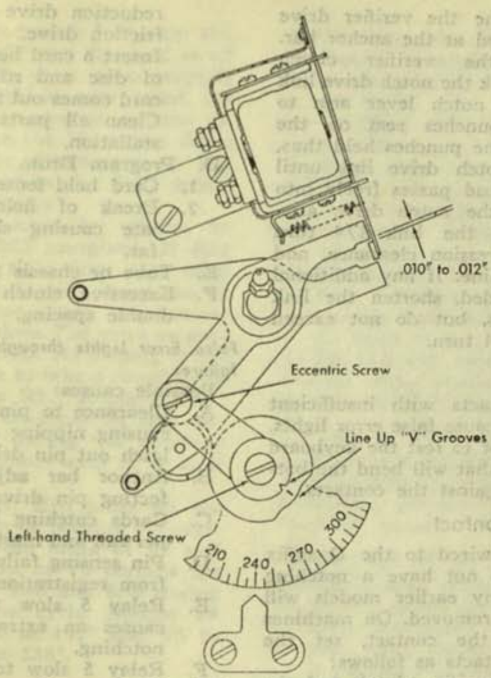


Figure 7. Notch Suppression Adjustment

plunger controls the operation of the notching punch interposer. Loosen the solenoid mounting screws and attract the plunger until it seats against its rubber mounted stop. Take up the play in the linkage of the interposer bar toward the front of the machine and position the magnet bracket vertically for .003" clearance between the error punch and interposer bar (Figure 8).

2. Form the stationary contact support for a minimum air gap of .025" and a minimum rise after making of .025".

Notch Drive Link

On every clutch cycle that doesn't cause notching, the punches are driven upward by the suppress arm, armature block, and eccentric bushing. Since the punch motion is opposite to the direction for notching, a clearance must be provided by adjustment. It is always advisable to check the upward punch clear-

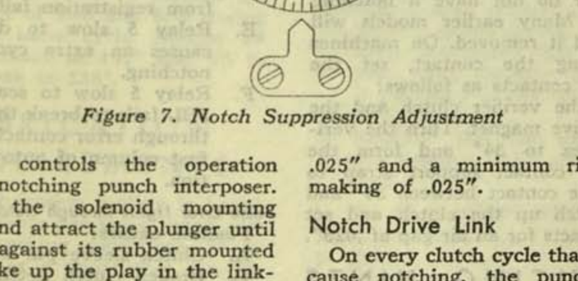


Figure 8. Last Column Notch Solenoid Adjustment

ance each time the verifier drive unit is adjusted at the anchor bar.

1. With the verifier clutch latched, unhook the notch drive link and lift the notch lever arm to make both punches seat on the cover. With the punches held thus, adjust the notch drive link until the bottom stud passes freely into the hole in the notch drive arm.

2. Shorten the link 1/4 turn for the suppression clearance, and test the machine. If any additional travel is needed, shorten the link by 1/4 turns, but do not exceed a total of 3/4 turn.

Keyboards

Latch contacts with insufficient air gap may cause false error lights. Be careful not to rest the keyboard on anything that will bend the bottom cover against the contacts.

Notching Contact

Machines wired to the D suffix and later do not have a notching contact. Many earlier models will have had it removed. On machines still using the contact, set the notching contacts as follows:

Trip the verifier clutch and the notch drive magnet. Turn the verifier index to 34° and form the notching contact support strap to make the contact between 34° and 38°. Latch up the clutch and set the contacts for an air gap of .025".

SERVICING HINTS

The following outline is provided to assist in diagnosis of certain machine conditions which often prove difficult when they are encountered for the first time.

False Error Lights through escapement failures.

Possible causes:

A. Interposer bail contact pressure or gap
B. Interposer armature
   1. Failing to trip off - drag
   2. Steel of high permeability
   3. Knockoff bail worn
C. Friction drive torque
   1. Low torque, card moves slowly. Reading attempted before card stops moving.
   2. Heavy torque, escape armature fails to pull out of tooth. Operating pin closes escape contact so same column is verified.
   3. Oil off gears or from the reduction drive getting on friction drive.
      Insert a card between faces of disc and run until the card comes out nearly clean. Clean all parts before installation.
D. Program Drum
   1. Card held loosely.
   2. Break of field definition late causing skipping too far.
E. Tube or chassis failures.
F. Excessive clutch overthrow-double spacing.

False Error Lights through verifying failures.

Possible causes:

A. Clearance to pin latch block causing nipping or failure to latch out pin drivers.
B. Anchor bar adjustment affecting pin driver travel.
C. Cards catching between upper rail and master bed plate.
D. Pin sensing failures resulting from registration failure.
E. Relay 5 slow to drop out causes an extra cycle after notching.
F. Relay 5 slow to seal. Relay 5BL fails to break the circuit through error contacts during first column of auto-verification.

False Error Lights through clutch failures.

Possible causes:

A. Clutch sleeve pin missing.
B. Broken clutch detent.
C. Clutch armature spring tension.
D. Excessive clutch overthrow.
E. Tube or chassis failure.

False Error Lights through error contact failures.

Possible causes:

A. N/C contacts fail to pick R43. Next column would appear in error.
B. N/O gap too close

False Error Lights through keyboard and miscellaneous causes:

A. Latch contacts so close they bounce closed.
B. Burned keyboard bail contact may cause only one of two magnets to be energized. Adjust restoring bail contact to take the arc.

Drum Skipping failures

A. Drum stops in column 82, fails to notch and continues to auto-feed. If a program card is punched to skip the last field and the card is off register, worn, or improperly installed, it may cause the drum to stop at column 82. Be sure the 12 contact drops out the escapement on 1/3 tooth when the field definition breaks.

B. Drum stops in column 82 with R22 energized. If R22 has a slow drop out, relay 25 fails to pick in column 81 and one more escapement takes place. The extra escapement drops R3 making it impossible to take a clutch cycle to drop R22. Replace R22.

C. Drum attempts to skip before or during OK notching on machines with D, E or F suffix.
Solution: R46 picks on the wrong cycle because the overlap of the make of V4 and the break of V5 permits the pick of R48 and R46 during the same cycle. Retime V4 to make at 132° and V5 to break at 138°.

LUBRICATION REQUIREMENTS

This lubrication outline is based upon 40 hours per week usage and average working conditions. It is presented as a guide that can be varied in frequency to meet individual machine requirements.

A code number is assigned to each unit to simplify the chart. To find each item affected on a unit, the verifier drive for example, refer to each item labeled 2. The complete code list follows:

1—Verifying frame and notching
2—Verifier drive unit
3—Eject and pin sense
4—Program
5—Card feed
6—Stacker
7—Mechanical drive

For keyboards, see Figure 30 of the Type 24-26 Reference Manual.

IBM 6, 3 MONTH PERIOD

1—Eccentric bearing and eccentric adjusting screw in the notch suppress arm.
2—a. Cam follower rollers
b. CB rollers (be sure they are free).

IBM 6, 6 MONTH PERIOD

1—Notching punch lever pivots.
1—Notching bell crank.
1—Punch interposer bar and punches (keep solenoid plunger dry).
1—Verifying pin latch pivots, sparingly.
2—Notch drive cam follower.
2—Error cam pivots and guide comb, sparingly.
2—Interposer pivots and felt washers.
3—Pin sensing bail shaft bearings. Saturate wicks by removing eject unit and using air holes in the moulding.
3—Pin bail arm stud.
4—Star wheel pivots, sparingly.
5—CF circuit breakers.

IBM 6, YEARLY PERIOD

3—Eject unit mechanism.
5—Card feed knife linkage.
6—Stacker gripper block pivots.
7—Drive motor.

IBM 22, 3 MONTH PERIOD

2—Notch drive armature block.
2—Verifier clutch spring, at least every 3 months. Wipe off excess. More frequent greasing is necessary if the clutch becomes noisy.
2—Knockoff bail cam follower.
2—Pin sensing bail drive link stud.

IBM 22, 6 MONTH PERIOD

1—Notch drive link, both ends.
1—Sliding surfaces of the pin drivers and latch springs.
2—Rear mounting plug grease fitting.
2—Error cams at pin driver lands.
2—Verifying bail, thin film.
2—Notch drive spring loops.
2—Notch drive armature at yoke ends.
2—Interposers at latching points and bails.
5—Card feed steel pressure roll pivots.

IBM 22, YEARLY PERIOD

1—Pressure roll release pin ends.
4—Program cam.
5—CF clutch, card pusher cam, card stop cam.
6—Stacker gripper cams, gears, and followers.
7—Escapement armature at pivot end.
7—Reduction drive housing. Keep grease 1/4" above the contact points of the grease wh[illegible] the housing is held in oper[illegible]ting position.

REFERENCE MANUAL

COLLATOR TYPE 77

CONTENTS

INTERNATIONAL BUSINESS MACHINES CORPORATION
New York, New York
Printed in U.S.A.
Form 22-3780-1

COLLATOR, TYPE 77

ADJUSTMENTS

Feed Hoppers

Position the front and rear hopper side plates so the holes in the card are aligned with the brushes and there is a .005" to .008" clearance over the length of the cards.

Position the hopper posts by adding or removing shims to obtain a .005" to .008" clearance over the width of the cards.

Feed Knives

The feed knife pivot screws should be adjusted so the feed knives travel .020" to .040" beyond the right or "12" edge of the card. Be sure the feed knives are square with the first set of feed rolls.

Feed Knife Guides

Adjust the feed knife guides for minimum sideplay without causing any binds.

Card Guides

Card guides are set for .020" clearance between the guides. The ends of the guides should clear the contact rolls by not less than .005".

Feed Rolls

Adjust all floating feed rolls for even tension over the entire length. Primary and secondary rolls are equipped with adjustable plungers; remaining rolls are equipped with pull springs.

Brushes

The brush unit assemblies should be checked for a minimum end-shake between the side frames at the pivot rod.

Use brush setting jig 454090 to set the brushes for a 1⅛" projection from the brush block to the toe of the brush; this should provide a ⅛" projection above the card line. If necessary, holes for the brush holder locating block may be elongated to secure a ⅛" projection. Use brush adjusting glass 450388 to position the brushes using scribed line farthest from the 90° bend.

Position the brush separator rolls so the distance from the inside of the front side frame to the front edge of the #1 brush groove in the separator roll is ⅝". This may be obtained by driving the bronze bearings in the separator roll bearing brackets in or out. Align the brushes to the middle of the brush separator roll slots by adjusting the brush block lateral aligning screws.

For the earlier machines not equipped with aligning screws, the adjustment is obtained by filing one end of the brush block and placing shims between the other end of the brush block and the side frame. In either case, it will be necessary to align individual brushes with the three-group brush bending tool.

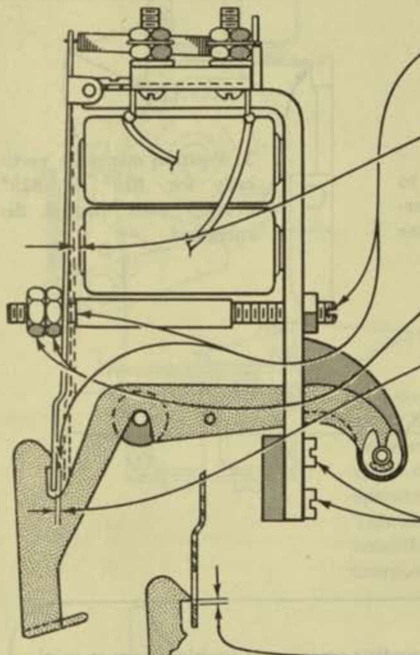
Shift the hopper side plates so that one set of brushes tracks through the center of the hole in card. If necessary to re-align other set of brushes, be sure the brush separator roll is adjusted along with the brush block assembly.

Rotate the picker knife cam on its shaft to cause the primary brushes to make through the hole in the card not later than 3° before the corresponding line of the index and break not earlier than 12° after the line of index. Repeat for secondary brushes. To obtain the correct timing for primary sequence brushes, adjust the brush block assembly. It is suggested that a dynamic timer be used when timing the brushes to obtain the best possible condition. Check columns at both ends of card using 1, 5 and 9 time.

Chute Blades

Chute blades should be shaped to provide sufficient tension to cause the blade to follow the select shoe. Form the blades so the tips of the secondary blades are 1/16" above the card line and the tip of the primary blade is 1/16" below the card line when the select shoe is latched in normal position. When the select shoe is unlatched, tips of the secondary blades should be 1/16" below the card line and the primary blade 1/16" above the card line.

Pocket Selection Magnets

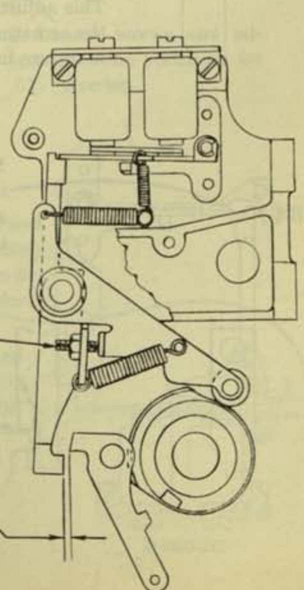


1. Adjust this screw so shoulder stops armature for .015" unlatching clearance. This should provide .003" to .012" clearance between armature and core.

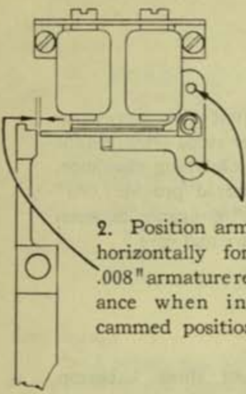
2. Adjust these backstop screws so that select shoe latch projects .005" beyond thickness of armature.

3. Loosen mounting screws and move magnet assembly up or down to provide .010" to .020" relatching clearance.

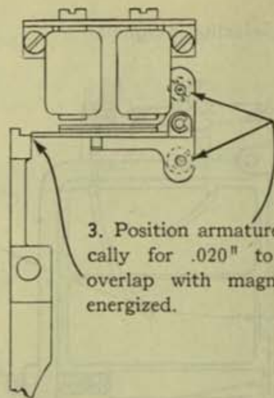
Primary and Secondary Clutches



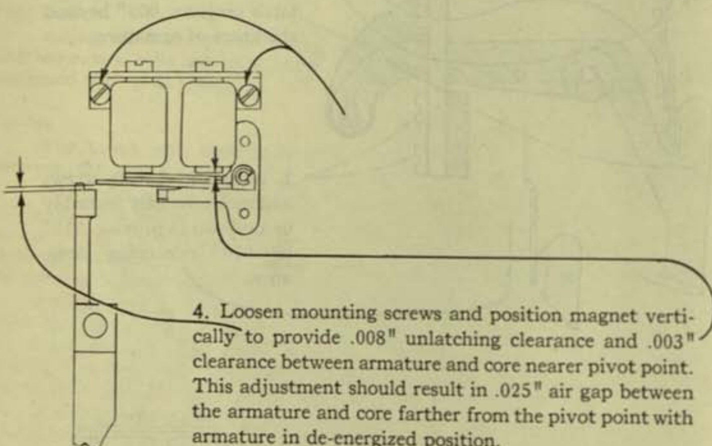
1. Set adjusting screw for .010" to .015" unlatching clearance. The pawl must not trip later than 220°.



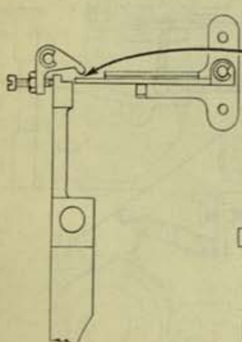
2. Position armature horizontally for .005" to .008" armature relatch clearance when in extreme cammed position.



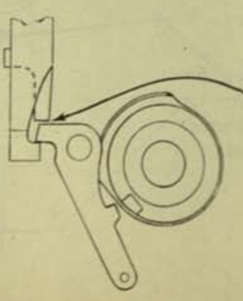
3. Position armature vertically for .020" to .025" overlap with magnet de-energized.



4. Loosen mounting screws and position magnet vertically to provide .008" unlatching clearance and .003" clearance between armature and core nearer pivot point. This adjustment should result in .025" air gap between the armature and core farther from the pivot point with armature in de-energized position.



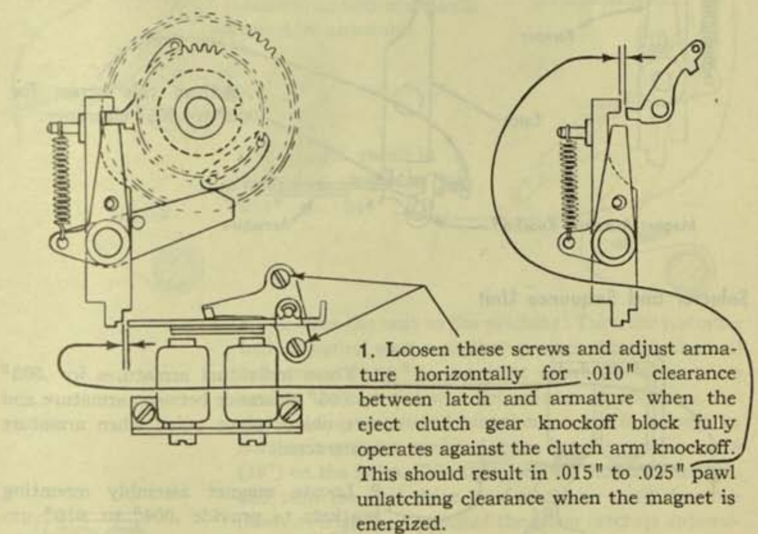
5. Adjust knockoff screw for .010" to .012" clearance with armature in extreme cammed position.

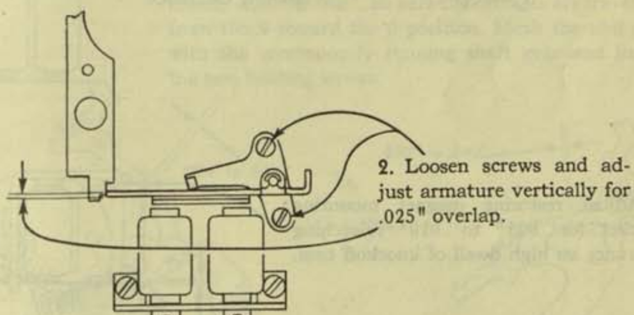


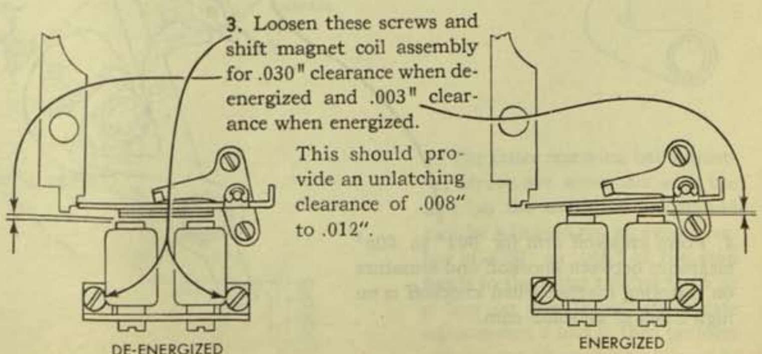
6. Peen or stone keeper for .003" clearance.

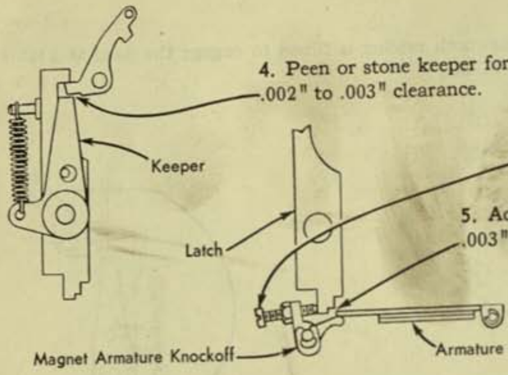
Eject Clutch Assembly

The eject clutch one-tooth ratchet is timed to engage the pawl at 235° ±2°. The adjustments are as follows:





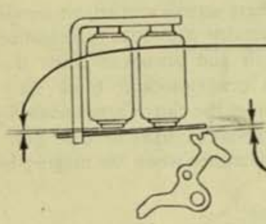




4. Peen or stone keeper for .002" to .003" clearance.

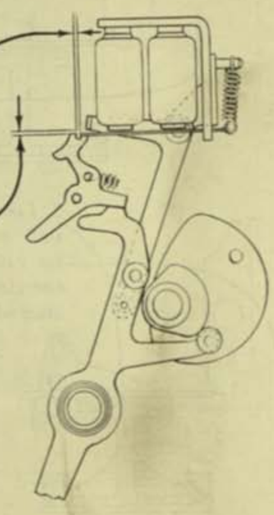
5. Adjust this screw for .003" to .005" clearance.

Selector and Sequence Unit



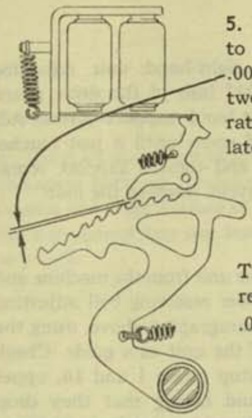
1. Form individual armatures for .003" to .005" clearance between armature and core nearer pivot point when armature is attracted.

2. Locate magnet assembly mounting brackets to provide .004" to .010" unlatching clearance.



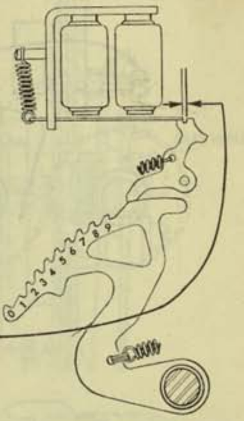
3. Adjust restoring magnet mounting bracket for .005" to .010" relatching clearance on high dwell of knockoff cam.

4. Form knockoff arm for .002" to .006" clearance between knockoff and armature on restoring magnet when knockoff is on high dwell of knockoff cam.

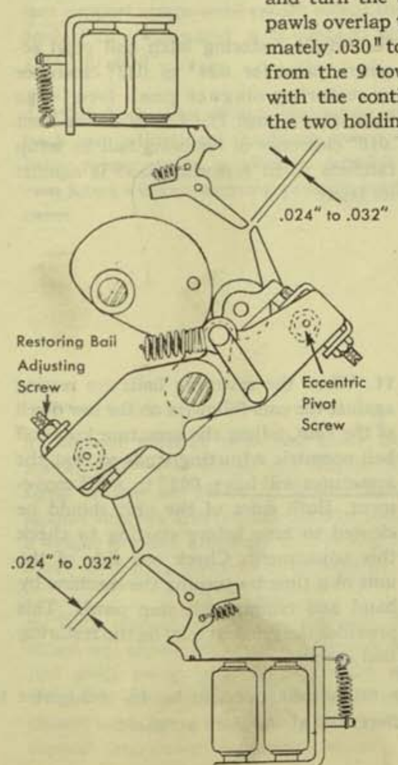


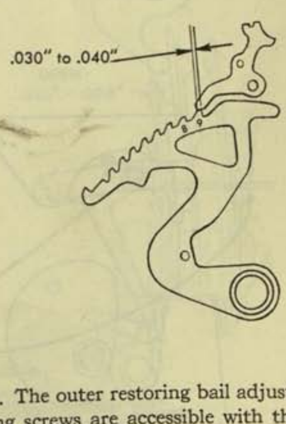
5. Move individual magnets to front or rear to provide .008" to .012" clearance between stop pawls and setup ratchet teeth with stop pawls latched on armature.

This should result in a relatching clearance of .010" to .014"

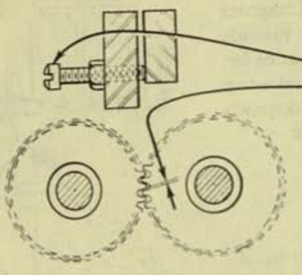


6. To time the unit to the machine: Turn the restoring bail adjusting screws so they project through the bail approximately 1/64" at the point where the screw bears against the cam follower. Set unit on support bars. Install holding screws and turn them in just far enough to hold unit without meshing gears. Set the machine at 8 (18°) on the index. Trip the restoring magnet armature and turn the unit drive gear clockwise until the stop pawls overlap the 9 tooth of the setup ratchets approximately .030" to .040". Be sure the ratchets are travelling from the 9 toward the 0 position. Mesh the unit gear with the continuously running shaft gear and install the two holding screws.



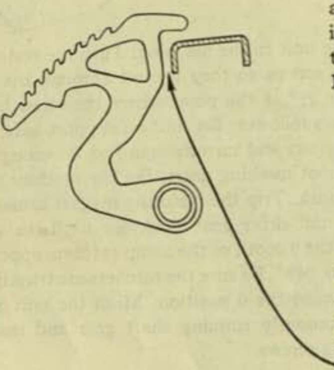


7. The outer restoring bail adjusting screws are accessible with the unit on the machine and should now be adjusted for an even overlap of .030" to .040" of the stop pawls to the setup ratchet teeth at a line on the index. (Complete adjustments 8 and 9, then perform adjustment 10 on the next page.)

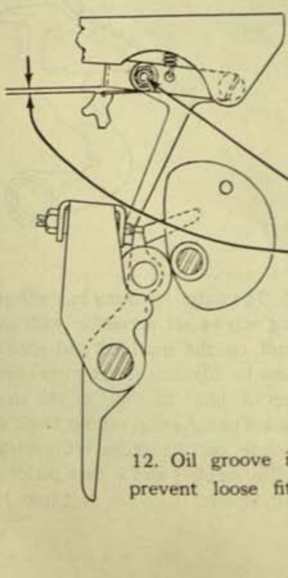


8. Position right-hand unit adjusting screw for .002" lash of the drive gears. Tighten right-hand support screw. Adjust left-hand screw until it just touches support bar and tighten support screw. This is to prevent warping the unit.

9. Remove the unit from the machine and adjust the lower restoring bail adjusting screws as in paragraph 6 above, using the upper half of the unit as a guide. Check by tripping stop pawls 1 and 16, upper and lower, and noting that they drop into the setup ratchet teeth at the same time on the restoring part of the cycle. Reinstall the unit on the machine.



10. Adjust restoring latch bail pawl eccentric pivot for .024" to .032" clearance to restoring magnet pawl. (see large illustration, page 7). Check for at least .010" clearance of restoring bail to setup ratchets when restoring pawl is against its latch.

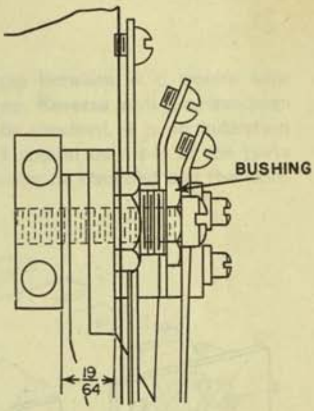


11. When the restoring bails are resting against the cam followers on the low dwell of the cam, adjust the armature knockoff bail eccentric adjusting studs so that the armatures will have .002" to .006" movement. Both sides of the unit should be cleared to zero before starting to check this adjustment. Check one side of the unit at a time by turning the machine by hand and tripping all stop pawls. This provides the greatest load on the restoring bail spring.

12. Oil groove in setup ratchet shaft should be 45° off center to prevent loose fit of differential guide plate on shaft.

Contact Assembly

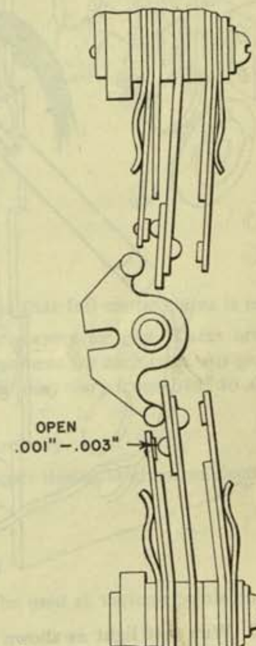
1. Set the adjustment bushings for 19/64″ clearance between mounting pads on side frames and outer surface of contact mounting bar. Adjust any one bushing to remove any rock.



2. With ones in lower section of unit, and upper section cleared to zero, adjust lower N/C contact support straps until center straps come against cam lobes and N/C contacts open .001″ to .003″.

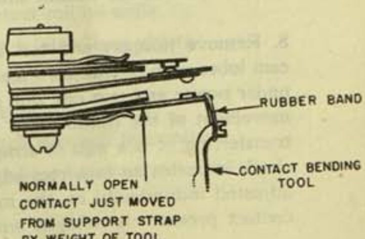
3. Clear lower reading and put ones in upper side of unit. Adjust upper N/C contact support straps until center straps come against cam lobes and N/O contacts open .001″ to .003″.

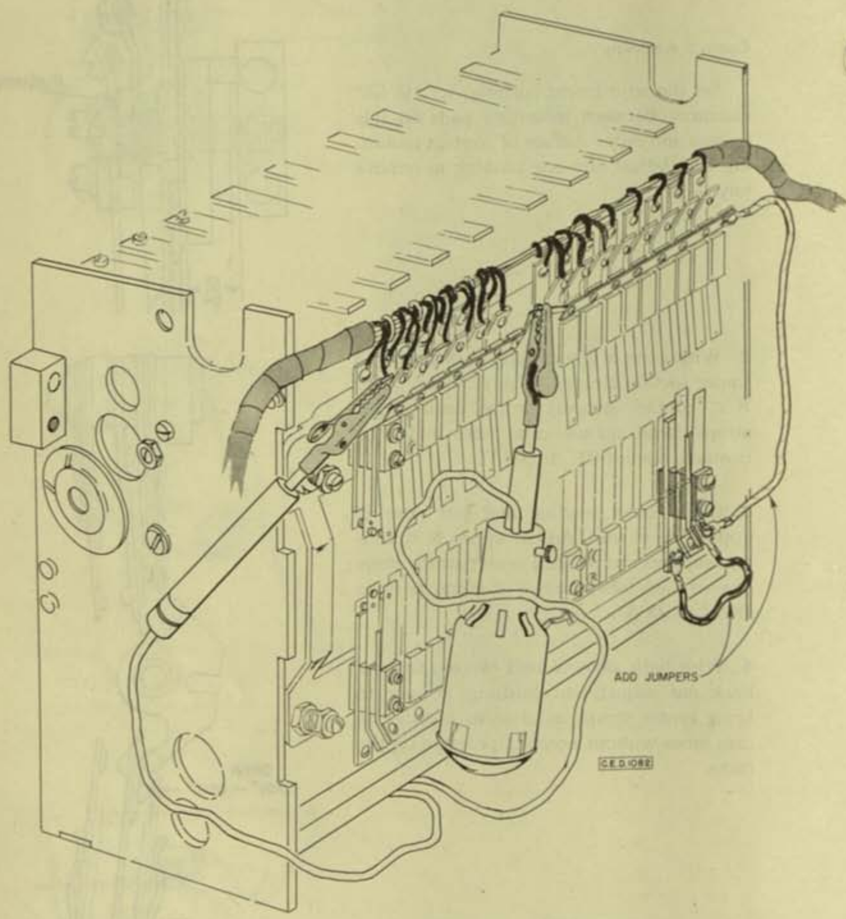
4. With both sides of unit cleared to zero, back out adjustment bushings evenly to bring center straps as close as possible to cam lobes without exerting pressure on the cams.



5. Remove contact unit and place horizontal with N/C straps up. Adjust N/O strap tension for 15 to 25 grams tension against support. Use contact bending tool as a weight to check adjustment. It should just move N/O strap away from its support.

6. With contact unit horizontal and N/C straps up, adjust center strap tension so it just pulls away from N/C contact with weight of contact bending tool. N/C strap should have just a perceptible rise from its support under tension of center strap.

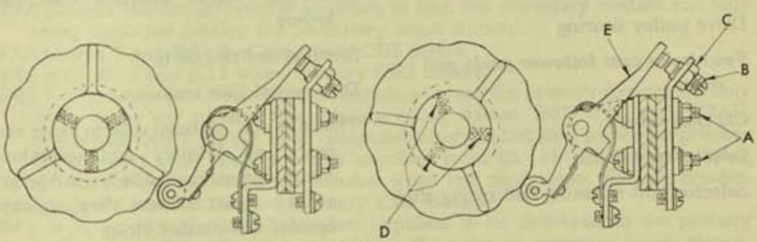




7. Wire test light as shown using a neon bulb. Adjust each contact position by bending N/O support strap until light just blinks out when center strap goes from N/C to N/O strap. Obtain smallest possible center strap motion with light out.

8. Remove jumpers and test light leads and recheck for no strap pressure on cam lobes with unit at zero reading. To check for this condition have machine idle under power and trip one side of each unit at a time. If there is an appreciable movement of the center strap on the side of the unit where the contacts are not transferring, it is a sign of strap pressure on cam lobes at zero reading. When this check indicates an incorrect adjustment, the contacts for that position should be adjusted individually on the machine by bending the N/C support strap until contact pressure is relieved with zero reading in both sides.

9. Check visually for a minimum of .020″ air gap between N/C points with zeroes in one side of the unit and ones in the other. Reverse zero, one readings and check other side. If this adjustment cannot be obtained, it is an indication of lost motion due to wear of the linkage. A check should be made of the parts affected in any position where this adjustment cannot be obtained and the worn parts replaced.



Circuit Breakers

1. Clean points.
2. Loosen screws A and align contact points so that full contact area is used.
3. Loosen locknut C and adjust screw B for correct air gap. There are 40 threads per inch on contact screw, giving .025" movement for each turn. Air gap of CB's 1, 2, 3 and 4 is .025". On all others the air gap may vary from .012" to .040" to obtain the correct contact duration.
4. Form at E so that contact surfaces meet squarely.
5. Loosen screws D and turn cam to obtain proper timing as given on electrical timing chart supplied with each machine.

LUBRICATION

The following list indicates the lubricants to be used at various points on the machine.

IBM 6

Feed knife slides

Select magnet armature pivot

Relay armature pivot

Selector unit
- Setup ratchet pivot shaft oil well and felt wick
- Stop pawl pivots
- Studs on differential link and guide plate (follow with No. 17)
- Restoring magnet knockoff cam follower rollers (follow with No. 17)

Contact roll oil wells

Clutch latch lever pivots

CB cam lever pivots

Pawl pivots

Clutch knockoff lever pivots

High speed contact rolls

IBM 9

Motor and generator bearings

Control panel frame pivot points

All oilite bearings
Feed roll bearings

Feed roll pressure shoes

Feed roll bearing pivots in brush assembly side plates

Remove screw in 1st lower CR (hollow) feed roll and lubricate eject clutch drive shaft

IBM 17

All feed roll drive gears and idlers

Variable speed cam

Drive pulley bearing

Feed knife cam follower guide and roller

CB cam rollers

Selector unit cams

Selector unit restoring bail spring stud

Clutch knockoff cam follower rollers

Restoring magnet knockoff cam followers

Sentinel switch points

Differential link studs

Thin film on: all linen dilecto cams and gears; all primary and secondary commutators; linen dilecto card levers at the point where they operate against the contact strap

Clutch magnet armature at latching point

IBM 21

Thrust bearings on ends of primary and secondary feed shafts

Repacking matched bearings on feed rolls

PURPOSES OF RELAY POINTS (Print Number 295577)

R1AL N/C, with R15BU and R13BL N/O, established a test circuit for the continuation of operation for another cycle if cards are in the primary hopper. R1AL N/O; with R3BU and R13BL N/C, shunt out the primary card lever controls when the secondary feed is being used alone.

R1AU, with R12BU, permits the energization of R17 for three cycles through R51BU when using the primary feed. After the three run-in cycles this circuit is disabled.

R1BL, with R3BL, prevents energization of R21 when there are no cards in either feed hopper, if the run-out key is depressed.

R1BU, with R3AL N/O and R9A N/C, shunts out the secondary card lever controls when the primary feed is being used alone.

R2AL, when N/C, permits a circuit to the primary feed clutch magnet and relay HS3 when cards are in the primary hopper. It should be noted that there are four card lever control contacts, one of which must be closed in order to energize the primary feed clutch magnet. It should be noted also that there are four card positions in the primary feed, so that it is necessary to have a card in one of these positions in order to operate the primary feed.

R2AU, with R7B N/C and R6B N/C, permits the hot 9 circuits to be completed only during run-out cycles, and prevents the hot 9 circuit during run-in cycles.

R2B, when closed, permits the automatic run-in circuits to be completed to the primary feed clutch and the secondary feed clutch. It prevents the completion of these circuits in the event the secondary feed is being used alone.

R3AL N/C operates in conjunction with R9A N/O as a test circuit for continuation of operation for another cycle, if cards are in the secondary hopper. R3AL N/O, with R1BU and R9A N/C shunt out the secondary card lever controls when the primary feed is being used alone.

R3AU, with R8B, permits energization of R17 for two cycles by means of the start key when using the secondary feed.

R3BL, with R1BL, prevents energization of R21 if the run-out key is depressed when there are no cards in either hopper.

R3BU, with R1AL N/O and R13B N/C, shunts out primary card lever controls when the secondary feed is being used alone.

R4A, when closed, permits a circuit to the secondary feed clutch magnet when cards are inserted in the secondary hopper. It operates in conjunction with the other two card-station contacts so that the secondary feed can operate only if cards are in one of the three positions in that feed.

R4B allows the hot 9 circuit to be completed to the secondary brushes only during run-out cycles. It prevents the hot 9 circuit from being completed during run-in cycles with cards in the secondary hopper.

R5A permits the circuit breaker impulses to feed the secondary contact roll only when cards are passing the secondary brush station.

R5B picks R8 and R9 when secondary CB2 makes.

R6A picks R12 and R13 when primary CB2 makes.

R6B N/O permits the circuit breaker impulses to feed the primary contact roll only when cards are passing the primary brush station. R6B N/C, with R2AU, permits the hot 9 circuit to be completed after the last card leaves the primary brushes, and when open, prevents impulses from the circuit breakers being sent to the primary sequence brushes when last card passes primary brushes.

R7A picks R14 and R15 when primary CB2 makes.

R7B N/O, permits the circuit breaker impulses to be delivered to the primary sequence brushes only when cards pass the primary sequence brush station. R7B N/C, with R2AU, permits the hot 9 circuit to be completed to the primary sequence brushes after the last card leaves that station, and when open prevents circuit breaker impulses from being sent to the primary brushes when the first card passes the primary sequence brushes.

R8AL, in conjunction with CR8, picks feed interlock R20, after the last card has left the secondary feed. When open, while cards are feeding, it prevents energization of this feed interlock relay.

R8AU holds R8 and R9.

R8B, with R3AU, permits energization of R17 for only two cycles, through operation of the start key, when using the secondary feed alone.

R9A N/C, with R1BU and R3AL N/O, permits the CR7 test circuit to be completed to R17 when the primary feed is being used alone. R9A N/O, with R3AL N/C, establishes a test circuit for continuation of operation for another cycle, if cards are in the secondary brush station.

R9B N/C establishes the circuit to the secondary feed magnets for the first two cycles when cards are in the secondary feed hopper at the beginning of a run, regardless of control panel wiring or basic set-up switch arrangement. This insures feeding the first card past the secondary brushes. R9B N/O establishes a circuit to the secondary feed clutch magnet at any time that a card is in a position just past the secondary brushes.

R10AL holds R10.

R10B and R11B are transfer points which make or break a circuit between the common, X and NO-X hubs of the secondary and primary X selectors respectively.

R11AL holds R11.

R12AL permits a circuit through the basic set-up switch *E* and the primary eject hubs to be completed to the eject feed clutch magnet only if a card is at the eject station.

R12AU N/C permits a circuit to the primary feed clutch for three cycles when first starting a run of cards. At the end of the third cycle this contact opens; thereafter, the energization of the primary feed clutch magnet is under the control of the basic set-up switch *P* or auxiliary wiring to the primary feed hubs. R12AU N/O completes a circuit to the primary feed magnet at any time when a card is in the eject station.

R12BL, with R14AL, picks feed interlock relay 20 after the last card leaves the primary feed.

R12BU, with R1AU, permits energization of R17 for only three cycles through operation of the start key when using the primary feed.

R13AL holds R12 and R13.

R13AU, with R14BU, provides a circuit for running cards out of the secondary feed during operations in which the secondary operates from conditions established between the primary and primary sequence brushes. An example of this type of operation would be feeding a blank card ahead of each primary group, in which case the secondary feed is operated by a high second primary reading in the sequence unit. After the last card leaves the primary feed, it is impossible to secure a high second primary reading; thereafter, R13AU and R14BU are used to feed the secondary clutch.

R13B N/C, with R3BU and R1AL N/O, completes the CR7 test circuit when there are no cards in the primary feed. R13B N/O, with R15BU and R1AL N/C establish the CR7 test circuit when cards are feeding in the primary feed.

R14AL, with R12BL, prevents energization of the feed interlock relay during the third cycle of the primary feed. It permits CR8 to complete a circuit to R20 after the cards have left the last station of the primary feed.

R14AU permits a circuit to the primary feed clutch magnet when a card has just passed the primary sequence brushes, thus it will provide a circuit to the primary clutch in case a single card is being passed through the primary feed.

R14BL opens during the second cycle of the primary feed and prevents energization of unit clearing relays 18 and 19, on the third cycle. This is necessary because the secondary feed is not operating on the third cycle of the primary, and the secondary restoring magnet should not be energized.

R14BU is discussed with R13AU.

R15A N/C permits an equal reading in the selector unit to operate the secondary feed clutch magnet after the last card passes the primary sequence brushes. This is necessary in the event that the last card in the primary feed is punched 9's, which condition would eliminate the high second primary condition and cause an equal second primary reading to open R26B points as the last card passes the primary brushes. The N/O points permit an equal condition in the sequence unit and an equal condition in the selector unit to operate the primary feed clutch normally.

R15BL holds R14 and R15.

R15BU operates with R1AL N/C and R13B N/O to establish the CR7 test circuit when cards are present in the primary feed.

R16AL holds cycle delay relay 16 (P) coil through R49B during the time that CR5 is open.

R16AU holds cycle delay relay 16 (H2) coil until past the pickup time of R49 to prevent R49B from arcing.

R16BL operates to transfer the circuit from the C and N hub to the C and X hub when the cycle delay relay is energized.

R16BU holds R16 pick coil during the time when R33 has dropped out and R49B may still be open from a drop-out impulse received during the previous cycle.

R17AL holds R17 and R50 during the time CR7 is made.

R17AU holds R17 and R50 during the time CR6 is made. These two cam timings overlap to provide a continuously running circuit.

R17B controls all circuits to the feed clutch magnets, unit restoring magnets, and plug to C hubs, allowing them to be completed only when start relay 17 is energized.

R18A prevents the pick of restoring interlock R21 until the third cycle of the machine, as this contact does not make until after CR1 makes and breaks for the second cycle even though the hopper contact may close.

R18B holds R18 and R19 in parallel with R17 during the first two machine cycles.

R19AL, AU, and *B* insure the clearing of the comparing units at the beginning of a run, as they are made for the first two cycles. This is required in applications where a selected impulse is used to restore any unit. For example, if a standard collating job follows a multiple column selection job with a finder card, a reading will remain in the unit from the previous finder card operation. This reading must be removed before the next operation.

R20A and R20B, when R20 is energized, connect the three readings from the selector unit together so that any one of the three readings will energize the low primary R22 and the low secondary R24; thus all cards will be selected after the last card leaves either feed. This is necessary to effect the selection of any cards punched 9's because the false 9 entered into one half of the unit would compare as an equal with a 9 punched in a card if R20 points were not in the circuit. Selection of any card other than a 9 card could be effected by a low reading, caused when the hot 9 circuit functions in the opposite feed.

R21A holds R21 once it has been energized, until the runout key is depressed.

R21B renders the start key ineffective after the run-in cycles. If, during a run, a jam occurs at one of the reading stations and opens a card lever, it is necessary to depress the run-out key.

R22A causes the eject clutch to operate on a low primary condition in the selector unit when the basic set-up switches are ON.

R22B causes the primary feed magnet and associated circuits to be energized on a low primary reading in the selector unit when the basic set-up switches are ON.

R23A causes the eject clutch magnet to be energized on an equal condition in the selector unit when the basic set-up switches are ON. It should be noted that this point also operates the primary clutch on an equal condition when the M. S. & S. switch is OFF.

R23B, with R15A N/O and R26A, operates the primary feed magnet on an equal condition in both comparing units. R23B also operates with R26B and R25A or R27A, to energize the secondary feed clutch magnet with an equal condition in the selector unit and a high or low condition in the sequence unit, when basic set-up switches are ON.

R24A causes the secondary feed clutch magnet to be energized on a low secondary reading in the selector unit, when basic set-up switches are ON.

R25A is discussed under R23B.

R26A is discussed under R23B.

R26B prevents operation of the secondary feed magnet when merging with the use of the selector unit only, on an equal condition in the selector unit and a high second primary reading in the sequence unit, when the primary change switch is OFF. The sequence unit may be used for checking sequence on another field and its reading should not affect the feed clutch circuits on such an operation.

R27A is discussed under R23B.

R28B through R32B are transfer contacts for the selectors to make or break the circuits between the C hub and the X and NX hubs.

R33A holds R33 to permit the cycle delay circuits to be established through R16.

R33B picks and holds cycle delay R16P until another hold circuit can be established for R16.

R34AL prevents the re-energization of error pick relays HS4 and 35 on the same cycle after the error reset key has been depressed.

R34AU holds error reset relay 34 for long enough to permit a feed operation after the reset key has been depressed.

R34B drops out error hold relay 35 when the error reset key is depressed.

R35A holds R35 and error lamp until the reset key is depressed.

R35B opens the CR7 test circuit to the start relay to stop the machine when an error is sensed.

R48AL holds R48 to keep the drive motor operating so that machines will latch their clutches under power. This is required because of the idling control circuits.

R48AU provides a hold for R48 during the time CR7 is open so that R48 will hold past the latching point of the clutches.

R48BL provides a circuit for the heavy duty relay which permits the drive motor to operate.

R48BU operates in parallel with R55A to keep the 115-volt circuits operating until 350° of the cycle on which R50, 17, and 55 drop. This insures correct reading of any 2 or 1 holes punched in card passing the brushes at that time.

R49A holds delay drop-out relay 49 through CR4 until CR5 opens to drop out cycle delay R16.

R49B opens the hold circuit for cycle delay relay 16.

R50AL points open to prevent recurrent impulses from CR2 from picking the error light after the error reset key has been depressed.

R50AU provides a hold for the heavy duty relay which controls the drive motor only so long as the machine is in actual operation.

R50BL opens the circuit to the running indicator lamp when the machine is not in operation.

R50BU provides a pick circuit for idling control relay 48 when the machine is put into operation.

R51A permits picking R50 and R17 to restart the machine after the stop key has been depressed or an error has occurred.

R51BL provides a hold for R51 for so long as the start key remains depressed, because R53B remains closed only for the duration of CR2.

R51BU provides a circuit to R17, R18 and R19 when the start key is depressed if R21B points are closed.

R52A opens to drop R21 when the run-out key is depressed so the start key will be effective on the next run-in operation.

R52BL provides a hold for R52 for so long as the run-out key remains depressed, because R53B remains closed only for the duration of CR2.

R52BU picks R50 and R17 to cause the machine to operate when the run-out key is depressed.

R53B provides a circuit to the start and run-out keys when the CR cams are turning.

R54A picks R54 when the bimetal strap bends sufficiently to cause it to close.

R54BL N O holds time delay relay 54 after it has been picked.

R54BL N C opens the circuit to the resistance coil wound around the bimetal strap when R54 picks.

R54BU prevents putting the machine into operation until after the vacuum tubes have had sufficient time to warm up.

R55A opens when R17 is not energized. This opens the 115-volt circuits to the control panel when the main line switch is ON, but the machine is not operating.

HS1 establishes a hold circuit for the secondary *X* selector relays HS1 and R10. A high-speed relay is required to assure operation of the *X* selector from an *X* impulse.

HS2 establishes a hold circuit for the primary *X* selector relays HS2 and R11 for the same reason given under HS1.

HS3 causes the eject clutch magnet to be energized on each cycle that the primary clutch magnet is energized.

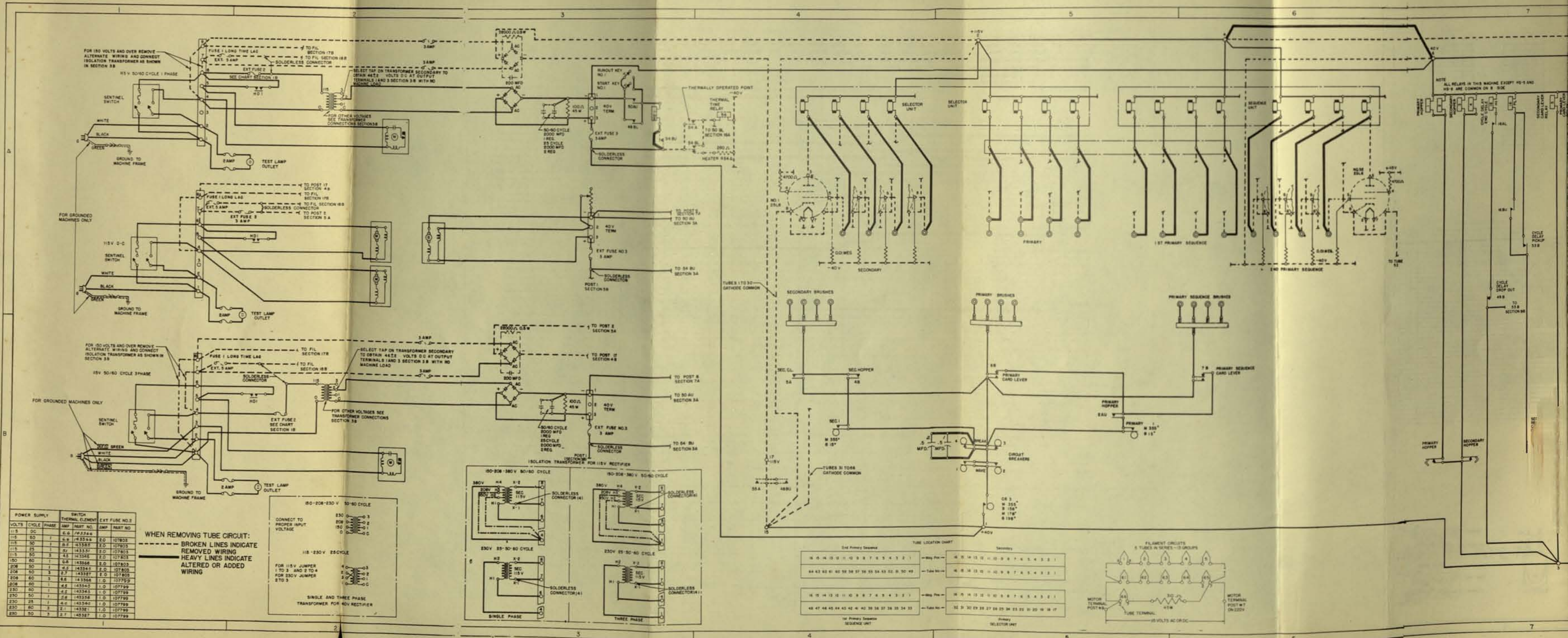
HS4 opens the feed clutch circuits when an error occurs so the machine will stop on the cycle in which the error was sensed.

HS5 picks HS1 and R10.

HS6 serves the same function for the primary *X* selector as HS5 does for the secondary *X* selector.

The primary, primary sequence, and secondary card levers pick relays which provide circuits to the respective contact rolls and a continuously running circuit.

The primary and secondary machine card lever contacts cause their respective feed clutch magnets to operate for the cycle in which a card is read at the primary sequence brushes and the secondary brushes, respectively, in the event that a single card is inserted in either feed.

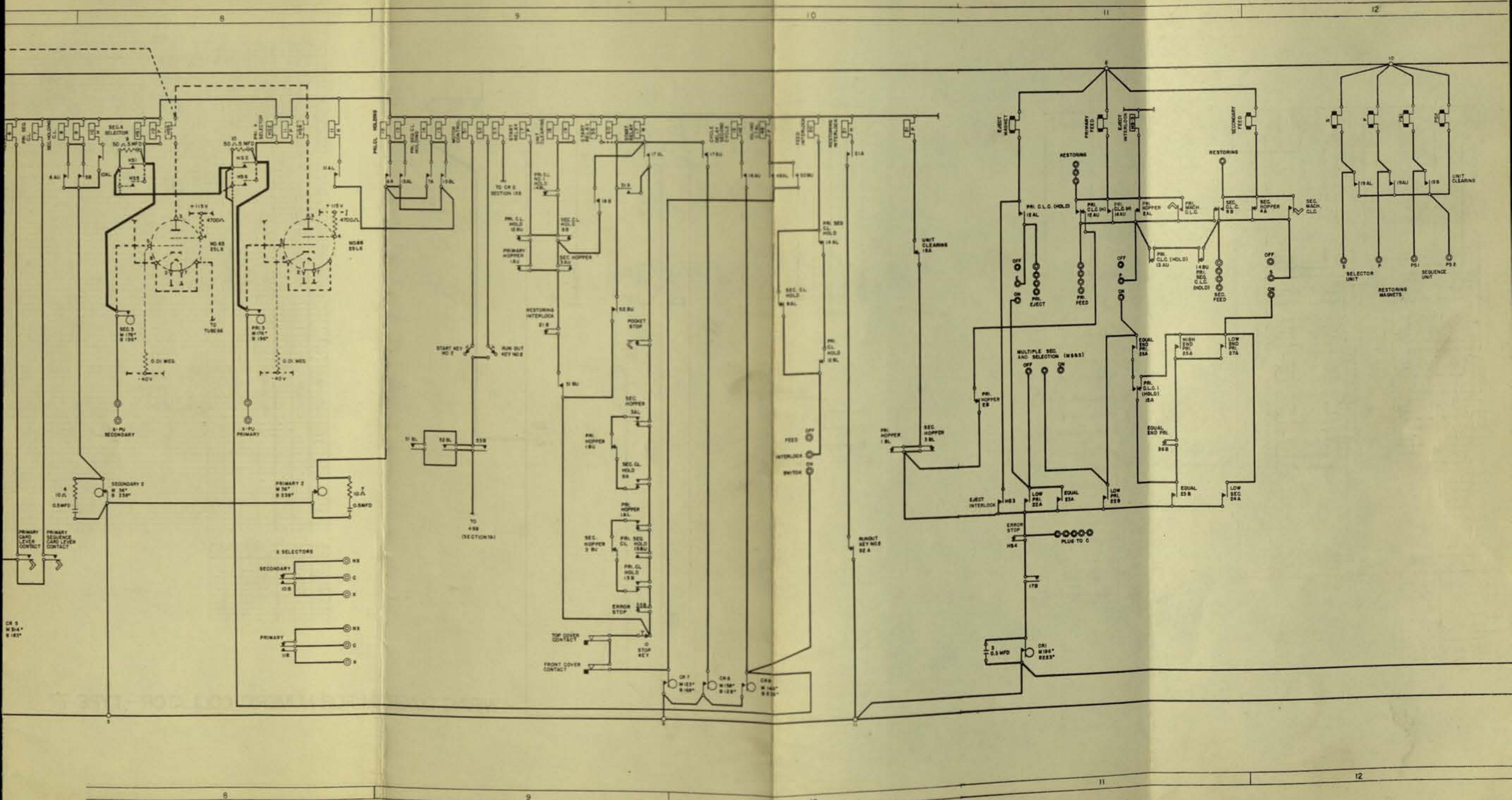


POWER SUPPLY			SWITCH THERMAL ELEMENT		EXT FUSE NO.2	
VOLTS	CYCLE	PHASE	AMP	PART NO.	AMP	PART NO
115	DC		6.6	143366		
115	60	1	6.6	143366	2.0	107803
115	50	1	8.5	143385	2.0	107803
115	25	1	5.1	143351	2.0	107803
115	50	3	4.5	143345	2.0	107803
150	60	1	6.8	143368	2.0	107803
208	50	1	4.5	143345	2.0	107803
208	50	3	2.7	143327	2.0	107803
208	60	3	6.6	143366	1.0	107799
208	60	1	4.5	143345	1.0	107799
230	60	1	4.5	143345	1.0	107799
230	50	1	5.6	143356	1.0	107799
230	25	1	4.0	143340	1.0	107799
230	60	3	2.1	143321	1.0	107799
230	50	3	2.7	143327	1.0	107799

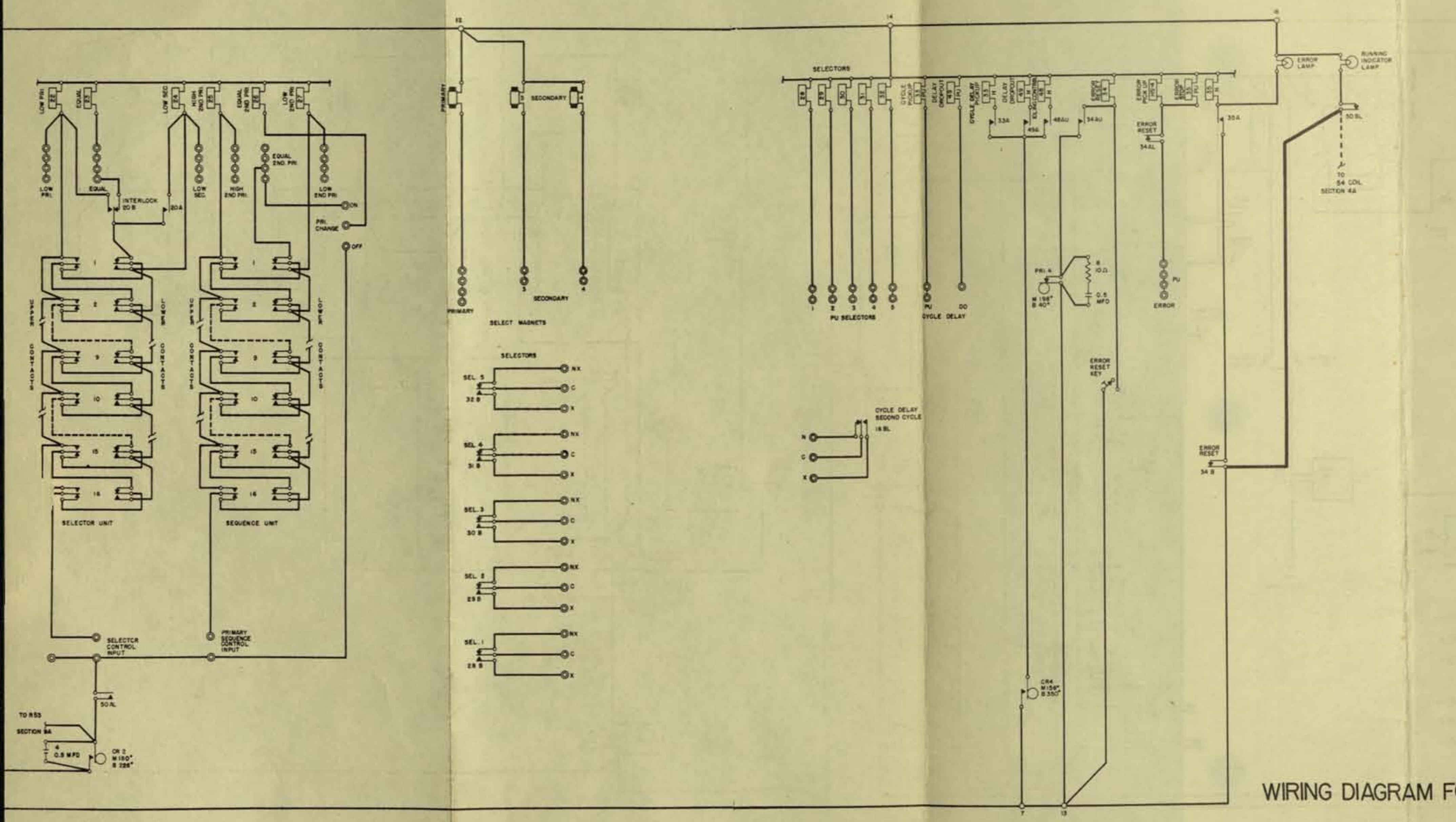
WHEN REMOVING TUBE CIRCUIT:

- - - - - BROKEN LINES INDICATE REMOVED WIRING

——— HEAVY LINES INDICATE ALTERED OR ADDED WIRING


8
9
10
11
12
RESTORING
SELECTOR UNIT
SEQUENCE UNIT
RESTORING MAGNETS
UNIT CLEARING
MULTIPLE SEC. AND SELECTION (MSSS)
PLUG TO C
X SELECTORS
SECONDARY
PRIMARY
START KEY NO 2
RUN OUT KEY NO 2
TOP COVER CONTACT
FRONT COVER CONTACT
ERROR STOP
STOP KEY
FEED
INTERLOCK
SWITCH
OFF
ON

295577



DUO RELAYS

RELAY NO	COIL PU	COIL H	CONTACT POINTS AL	AU	BL	BU	NAME	ABBREVIATION
1	7A		9B	9A	10B	9B	PRIMARY HOPPER	PRI. HOPPER
2	7A		11A	5B	11A		PRIMARY HOPPER	PRI. HOPPER
3	7A		9B	9A	10B	9B	SECONDARY HOPPER	SEC. HOPPER
4	7A		12A		4B		SECONDARY HOPPER	SEC. HOPPER
5	7A		4B		8A		SECONDARY CARD LEVER RELAY	SEC. C. L.
6	7A		9A		5B		PRIMARY CARD LEVER RELAY	PRI. C.L.
7	7A		9A		6B		PRIMARY SEQUENCE CARD LEVER RELAY	PRI. SEQ.C.L.
8	7A		10A	7A	9A		SECONDARY CARD LEVER RELAY HOLD	SEC. C.L. HOLD
9	7A		5B		11A		SECONDARY CARD LEVER RELAY HOLD	SEC. C.L. HOLD
10	8A	8A	8A		8B		SECONDARY X SELECTOR	SEC. X SELECTOR
11	8A	8A	8A		8B		PRIMARY X SELECTOR	SEC. X SELECTOR
12	9A		11A	11A	10A	9A	PRIMARY CARD LEVER RELAY HOLD	PRI. C.L. HOLD
13	9A		9A	11B	9B		PRIMARY CARD LEVER RELAY HOLD	PRI. C.L. HOLD
14	9A		10A	11A	9A	11A	PRIMARY SEQUENCE CARD LEVER RELAY HOLD	PRI. SEQ.C.L. HOLD
15	9A		11A		9A	9B	PRIMARY SEQUENCE CARD LEVER RELAY HOLD	PRI. SEQ.C.L. HOLD
16	7A	7A 10A	7A	10A	15B	7A	CYCLE DELAY SECOND CYCLE	
17	9A 9A		10A	10A	11B		START RELAY	
18	9A		10A		9A		UNIT CLEARING	
19	9A		12A	12A	12A		UNIT CLEARING	
20	10A		13A		13A		FEED INTERLOCK	
21	10A	10A	10A		9A		RESTORING INTERLOCK	
22	13A		11B		11B		LOW PRIMARY	LOW PRI.
23	13A		11B		11B		EQUAL	
24	13A		11B				LOW SECONDARY	LOW SEC.
25	13A		11A				HIGH SECOND PRIMARY	HIGH 2ND PRI.
26	13A		11A		11B		EQUAL SECOND PRIMARY	EQUAL 2ND PRI.
27	13A		11A				LOW SECOND PRIMARY	LOW 2ND PRI.
28	15A				14B		SELECTOR 1	SEL. 1
29	15A				14B		SELECTOR 2	SEL. 2
30	15A				14B		SELECTOR 3	SEL. 3
31	15A				14B		SELECTOR 4	SEL. 4
32	15A				14A		SELECTOR 5	SEL. 5
33	15A	15A	15A		7A		CYCLE DELAY PICKUP	
34	16A		16A	15A	16B		ERROR RESET	
35	16A	16A	16A		9B		ERROR HOLD	
48	10A	15A	10A	15A	3A	4B	IDLING CONTROL	IDLING CTRL
49	15A	15A	15A		7A		CYCLE DELAY DROPOUT	
50	9A		13B	3A	16A	10A	START RELAY	
51	9A		9A		9B	9A	MOTOR CONTROL RELAY	
52	9A		10B		9B	9A	MOTOR CONTROL RELAY	
53	9A				9B		MOTOR CONTROL RELAY	
54	4A		4A		4A	4A	THERMAL TIME RELEY	
55	9A		4B				START RELAY	

H.S. RELAYS

RELAY NO.	COIL PU	COIL H	CONTACT POINTS AL	AU	BL	BU
1	8A		8A			
2	8A		8A			
3	11A		11B			
4	16A		11B			
5	8A		8A			
6	8A		8A			

POSTS

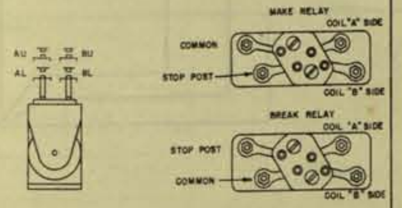
NO	LOCATION
1	5B
2	5A
3	7B
4	6A
5	5B
6	7A
7	15B
8	11A
9	10B
10	12A
11	10B
12	14A
13	15B
14	15A
15	4B
16	16A
17	4B

CAPACITORS

NO	LOCATION
1	5B
2	5B
3	11B
4	13B
6	6B
7	8B
8	15A
9	8A
10	8A

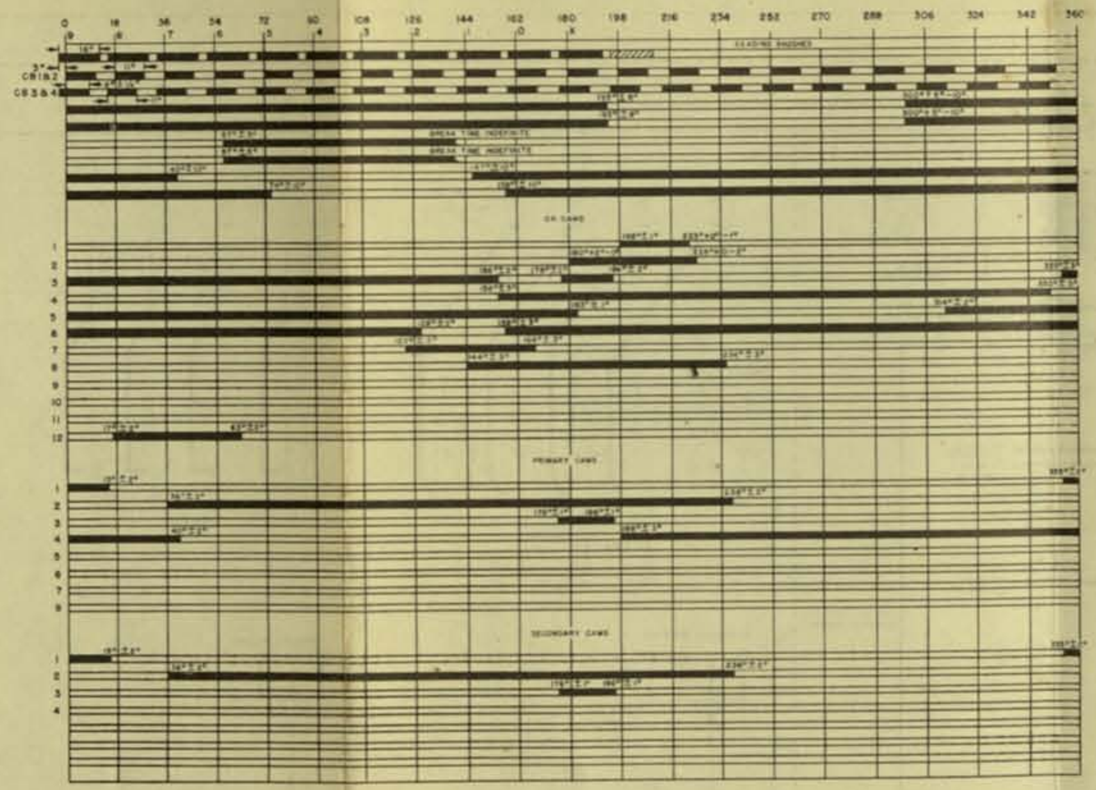
MISCELLANEOUS ITEMS

NAME	ABBREVIATION	LOC
PRIMARY HOPPER	PRI. HOPPER	7B
SECONDARY HOPPER	SEC. HOPPER	7B
SECONDARY READING CARD LEVER CONTACT	SEC. READING C.L.C.	7B
PRIMARY CARD LEVER CONTACT	PRI. C.L.C.	7B
PRIMARY SEQUENCE CARD LEVER CONTACT	PRI. SEQ. C.L.C.	7B
POCKET STOP		9A
TOP COVER CONTACT		9B
FRONT COVER CONTACT		9B
PRIMARY MACHINE CARD LEVER CONTACT	PRI. MACH. C.L.C.	11A
SECONDARY MACHINE CARD LEVER CONTACT	SEC. MACH. C.L.C.	12A
SELECTOR UNIT CONTACTS		13B
SEQUENCE UNIT CONTACTS		13B
RUNOUT KEY 1		3A
START KEY 1		3A
STOP KEY		9B
START KEY 2		9A
RUNOUT KEY 2		9A
ERROR RESET KEY		16A
SELECTOR UNIT MAGNETS		4&5A
SEQUENCE UNIT MAGNET		5&6A
EJECT MAGNET		11A
PRIMARY FEED MAGNET		11A
SECONDARY FEED MAGNET		12A
RESTORING MAGNETS		12A
PRIMARY SELECT MAGNETS		14A
SECONDARY SELECT MAGNET		14A



WIRING DIAGRAM FOR NUMERIC COLLATOR—TYPE 77

ELECTRICAL TIMING

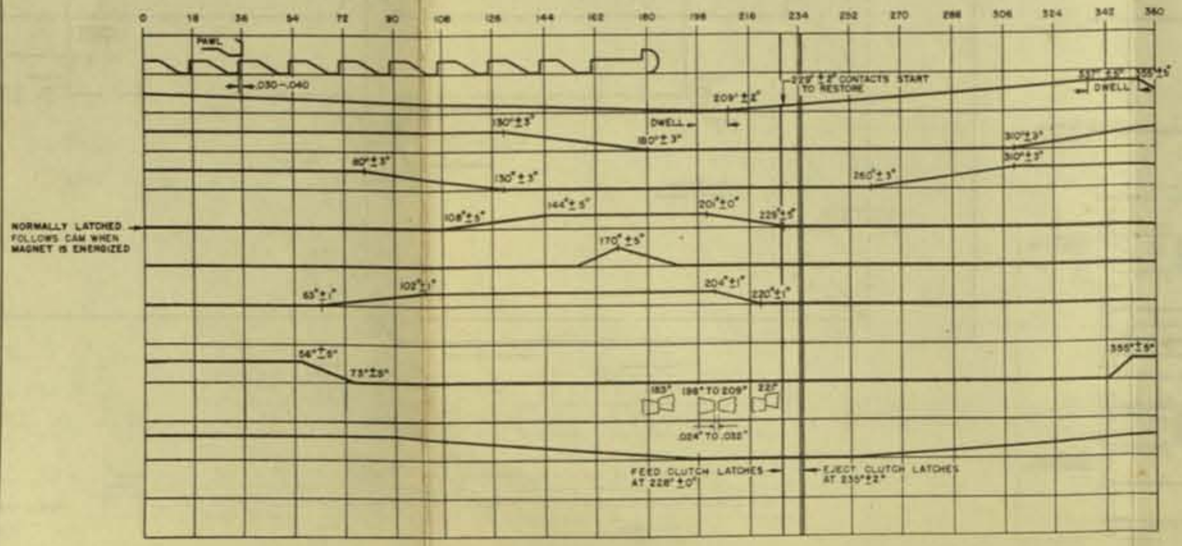


NO	LOC	NAME
1 & 2	5B	10 LOBE CIRCUIT BREAKER
3 & 4	5B	10 LOBE CIRCUIT BREAKER

PRIMARY CARD LEVER CONTACT 1 & 2
SECONDARY CARD LEVER CONTACT
PRIMARY HOPPER CONTACT
SECONDARY HOPPER CONTACT
ALPHA ZONE ONLY - PRI. AND SEC. MACHINE C-L-C
NUMERICAL ONLY - PRI. AND SEC. MACHINE C-L-C

NO	LOC	NAME
1	11B	FUNCTION CONTROL IMPULSE
2	13B	UNIT CONTROL IMPULSE
3	5B	BRUSH READING CONTROL
4	15B	PCD SECOND CYCLE PICKUP
5	7B	CARD LEVER CONTROL
6	10B	RUN CONTROL HOLD
7	10B	RUN CONTROL TEST
8	10B	FEED INTERLOCK
12	NS	ZONE READ CONTROL
1	5B	9 RUNOUT IMPULSE
2	8B	CARD LEVER AND "X" HOLD
3	8A	"X" PICKUP
4	15A	PRIMARY CYCLE DELAY AND ERROR
1	4B	9 RUNOUT IMPULSE
2	6B	CARD LEVER AND "X" HOLD
3	8A	"X" PICKUP

MECHANICAL TIMING



SET UP RATCHET AND PAWL

RESTORING BAIL

RESTORING MAGNET ARMATURE KNOCK-OFF

RESTORING PAWL RESET CAM

PRIMARY AND SECONDARY SELECT CAMS

SELECT MAGNET ARMATURE KNOCK-OFF

FEED CLUTCH LATCH LEVER

EJECT CLUTCH ARMATURE LATCH CAM

RESTORING BAIL LATCH PAWL

CARD FEED CAM

IBM CUSTOMER ENGINEERING **REFERENCE MANUAL**

PREVENTIVE MAINTENANCE
Collator Type 077

CONTENTS

INTERNATIONAL BUSINESS MACHINES CORPORATION
New York, New York
Printed in U.S.A.
Form 22-5743-1

PREVENTIVE MAINTENANCE
Collator, Type 077
FEEDS

I. Cleaning

Proper cleaning is one of the most important parts of preventive maintenance on the 077. Many of the troubles on this machine stem from crooked feeding of the cards. Dirt on the feed rolls or in the teeth of the feed roll gears will cause bouncing of the rolls and aggravate any poor feeding condition. Therefore, special care should be taken to clean *all* dirt and old grease from these points, not forgetting the feed roll gears located in the removable brush assembly units. Both brush assembly units and the dust covers over the primary feed rolls should be removed before cleaning the feeds. The following list gives a number of points that should be checked for cleaning:

1. **Contact Rolls.** These should be cleaned even if there is no evidence of burning. Use an ink eraser to clean.
2. **Upper Feed Rolls and Brackets.**
3. **Selector Magnets.** A tab card dipped in cleaning fluid may be used to clean dust and grease from between the armature and core.
4. **Feed Hoppers and Under Feed Knives.**
5. **Main Drive Shafts and Gears.** Pay particular attention to dirt in the teeth of feed roll drive gears.
6. **Feed Rolls.**
7. **Feed Clutches.**
8. **Brush Separator Rolls.** Pay particular attention to dirt between separators. Revolve the rolls and watch for brush movement. Any dirt between the separators will result in brush movement.

II. Inspection

1. **Brush Assemblies.** (see *General Section*) Check the following:
   (a) END SHAKE. All possible end shake should be removed from the contact and brush separator rolls by shifting the end bearings.
   (b) BRUSH SEPARATORS
   (c) BRUSHES
   (d) ALIGNMENT TO SCRIBED LINE. Use brush gauge #450388 and the line furthest from the bend in the gauge.
   (e) BRUSHES EVENLY SPACED BETWEEN SEPARATORS. Revolve the separator roll while checking to make sure brush does not touch at any point. Use brush bending tool to align any brushes necessary. It will be easier to reach some of the brushes if the card guide over them is removed. Replace any rolls with broken segments or on which the steel collars are badly worn. On the latest Type 077 machines, new brush holder locating blocks have been released. These new blocks are approximately ten thousandths thinner than the part which they replace and are threaded for the brush block aligning screw, Part #197475. It is, therefore, possible to align the majority of the brushes readily to the center of the grooves in the brush separator rolls. However, it will still be necessary to use the three group brush bending tool to align such brushes as cannot be centered in the separator roll by the lateral adjustment of the brush block.

   The brush separator rolls should be positioned before attempting to align the brushes so that the distance from the inside of the front side frame to the front edge of the first groove in the separator roll is 5/8". If this adjustment is obtained prior to attempting to align the brushes to the separator roll, it will make it easier to obtain correct brush alignment, particularly in the primary feed and also in the secondary feed on machines equipped with additional brushes for alphabetical collating.
   (f) BRUSH TRACKING
   (g) BRUSH TIMING. If no dynamic timer is available, feed cards to brush station under power and then through brushes by hand timing

on a "5" hole. It is advisable to check also at least one column in all positions, "9" through "1" to check wear on variable speed cam.

2. Feed Drive Shafts. Check the following:
   (a) END PLAY in either shaft will further aggravate poor feeding conditions. End play may be removed at end bearings.
   (b) WORN GEAR COLLARS for wear, loose pins, etc.
   (c) LOCK NUTS ON FEED ROLL WORM GEARS. If these are loose, variation in feeding will result. The spiral gears that drive the contact rolls on Type 077 Collators are accurately meshed with the worm drive to insure constant speed of the roll. Variations in manufacturing tolerances, if not compensated for when meshing the gears, will result in variation in contact roll circumference speed. This in turn will cause erratic brush timing and occasional failures.

   To insure that the correct relationship between the gear members does exist when replacing a contact roll, the spiral gear should be tied with twine or a rubber band in its original position before removing the contact roll. Where it is required that replacement gears be installed, it may be necessary to try the new gear in several positions of mesh, checking brush timing dynamically at 9, 7, 5, etc., until the most satisfactory overall condition is obtained. It is necessary to check at least 11 consecutive cards to know that the gear mesh is correct.
   (d) WORM GEAR DRIVING EJECT ROLL for wear and loose set screws; their being loose will affect the primary select magnet timing.
   (e) CLUTCH ADJUSTMENTS. Primary, Secondary and Eject.
   (f) PRIMARY AND SECONDARY CAM CONTACTS. (see *General Section* under *CB Contacts*)

3. Feed Units. (see *General Section—Horizontal Feeds*)
   (a) FEED KNIFE ADJUSTMENTS
   (b) FEED KNIFE SLIDE GUIDES. This is especially important on the 077 since the feed knives are returned by spring action only.
   (c) EVEN FEEDING OF CARDS
   (d) HOPPER SIDE PLATES are adjusted to position brushes to the center of holes. In the primary unit the sequence brushes should be used for this. Run the test card under power through only the sequence brushes and remove it by dropping the brush assembly, then the alignment of the remaining set of brushes may be checked by running a chalked card through the machine and comparing the difference in the width of the brush marks.
   (e) ROLLER THROAT
   (f) FEED ROLL TENSION
   (g) TIMING OF FEED KNIVES. Obtain proper timing by rotating the feed knife cam on the primary shaft. Care must be taken not to move this cam laterally on the shaft as it may cause binds in the feed knife cam follower guide.
   (h) HOPPER POSTS

4. Selection Magnets for timing and adjustment.
5. Chute Blades
6. Card Lever Contacts. (see *General Section*)
7. Make a final check for even feeding by running a card under power to, but not through, the eject station. With the power off, trip the eject clutch and turn the machine by hand. If the card has fed evenly through the primary station, it will be gripped by the eject roll and pulled evenly ahead without twisting.

III. Lubrication

IBM 6

(1) Feed knife slides.
(2) Select magnet armature pivots.
(3) Contact roll oil wells. The shafts on each end of the high speed contact rolls are hollow and act as oil wells to lubricate the idler section. Oil should be pumped into the wells in the center of these shafts at both front and rear ends.

(4) Feed clutch latch lever pivots.
(5) Clutch knockoff lever pivots.
(6) Feed clutch armature pivot points.

IBM 9

(1) Upper and lower feed roll bearings. In all cases (even on machines equipped with Bijur System) the feed roll and brush separator roll bearings in the brush assembly units must be oiled by hand.
(2) Feed roll pressure shoes.
(3) Eject clutch drive shaft. The first lower continuously running feed roll is hollow. Inside of it, and turning at a different speed, is the eject clutch drive shaft. Remove a screw located on the hollow feed roll about an inch in from the front casting. Through this screw hole, lubricate the eject clutch drive shaft.
(4) Feed drive shaft oil cups, one on secondary and two on primary shafts.

IBM 17

(1) All main drive shaft feed roll gears.
(2) Feed knife cam follower guide and roller.
(3) Primary and secondary cam contact rollers.
(4) Eject clutch knockoff arm.
(5) Primary and secondary clutch knockoff cam follower roller.
(6) Thin film on linen dilecto cams.
(7) Feed clutch magnet armatures at latch point.

IBM 21

(1) Thrust bearings on end of feed drive shafts.

CONTINUOUS RUNNING UNITS

I. Cleaning

(1) STACKER POCKETS. Clean all dirt from feed roll surfaces and dust out of pockets. Clean stacker tube with cloth dipped in cleaning fluid, but do not oil.
(2) VARIABLE SPEED CAM. All dirt and old grease from around cam and from linen dilecto gears.

II. Inspection

(1) STACKER POCKETS for free operation and worn auxiliary stacker springs.
(2) CONTINUOUS RUNNING SHAFT for loose pins in drive gears pinned on it.
(3) VARIABLE SPEED CAM AND CAM FOLLOWER for wear. This can be partially checked by punching one card column for all holes "9" through "1". Any variation of timing will indicate wear at this point. Another method is to turn the machine to a point on the index of about 226° to 228°. At this point hold the reverse lock free with a screw driver and rock back and forth on the large linen dilecto gear back of the index. If the cam roller is not worn, the CR Drive Shaft will rock with the gear without any appreciable lag or slop.
(4) CR CAMS (see *General Section—CB Units*). Duration time of CB1-2-3-4 on the 077 should be 8° on the tube type, and 6° on the non-tube type.

III. Lubrication

IBM 6

(1) CR cam contact lever pivot point.

IBM 9

(1) CR drive shaft oil cups. One located behind sequence unit and the other beside the secondary one tooth ratchet gear.
(2) CR feed roll bearings (front and rear). Remove front cover to get at front feed roll bearings.
(3) Reverse friction lock.
(4) CR cam contact shaft bearings.

IBM 17

(1) CR feed roll drive gears.
(2) Linen dilecto cams: light film only.
(3) CR cam follower rollers.

IBM 21

(1) Variable speed cam.
(2) Drive pulley bearings.

SELECTOR AND SEQUENCE UNITS

MOST OF THE cable wires going to the bottom connections of these units terminate on the upper and middle rows of the bakelite binder post panel located directly under the units. Disconnecting the cable at panel instead of on the bottom of the units will greatly facilitate removal of the wires so that it will only be necessary to remove 3 wires that go directly to the unit instead of all 19.

The 3 wires that do not terminate on the binder post panel are the heavy common lead to the setup magnets (a red wire in most machines), and the 2 wires going to the restoring magnet, (1 red and 1 black wire). Care should be taken in noting the color coding of the restoring magnet wires before removal in order that they be replaced the same way to insure proper polarity to the magnets.

I. Cleaning

The contact unit should be removed and all dirt and old grease should be cleaned from the cams, cam followers and the setup ratchet pivot shaft.

II. Inspection

1. **Magnet Armatures** for wear.
2. **Setup Bail Adjusting Screws** for wear.
3. **Setup Bail Cam Follower** for wear.
4. **Setup Bail Springs Have Their Heaviest Load** at a point where they are stretched the least. As they age, the unit sometimes fails to clear and sets up 9's. This will usually show up if setup pawls are tripped and one side of unit is restored slowly by hand. If, at the time cams are at the low point, it is possible to push setup bail back, the springs are not strong enough and should be replaced or shortened.
5. **Differential Links** for wear. This may be easily checked as follows: With zeros in the unit, lay a scale or other straight edge across the lower operating surface of the linen dilecto cams. Holding the scale thus, rock each cam. Any excess movement of a cam indicates a worn differential link stud.
6. **Setup Pawl Pivot Rod** for wear. This should be carefully checked for any vibration in the ratchet guide plate assembly. If the rod is slightly loose in its mounting, the setup pawls will vibrate sufficiently to unlatch armatures occasionally even in positions not wired. On units having locating set screws for ratchet guide plate assembly, any movement of the pivot rod is easily seen. Since the rod is removed through these holes to simplify replacing a pawl, it is obviously plainly visible.
7. **All Unit Adjustments.** A quick check on proper overlap of stop pawls to the setup ratchet teeth is to set machine at 160° and trip stop pawls by hand. The pawls should have just enough room to seat in the "one" tooth. But should not do so at 162°.
8. **Contact Unit Adjustment.** Care should be exercised in changing tension on the center strap, since too much tension in the normally closed direction places a load on the cam and linkages and can cause the setup ratchet to drop back a tooth under certain operating conditions. For example, if one setup ratchet is stopped at number 5 tooth for a few cycles, the movement of the other ratchet actuates the differential link and the control lever (each cycle), due to excess tension on contact straps, to such an extent that this ratchet is moved from the #5 tooth to the #6 tooth.

This condition must be watched because if the latest type cams are installed in unit, the increased travel of center strap may cause too much load because of some previous increase in contact strap tension.

With power on the machine, no cards and all 16 positions wired, trip the bottom restoring magnet mechanically in both units. At "one" time short the primary card lever and turn the machine to 160°. At this time all positions are the same as they would be if "ones" had been read into the units.

None of the lower contacts should be making on the outer (N/O) straps. Turn the machine to 162° and all of the N/O straps should be made.

Clear the unit and repeat this check for the upper points by tripping the upper restoring magnets and shorting the primary sequence and secondary card levers.

The inner (N/C) contacts should be set so that with zeros in the unit the center strap will break away from the inner (N/C) strap before making on the outer (N/O) strap. This can easily be checked with zeros in the unit by plugging one end of a test light into the control input hub on the control panel and the other end to the equal hub of the unit being tested. If the two unequal hubs of the unit are both jack-plugged to the equal, the light will stay on at all times unless one of the center straps is not made on either its N/O or N/C side. Check the points one at a time using a spring hook or contact bending tool to pull the center strap forward. The N/C contact should break before the N/O contact makes, thus allowing the light to go out momentarily.

III. Lubrication

Keep restoring bails and operating cams and springs lubricated so that bails operate freely and fully restore the pawls when the unit is turned over by hand. Check to see that the oil cup is feeding oil to the set up ratchet shaft as well as to the wick which runs almost the length of the shaft.

IBM 6

(1) Setup ratchet pawl shaft oil well. This is the only part of the unit that is lubricated automatically with the Bijur System.
(2) Stop pawl pivots.
(3) Differential link studs followed with IBM 17.
(4) Restoring magnet knockoff cam follower, followed with IBM 17.

IBM 17

(1) Cams.
(2) Restoring bail spring stud.
(3) Differential link studs.
(4) Restoring magnet knockoff cam followers.

TUBE UNIT

I. Line Voltage

Check AC line voltage to insure that it is 112.5 volts or upwards. This will provide a minimum of 22.5 volts across the heater of each tube.

II. Heater to Cathode Short

In some instances, open filament tube failure is due to a heater to cathode short in another tube in the same filament string. This short can be of a high enough resistance so as not to extinguish the tube in question, but will put a higher than normal voltage on the filaments of some of the tubes in the string depending on the location of the shorted tube with respect to the line. A quick test of all tubes for a cold short can be made by removing the cathode common from 40 volt plus post #1 and connecting an ohmmeter from this wire to main line terminal #8. A cold short in any of the tubes will show a deflection on the meter.

It is advisable, when replacing a tube with an open filament, to check with an ohmmeter the rest of the tubes in the string for heater-to-cathode shorts, rejecting any tubes with a shorted or partially shorted condition. If filament failures persist in a string, the tubes in that string should be checked for a "hot short" between filament and cathode as some shorts do not show up unless the filaments are heated. This test can be done on any standard tube checker.

III. Voltage Drop Across the Magnets

With power on, connect the voltmeter across magnet terminals of position to be checked. Manually turn the machine to between 150° and 230° to make the "on" side of the feed interlock switch hot. Insert a plug wire from this "on" hub to the input hub of the position to be checked. If the instantaneous voltage read is less than 16 volts, the tube should be replaced. Test each position one at a time in this manner, taking care that the voltmeter is connected across the magnet before inserting the plug wire in the input hub for that position, as the correct voltage to be read is the instantaneous voltage at the time the magnet is first energized. The instantaneous voltage drop across a magnet energized by a weak tube may be less than 16 volts, but the voltage drop can increase as much as 10 volts in 15 seconds after the magnet is first energized. Reading the meter at that time would make a weak tube seem satisfactory.

In order to insure that failures in the brush circuit do not result in replacing tubes where they are not required, the brush input to the magnets has been purposely avoided in this procedure.

IV. Vibration Test

Vibration will sometimes cause intermittent shorts resulting in incorrect readings in the units. This may be tested for by running the collator test number one and tapping each tube several times with the eraser end of a pencil while cards are feeding. Any errors resulting only when a tube is tapped will indicate a vibration short in that tube.

BASE

1. **Relays.** (see *General Section*)
2. **Motor Generator.** (see *General Section*)
3. **Bijur System.** (see *General Section*)
4. **Control Panel.** (see *General Section*)

OPERATION TESTS

PUNCH TEST cards as indicated by the following table. To avoid repetition some cards have been omitted from the list but 144 cards should be punched. The punching of the test field for those which are omitted from the list follows a regular progression, in the pattern indicated by the first part of the list.

TEST FIELD	CARD NO.	TEST FIELD	CARD NO.	TEST FIELD	CARD NO.
---------------1	001	-------------999	027	-------etc.-----	
---------------2	002	------------1999	028	------9999999999	090
---------------3	003	------etc.-----		-----19999999999	091
---------------4	004	------------9999	036	-------etc.-----	
---------------5	005	-----------19999	037	-----99999999999	099
---------------6	006	------etc.-----		----199999999999	100
---------------7	007	-----------99999	045	-------etc.-----	
---------------8	008	----------199999	046	----999999999999	108
---------------9	009	------etc.-----		---1999999999999	109
--------------19	010	----------999999	054	-------etc.-----	
--------------29	011	---------1999999	055	---9999999999999	117
--------------39	012	------etc.-----		--19999999999999	118
--------------49	013	---------9999999	063	-------etc.-----	
--------------59	014	--------19999999	064	--99999999999999	126
--------------69	015	------etc.-----		-199999999999999	127
--------------79	016	--------99999999	072	-------etc.-----	
--------------89	017	-------199999999	073	-999999999999999	135
--------------99	018	------etc.-----		1999999999999999	136
-------------199	019	-------999999999	081	-------etc.-----	
-------etc.-------		------1999999999	082	9999999999999999	144

TEST I: Tests General Machine Operation

Control Panel Wiring: Wire control panel as shown in Figure 1.
Feeds: One deck of 144 cards in each feed unit.

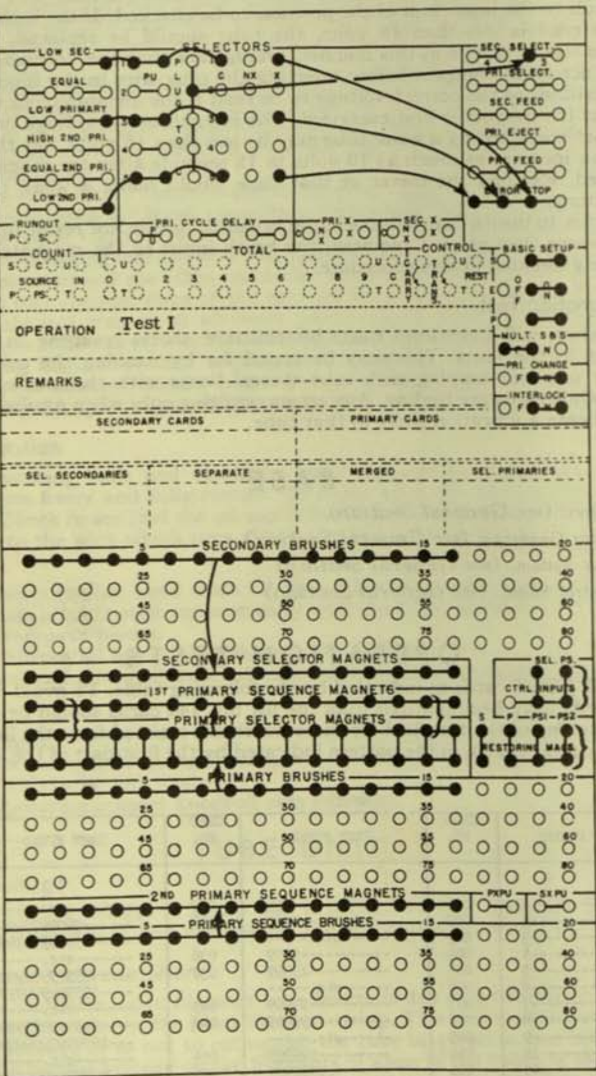


Figure 1

Run-in: Primary feed should take three cycles, and the secondary two. This tests the card lever circuits to the clutches.

Since the decks are matched, after the first three machine cycles the selector unit should have an equal reading and the sequence unit a high 2nd primary.

Note: *The error stop is used to stop the machine on an unequal reading in the selector unit or low 2nd primary in sequence unit.*

This tests the feeds for correct feeding, the brushes for proper reading; the setup magnets, selector contacts, and stop pawls for proper operation. In case any of the above are in error the machine will stop with the erroneous reading in the units.

Check the selector unit for an equal reading and the sequence unit for a high 2nd primary. The unit which does not satisfy this condition is the the unit in error. During this test, both feeds should run continuously. This tests the clutch pawls for "pulling out" during the cycle. If either clutch pulls out during a feed cycle, an erroneous reading will enter the selector unit and the error stop will function to stop the machine. If this happens, the last card in the secondary select pocket 3 and the merge pocket will not match. When test has been run satisfactorily, remove the "Plug to C" to "Sec. select #3" and merge these two groups.

TEST II: Tests Primary Feed Clutch for Latching and Unlatching

Control Panel Wiring: Functional plugging as shown in Figure 2. Brush wiring same as previous test.

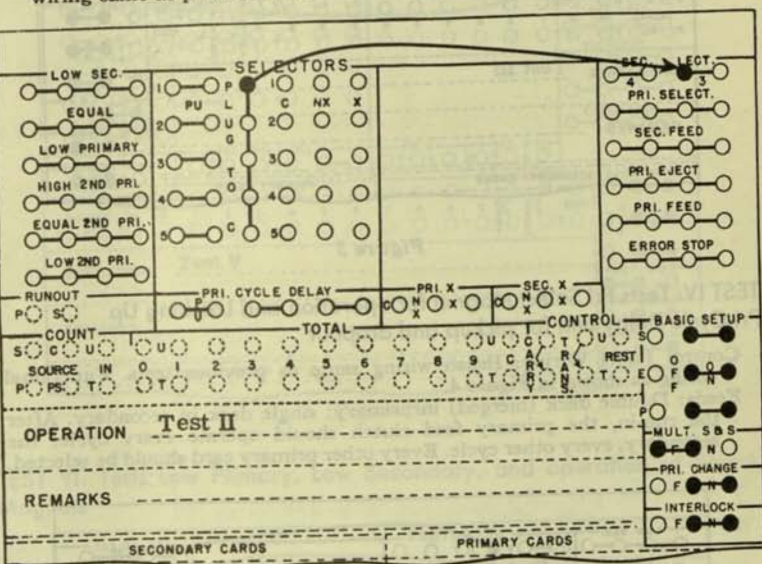


Figure 2

Feed Units: Single deck in primary; double deck (merged) in secondary. After the run-in, watch the feed clutches. Primary should operate every other cycle, secondary should operate every cycle. On one cycle the conditions will be selector unit equal with sequence unit high 2nd primary, and on the following cycle selector unit low secondary. These conditions will alternate.

Perform this test a second time, with M. S. & S. ON. After the three run-in cycles the secondary clutch will operate for two cycles, the primary for one cycle, secondary for two cycles, primary for one cycle, etc. The primary eject clutch will operate continuously.

This also tests the selector unit for equal and low primary readings and the sequence unit for a high 2nd primary, tests restoring bails of sequence and selector units for latching up, and tests feed clutches for latching and unlatching.

TEST III: Tests Secondary Feed Clutch for Latching Up

Control Panel Wiring: Brush wiring as Test I. Functional plugging as shown in Figure 3.

Feed Units: Double deck (merged) in primary, and single deck in secondary. After the run-in, primary feed clutch should operate every cycle, secondary every other cycle.

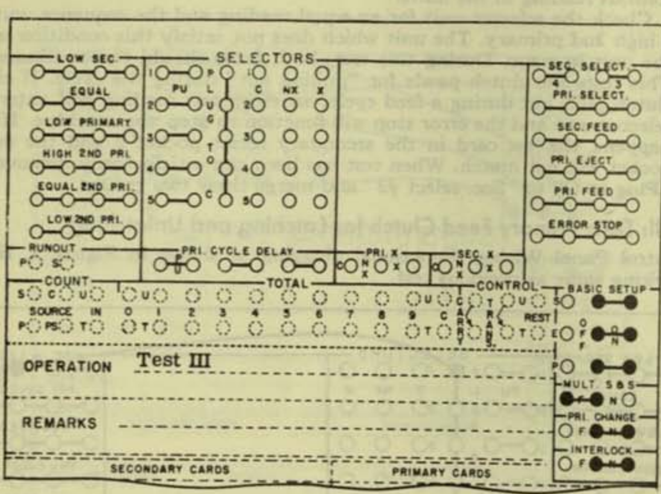


Figure 3

TEST IV: Tests Pri Select Magnet for operation and Latching Up Pri Cycle Delay unit for pickup and dropout

Control Panel Wiring: Brush wiring same as previous tests. Functional wiring as shown in Figure 4.

Feeds: Double deck (merged) in primary; single deck in secondary. After the run-in, the primary feed clutch should operate every cycle; the secondary, every other cycle. Every other primary card should be selected.

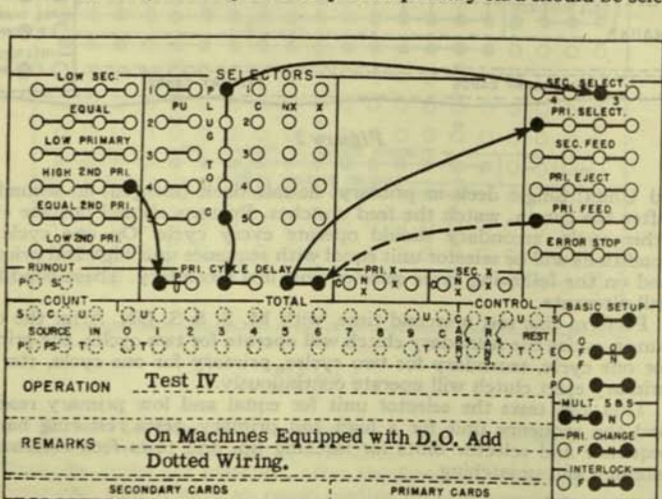


Figure 4

The primary cards selected, therefore, constitute one complete test deck of 144 cards. These cards can be matched with another 144 card deck by machine, or checked visually. (After this test two decks should be merged for next test.)

TEST V: Tests Secondary Select Magnet 4

Control Panel Wiring: Brush wiring same as previous tests. Functional wiring as shown in Figure 5.

Feeds: Single deck in primary; double deck (merged) in secondary. After the run-in, the primary should operate every other cycle; secondary should operate every cycle. Every other secondary card should be selected. Watch Sec. Pocket #4, or check cards after operation has been completed. Cards in pocket 4 should constitute one deck of 144 cards.

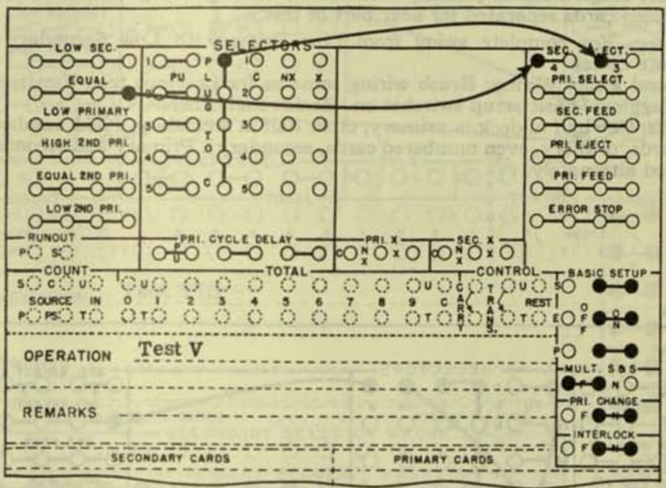


Figure 5

TEST VI: Tests Low Primary, Low Secondary, and operation of Select Magnets

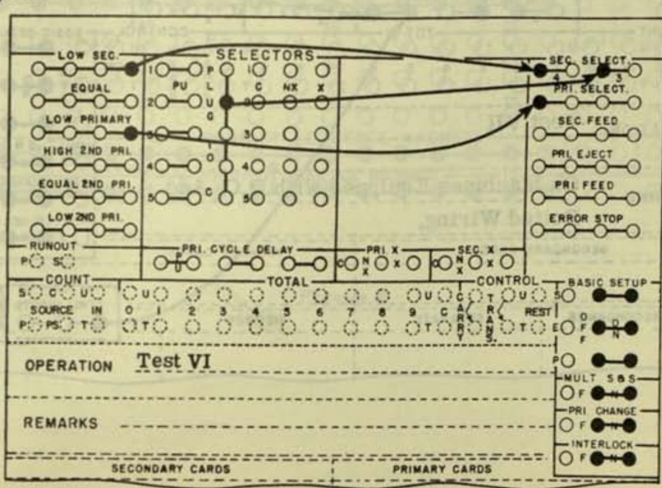


Figure 6

Control Panel Wiring: Brush wiring as shown in previous tests. Functional plugging as shown in Figure 6.

Feed Units: In primary, single deck with cards 4, 9, 27, 56, 68, 109 removed. Secondary, single deck with cards removed for 7, 13, 30, 59, 64, 88. (These numbers correspond to punching columns 78, 79, 80.) Check for correct selection of unmatched cards. If operation is satisfactory, cards may be filed in their correct positions by hand.

TEST VII

A — Tests: Primary Cycle Delay Unit.

Control Panel Wiring: Brushes wired same as in previous tests. Functional plugging shows in Figure 7.

Feeds: Single deck in primary feed. Every other primary card is selected. (Keep cards separated for next part of test.)

B — Tests: For complete swing from Low Primary to Low Secondary on alternate cycles.

Control Panel Wiring: Brush wiring same as for previous test. Functional plugging—basic setup switches on. Remove all others.

Feeds: One half of deck in primary, other half in secondary. (Odd numbered cards, primary, even numbered cards, secondary). Primary and secondary feed alternately.

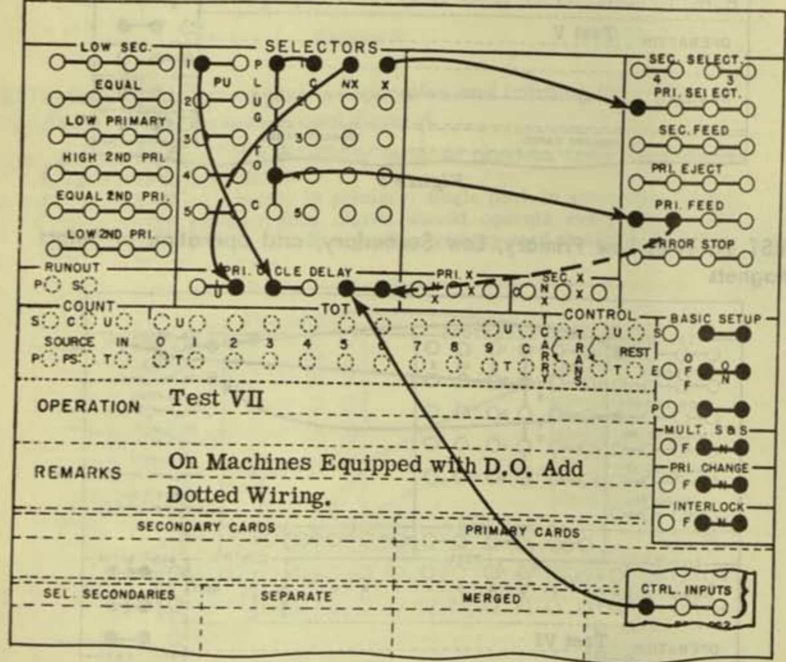


Figure 7

TEST VIII: Tests Low Second Primary and Error Light

Control Panel Wiring: Wire as shown in Figure 8.

Feeds: Reverse the sequence of some of the cards and run in primary feed. Watch for red light at every step down in sequence.

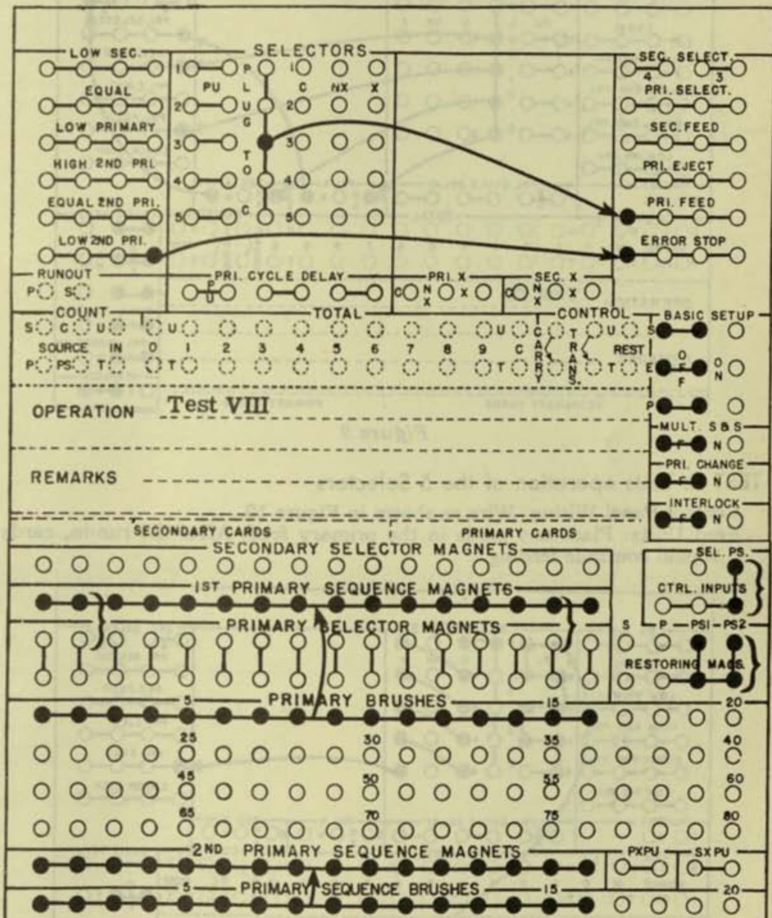


Figure 8

TEST IX: Tests X-Selectors

Control Panel Wiring: Wiring as shown in Figure 9 with secondary brush #60 wired to sec. X pickup and primary brush #60 wired to Pri X pickup.

Feed Units: Place one deck in primary feed and one deck in secondary feed. All X-60 cards should be selected.

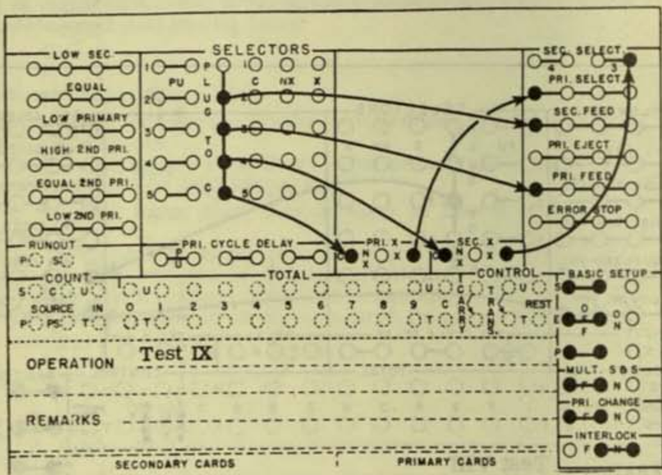


Figure 9

TEST X: Tests operation of the 5 Selectors

Control Panel Wiring: Wire as shown in Figure 10.

Feed Units: Place any cards in the primary feed. After the run-in, cards should continue feeding.

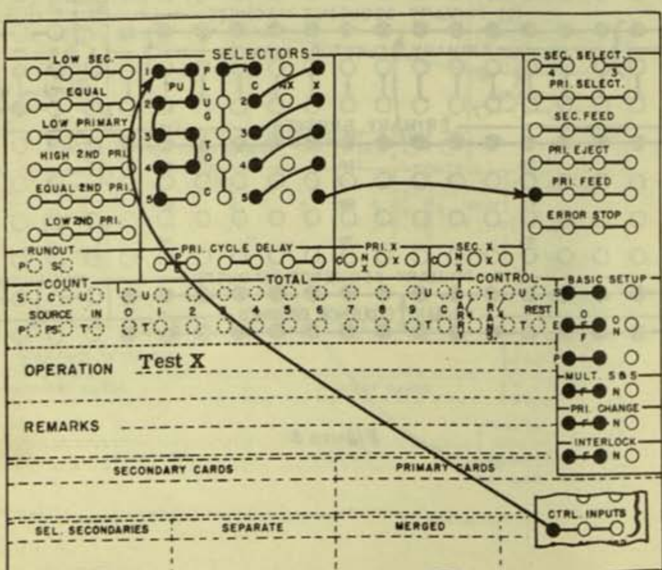


Figure 10

HORIZONTAL SORTER

GENERAL

The punched cards are fed into this machine horizontally from a magazine and are electrically arranged into any desired relationship. There are thirteen pockets in the machine, twelve of which are for the corresponding position in each column of the card.

Any desired cards may be automatically selected from a group and placed in their corresponding pockets, while the remaining cards will be placed in the "R" pocket without disturbing their original relationship.

SPEED

This machine is designed to operate at a speed of 360 to 400 cards per minute, and must not under any circumstances be operated in excess of 400 cards per minute.

CAPACITY

Each card pocket holds approximately 800 cards. However it is well not to allow more cards to accumulate in any pocket than can be conveniently removed with one hand. The feeding magazine has a card capacity of approximately 900 cards and it can be fed continuously.

CURRENT REQUIREMENTS

This machine has a maximum starting current of 6.5 amperes and a maximum running current of 2.0 amperes.

OPERATION

To set the brush in position for sorting any given column on the card, revolve the operating handle until the pointer is opposite the number corresponding to the column on which the cards are to be sorted. Next place the punched cards face down in the magazine (printed side down) with the top edge toward the card knives and put the pressure weight on. If it is desired to sort all positions on the card from 9 to 12 inclusive (regular sorting) all the commutator switches must be as shown in Fig. 1. Should it be desired to sort or select any one or more numerals in a given column it will be necessary to pull down all commutator switches EXCEPT those corresponding to the positions to be selected. Fig. 2 illustrates the commutator with the switches arranged to select 6-3-0 positions, which will be sorted into their corresponding pockets, the remaining cards sorting into the "R" pocket in their original sequence.

PRINCIPLE OF HORIZONTAL SORTING (See Figs. 3 and 4)

The principle upon which this machine operates is as follows: Cards are fed horizontally from a mazagine and pass directly under the card brush A and

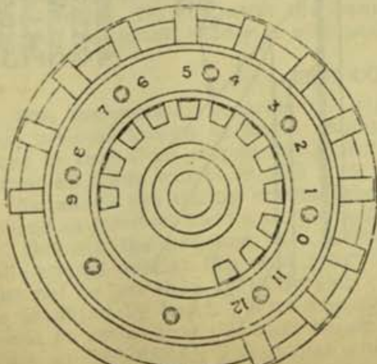


Fig. 1

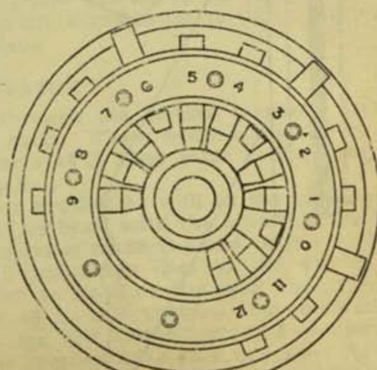


Fig. 2

Printed in U.S.A.
Form 22-8442-0

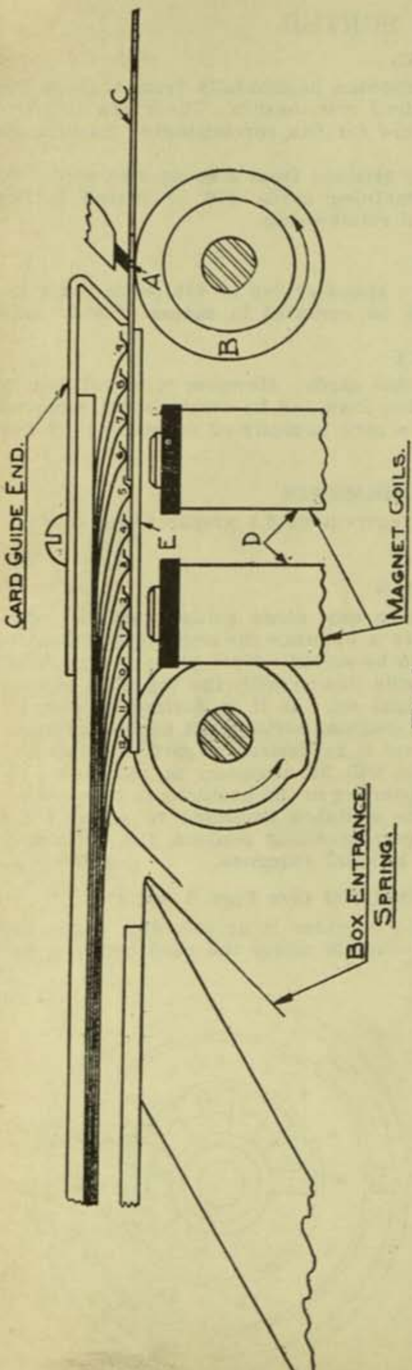

C
A
B
CARD GUIDE END.
E
D
MAGNET COILS.
BOX ENTRANCE SPRING.

Fig. 3

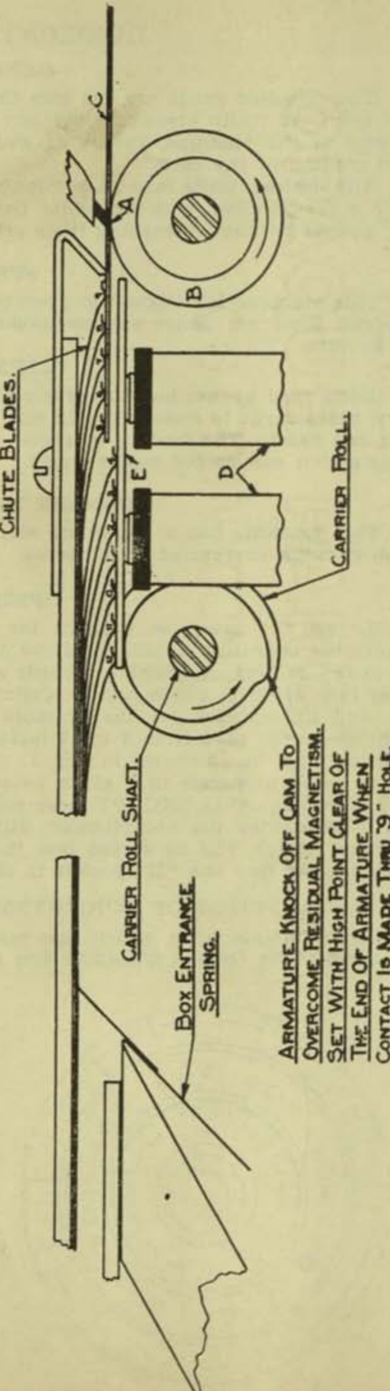

C
A
B
CHUTE BLADES.
E
D
CARRIER ROLL.
CARRIER ROLL SHAFT.
BOX ENTRANCE SPRING.
ARMATURE KNOCK OFF CAM TO
OVERCOME RESIDUAL MAGNETISM.
SET WITH HIGH POINT CLEAR OF
THE END OF ARMATURE WHEN
CONTACT IS MADE THRU "9" HOLE.

Fig. 4

over the brass roll B. Assuming that the card C is punched "4" it will have traveled under the 9, 8, 7, 6 and 5 chute blades as shown in Fig. 3. The brush makes contact completing the selecting circuit. The sorting magnet D thus becomes energized attracting the armature E, and the 4, 3, 2, 1, 0, 11 and 12 chute blades follow down with the armature E thus creating an opening between the 5 and 4 chute blades (See fig. 4), through which the card is conveyed by carrier rolls to its respective pocket. If a blank or unpunched card is fed into the machine the brush A fails to make contact with the brass roll B; therefore the sorting magnet D does not receive an impulse and the armature E will not pull down. Consequently, the card is carried into the "R" pocket.

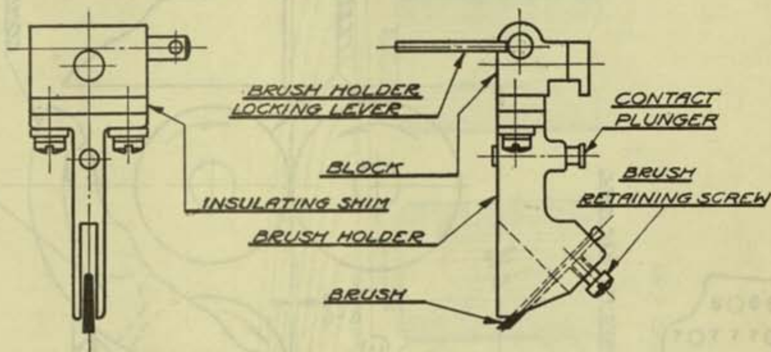


Fig. 5

THE CARD BRUSH

To insert a new card brush, raise the operating handle one-half turn until it is directly opposite its normal position.

This has raised the brush holder from the brass contact roll. The brush holder locking lever (See fig. 5) can now be raised to the position shown and the brush holder assembly removed. Next loosen the brush retaining screw and pull out the defective card brush.

When a new brush is inserted it must be timed in the following manner: Feed a card punched "8" by hand until the card brush makes contact through the punched hole. When contact is made the end of the 9 chute blade should overlap the card 1/64" to 1/32" maximum (See "A", fig. 6). There must not be less than 1/64" overlap of the chute blade on the card when turning the machine by hand. With the card brush in this position the commutator should be set so that its inner brush is making full contact on the 8 segment. (See "B", fig. 6). When replacing the brush holder assembly follow the above instructions in the reverse order. Do not lower the handle and allow the brush to touch the brass roll until the brush holder is clamped in place.

THE COMMUTATOR

The commutator controls the circuit through the sorting magnet. It has three brushes known as inner, center and outer. These brushes should be adjusted so that they project out of the holder 3/16". They must be carefully set so that all three will be in line with each other.

To check the timing of the commutator brushes as well as the card brush proceed as follows: Feed a card punched "8" by hand until the brush makes contact through the punched hole. When contact is made the end of the 9 chute blade should overlap the card 1/64" to 1/32" maximum (See "A" fig. 6). There must not be less than 1/64" overlap of the chute blade on the card when turning the machine by hand. With the card brush in this position the commutator should be set so that its inner brush is making full contact on the 8 segment as shown at "B" fig. 6. The center and outer brushes have only to be set for the proper projection as described above. The commutator is fastened to its shaft with two set screws.

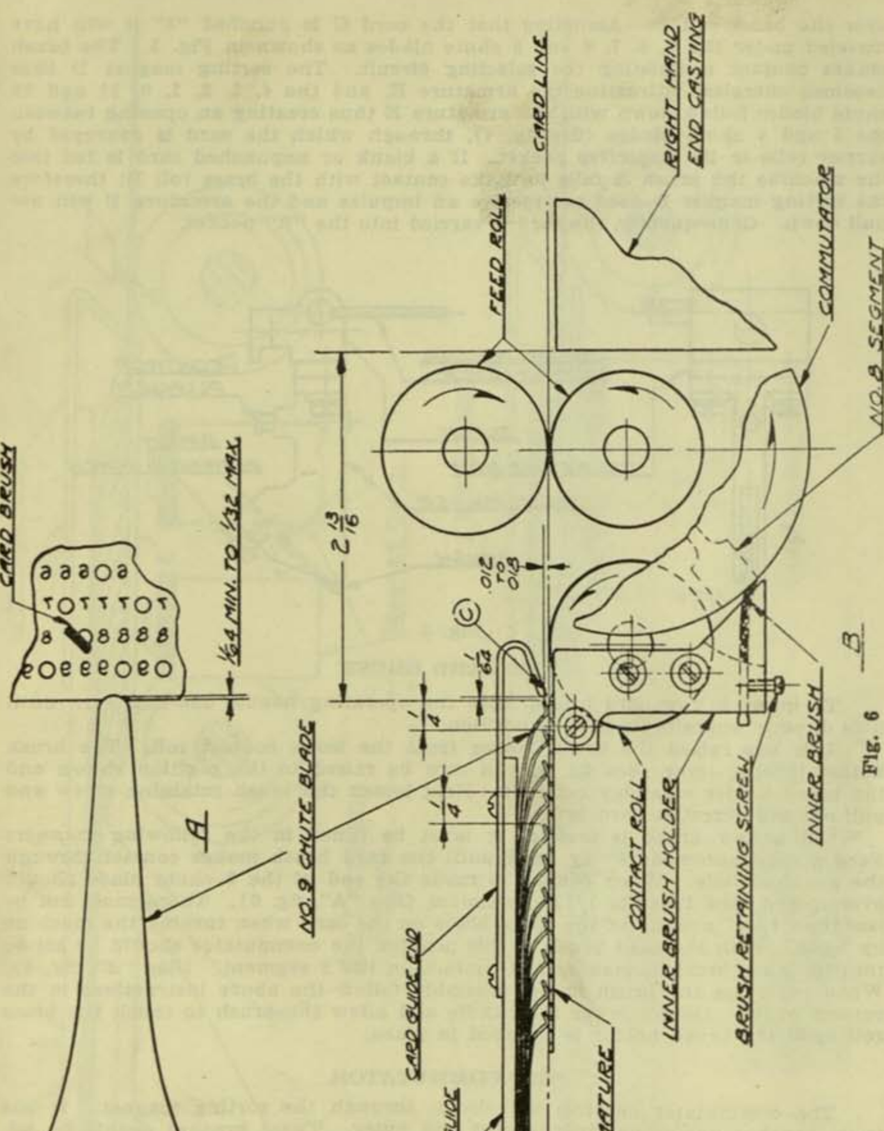

CARD BRUSH
1/64 MIN. TO 1/32 MAX
A
NO.9 CHUTE BLADE
$2\frac{13}{16}$
.012 TO .018
C
1/64
1/4
1/4
CARD GUIDE END
CARD GUIDE
ARMATURE
CARD LINE
CONTACT ROLL
INNER BRUSH HOLDER
BRUSH RETAINING SCREW
INNER BRUSH
B
FEED ROLL
CARD LINE
RIGHT HAND END CASTING
COMMUTATOR
NO.8 SEGMENT

Fig. 6

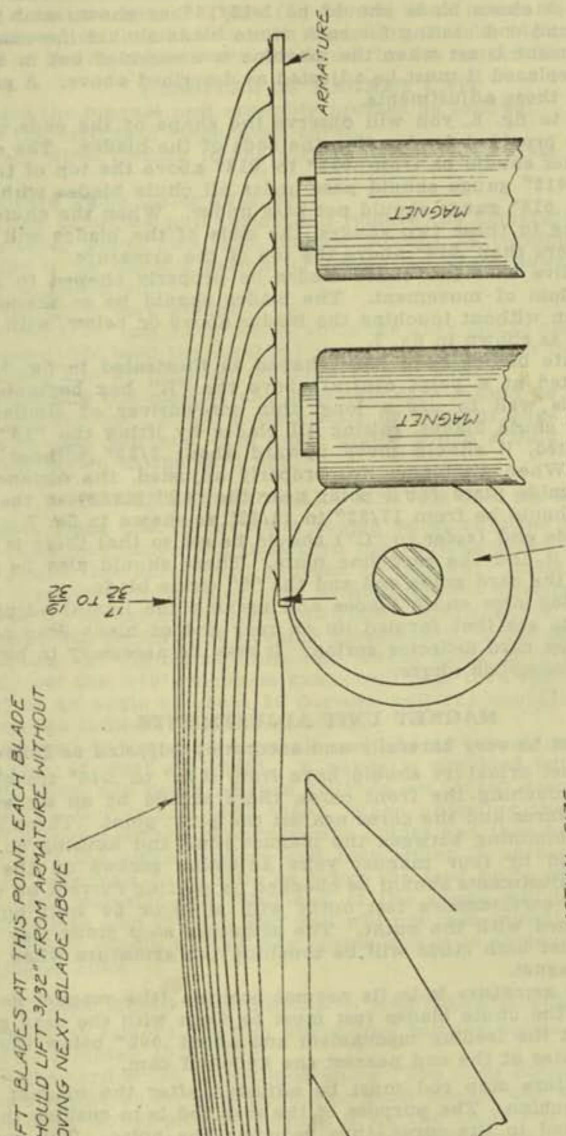

ARMATURE
MAGNET
MAGNET
KNOCKOFF CAM
17/32 TO 19/32
ACTUAL SIZE
LIFT BLADES AT THIS POINT. EACH BLADE
SHOULD LIFT 3/32" FROM ARMATURE WITHOUT
MOVING NEXT BLADE ABOVE

Fig. 7

CHUTE BLADE ADJUSTMENTS (See Fig. 6)

It is very important that the chute blades be properly adjusted laterally in relation to the right hand end casting. The end of the 9 chute blade should be 2-13/16" from the right hand end casting (See fig. 6) with the card guide in place. The distance from the end of one blade to the next should be ¼". In other words, the 9 chute blade should be 2-13/16" as shown and the distance from the right hand end casting for each chute blade should increase by exactly ¼". This adjustment is set when the machine is assembled but in case a chute blade has to be replaced it must be adjusted as described above. A gauge is provided for making these adjustments.

By referring to fig. 6, you will observe the shape of the ends of the chute blades. A tool is provided for bending the ends of the blades. The extreme end of the chute blades should be from .012" to .018" above the top of the armature as shown. The .012" gauge should pass under all chute blades without striking the ends, but the .018" gauge should not pass under. When the chute blades are adjusted according to these two gauges, the ends of the blades will not be less than .012" nor more than .018" above the top of the armature.

It is imperative that the chute blades be properly shaped to give correct tension and freedom of movement. The blades should be so shaped that they will lay in position without touching the blades above or below, with a clearance of 1/32" to 3/64" as shown in fig. 7.

After all chute blades have been shaped as illustrated in fig. 7, the entire set should be lifted at a point central above the "R" box beginning with the "12" blade. It is well to use a long, thin screwdriver or similar tool with which to lift the chute blades, raising all blades by lfting the "12" blade. As each blade is lifted, it should move upward about 3/32" without raising the blade above it. When all blades are properly adjusted, the distance from the top of the card guide plate (at a point near the "12" blade) to the top of the "9" chute blade should be from 17/32" to 19/32" as shown in fig. 7.

The card guide end (refer to "C") should be set so that there is a clearance of .008" between it and the card line plate. There should also be a clearance of 1/64" between the card guide end and the "9" chute blade.

When installing new chute blades and making the lateral adjustment care should be taken to see that formed lip on rear end of blade does not interfere with action of brass card deflector spring. It may be necessary to bend this part of the blade to accomplish above.

MAGNET UNIT ADJUSTMENTS

This unit must be very carefully and accurately adjusted as follows:

1. The magnet armature should have from .040" to .045" travel and when its residuals are touching the front cores, there should be an air gap of .005" between the armatures and the cores nearest the pivc* point. These adjustments are obtained by shimming between the magnet yoke and housing on the earlier type machines and by four magnet yoke adjusting screws on the later type machines. The adjustments should be checked by putting current on the magnet, using the regular serviceman's test outfit with a 40 or 50 watt bulb in place of the one furnished with the outfit. The armature stop studs may have to be filed slightly so that both studs will be touching the armature when there is no current on the magnet.

2. When the armature is in its normal position (the magnet de-energized) its surface where the chute blades rest must be flush with the card guide plates at the end nearest the feeding mechanism and about .005" below the surface of the card guide plates at the end nearest the knockoff cam.

3. The armature stop rod must be adjusted after the magnet unit is assembled in the machine. The purpose of the stop rod is to cushion the armature when it is attracted to the cores, thus reducing the noise. The stop must be adjusted up as high as possible in order that the noise while operating will be minimum but there must still be sufficient travel of the armature (.040" to .045" with the current on the magnet) to insure proper sorting. If this armature stop rod is adjusted up too high, the machine may sort "low" or tear the cards.

4. The armature pull spring must be adjusted after the unit is assembled in the machine. Put sufficient tension on this spring to just pull the armature

to the stop studs on the card guide plate when the magnet is de-energized, then give the adjusting screw an additional three-quarters of a turn and set the check nut. If the tension on this spring is too great, the machine will sort "low" when selecting, on the contrary, if the tension is too weak, the machine may sort "high" or all cards go into the "9" pocket.

5. The armature knockoff cam (D, fig. 10) is to overcome residual magnetism. It is pinned on the shaft in such a position that its high point will be just past the end of the armature when the brush makes contact through a "9" hole.

REMOVAL OF MAGNET UNIT

To remove the magnet unit assembly proceed as follows:

Remove the card feed mechanism cover.

Disconnect wires leading to the sorting magnet and brass contact roll feed brush.

Remove card guide plates (Fig. 8).

Unhook the armature pull spring and remove the armature.

Remove taper dowel pins from magnet housing by turning in on the 10-32 nuts. Turning in on the nut loosens or draws the taper dowel slightly so that it can easily be pulled out.

Loosen the lower card guides.

Remove the 5/16" cap screw which holds the filler blocks and magnet housing and at the same time hold the magnet housing assembly with the left hand. The magnet unit can now be removed for inspection or repair.

When replacing the magnet unit assembly care should be taken to see that it is properly lined up. Place a steel scale or straight edge across the lower card guides, contact roll and card guide plates which should all be in perfect alignment and known as the card line.

THE THROAT AND CARD KNIVES (See fig. 9)

The throat block and throat knife should be so adjusted that an .008" and not a .010" thickness gauge will pass thru the opening three ways as shown in fig. 9. To obtain this adjustment proceed as follows: Raise the throat knife slightly and move the throat block until its high point is directly in line with outside surface of the throat knife, move knife down until the .008" and not the .010" thickness gauge will go thru the opening horizontally. Then set the throat knife adjusting screws. If the throat knife and throat block have been properly set, the .008" and not the .010" thickness gauge will pass thru the opening, (1) horizontally, (2) at an angle of about 30 degrees, and (3) should follow thru when held down on the radius of the throat block.

The card feed knives are adjustable and should be set evenly on each side for a projection of .004" to .0045". A gauge is provided with two notches in it at opposite ends, one notch marked "GO" is cut .0045" deep and the opposite end marked "No Go" is cut .004" deep. When adjusting the card knives it is necessary to first remove the card magazine guides and then loosen the clamping screws that hold the knife in place and turn either in or out on the adjusting screws as the case may be to raise or lower the feed knife (See fig. 9). If the knife is properly adjusted the "Go" end of the gauge will pass over the feed knife on either side, and the "No Go" end will not pass over the projection. The knife must project evenly all the way across and it is obvious that both knives must be adjusted alike.

INDEX HEAD AND FEEDING MECHANISM (Fig. 10)

If necessary to remove the first upper feed roll the entire index head mechanism must be removed as follows:

Remove the card brush as outlined under "The Card Brush."

Remove straight dowel pins E, one on each side of the mechanism.

Remove taper dowel pins by turning in on the 10-32 nut G. This draws or loosens the taper dowel pin which can then be easily removed.

Remove both front card guides (See fig. 9).

Disconnect the wire that feeds the brush holder contact rail.

Lift front feed roll slightly and insert a common pin or piece of wire in the holes F, one in each side casting. This pin or piece of wire which is inserted must engage in a slot provided in the spring plunger so as to prevent the plunger and spring from jumping out when the index head mechanism is removed.

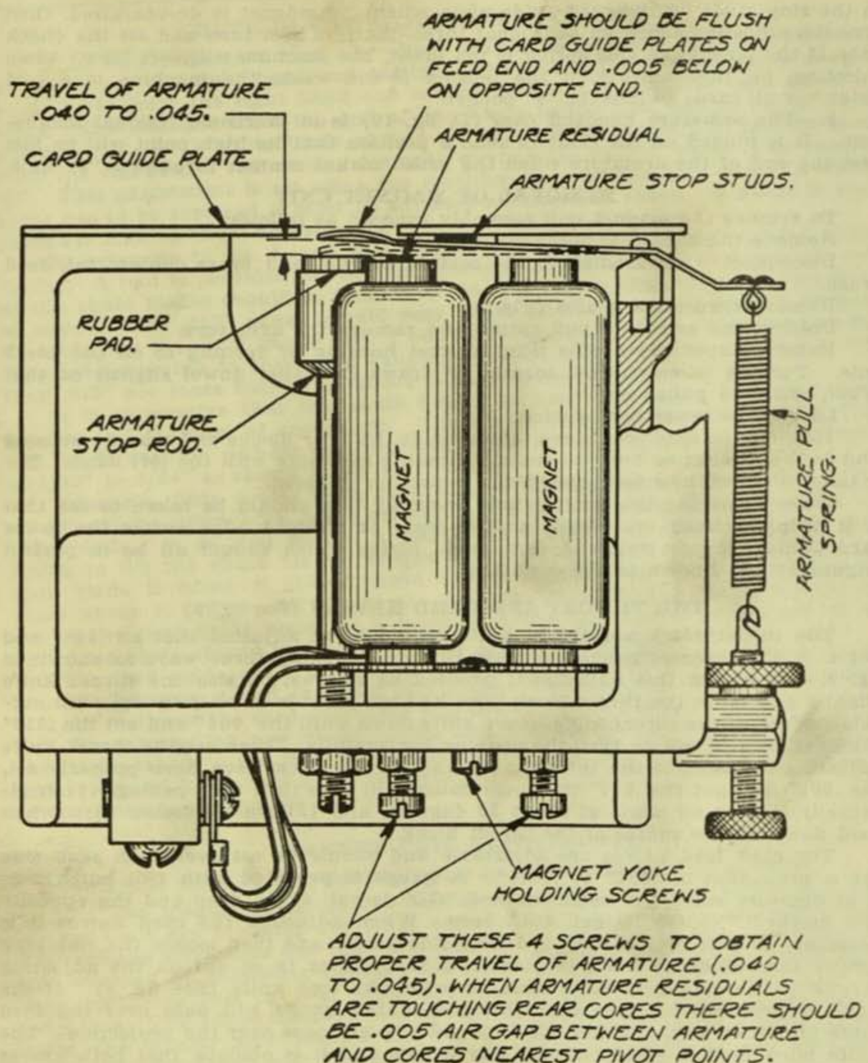

ARMATURE SHOULD BE FLUSH WITH CARD GUIDE PLATES ON FEED END AND .005 BELOW ON OPPOSITE END.
TRAVEL OF ARMATURE .040 TO .045.
ARMATURE RESIDUAL
CARD GUIDE PLATE
ARMATURE STOP STUDS.
RUBBER PAD.
ARMATURE STOP ROD.
MAGNET
MAGNET
ARMATURE PULL SPRING.
MAGNET YOKE HOLDING SCREWS
ADJUST THESE 4 SCREWS TO OBTAIN PROPER TRAVEL OF ARMATURE (.040 TO .045). WHEN ARMATURE RESIDUALS ARE TOUCHING REAR CORES THERE SHOULD BE .005 AIR GAP BETWEEN ARMATURE AND CORES NEAREST PIVOT POINTS.

Fig. 8

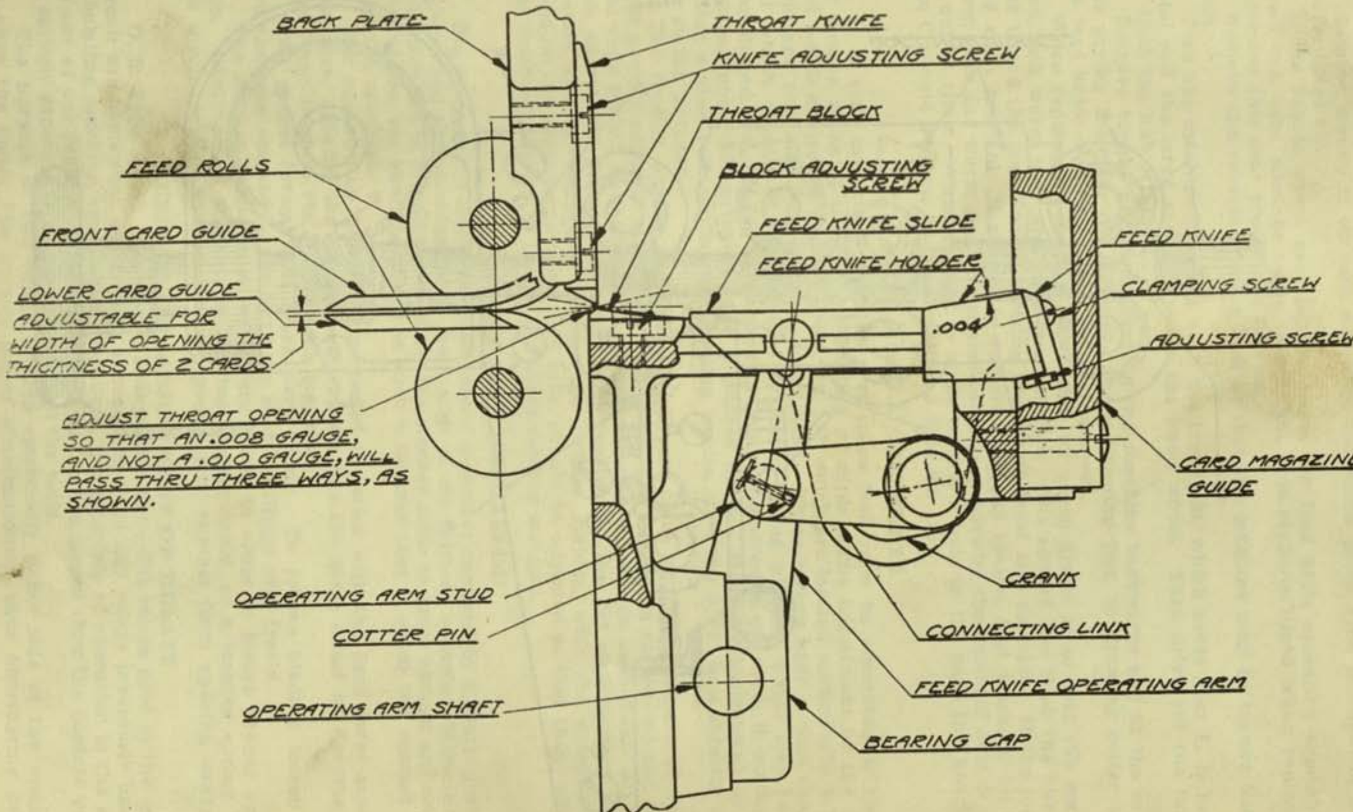

BACK PLATE
THROAT KNIFE
KNIFE ADJUSTING SCREW
THROAT BLOCK
FEED ROLLS
BLOCK ADJUSTING SCREW
FEED KNIFE SLIDE
FRONT CARD GUIDE
FEED KNIFE
FEED KNIFE HOLDER
CLAMPING SCREW
LOWER CARD GUIDE ADJUSTABLE FOR WIDTH OF OPENING THE THICKNESS OF 2 CARDS
.004
ADJUSTING SCREW
ADJUST THROAT OPENING SO THAT AN .008 GAUGE, AND NOT A .010 GAUGE, WILL PASS THRU THREE WAYS, AS SHOWN.
CARD MAGAZINE GUIDE
CRANK
OPERATING ARM STUD
CONNECTING LINK
COTTER PIN
FEED KNIFE OPERATING ARM
OPERATING ARM SHAFT
BEARING CAP

Fig. 9

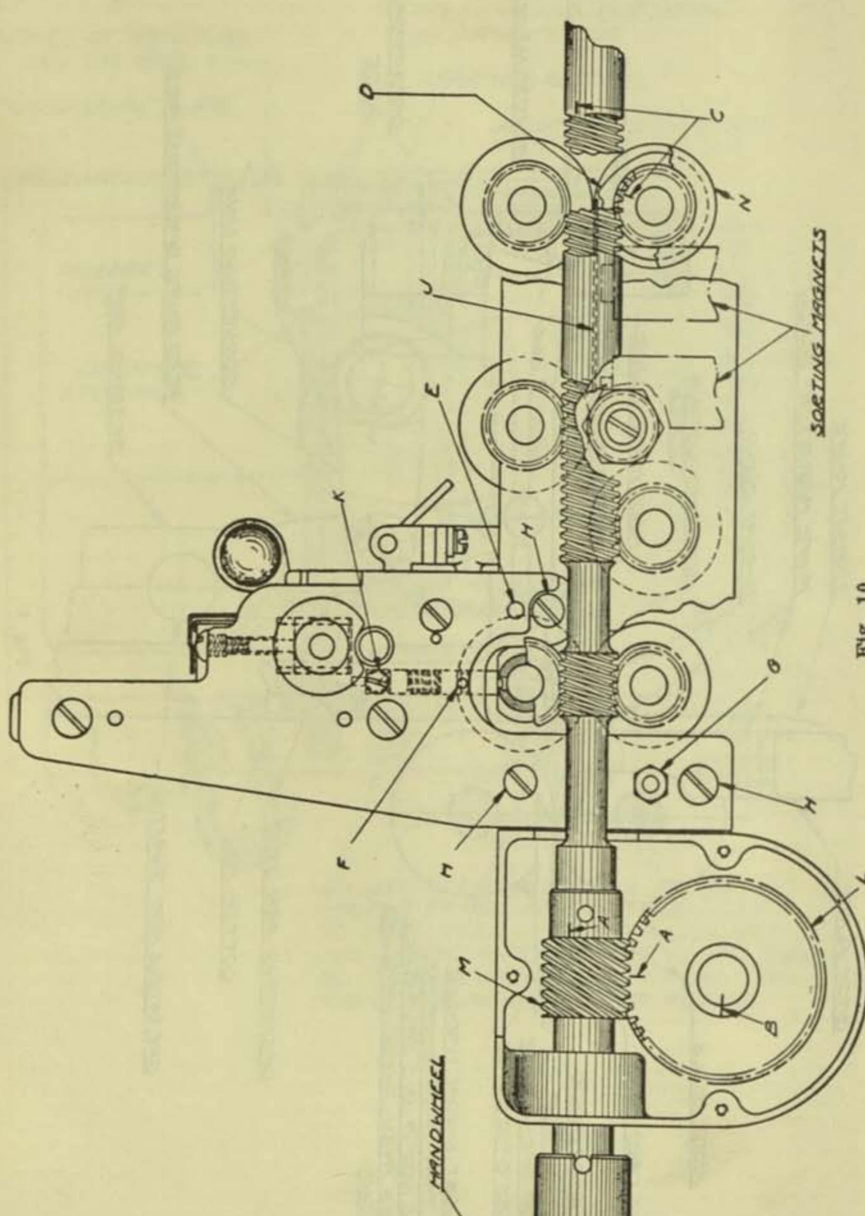


Fig. 10

Remove screws H on both sides and the entire index head mechanism may then be lifted off.

If the bronze worm gear L that drives the feed knife operating arm shaft is removed, care must be taken to see that it is properly timed when replaced. To remove this gear proceed as follows:

Remove the reverse friction lock so that the machine may be turned backwards.

Turn the machine by hand until the taper pin, which holds gear L, is horizontal and the large end is towards the hand wheel. Then drive out the taper pin from the hub of gear L.

Remove bronze gear L by turning the machine backwards and at the same time prying the gear off. Remove the connecting link by drawing cotter pin. The feed knife crank shaft can then be removed.

When replacing gear L mesh it with its worm driver M so that the marks A on both worm gear and its driver coincide. The scribed line B on the hub of gear L and the feed knife operating arm shaft must also coincide. If the lower feed shaft assembly N should be removed for any reason, spot marks C on the worm gear and worm shaft must also coincide, otherwise the knockoff cam D will be out of time. When contact is made thru a 9 hole in the card the knockoff cam C should be clear of the armature J (See fig. 10).

FEED ROLL ADJUSTMENTS

It is very important that the first three feed rolls be accurately adjusted for tension so as to insure even feeding of cards. The adjustment of the first feed roll is controlled by screws (K, fig. 10) which are located horizontally in the front and rear side frames of the index head. These screws have a cone shaped end which operate at right angles against a spring plunger which also has a cone shaped end. If for any reason the adjusting screw is removed, it cannot be replaced until the spring plunger is pushed down. This is accomplished by inserting a steel rod, similar to a sorting needle, thru the 3/32" hole directly over the spring plunger.

The tension on the first feed roll should have an even pressure of six to eight pounds adjusted equally on each side. The tension on the second and third feed rolls should be four to five pounds adjusted equally on each side. All feed rolls except the first are adjusted as to tension by the flat steel springs which operate against the feed roll bearings. These springs, with the exception of those on the second and third feed rolls, should be adjusted so that there will be just sufficient tension to insure the cards feeding straight.

POCKET STOP MECHANISM

The pocket stop mechanism consists of a contact operated by a shaft to which is connected an individual lever from each of the thirteen pockets. When sufficient cards are in the pocket to cause the stacker table to press against any one of these levers, the shaft is turned in such a manner that it opens the contact and stops the machine.

The pocket stop contact is connected in series with the card lever contact. Therefore, opening the pocket stop contact has the same effect as opening the card lever contact, viz., to stop the machine.

The pocket levers must work very freely. To relieve binding loosen the two end bearings and adjust until the shaft oscillates very freely.

The stacker tables must work very freely in order to insure proper operation. Obviously, a sluggish or binding stacker table, or a stacker spring with too much tension, will prevent the pocket stop contact from opening easily.

PURPOSE AND ADJUSTMENT OF RELAYS

G. E. Type Heavy Duty Motor Relays (fig. 11)—The relays used in the motor circuit are somewhat different in appearance from any relays previously used in tabulating machine equipment. However, the principle of operation is the same as any of our regular four post relays, that is, the circuit thru the contact points is entirely separate from the circuit thru the coils.

The purpose of two relays located electrically either side of the motor, is to open the motor line at two points simultaneously, thus distributing over a large metallic surface, an otherwise destructive arc.

These relays should require no adjusting other than to see that the armature works freely and that the armature tension springs are adjusted equally so that both armatures will release at the same time.

Card Control Relay—The purpose of this relay is to prevent starting the machine while feeding cards by hand or in other words, to prevent starting the machine by any method other than depressing the start key.

Brush Relay—This relay picks up when the card brush makes contact thru the punched hole in the card and its purpose is to lock the selecting circuit for the remainder of each card cycle.

Adjustments—1. Line up contact points with pivot screws and set finger tight. Back off one screw 1/6 turn and lock check nuts.

2. Set armature square with base by use of contact and stop screws. Lock the top screw in this position.

3. Move the magnet cores by screws on back of slate base for .012" air gap between armatures and cores on card control relay and .005" on brush relay.

4. Adjust lower screw for .012" air gap between contact points on the card control relay and .008" on brush relay.

5. The tension on armature pull spring of brush relay should be just sufficient to overcome gravity with relay turned upside down.

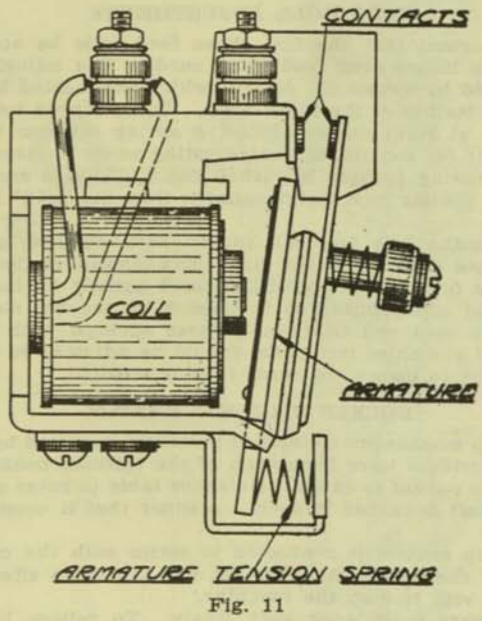


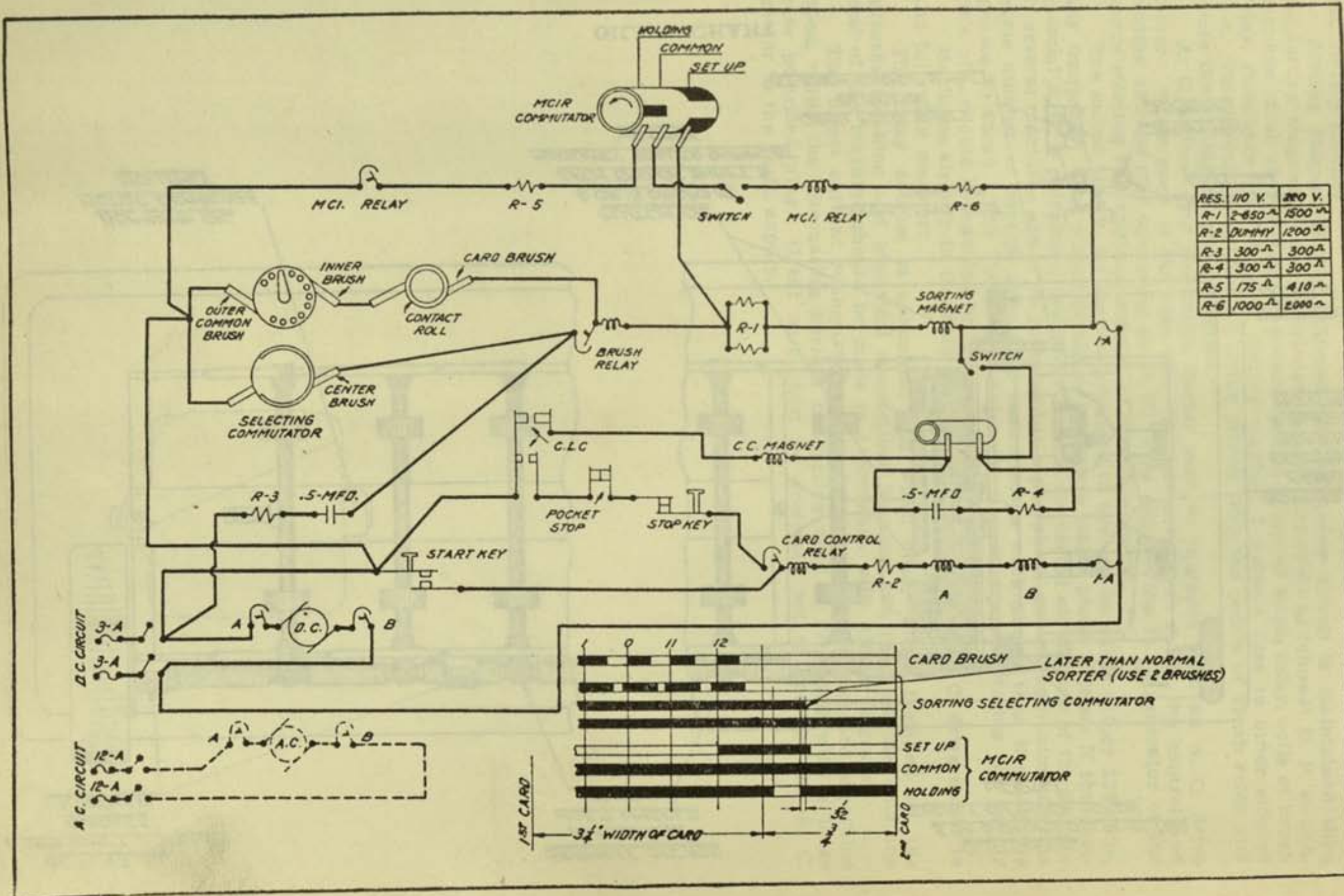
Fig. 11

CIRCUITS

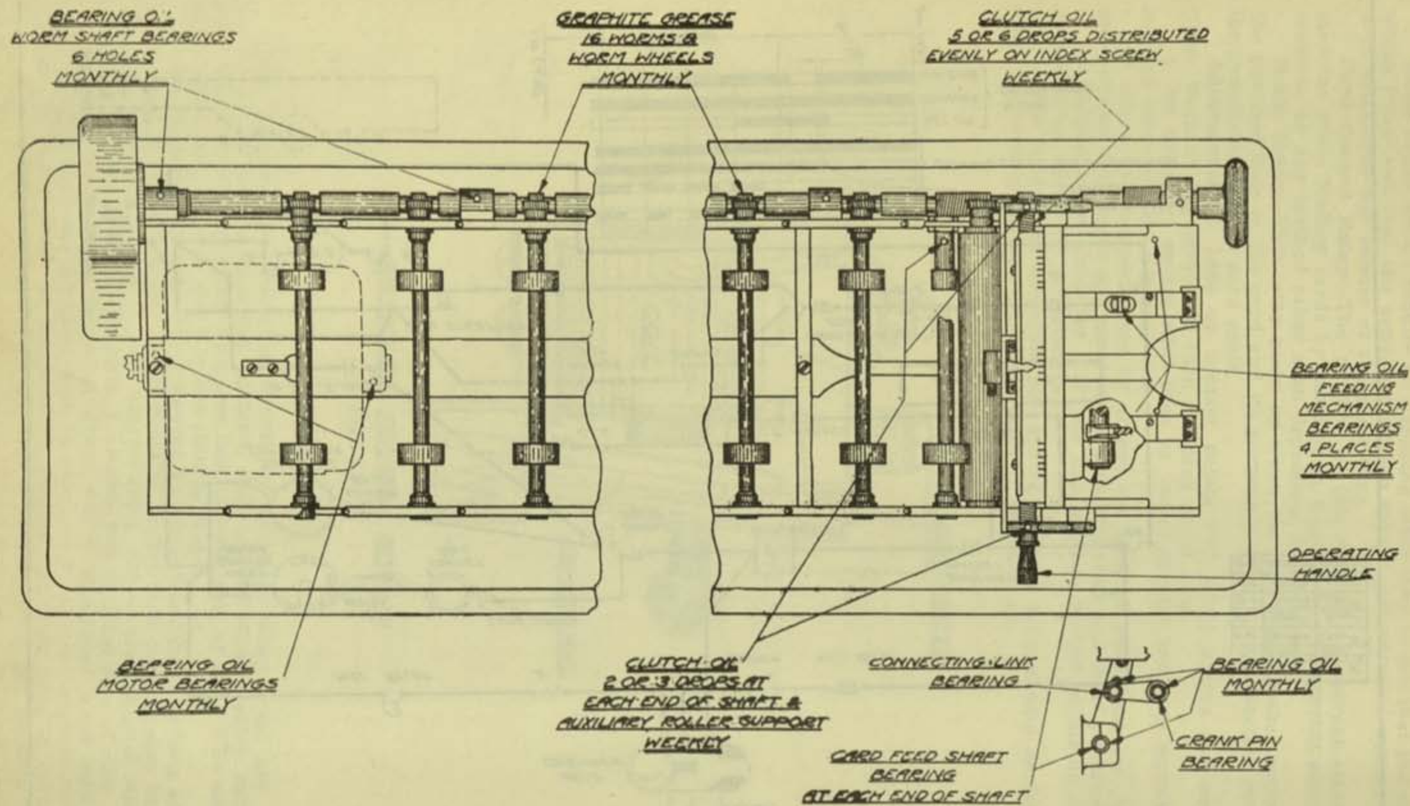
Start Circuit—The following circuit is completed when start key is depressed: D. P. switch, start key contacts, coils of card control relay, resistance R-2, coils of A and B relays, 1 ampere fuse to other side of line. This energizes card control relay, also A and B relays starting motor.

Motor Running Circuit—The following circuit is maintained as long as cards are feeding: D. P. switch, card lever contacts, pocket stop contact, stop key contact, gooseneck and points of card control relay, coil of card control relay, resistance R-2, coils of A and B relays, 1 ampere fuse to other side of line.

Selecting Circuit—The following circuit will be completed when card brush makes contact thru the punched hole in card: D. P. switch, common brush of commutator, inner brush of commutator, contact roll, thru hole in card, card brush, coils of brush relay, resistance R-1, sorting magnet, #1 ampere fuse to



RES.	110 V.	220 V.
R-1	2-650 Ω	1500 Ω
R-2	DUMMY	1200 Ω
R-3	300 Ω	300 Ω
R-4	300 Ω	300 Ω
R-5	175 Ω	410 Ω
R-6	1000 Ω	2000 Ω



OILING CHART

other side of line. When this circuit is completed it energizes the brush relay and sorting magnet.

Sorting Magnet Holding Circuit—The following circuit is maintained thru the sorting magnet for the remainder of each card cycle as follows: D. P. switch, common brush of commutator, gooseneck and points of brush relay, coils of brush relay, resistance R-1, coils of sorting magnet, 1 ampere fuse to other side of line. This circuit completes a holding circuit thru the points of brush relay and keeps the sorting magnet energized.

A. C. Drive—Any Horizontal Sorter may be equipped with an A. C. drive motor. When such is the case only the motor runs on A. C., the control and sorting circuits still operating on D. C. This relieves the D. C. generator of the heavy starting and running current of the drive motor.

The motor (1/4 h. p.) may be arranged to operate on either 110 or 220 volts, any frequency. The motor furnished is always single phase because if the commercial A. C. is polyphase, the motor may be connected on any one of the phases. If several machines are to be connected to a polyphase system, approximately the same number of motors should be connected to each phase, thus keeping the phases balanced. The question of balancing phases, properly fusing the supply line, etc., should be handled by the customer's electrician.

Machines already in the field may be equipped with an A. C. drive motor in the following manner:

The relay cabinet is assembled and wired ready to be installed on the present machine and electrical connections between the relay cabinet and the rest of the machine should be made in accordance with wiring diagram.

The direct current connecting cord is furnished with a standard separable plug, while the alternating current connecting cord is furnished with a large size polarized plug. Great care must be exercised not to connect the A. C. motor to the D. C. supply.

MULTIPLE COLUMN SELECTOR

Description:

The Horizontal Sorter may be equipped with a Multiple Column Selection Device which has two distinct uses:

1. Multiple column selection will permit selecting from a file of cards those cards which are punched with a predetermined alphabetical, numerical or combination indication within any ten adjacent columns. In a single run, selected cards of the desired classification will fall in the "Reject" pocket while the remaining cards will be deposited in the "12" pocket of the sorting machine. The sequence of the unselected cards will not be disturbed.

By means of this device it is possible to select all the cards for a specified branch, agent, product, date, part number, or other class of data.

2. Zero elimination permits greater speed in the completion of either alphabetical or numerical sorting operations, through the automatic rejection of cards which require no further sorting.

The unit is mounted under the feed hopper and consists of the following: Ten switches controlling ten positions of selection, one switch to control "0" elimination, two switches for operating control, a ten-position demountable brush assembly, transfer unit, plugboard, selecting commutator, four commutators, two resistances and three additional relays.

One to ten columns inclusive may be handled for either selection or "0" elimination.

Plugboard Arrangement Fig. 1

There are three different groups of plughubs on the plug board.

Group 1—Consists of 10 double hubs, under a general heading "Brushes," marked "Zone Punching." These hubs represent brush positions and are plugged for the 0, 11, and 12 for alphabetic selection.

Group 2—Consists of 10 double hubs, under the same general heading "Brushes," marked "Lower Punching." They represent the brush positions and are plugged for 9 through 12 for numeric selection and 9 through 1 for alphabetic selection.

Group 3—Consists of 12 single hubs marked 9-12 and are called "Selector" hubs. These hubs represent the 12 positions on the card. One single hub designated S C is the Sorting Common hub which is used for sorting or counting common information from more than one column.

(1) Multiple Column Selection of Numeric Punching
Sort Selection Switch—Select
Zero Elimination Switch—Sort
Brush Selection for Sorting Switches—Select

Plug from hubs marked "Lower Punching" to hubs marked "Selector," corresponding to numerical figures being selected. In brush positions being used, insert a two-way plug from the lower row of hubs marked "Zone Punching" to the upper row of hubs marked "Lower Punching" as designated by heading "Common for Numeric."

(2) Multiple Column Selection of Alphabetical Punching
Sort Select Switch—Select
Zero Elimination Switch—Sort
Brush Selection for Sorting Switches—Select

Plug from hubs marked "Lower Punching" to hubs marked "Selector" for numeric part of alphabet character. Plug from hubs marked "Zone Punching" to hubs marked "Selector" for Zone part of alphabet character.

(3) Zero Elimination
Sort Select Switch—Sort
Zero Elimination Switch—"0" Elimination
Brush Selection for Sorting—
"Sort" in position corresponding to units position of field being sorted.

In the same field, column positions to the left of the units position should be plugged from hubs marked "Lower Punching" to "zero" hub of "Selector" plughubs. It will be necessary to common these columns by plugging from the upper row of "Zone Punching" hubs to the lower row of "Lower Punching" hubs.

At the end of each sort, it will be necessary to turn the "Brush Selection for Sorting Switch" for the next column to its "Sort" position. For example, after sorting the units position it will be necessary to turn the tens position switch "Sort" etc.

(4) The sorting common plugboard hub was provided to permit sorting on any of the brushes with the brush selection for sorting switches set to the select side in order to select a common digit from one or a multiple number of columns. A typical problem would be to sort out a multiple number of columns in which a 5 may be perforated.

CIRCUIT DESCRIPTION

Multiple Column Selection

The following description illustrates the manner in which the machine performs when selecting a card perforated with the two digit number 54 from a file of cards.

First card punched 53. The following circuits are effective. At 5 brush reading time, a circuit is complete from main line fuse, main line switch, to one side of start key contact, commutator No. 2, to one side of MCS commutator No. 1, zero elimination switch, contact roll common brush, contact roll, selection brush No. 2, one leg of selection switch set to select, closed side of transfer points, plugboard, plugwire, No. 5 hub of selection, No. 5 brush, No. 5 sector of selection commutator, common brush feeding individual sectors, MCS No. 1 relay coil, MCS R No. 1, 1 a fuse, main line switch to main line fuse. Energizing MCS No. 1 will complete the following holding circuit which is effective for the entire reading portion of the card under control of MCS commutator No. 2. From the main line fuse, main line switch, to one side of start key contact, No. 2 MCS commutator, gooseneck of the brush relay, gooseneck of MCS relay No. 2, normal open points of MCS relay No. 1, coil of MCS relay No. 1, MCS-R No. 1, 1 a fuse, main line switch to main line fuse. At three time the following circuit is complete: From main line fuse, main line switch, to one side of start key contact, No. 2 MCS commutator, one side of No. 1 MCS commutator, zero elimination switch, contact roll common brush, contact roll, No. 1 select brush, select side of No. 1 select switch, normal closed side of No. 1 transfer contact, plugboard, plugwire to No. 4 selection plughub, commutator selection brush No. 4, selection commutator which at this time is not making on a sector but connects this selection brush with the common selection commutator brush No. 13 which completes a circuit to MCS relay coils No. 2 and 3, MCS R No. 2, 1 a fuse, main line switch to main line fuse. A similar holding circuit is effective for MCS relay coils No. 2 and 3 as for MCS relay coil No. 1.

The effect of energizing MCS relay No. 1 for a 5 reading which is a selected figure in this example was to transfer the No. 1 relay points and disconnect a circuit to the No. 3 and 4 MCS commutator. However, since this card was likewise punched with a 3 which is not a selected figure in the example, the energization of MCS relays No. 2 and 3 completes the following circuit to the brush relay and sorting magnets so as to sort the card not selected into the 12 pocket. From main line fuse, main line switch, one side of start key contact, MCS commutator No. 2, gooseneck of brush relay, gooseneck of MCS relay No. 2, armature of MCS relay No. 2, MCS commutator No. 3, MCS commutator No. 4, brush relay coil, resistance, sort magnets, 1 a fuse, main line switch to main line fuse. From the above it is obvious that any card perforated with one or more columns in disagreement with the selected digits plugged will cause MCS relays No. 2 and 3 to pick up and cause this card to sort into the twelve pocket.

A card punched 54 in passing through the machine would have completed a circuit to MCS relay coil No. 1 twice, once for the five perforation and once for the four perforation as the brush readings on the selecting commutator agreed with the digits plugged. When such agreement occurs, no circuit to MCS relays No. 2 and 3 will be effective and since MCS relay points No. 1 are transferred, the brush relay and sorting magnets are not energized; consequently, the card will be deposited into the reject pocket.

Groups of numbers may also be selected within certain limitations. All cards between 1 and 9, 10 and 99, 100 and 999, etc., may be selected with one passage of the cards. It is not possible to select between two numbers such as 256 to 375, as the controlling digit is always the column to the left of the digit of the highest order. When selecting all cards between 1 and 9 the controlling digit would be the tens position; for selecting all cards from 10 to 99 the controlling digit is the hundreds position, etc.

ZERO ELIMINATION

Zero elimination may be accomplished in conjunction with standard sorting operations. The object of zero elimination is to enable an operator to start a tabulation prior to the completion of a sort. Set switches as illustrated under Plugging and Switch Set-up No. 3. Example: Zero elimination on a four digit number.

The first sort would be on the units column. Cards punched 1 to 9 inclusive in the units position will sort in the 1 to 9 pockets. The following circuit will result: From main line fuse, main line switch, one side of start key contact, MCS commutator No. 2, MCS commutator No. 1, contact roll common brush, contact roll, select brush No. 1, brush selection for sorting switches No. 1 set to sort, brush selection sorting switches No. 2, 3 and 4 set to select, standard commutator segment brush, segment, commutator common brush, sort select switch No. 2-R, brush relay coil, resistances, sorting magnets, 1 a fuse, main line switch to main line fuse.

Zero elimination has little or no function on the first sort, as the only possible elimination on this sort on this example would be if the card were punched with four zeros. This card would reject as MCS commutator No. 1 breaks between 1 and 0, thereby rendering the contact roll inoperative for 0, 11 and 12 sensings. Had a zero been punched in the units position and a significant digit been punched in any one of the other three columns, this card would sort in the zero pocket. The circuit is as follows: From main line fuse, main line switch, one side of start key contact, MCS commutator No. 2, MCS commutator No. 1, contact roll brush common, contact roll, select brush, brush selection for sorting switch set to select in any of the three columns where a significant digit appears, transfer points closed side, plugboard, plugwire to "0" selection hub, selection commutator, brush 13, MCS relay coils No. 2 and 3, MCS R No. 2, 1 a fuse, main line switch to main line fuse.

Energizing MCS No. 2 relay will establish a holding circuit for relay coils MCS No. 2 and 3 through MCS commutator No. 2 as previously described under multiple column selection.

Energizing MCS relay No. 3 will close its points which are wired to shunt around MCS commutator No. 1, which will render the contact roll operative to sort on 0. Therefore, a card perforated 0600 would be sorted in the zero pocket.

Sorting on the tens columns will cause cards punched 0001, 0002 to 0009 inclusive to reject and enable an operator to remove these cards to start a tabulation.

Sorting on the hundreds column will cause cards punched 0010, 0011 to 0099 inclusive to reject, thereby permitting continuous flow of cards to the tabulator prior to the completion of the sorting operation.

For each column sorted the brush selection for sorting switch must be thrown from the select side to the sort side, thereby disconnecting the switch of the lower order.

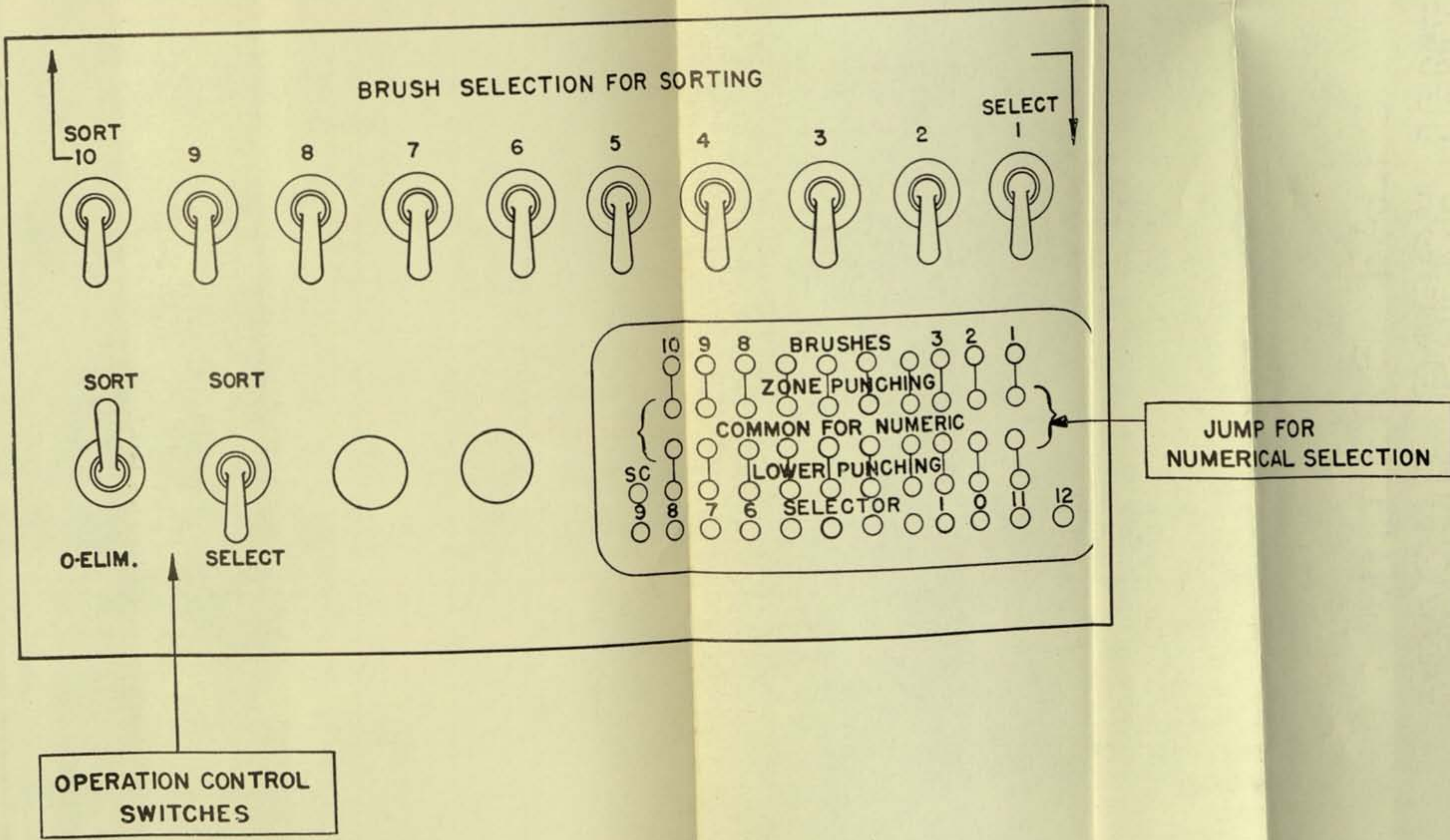
ALPHABETICAL MULTIPLE COLUMN SELECTION

Selection of alphabetical characters is accomplished in the same manner as for numerical selection. A mechanical cam actuated set of 10 transfer points is provided to separate the numerical zone punchings from the alphabetical zone punchings.

It is apparent from the description of numerical selection that as long as the punchings agreed with the selection hubs plugged in each of the respective columns that only MCS relay No. 1 was energized and the circuit to commutator No. 4 was broken so that the cards were rejected. A difference in punching in any one of the columns selected energized MCS relays No. 2 and 3, which in turn completed a circuit to MCS commutators No. 3 and 4 which energized the sorting magnet at 12 and caused these cards to be separated from the remainder of the group.

The circuits for alphabetic multiple column selection are identical to those for numerical, the only difference being that alphabetical selection each column is sensed twice for agreement.

FIG. I



Printed in U. S. A.

SELECTING COMMUTATOR

FIG. 2

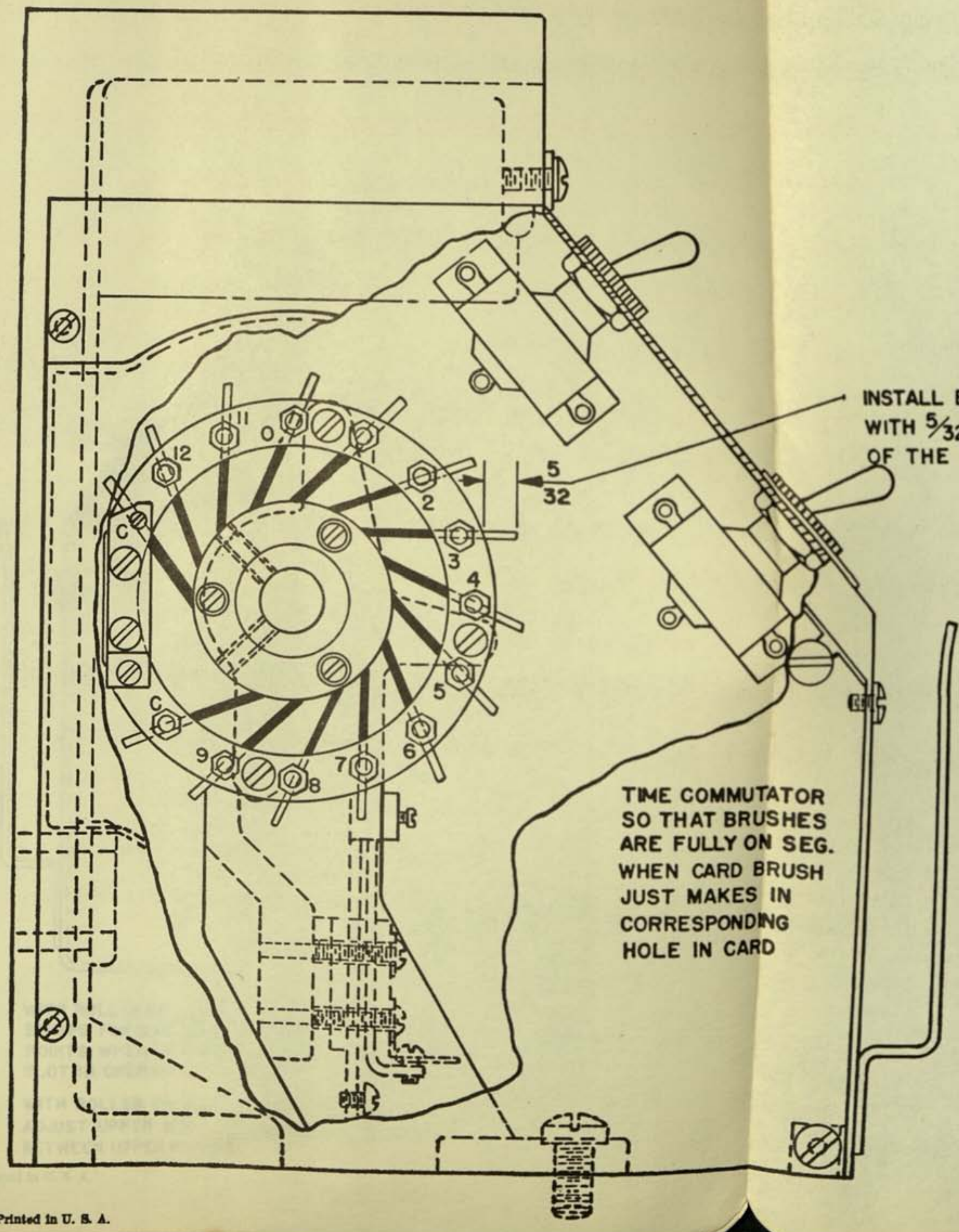
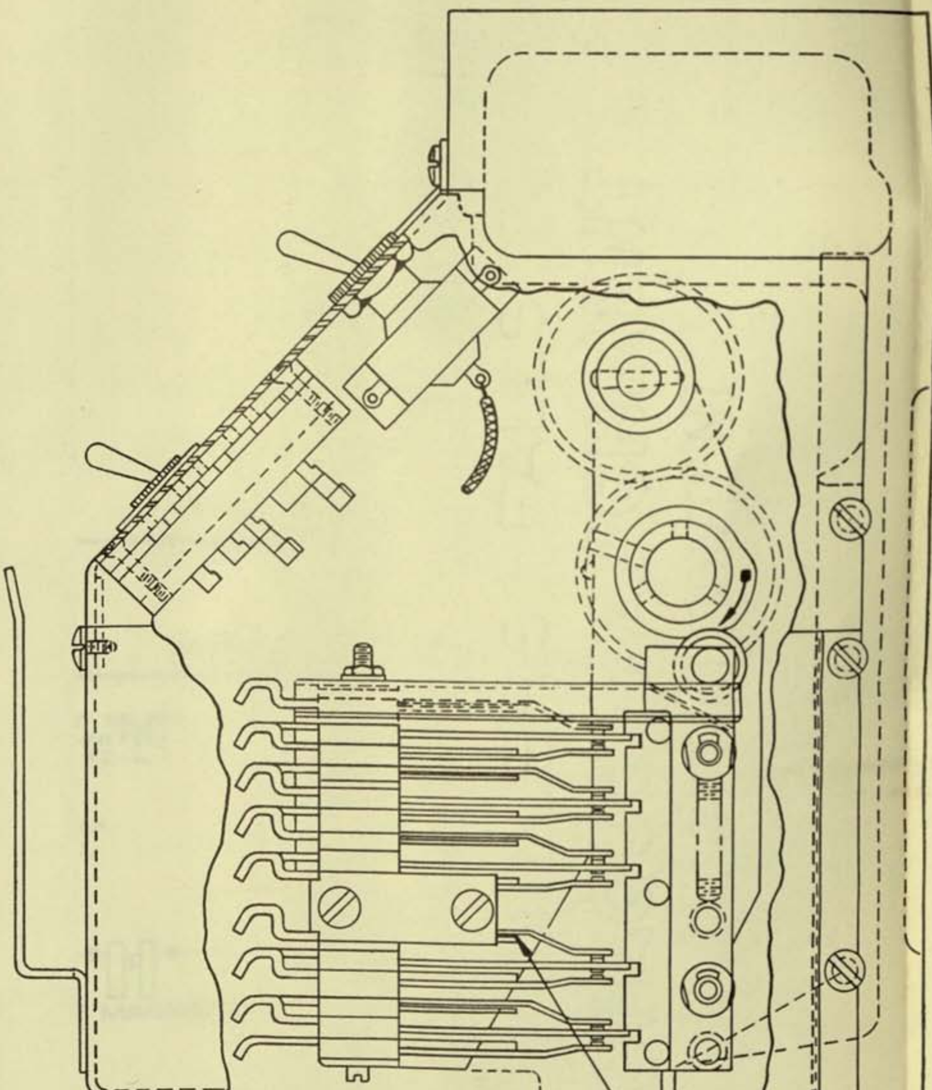


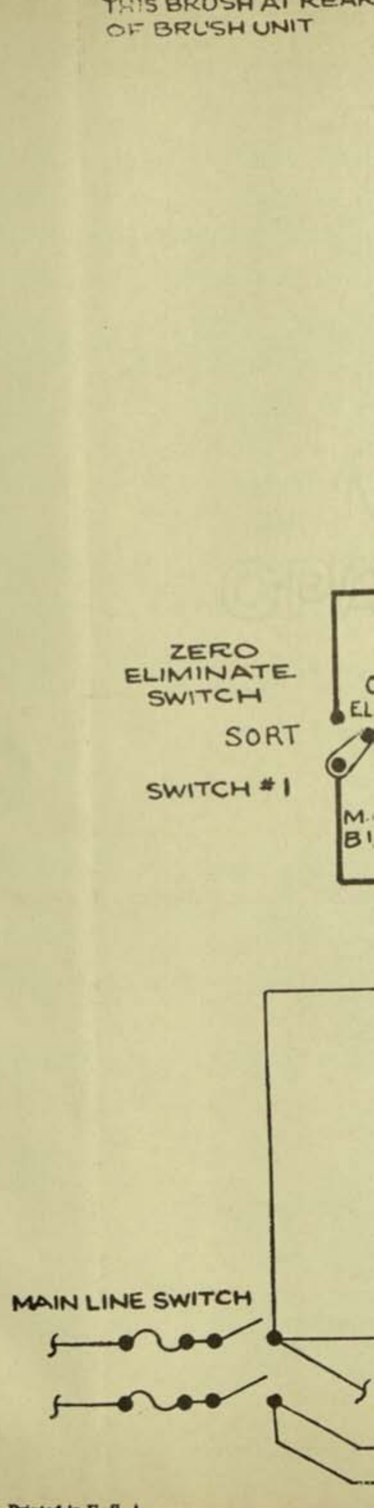
FIG. 3



WITH ROLLER ON LOW DWELL OF CAM ADJUST LOWER STRAPS FOR .030 CLEARANCE BETWEEN LOWER POINTS WHEN CENTER STRAP RESTS IN TOP OF SLOT IN OPERATING PLATE.

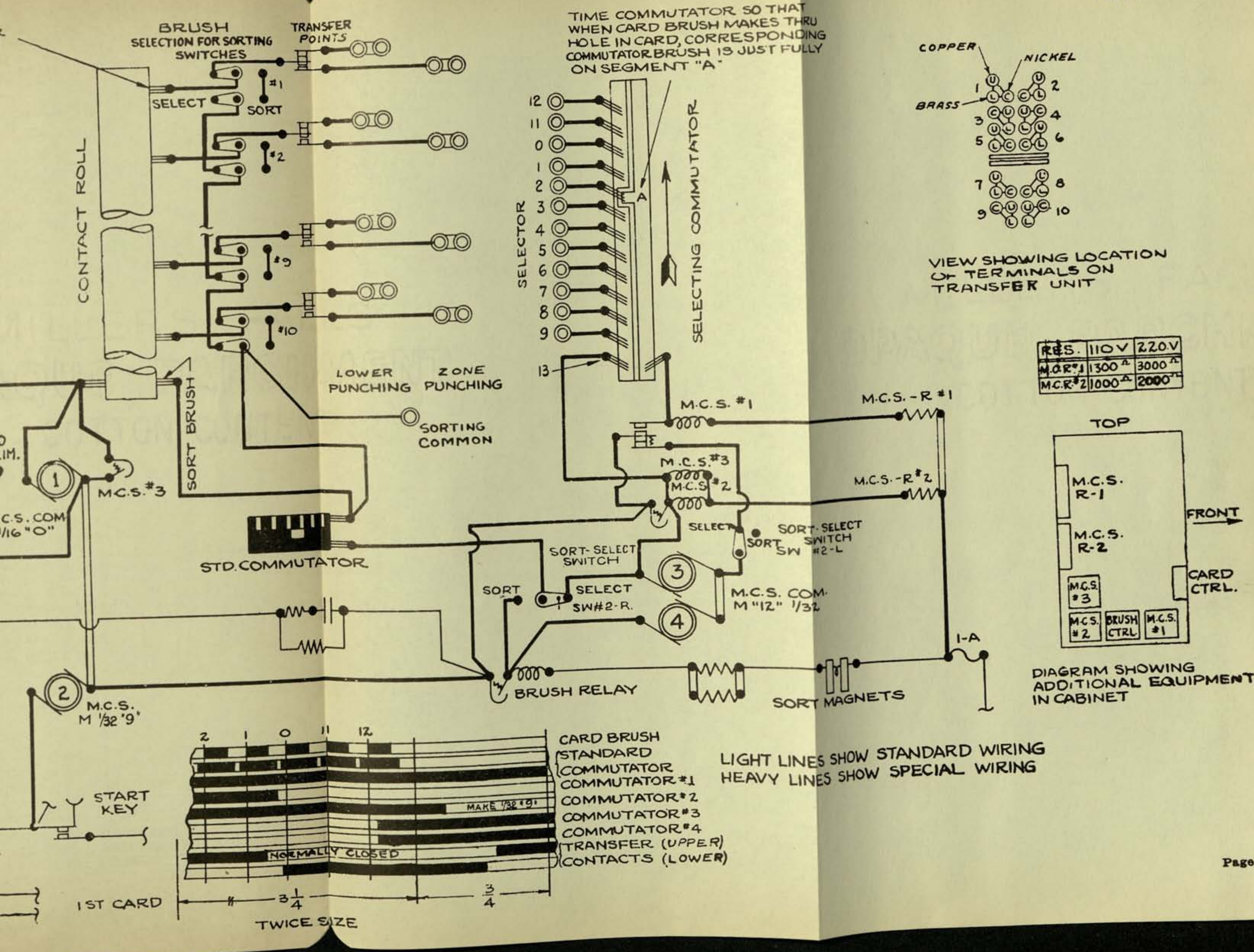
WITH ROLLER ON HIGH PORTION OF CAM ADJUST UPPER STRAPS FOR .030 CLEARANCE BETWEEN UPPER POINTS.

CENTER STRAP TO HAVE SUFFICIENT TENSION TO RAISE NORMAL CLOSED SIDE OFF BRASS SUPPORT .010



Printed in U. S. A.

FIG:4



RES.	110 V	220 V
M.C.R. #1	1300 Ω	3000 Ω
M.C.R. #2	1000 Ω	2000 Ω

CARD MATCHING DEVICE

General—The Card Matching Device is an attachment for the Horizontal Sorter which is used to select matched cards from a group of cards by means of contrasting corner cuts, or from a punched hole. This device may be readily installed on any horizontal sorting machine.

A representative use is the reconciliation of bank statements for tabulating card checks. A punched duplicate of each check is created on a square corner card and retained in the tabulating department. The original checks (distinguished by a corner cut) when returned are sorted along with the duplicates in check number sequence. They are then matched; the paired originals and duplicates fall into the 12 pocket, while the duplicates not preceded by original checks fall into the R or reject pocket. The latter unmatched cards represent outstanding bank checks.

The foregoing general description requires an offset brush holder and also that the detail cards have a 3/8" 45° corner cut. The cards are fed face down with the "9" edge toward the feed rolls with the detail cards in advance of the master cards.

Master card matching may also be accomplished by a twelve perforation in the detail cards, in which case it is not necessary to use an offset brush holder, as any predetermined column may be punched with this twelve perforation. The regular sorting brush would be used.

NOTE—When placing cards in the card magazine to be matched, operator must check to see that the first card to go through machine is a detail card, otherwise the first card will be sorted incorrectly.

Principle of Operation—The detail and master cards should be first sorted into class or identification number groups by placing the master cards ahead of the detail cards. This is standard sorting procedure.

Replace the regular card brush holder with the offset brush holder provided and set same on either the first or last column to correspond with cut corner on the detail card. If a 12 perforation is used to identify the detail cards, set the regular brush holder in the predetermined column selected for the 12 perforation.

Place sorted master and detail cards in the magazine face up with the "9" edge leading, turn matching device switch to its "ON" position and depress start key. Cards sorted into the "12" pocket represent detail cards followed by a single master card. All cards rejected represent master cards for which there were no detail cards.

Units—The Matched Card Matching Device consists essentially of the following:

1 MCI relay
1 Commutator Assembly MCIR
1 Control Switch
2 Resistances.

The relay and resistances are mounted inside of the standard relay cabinet. The switch is mounted on the right hand end cover. The MCIR commutator and brush holder assembly are mounted on the rear of the machine adjacent to the card feed worm gear housing.

Circuit Description—Wiring diagram (Fig. 3) shows the complete wiring of circuits for the Horizontal Sorter equipped with the master card matching device.

All sorting and total card counting circuits remain the same as heretofore, the only difference being the addition of the card matching control circuit which functions as follows:

When a corner cut or 12-punched detail card passes under the brush, the sorting magnet will be energized in the usual manner as the card brush makes contact at "12" and this card will pass into the "12" pocket. At the same time the card brush makes contact the MCIR setup brush completes a circuit through MCIR commutator, common brush, switch, relay coils, R-6 resistance and 1 ampere fuse.

During the first cycle this latter circuit energizes the coils of MCI relay closing its points which will complete a holding circuit from 1 ampere fuse, R-6 resistance, MCI relay coils, switch, common brush, holding brush, R-5 resistance, MCI relay points, main switch. The MCI holding circuit remains closed until after the 12 position of the second or following cycle. During this second cycle if the card has a square corner or is not punched with a "12" in the controlling column, the card brush circuit will not be completed at "12" and the card would normally be rejected, but in this case the MCI setup brush will make contact at "12" completing a circuit from the MCI commutator, setup brush, R-1 resistance, sorting magnet and 1 ampere fuse, energizing the sorting magnet until the MCI holding brush opens the circuit on this second cycle. This card will be sorted into the "12" pocket with its preceding detail card.

After the MCI holding circuit has been broken on any cycle following the last detail card, it will not be energized again except from the card brush circuit. This latter condition explains why a second master card not preceded by a detail card will be rejected.

Adjustments—1. Adjust MCIR commutator brushes to have 3/16" projection from the holder.

2. Time MCIR commutator in accordance with chart shown on wiring diagram, Fig. 3.

3. Time special selecting commutator holding brush in accordance with chart shown on wiring diagram, Fig. 3.

4. MCI relay should be adjusted for .005" clearance between armature and cores, and .005" clearance between points.

5. Time the special offset card brush so that when the index indicator is set on the first or last column according to customer's requirements, the card brush will make contact at the edge of the cut corner when the card is 1/64" to 1/32" under the #11 chute blade.

Installation—Four holes should be drilled in left side of relay cabinet to accommodate two special resistance coil panels as shown in Fig. 1.

Remove stud and spring cover from rear side rail and remove cover assembly, as shown in Fig. 2.

Install mechanism bracket assembly complete, including MCI commutator, also brush holder assembly. (See Fig. 2).

Replace selecting commutator brush holder with special brush holder.

Install new worm shaft cover.

Install cable assembly and connect same as shown on diagram, Fig. 3.

FIG-1

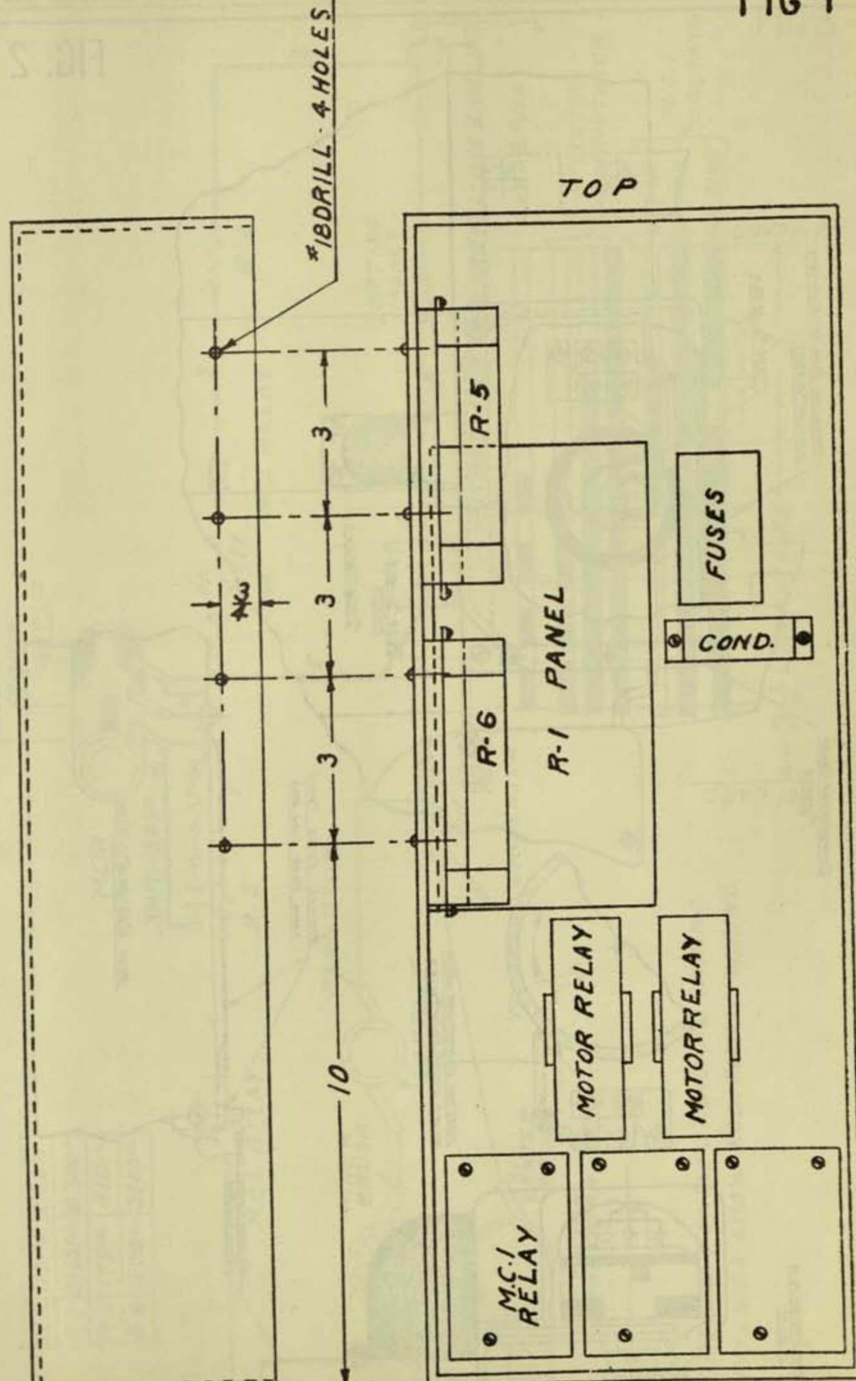
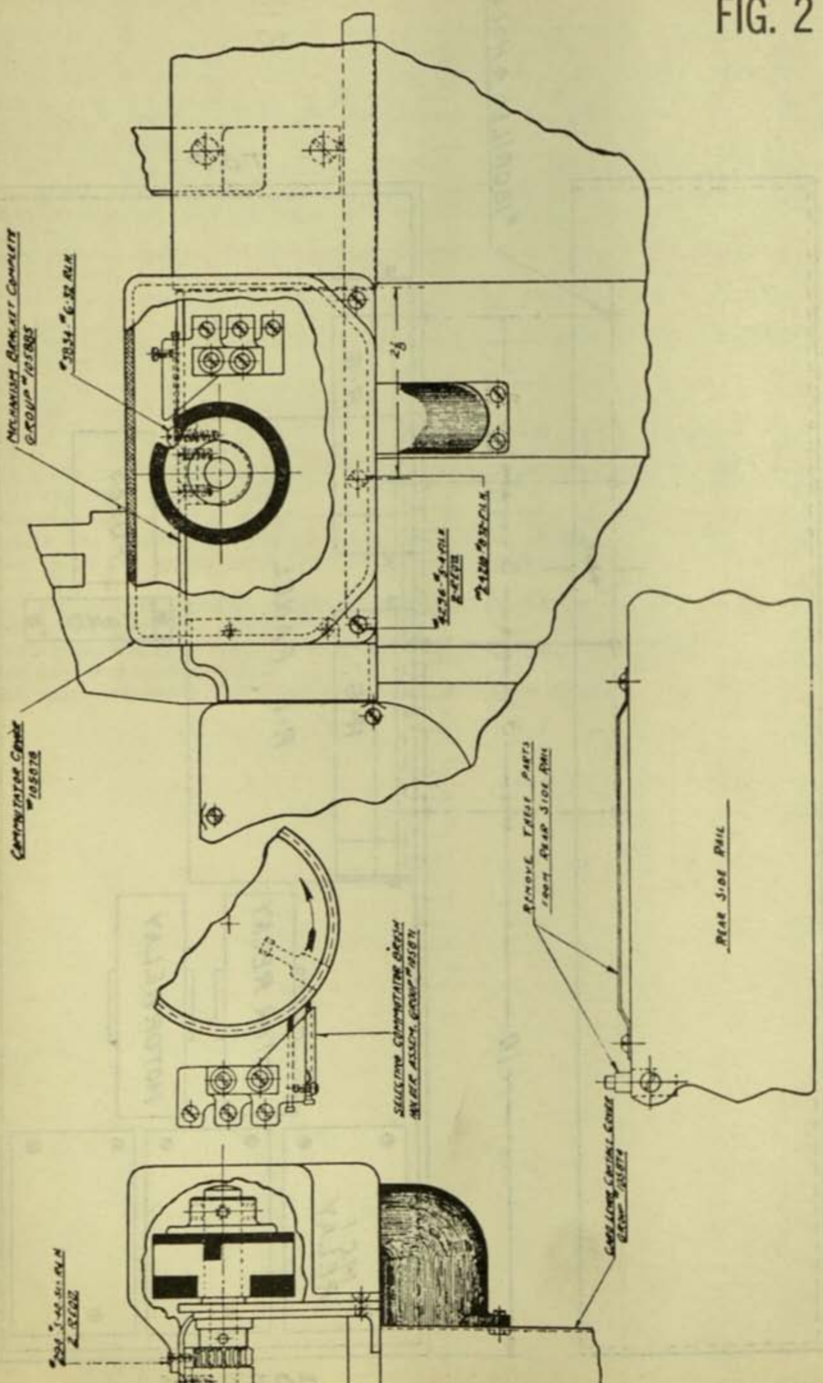

#18DRILL · 4 HOLES
TOP
R-5
R-6
R-1 PANEL
FUSES
COND.
MOTOR RELAY
MOTOR RELAY
M.C.1 RELAY
3
3
3
10
BOTTOM

FIG. 2



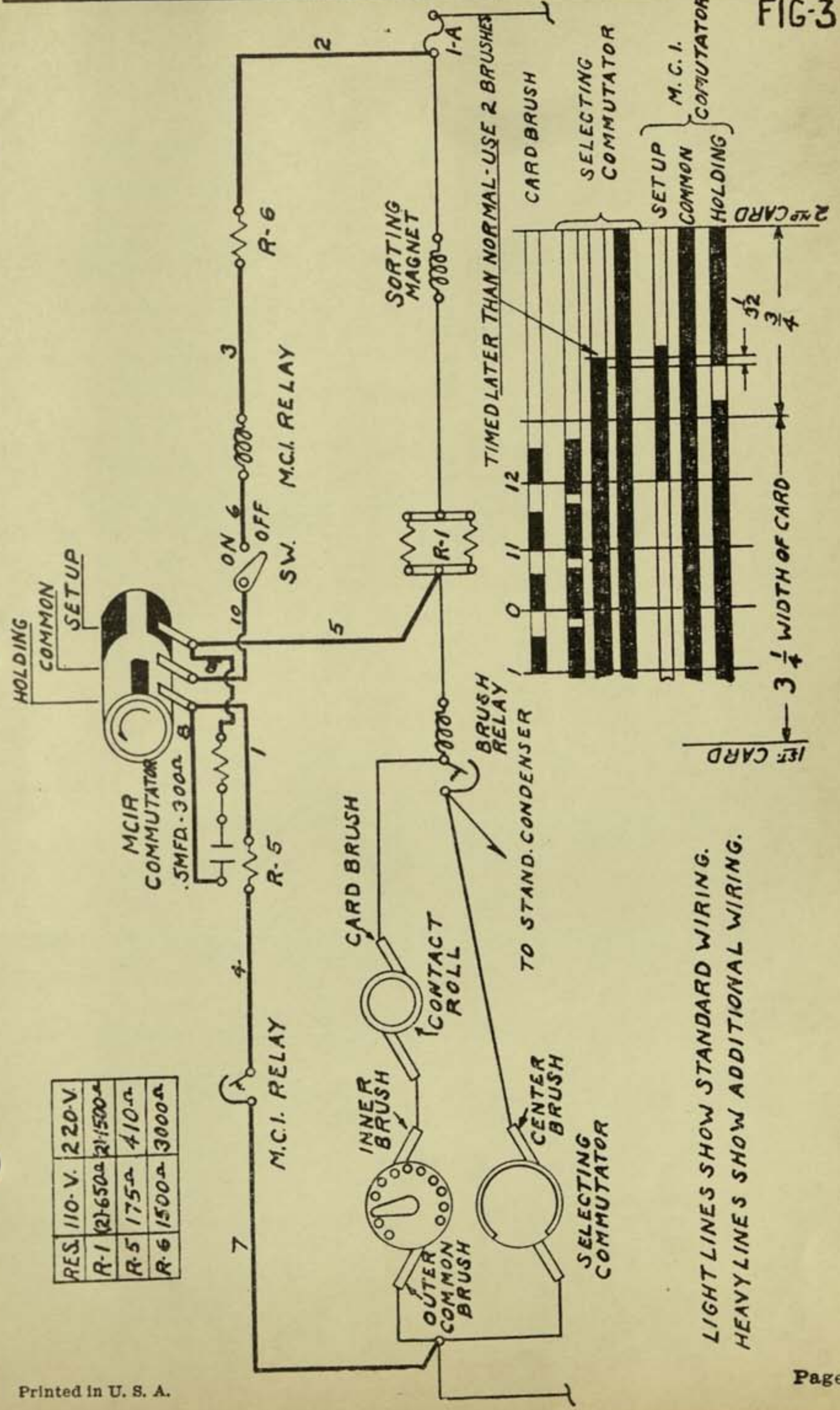


FIG-3

LIGHT LINES SHOW STANDARD WIRING.
HEAVY LINES SHOW ADDITIONAL WIRING.

TOTAL CARD COUNTER

The Total Card Counting attachment for the Horizontal Sorter is a device for counting all cards that pass through the machine. The counter is mounted under the magazine at a suitable angle to permit easy reading. The counter is operated electrically, has maximum capacity of 99,999 cards and it may be reset to "O" by turning the knurled knob on the end of the center shaft.

The mechanism consists of a "Veeder" counter and the necessary contacts and electro-magnet for operating it. The Veeder counter, electro-magnet, armature, and operating levers comprise one complete assembly. The armature is of the oscillating type and when the electro-magnet is energized, a pull is exerted on the armature which turns it sufficiently to operate the Veeder counter through a combination of levers. The travel of the armature is limited by fibre stops which arrest the main operating lever and insure silent operation.

The armature is returned to its de-energized position by a spring incorporated in the armature and attached to a clamp under the bearing cover. The spring tension may be adjusted by loosening the bearing cover and turning the clamp slightly. However, this should not be necessary, as it is properly adjusted before leaving the factory.

The contacts necessary to operate the counter magnets are the commutator with brushes and a special card lever contact. The commutator is made in two sections so that it may be easily clamped to the card feed knife crank shaft. It contains only one segment of a conductive material and completes a circuit, through this segment and the two brushes on each card cycle. (See fig. 1).

The card lever contact is of the double "make" type; that is, two circuits are completed at once. The outer contact is used in the card counting circuit and the inner contact in the control circuit. The automatic po ket stop contact is connected in series with the inner card lever contact.

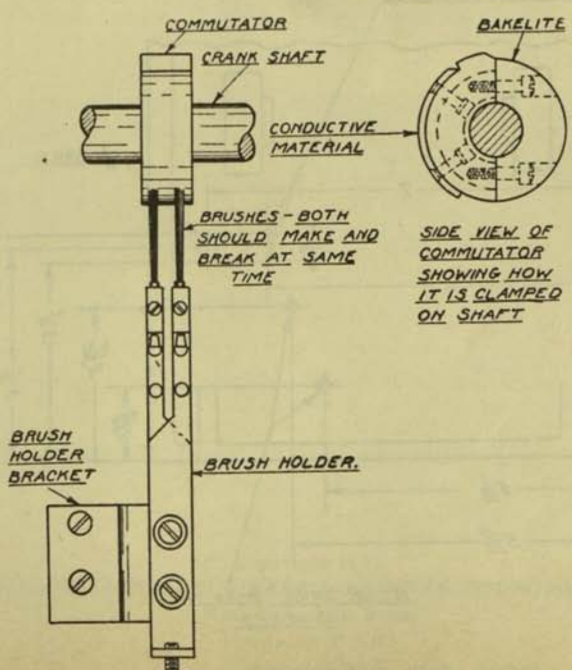


Fig. 1

The card counter is connected in series with both the special commutator contact and the outer card lever contact. Therefore, when both are closed at the same time, which occurs each cycle that cards are feeding, a circuit is completed thru the counter magnets and the counter adds "one." (See diagram).

The attachment may be installed on machines already in the field in the following manner:

Replace the card lever contact with the special double point contact provided.

Install the commutator on the card feed knife crank shaft.

Drill and tap the right end casting as per Fig. 2. The two 5-40 holes are for mounting the brush bracket. The two 14-24 holes are for mounting the counter bracket. The 3/8" hole is for the insulating bushing.

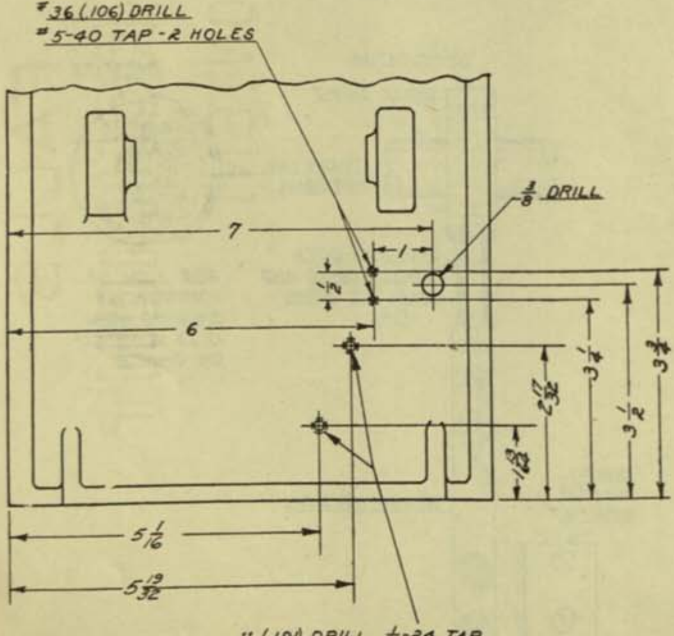
Install the brush bracket and brush assembly. Square end brushes should always be used and must be adjusted until they just clear the bakelite portion of the commutator.

Install the card counter bracket and card counter. The face of the card counter protrudes slightly thru a hole in the front of the right end cover.

Install fibre bushing in the 3/8" hole in right end casting. Rewire the machine according to wiring diagram. No resistance is necessary with this style counter, except in the first few 220 volt machines. The two coils are connected in parallel for 110 volt operation, and in series for 220 volt operation. However, they will be connected in parallel when shipped from the factory for installation on machines in the field and must be changed by the repairman before being installed on 220 volt machines.

Time the commutator so that the brushes make contact just after the center brush leaves the brass segment of the selector commutator.

Install the new end cover and test the machine, making sure that the counter operating lever does not strike the cover. The head of the screw that clamps the operating lever to the counter shaft should be down.



RIGHT END CASTING
OF HORIZONTAL SORTER.

Fig. 2

PREVENTIVE MAINTENANCE — Sorter Type 80

CONTENTS

New York, New York
Printed in U.S.A.
Form 22-5746-2

PREVENTIVE MAINTENANCE

Sorter, Type 80

DRIVE AND CARD FEED MECHANISM

I. Cleaning

Brush out thoroughly all accumulated card dust and dirt from card magazine and feed area into waste basket or suitable container, never on the floor. Clean all dirt and old grease from worm gears, drive shaft, and oil holes of feed roll bearings.

II. Inspection

1. Feed. (*see General Section—Horizontal Feeds*)
   (a) CLEANING
   (b) FEED KNIFE ADJUSTMENTS
   (c) FEED KNIFE GUIDE SLIDES
   (d) CRANK SHAFT AND CONNECTING LINK BUSHING for wear indicated by excessive movement of feed knife slide assembly.
   (e) EVEN FEEDING OF CARDS
   (f) HOPPER SIDE PLATES
   (g) ROLLER THROAT
   (h) FEED ROLL TENSION particularly on first three sets of gears. Also, check for wear on these.
   (i) HOPPER POSTS

2. Horizontal Shaft
   (a) WORM GEARS for wear and lubrication.
   (b) THRUST BEARING for wear and lubrication.
   (c) REVERSE LOCK for wear on pawl and spring retaining washer.
   (d) DRIVE PULLEY for wear and looseness on shaft.

III. Lubrication

IBM 6

(1) Index spindle.

IBM 9

(1) Feed roll bearings, both upper and lower.
(2) Oil cups on horizontal shaft bearing.
(3) Reverse lock mechanism including the spring retaining washer.
(4) Feed knife assemblies.

IBM 17

(1) Large worm gear at hopper end of horizontal shaft.
(2) Feed roll drive worm gears.

IBM 21

(1) Feed knife crank shaft and operating arms bearings.
(2) Thrust bearing on pulley end of horizontal shaft.

SORTING MECHANISM

I. Cleaning

Remove card guide and sort magnet armature and thoroughly clean all dirt and card lint from machine. Be sure and clean all dirt from stop studs on bottom of card guide, but do not use Trimite to clean these. Replace the guide and armature after inspecting them for wear. Be sure and clean dust from between contact roll and common brush bracket.

II. Inspection

1. Sort Magnet Armature for wear and worn residuals while armature is off, and adjustments after re-installing it. Be sure and check for proper return spring tension after checking chute blades.

2. **Chute Blades** for wear, proper tension and adjustments. A fast way of checking some chute blade adjustments is by use of a gauge made in the following manner:

   Cut an old chute blade into a strip about 9" in length. Finish one end so it is straight and square. About 1/4" from the end scribe a line across the chute blade. Mark off eleven more lines 1/4" apart from this line. This will make 12 scribed lines. Scribe another line 2 13/16" from the last line. When the gauge is inserted into the chute blades through the throat to this line, it will show the proper position of the #9 chute blade and the following blades as they are 1/4" apart. This can be used for positioning of new blades when they are installed. This gauge can be used to check the card guide end adjustment as it is .008" thick.

   Check chute blade tips with chute blade gauge. Gauge should slide under tips and not hit end of blades. This will test chute blade tips for cards passing under the tips.

   Slide gauge through so all chute blades are resting on top of gauge. Attract sort armature. Withdraw gauge and check each blade to see if gauge will slide over each tip and not hit end of chute blade. This will test each chute blade tip for card passing over the end of chute blade.

   Check clearance between card guide and card guide end with gauge.

3. **Commutator**
   (a) CLEANING. Remove commutator and clean segments and switch contact spots with Trimite Paper. Replace commutator if badly worn.
   (b) SWITCH CONTACT STRIPS for good tension.
   (c) BRUSHES for wear and timing. If it is necessary to replace a brush be sure to stone the face slightly to remove any sharp edges that would cut and wear commutator.

4. **Sorting Brush Holder Assembly** for freedom of contact plunger, worn or loose locating pins and centering of brush in hole. Centering of brush can be checked by punching a group of cards in all positions 9 through 12 in columns 1-40-80. As these cards run through the machine with the sorting brush on one of these columns, any variation of the brush from the middle of the punched holes can be easily seen.

5. **Sort Brush** for wear and timing. When the brush has a positive potential with respect to the contact roll, an insulating film is formed on the face of the brush which either prevents or delays the impulse through the hole in the card, and when it has a negative potential with respect to the contact roll, the chance of building up the insulating film is minimized to a large extent. This can be checked by raising the card brush from the contact roll, turning the machine until the sort commutator is resting on a segment and determining the polarity of the contact roll with a voltmeter. If the negative terminal of the voltmeter is placed against the card brush holder and the positive terminal against the contact roll and the meter deflects in the proper direction, no change is necessary in the machine. If, however, the voltmeter reads backwards, the output leads of the selenium rectifier should be reversed on AC machines. On DC machines, it will either be necessary to provide polarized plugs on the attachment cord or identify the plug and instruct the operator so that the attachment cord will always be plugged in the same way. The wiring to the polarized plug must be such that the brush will be negative with respect to the contact roll when inserted. WHEN POLARITY IS REVERSED, CLEAN ROLL AND REPLACE CARD BRUSH.

6. **Sort Magnet Armature Knockoff** for timing and wear. The sorting magnet armature knockoff is now adjustable in order that it may be effective at all times, and consists of a threaded stud mounted in the third lower feed roll assembly and held in position by a locking nut. The stud should be adjusted for a clearance of .005" to the sorting magnet armature with the magnet de-energized and the armature held in position at the limit of its upper travel by spring tension.

III. Lubrication

IBM 9

(1) Very slight amount on sort magnet armature pivots.
(2) Spindle pivots bearings and positioning rollers.

IBM 17

(1) Very light film on surface of commutator.
(2) Cotter pin where it hooks the spring and where it comes through the hole in the sort magnet armature.

BASE

I. Cleaning

The entire base of the machine, including legs and braces, should be cleaned with a rag dipped in cleaning fluid.

II. Inspection

1. **Stacker Pockets** (see *General Section*). Also check card deflectors for wear.
2. **Card Levers and Pocket Stop** (see *General Section—Card Levers*).
3. **Duo Relays** (see *General Section*).
4. **Slate Base Relays.** Particular attention should be paid to the brush relay as this receives the most wear.
   (a) ARMATURE PIVOT SCREWS for wear. If worn out of round, these should be replaced. Remove the relay from the machine to replace and re-adjust the pivot screws properly. Use IBM 6 on these.
   (b) ADJUSTMENTS of .005" between armature and cores when attracted, and .008" between contact points when de-energized.
   (c) RETURN SPRING for good tension.
5. **Drive Motor** (see *General Section—Motor Generators*). Excessive tension of the "V" Belt on Type 75 and 80 machines reduces the life of the belt and the left hand bearing of the horizontal drive shaft, and also reduces the speed of the machines. Tests have been conducted which have shown that the "V" Belt on this machine should be relatively loose in comparison to the tension applied by most customer engineers. The proper tension may be obtained by adjusting the motor platform so that when the belt is grasped at the top of the base there will be a barely perceptible movement of the motor platform as the distance between the inner faces of the belt at this point is reduced to between 1¾" to 2". Care should be taken to tighten the motor platform adjusting screw properly so that it does not settle and destroy this adjustment. Lubricate the motor with a few drops of IBM 9 lubricant.
6. **Bijur System** (see *General Section*).
7. **Veeder Counters** for armature travel and freedom of movement. Lubricate with IBM 6.
8. **75 Vertical Shaft.** Clean commutators with rag soaked in cleaning fluid. Check commutators and brushes for wear and timing. Lubricate commutator surfaces with very light film of IBM 17.
9. **Contact Roll Cover Switches and Latch.** Check for proper operation.

TESTS

RUN A STANDARD test deck, 9's first, then 12's first to check all chute blades and sorting into all pockets. Check especially for any nicking or marking of the cards.

Machines equipped with special devices should have test decks run through to check these units.

IBM CUSTOMER ENGINEERING REFERENCE MANUAL

PREVENTIVE MAINTENANCE

Accounting Machine Type 285

CONTENTS

New York, New York
Printed in U.S.A.
Form 22-5751-0

PREVENTIVE MAINTENANCE
Accounting Machine, Type 285

CARD FEED UNIT

I. Cleaning

All dust and dirt should be brushed out of the hopper. Remove contact roll and brush assembly to clean feed unit properly. An easy way to clean dirt from the surface of the feed rolls is to hold the end of a card that has been dipped in IBM 6 lubricant and allow it to drag between two rolls while they are turning. This wiping action will take most of the dirt off the rolls. Be sure that all dirt and foreign material is removed from the gear teeth, as this will cause the gears to bounce and result in uneven feeding of the cards.

II. Inspection

1. Feed Unit

(a) FEED KNIFE for an even projection of .0045"-.005". Use a leaf gauge and check by feeling for a projection over the edge of the gauge.

(b) CARD LEVELERS for $\frac{1}{64}$" clearance to top of cards.

(c) THROAT BLOCK for having crown in line with top edge of throat knife.

(d) THROAT KNIFE for wear and for .008"-.010" opening. If the throat block is properly adjusted, an .008" gauge should pass freely through in the three directions, but a .010" gauge should not pass.

(e) HOPPER SIDE PLATES. These should be checked for proper card brush alignment and far enough apart to allow .005"-.008" clearance over the length of the card. This can be easily checked by inserting a card between the hopper side plate and the cards in the hopper. Adjusting the filler plates for a snug fit of this card will give approximately .006"-.007" clearance.

With brush assemblies in the machine, run in cards punched 5 in alternate columns, stopping the machine between 7 and 6. Remove contact roll assemblies and check alignment of the punched holes with the separator slots. Each punched hole must be exactly centralized over the space between separators. This should be checked with the cards against first one side and then the other side of the hopper bed. If the two sets of brushes are not in line with each other, adjust the entire brush holder and separator assembly of one set. The brush holder and separator assembly can be shifted slightly because of oversize holes for the mounting screws.

(f) FEED ROLL TENSION for being even all the way across. Check this with power off by inserting four strips of a card between the rolls, and comparing the tension as each strip is pulled out of the rolls. Repeat at five or six different points throughout the cycle. If tension is not even, look for worn feed roll bearings, bent feed rolls, foreign matter in feed roll gears which causes the feed rolls to separate, or misalignment of the feed roll gears on the two ends which will cause the gears to climb up on the teeth. The last can best be remedied by loosening the two set screws in both gears, and turning the feed roll slightly so that the set screws will find new seats. Run the machine a few cycles to allow gears to fully mesh and tighten the set screws.

When tightening the drive gear, set it for no more than .004" end play. Remove the feed roll pressure bracket to check this.

As a final check to make sure that the feed rolls are not weaving in and out, run the machine and watch both end bearings of the feed rolls on the *inside* of the feed castings. Any perceptible movement may cause the cards to be fed unevenly, resulting in arcing of the brushes or other improper operations. The above test should be made with *no cards* being fed, because when cards are fed, the feed rolls do move back and forward the thickness of the cards.

2. Brush Assemblies (see *General Section*)

(a) CLEANING

(b) BRUSH SEPARATORS

(c) BRUSHES
(d) 1/8" PROJECTION
(e) BRUSH ALIGNMENT TO SCRIBED LINE
(f) BRUSHES EVEN SPACED BETWEEN SEPARATORS
(g) BRUSH TRACKING
(h) BRUSH TIMING

3. Card Levers (see *General Section*)

4. Stacker

(a) BROKEN STACKER SPRINGS
(b) TIMING to grip cards in middle of "9".
(c) ESCAPE VALVE at top of dash pot so that the stacker table returns fully to normal when released, but so that it does not strike with force.

5. Feed Clutch

(a) WEAR particularly on the driving pawl and the release pin for looseness. Either of these conditions may cause a "chattering" clutch. It is necessary to remove the drive pulley to check these. Do not forget that the screw holding the drive pulley is a left-hand thread.
(b) LATCH for unlatching and re-latching clearances.
(c) CLUTCH MAGNET CONTACT for dirt, burnt points and adjustment.

6. Card Feed CB's (see *General Section—Circuit Breaker Cams*)

7. Contact Roll Assembly for freedom of movement and no burnt or arced spots. Also check contact plungers for freedom of operation.

III. Lubrication

IBM 6

(1) CF-CB cam follower rollers, followed by IBM 17.
(2) CF-CB cam contact pivot points.

IBM 9

(1) Cross beam bearing surfaces.
(2) Cross beam links at pivot points.
(3) All gear shaft and feed roll bearings on both sides of the feeds.
(4) Idler gear bearings on both sides of the feed.
(5) Two oil cups, one on each of the CF-CB shafts.
(6) Feed roll pressure bracket oil wells.
(7) Clutch and drive pulley pivot points.
(8) Drive motor bearings.
(9) Stacker drive gear pivots.
(10) Stacker drum pivots.
(11) Card weight roller pivots.
(12) Contact roll bearings and gear chain driving the contact roll. These are located inside the side castings alongside of the brush assembly.

IBM 17

(1) Light film on gear teeth.
(2) Very light film on linen dilecto CF-CB cam surfaces.
(3) Stacker opening cams.

COUNTER UNITS

UNLESS A COUNTER has been giving trouble, it need not be removed from the base when inspected. If ever a counter has to be removed from the base to replace a part, take advantage of the opportunity to lubricate all cams and followers accessible from the bottom of the counter.

I. Cleaning

Clean all old grease and dirt from the unit. If too much lubrication has been used in the past, oil and dirt sometimes accumulates between the add magnet cores and their armatures. This can be wiped off with a rag soaked in cleaning fluid at the time the add magnets are removed for inspection of their armature residuals.

II. Inspection

1. Lower Counter (see *601 Section for details*)
   (a) ADD WHEEL CLUTCH GEAR
   (b) ADD MAGNET ARMATURES
   (c) CLUTCH TEETH OVERLAP
   (d) OVERTHROW LOCK ASSEMBLY
   (e) CARRY MAGNET

2. Upper Subtract Counter
   (a) SUBTRACT MAGNET ARMATURE for loose pins.
   (b) LATCH LEVER for overlapping the latch by $\frac{1}{32}$". This will also indicate that the unlatching clearance is right. If it is too great, the unlatching will be sluggish, resulting in "adding over."
   (c) SUBTRACTION PAWL for overlap on ratchet. This should be $1/4$ tooth at any line of index, and $\frac{1}{64}$" to $\frac{1}{32}$" at "F". See next item for test of this under power.
   (d) HEX NUT for adjustment by tripping off the adding clutches, unlatching the three-point latches and turning the three-lobe cams. As soon as the roller starts up the high dwell, the clutch should start disengaging.

   This adjustment must be made carefully, because a too low setting of the hex nut will prevent the clutch teeth from bottoming.

   To check under power the hex nut and subtract pawl overlap settings, plug the counter to subtract, and subtract all 9's in the counter. The adding wheels (except the ninth position) should not move when subtracting 9's. Remove carry magnet wire to prevent carrying of elusive 1 to units position.

   If all the adding wheels "rock", it indicates that the clutches are not disengaging early enough to prevent "nipping". The overlap of the subtraction pawl on the ratchet will have to be increased by changing the relationship of the intermediate gears. If only one or two wheels "rock", the hex nut adjustment for these positions should be changed.
   (e) LOWER COUNTER ARMATURE KNOCKOFF for alignment with the add magnet armature and for adjustments. Place a light at the back of the counter and check to see that the armature knockoffs extending downward into the lower counter from the top counter line up laterally with the armature, when the rollers are on the high points of the three-lobe cams. At this point check also each lower armature knockoff by pushing the lower armature with a screwdriver back against its cores. There should be increased spring tension on the armature as soon as it is moved.

   With the three-point latches latched and the rollers in the low dwells of the cams, the add magnet armatures should unlatch the clutch lever without touching this knockoff. This applies to the earlier as well as to the present type of lever.

   The above checks on the lower counter armature knockoff adjustments are very important because improper knockoff action may result in "7 over" trouble when subtracting 9's. If any individual positions fail to meet these conditions, it will be necessary to bend the individual knockoffs.

3. Top Counter Moulding Assembly (see *601 section for detail*)

4. Counter Reset Clutches for freedom operation and proper adjustment of the reset shaft collar which will position the reset shaft gear on its shaft so that when the clutch is manually engaged, the coupling pins will operate freely into the reset shaft gear (with the machine in a latched position). Also check for loose screws in the kick-over fingers.

III. Lubrication

IBM 6

(1) Adding clutch lever pivots.
(2) Adding clutch gear pivots.
(3) Add wheels.
(4) Top counter shaft pivots.
(5) Three-lobe cam pivots.

IBM 9

(1) Clutch disengaging lever bail pivots.
(2) Overthrow lock pivots.
(3) Carry lever bail pivots.
(4) All bearing on both side plates.
(5) Oil wells in counter drive shaft bearings under each counter.
(6) Oil well in counter reset shaft bearings in front of each counter.

IBM 17

(1) Clutch grooves on add wheel clutch gears.
(2) Overthrow and carry lever bail cams.
(3) All cam surfaces under counter; these should be lubricated every time counter is removed.
(4) Light film on the inside surface of the top counter mouldings any time they are removed.

PRINT MECHANISM

I. Cleaning

This will be covered in each unit under the inspection heading.

II. Inspection

1. **List Mechanism** The carriage and magnet unit should be removed to inspect properly the mechanism under them.
   (a) CLEANING. Wipe off all dirt and old grease from bearing surfaces.
   (b) ROCKER SHAFT for wear and loose pins.
   (c) MAGNET UNIT STOP PAWL RESTORING MECHANISM for wear and binds. These should work freely and not bind with one another.
   (d) LIST CAM for freedom from bind on its shaft and for wear of internal cam. The cam rocking on its shaft when the machine is set to tab and cards are feeding is an indication that the cam is not properly lubricated.
   (e) LIST CAM FOLLOWER ROLLER for wear and freedom of operation.
   (f) LIST CAM PAWL for loose pivot, freedom of operation, and unlatching clearance.
   (g) HAMMER TRIP LEVER ARMS for wear on the end that operates against the side operating links. A small amount of wear here can cause one side to trip off before the other.

2. **Total Print Mechanism**
   (a) CLEANING. Wipe all dirt and old grease from bearing surfaces. Wash any grease from reset clutch contact and "P" cams with cleaning fluid.
   (b) RESET CLUTCH for freedom of operation, worn pivots and adjustments.
   (c) WORM GEAR for wear and proper lubrication.
   (d) "P" CAMS (see *General Section—Make and Break Cam Contacts*)
   (e) TOTAL PRINT CB's (see *General Section—Circuit Breaker Cams*). Timing on these should be set according to the total print list lap, but only after this total print list lap has been previously checked.

(f) TOTAL PRINT EMITTER. The brushes for wear and damage. Replace any that show a noticeable bevel. Apply a thin coat of IBM 17 lubricant to emitter. Time brushes so that they make before and break after total print CB's.

3. Magnet Unit

(a) CLEANING. Clean all dust and staples from unit. Check for paper clips among terminal posts.
(b) STOP PAWLS for freedom of operation.
(c) STOP PAWL RESTORING BAIL for relatching all stop pawls.
(d) KNOCKOFF BAR for adjustments.

4. Print Unit

(a) CLEANING. If the face of the type is dirty and filled with ink, crank the machine so that the type bars rise to their upper limit of travel and clean them with a plastic type cleaner. The type may be cleaned by rolling the cleaner over the face of the type. This operation will remove all ink and dirt in the type face. If both the type face and type tail are loaded with ink, the type unit should be taken off the machine and the type bars removed. Once the bars are removed, it is best to use a brush and completely clean the entire bar with cleaning fluid. At the same time, compress the type springs so that the ink may be thoroughly washed from the interior of the type case. It is essential that bars washed in cleaning fluid be re-lubricated with IBM 6.
(b) TYPE BARS BEFORE REPLACING for broken or weak type springs, worn type case, loose rivets, bent type, etc.
(c) TYPE BARS AFTER REPLACING for binds or sticky conditions. Return all type bars to their original position.
(d) SIDE OPERATING LINKS for wear and tripping off evenly. Both ends must trip at exactly the same time. Check this by turning the machine over by hand, going very slowly at the point where hammers fire.
(e) HAMMERS for broken springs and for free movement in their comb. They should all restore with the hammer bail with none of them lagging back. Any dirt in the comb will interfere with the hammer return.
(f) CROSS HEAD TRIP LEVER LATCH for even tripping of the trip levers and for wear where the trip lever comes up against the latch. This should also be checked by turning the machine over by hand, making sure that both trip levers do latch and that they both unlatch at exactly the same time.
(g) RESTORING BAIL OPERATING LEVER for loose shaft. This can be checked by removing both springs and holding one lever solidly in place; try to rock the other one. There should be little or no movement on one end that is not immediately transferred to the other end.
(h) LIST LAP. This should be checked for both list and total lap. The lap on the right-hand side can be easily seen by looking through the hole in that end. The lap on the left end can also be seen through the hole in the right-hand side if a thin strip of white paper is inserted between the last bar on the left and the side casting. By shining a light on to the right side of this paper, enough light will reflect back to the stop pawls to enable them to be seen easily.
(i) RIBBON FEED. Check the ribbon feed ratchet wheels for wear; see that when the ribbon reaches the end of the spool, the operating rivet in the ribbon will cause the ribbon to reverse.

5. Standard Carriage

(a) CLEANING. Remove as an assembly to clean out all paper dust and form staples. Use IBM #9 lubricant on all rollers and operating bails, and also on feed pawl and detent roller under carriage cover at left end of the assembly.
(b) PLATEN for proper clearance to type bars.

(c) PLATEN FEED RATCHET for proper spacing on both list and total. The detent roller should fully seat in the detent ratchet after each space. Check with carriage in both extreme right and extreme left positions.

III. Lubrication

IBM 6

(1) Hammer pivots.
(2) Type bars and type tails.
(3) Ribbon feed mechanism pivots.
(4) Magnet unit stop pawl pivots.
(5) Latch restoring pivots (both sides).
(6) Stop pawl restoring bail pivots (both sides).
(7) Print magnet armature pivots.
(8) Total print CB cam roller and pivots.

IBM 9

(1) Restoring bail pivots (both sides).
(2) Side operating link pivots (both sides).
(3) Two oil cups; one at each end of type bars.
(4) Type bar lift arm pivots.
(5) Cross head connecting link studs and pivots (both sides).
(6) Rocker shaft pivots (both ends and center).
(7) List and reset clutch pivots.
(8) List tab handle shaft pivots.
(9) List shaft bearing.
(10) Total print shaft (bearings at both ends and bronze gear).
(11) Worm gear bearings.
(12) Cross head trip lever latches at pivot points.
(13) Line spacing mechanism pivot points.

IBM 17

(1) Restoring bail operating levers where trip lever adjusting screws strike.
(2) Bottom tip of trip lever.
(3) Cross head pawl.
(4) Internal cut in list cam.
(5) All cam follower rollers on list and total cams.
(6) Total print CB cam rollers.
(7) Very light film on linen dilecto.
  (a) "P" cam surfaces.
  (b) TPCB cam surfaces.
  (c) Emitter surfaces.
  (d) Type bar lever bumper stop.
(8) Stop latch arm assembly.
(9) Line spacing cam and rollers.

IBM 21

(1) List cam grease fitting.

BASE

I. Cleaning

The entire machine should be wiped down with a rag soaked in cleaning fluid.

II. Inspection

1. "L" Cams (see *General Section—Make and Break Cams*)
2. Relays (see *General Section—Duo Relays*)
3. Control Panel (see *General Section*)
4. Motors (see *General Section*). Check both drive and reset motors.

III. Lubrication

IBM 6

(1) Duo relay armature pivots.

IBM 9

(1) Motor bearings (only a small amount).
(2) Control panel pivot frame.

IBM 17

(1) Light film on linen dilecto cam sufaces of "L" and total print CB cams.
(2) Cam follower rollers on total print CB's.
(3) MCR armature pivot points.

TEST

CUT THE CB duration down to ⅛" by advancing the break time. Then use a 200 card test deck to check list, add, subtract and control. If in proper condition, the machine should work correctly on this short duration time.

ALPHABETICAL ACCOUNTING MACHINE

TYPE 405

Customer Engineering Reference Manual
EAM Section 405

CONTENTS

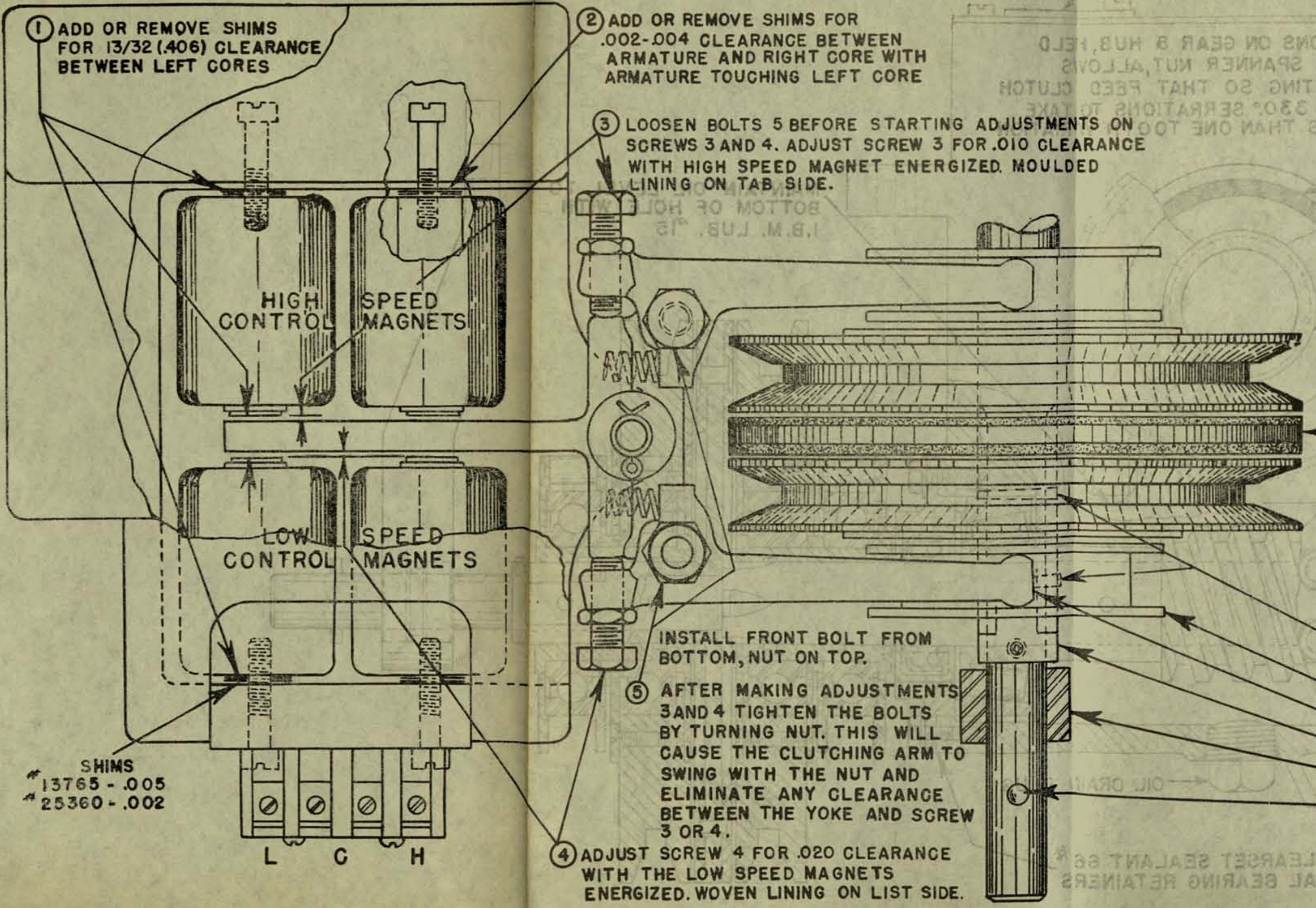
NEW YORK, NEW YORK
Printed in U. S. A.
Form 82-3075-0—1500—JCP—2-51

TWO SPEED CLUTCH MAGNET UNIT

(1) ADD OR REMOVE SHIMS FOR 13/32 (.406) CLEARANCE BETWEEN LEFT CORES

(2) ADD OR REMOVE SHIMS FOR .002-.004 CLEARANCE BETWEEN ARMATURE AND RIGHT CORE WITH ARMATURE TOUCHING LEFT CORE

(3) LOOSEN BOLTS 5 BEFORE STARTING ADJUSTMENTS ON SCREWS 3 AND 4. ADJUST SCREW 3 FOR .010 CLEARANCE WITH HIGH SPEED MAGNET ENERGIZED. MOULDED LINING ON TAB SIDE.

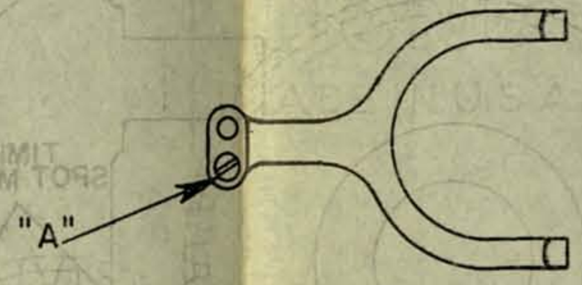


INSTALL FRONT BOLT FROM BOTTOM, NUT ON TOP.

(5) AFTER MAKING ADJUSTMENTS 3 AND 4 TIGHTEN THE BOLTS BY TURNING NUT. THIS WILL CAUSE THE CLUTCHING ARM TO SWING WITH THE NUT AND ELIMINATE ANY CLEARANCE BETWEEN THE YOKE AND SCREW 3 OR 4.

(4) ADJUST SCREW 4 FOR .020 CLEARANCE WITH THE LOW SPEED MAGNETS ENERGIZED. WOVEN LINING ON LIST SIDE.

ON MACHINES EQUIPPED WITH THE STYLE FORKED ARM SHOWN BE SURE THAT LOCKING SCREW "A" IS ONLY TURNED DOWN TO SEAT. ANY ADDITIONAL FORCING OF THIS SCREW WILL CAUSE THE FORKED ARM TO WARP AND RESULT IN THE DRIVE PULLEYS BINDING WHEN CHANGING SPEEDS.

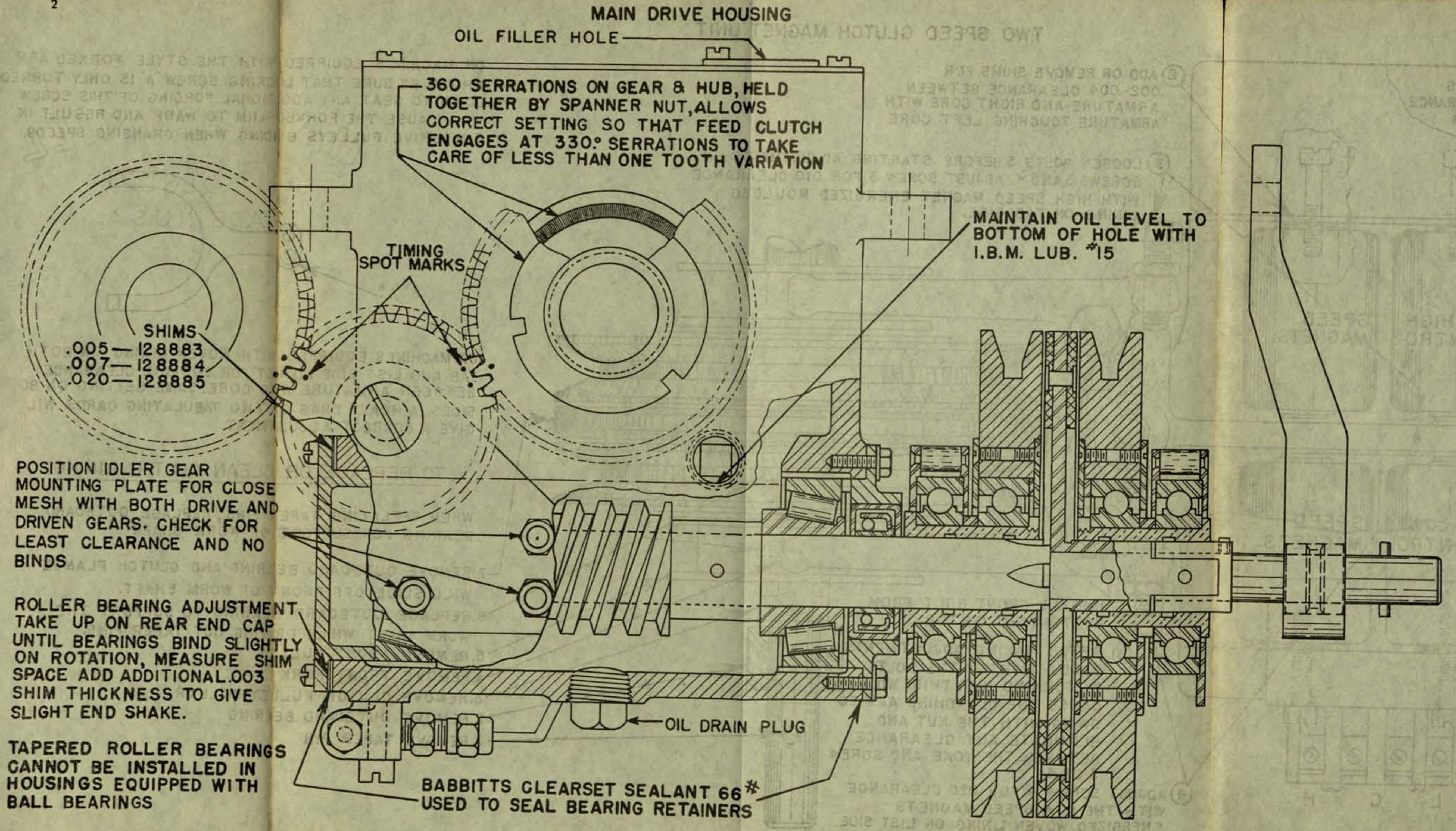


ON MACHINES EQUIPPED WITH WOVEN LINING ON BOTH TAB AND LIST SIDE ADJUST FOR .008-.012 CLEARANCE BETWEEN ARMATURE AND CORE. SAME SETTING ON BOTH SIDES. A HEAVY DRAG ON TWO TABULATING CARDS WILL GIVE A CORRECT ADJUSTMENT.

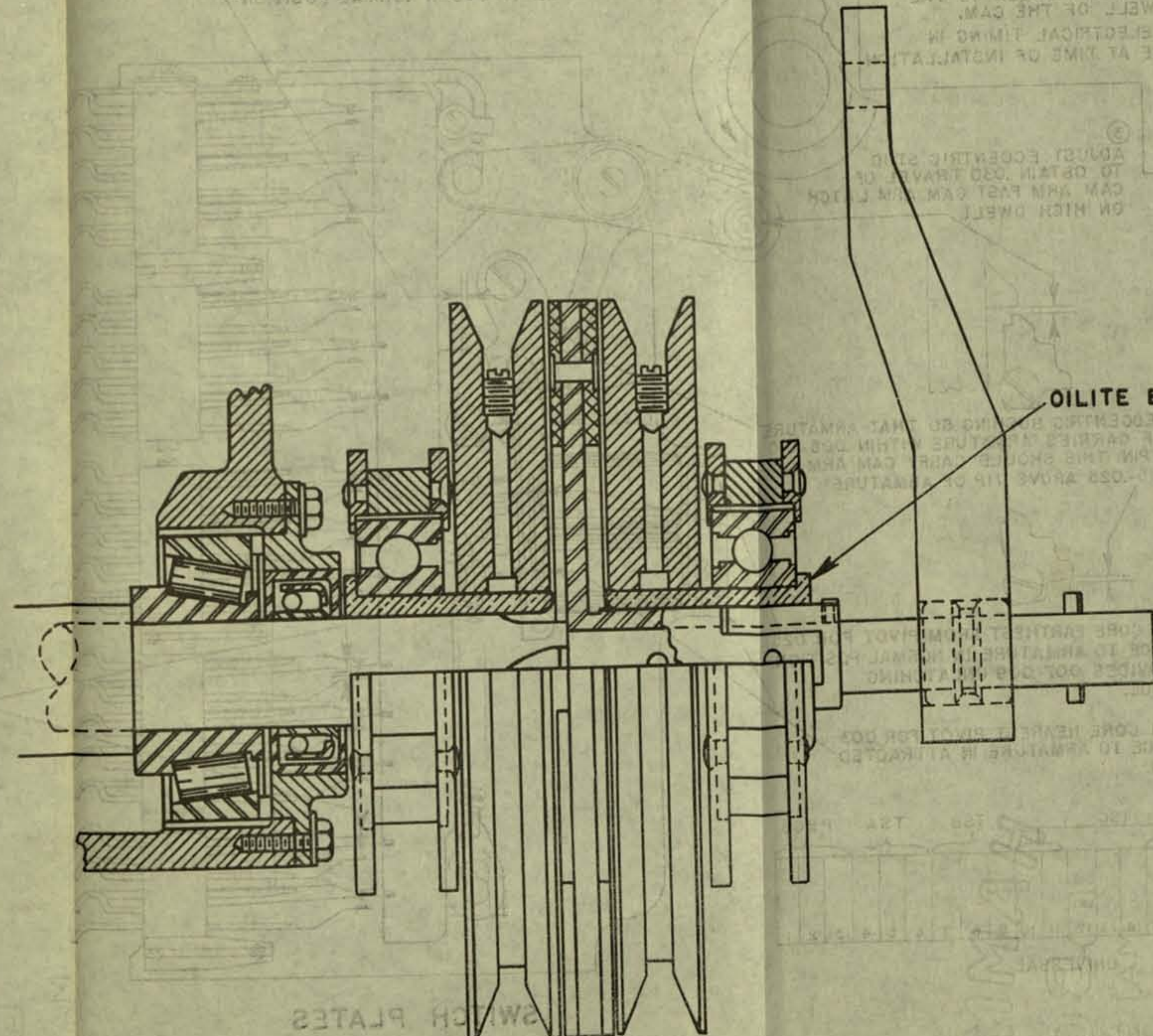
TO REPLACE OR CLEAN CLUTCH LINING

WHEN REPLACING TAPER PINS, REPLACE OUTBOARD BEARING FOR SUPPORT OF WORM SHAFT

7. REMOVE OUTBOARD BEARING AND CLUTCH FLANGE WILL SLIDE OFF FRONT OF WORM SHAFT.
6. REPLACE OUTBOARD BEARING TO SUPPORT THE WORM SHAFT WHILE DRIVING OUT TAPER PINS.
5. REMOVE FRONT PULLEY
4. REMOVE FRONT FORK
3. REMOVE CLUTCH PULLEY COLLAR
2. REMOVE OUTBOARD BEARING
1. REMOVE TAPER PIN


MAIN DRIVE HOUSING
OIL FILLER HOLE
360 SERRATIONS ON GEAR & HUB, HELD TOGETHER BY SPANNER NUT, ALLOWS CORRECT SETTING SO THAT FEED CLUTCH ENGAGES AT 330° SERRATIONS TO TAKE CARE OF LESS THAN ONE TOOTH VARIATION
TIMING SPOT MARKS
SHIMS
.005—128883
.007—128884
.020—128885
MAINTAIN OIL LEVEL TO BOTTOM OF HOLE WITH I.B.M. LUB. #15
POSITION IDLER GEAR MOUNTING PLATE FOR CLOSE MESH WITH BOTH DRIVE AND DRIVEN GEARS. CHECK FOR LEAST CLEARANCE AND NO BINDS
ROLLER BEARING ADJUSTMENT. TAKE UP ON REAR END CAP UNTIL BEARINGS BIND SLIGHTLY ON ROTATION, MEASURE SHIM SPACE ADD ADDITIONAL .003 SHIM THICKNESS TO GIVE SLIGHT END SHAKE.
TAPERED ROLLER BEARINGS CANNOT BE INSTALLED IN HOUSINGS EQUIPPED WITH BALL BEARINGS
OIL DRAIN PLUG
BABBITTS CLEARSET SEALANT 66# USED TO SEAL BEARING RETAINERS

TWO SPEED CLUTCH PULLEYS EQUIPPED WITH OIL HOLES



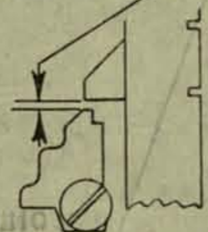
SWITCH PLATE UNIT

ON P.B.C.B. PLATES ADJUST ECCENTRIC STUD FOR .001-.002 CLEARANCE OF ROLLER TO THE LOW DWELL OF THE CAM.

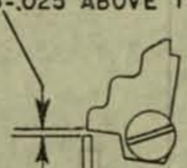
CHECK ELECTRICAL TIMING IN MACHINE AT TIME OF INSTALLATION

CAM ARM SHOULD OVERLAP CAM ARM LATCH .062 IN NORMAL POSITION

③ ADJUST ECCENTRIC STUD TO OBTAIN .030 TRAVEL OF CAM ARM PAST CAM ARM LATCH ON HIGH DWELL

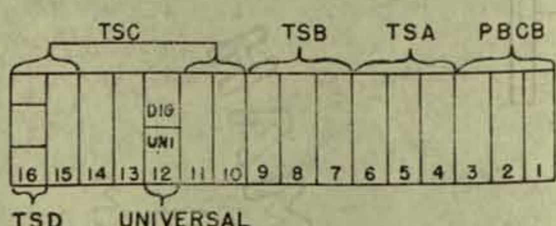


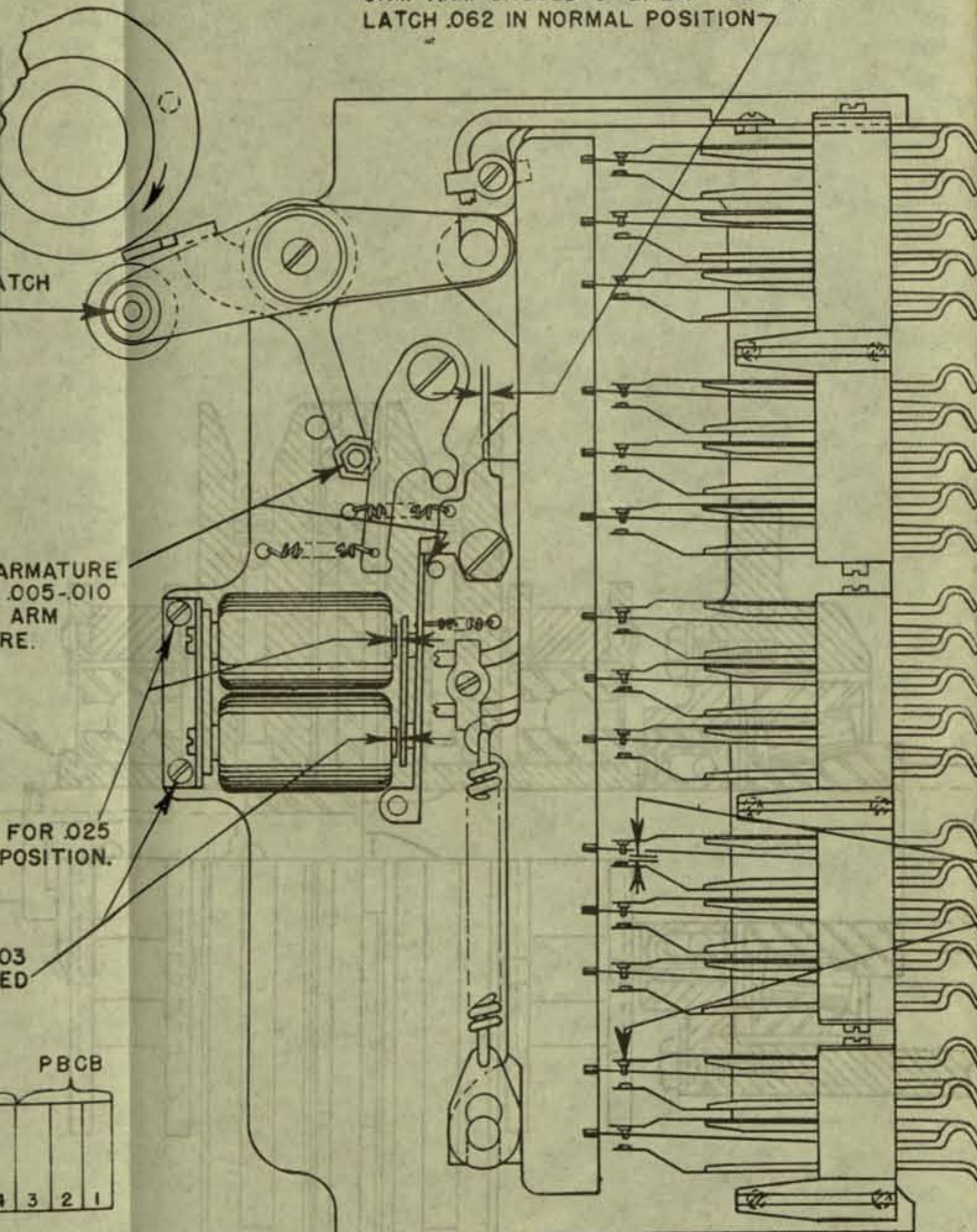
④ ADJUST ECCENTRIC BUSHING SO THAT ARMATURE KNOCKOFF CARRIES ARMATURE WITHIN .005-.010 OF STOP PIN. THIS SHOULD CARRY CAM ARM LATCH .015-.025 ABOVE TIP OF ARMATURE.



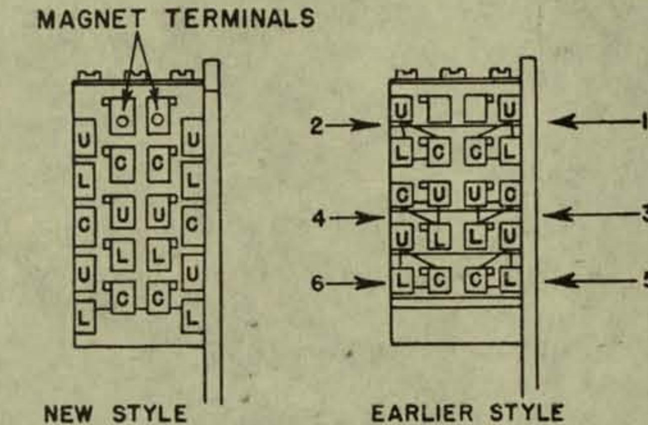
① POSITION CORE FARTHEST FROM PIVOT FOR .025 CLEARANCE TO ARMATURE IN NORMAL POSITION. THIS PROVIDES .007-.009 UNLATCHING CLEARANCE.

② POSITION CORE NEAREST PIVOT FOR .003 CLEARANCE TO ARMATURE IN ATTRACTED POSITION.





SWITCH PLATES



PBCB CONTACTS

ADJUST WITH CAM ROLLER IN CENTER OF DWELL AT 330°

.023-.025 AIR GAP UPPER CONTACTS M-336 B-186
.025-.028 AIR GAP LOWER CONTACTS M-202 B-250

TSA-TSB-TSC CONTACTS

WITH PLATE LATCHED ADJUST UPPER STRAP TO HAVE 1/64 TO 1/32 MOVEMENT AT CONTACT STRAP. CENTER AND LOWER CONTACT SHOULD HAVE .050 AIR GAP AT THIS TIME.

WITH PLATE UNLATCHED ADJUST LOWER STRAP TO HAVE 1/64 TO 1/32 MOVEMENT AT CONTACT POINTS. CENTER AND TOP STRAP SHOULD HAVE GOOD .040 AIR GAP.

TSA- M-300 B-186
TSB M-340 B-205
TSC M-335 B-184

PLATE #12

DIGIT TRANSFER CONTACTS .050 AIR GAP M-235 B-280

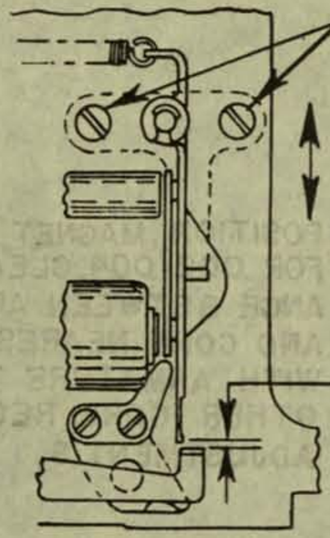
UNIVERSAL CONTACTS .018 AIR GAP M-168 B-222

TSD CONTACTS

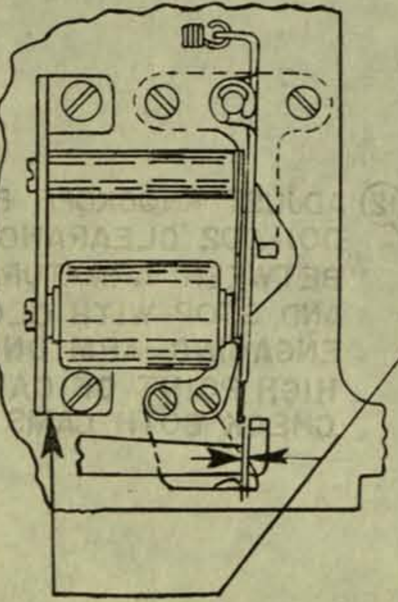
.050 AIR GAP IN NORMAL LATCHED POSITION M-335 B-184

CHECK ELECTRICAL TIMING ON CORRECT PRINT FOR MACHINE.

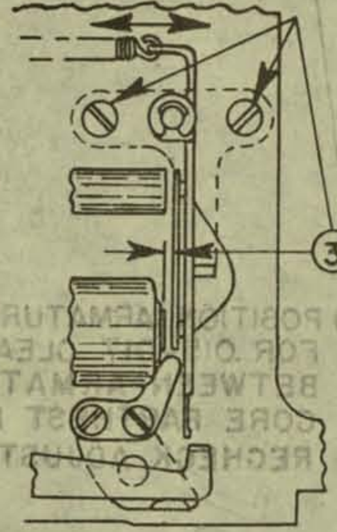
COUNTER-CANCELLATION MAGNET-ADJUSTMENTS



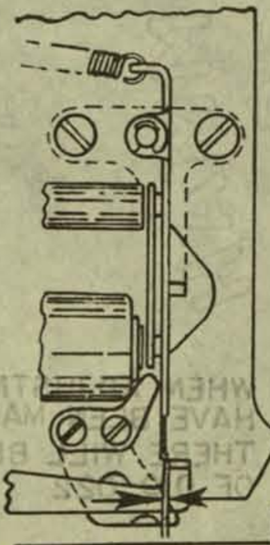
(1) POSITION ARMATURE PIVOT FOR .020-.025 TRAVEL PAST LATCH POINT WITH RESET ARM ON HIGH POINT OF CAM



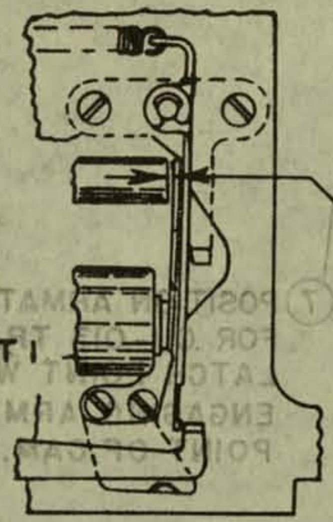
(2) POSITION LOWER CORE WITH ARMATURE IN ATTRACTED POSITION FOR .002-.004 UNLATCHING CLEARANCE



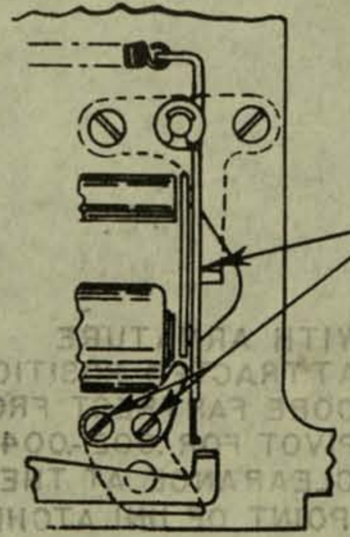
(3) POSITION ARMATURE BACKSTOP FOR .015-.017 CLEARANCE BETWEEN ARMATURE AND CORE FARTHEST FROM PIVOT. RECHECK ADJUSTMENT 1



(4) WHEN ADJ 2 & 3 HAVE BEEN MADE CORRECTLY THERE WILL BE AN OVERLAP OF .019-.022

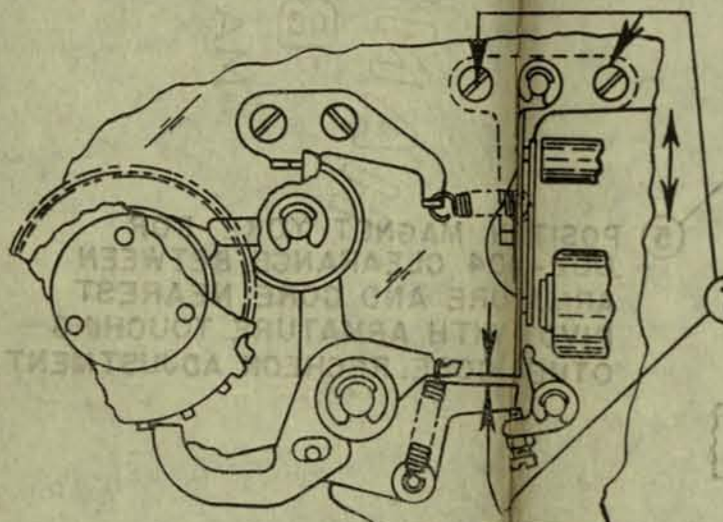


(5) POSITION MAGNET YOKE FOR .002-.004 CLEARANCE BETWEEN ARMATURE AND CORE NEAREST PIVOT WITH ARMATURE TOUCHING OTHER CORE. RECHECK ADJUSTMENT 2.

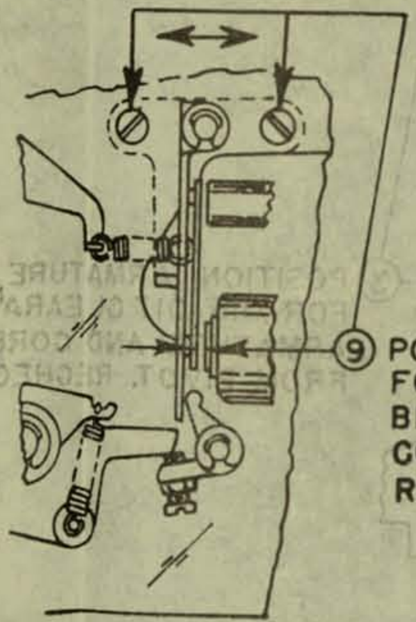


(6) ADJUST KNOCKOFF FOR .001-.002 CLEARANCE BETWEEN ARMATURE AND STOP WITH RESEST ARM ON HIGH POINT OF CAM

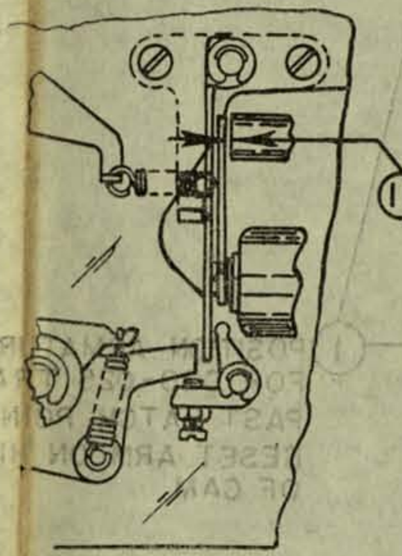
ADD MAGNET ADJUSTMENTS



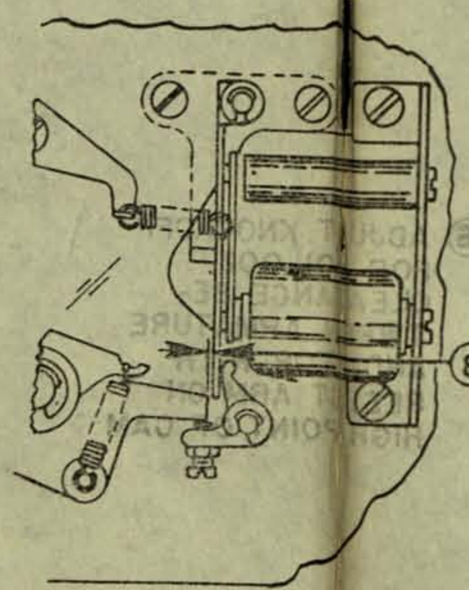
(7) POSITION ARMATURE PIVOT FOR .011-.013 TRAVEL PAST LATCH POINT WITH CLUTCH ENGAGING ARM ON HIGH POINT OF CAM.



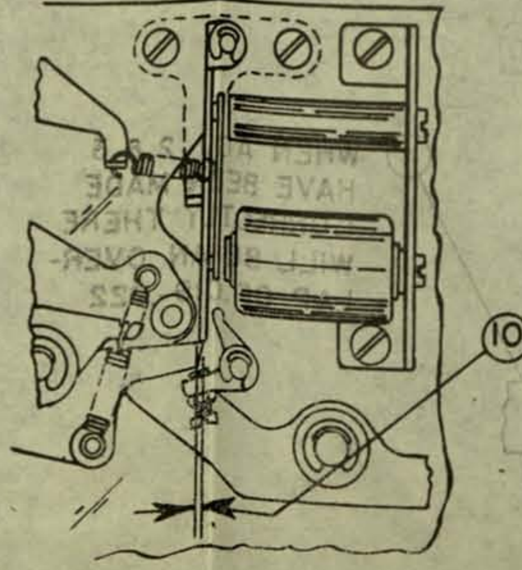
(9) POSITION ARMATURE BACKSTOP FOR .015-.017 CLEARANCE BETWEEN ARMATURE AND CORE FARTHEST FROM PIVOT RECHECK ADJUSTMENT 7.



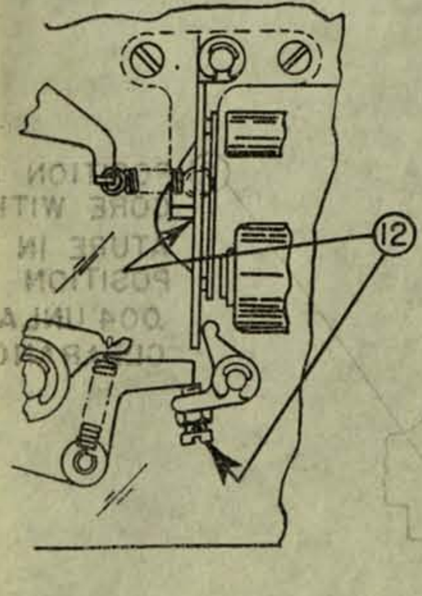
(11) POSITION MAGNET YOKE FOR .002-.004 CLEARANCE BETWEEN ARMATURE AND CORE NEAREST PIVOT WITH ARMATURE TOUCHING OTHER CORE. RECHECK ADJUSTMENT 8.



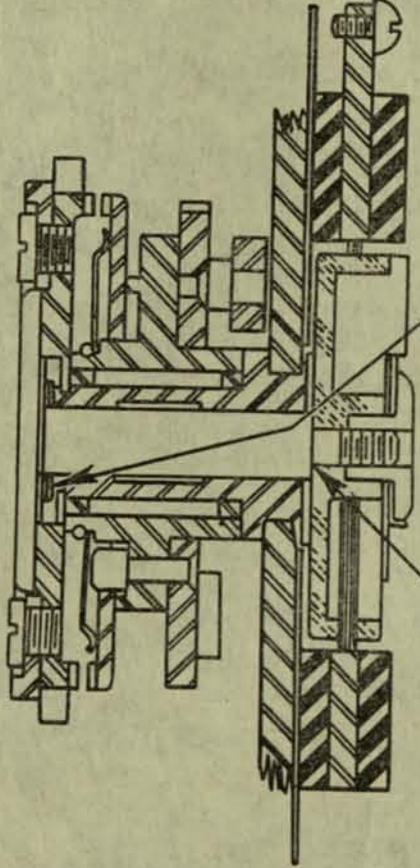
(8) WITH ARMATURE ATTRACTED POSITION CORE FARTHEST FROM PIVOT FOR .002-.004 CLEARANCE AT THE POINT OF UNLATCHING



(10) WHEN ADJUSTMENTS 8 AND 9 HAVE BEEN MADE CORRECTLY THERE WILL BE AN OVERLAP OF .019-.022



(12) ADJUST KNOCKOFF FOR .001-.002 CLEARANCE BETWEEN ARMATURE AND STOP WITH CLUTCH ENGAGING ARM ON HIGH POINT OF CAM CHECK BOTH CAMS



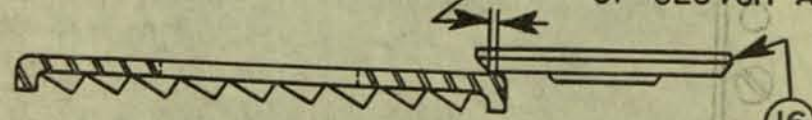
(13) ADD OR REMOVE SHIMS #123534 FOR .003-.010 CLUTCH CLEARANCE

(14) ADD OR REMOVE SHIMS #123534 FOR .001-.002 END SHAKE OF SHAFT

AFTER ADJUSTING (14) CHECK FOR NOT LESS THAN .003 CLUTCH CLEARANCE WITH LOWER WHEEL RAISED AND ADDING WHEEL DOWN

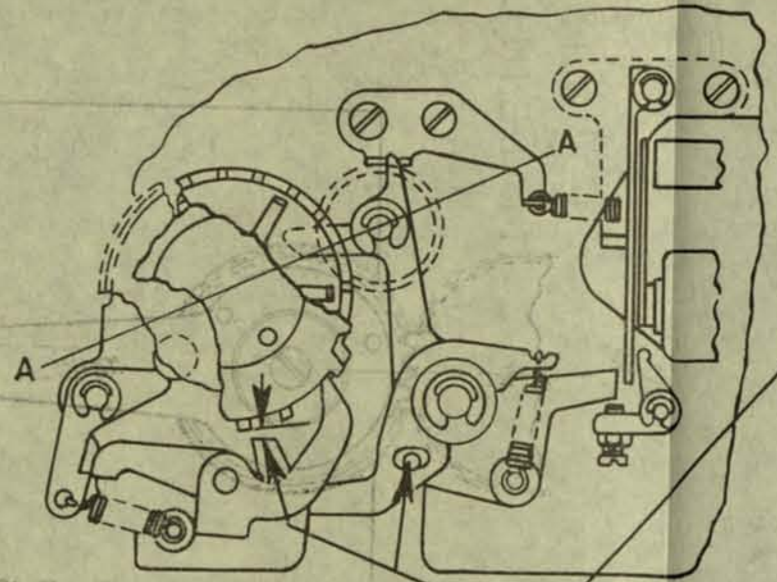
CHECK FOR NOT MORE THAN .010 WITH LOWER WHEEL DOWN AND ADDING WHEEL UP

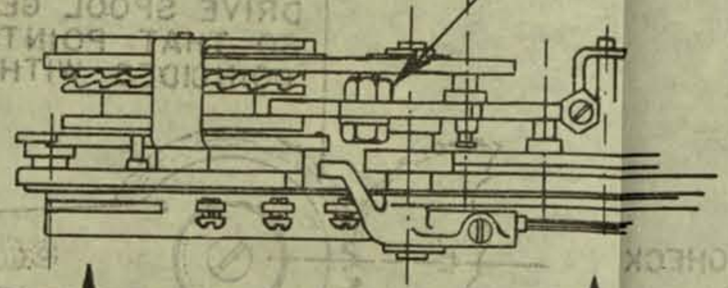
(15) ADJUST CLUTCH ENGAGING ARM STOP FOR .008-.009 OVERLAP OF CLUTCH AND CAM



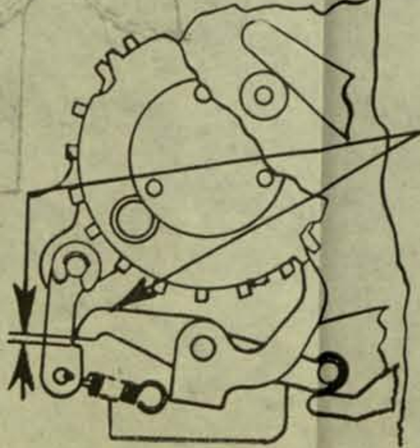
(16) CAMS .060, .065, OR .070 THICK AVAILABLE TO OBTAIN MAXIMUM TOOTH ENGAGMENT WITHOUT BOTTOMING. USE SHIM 127413 .002 THICK TO OBTAIN CLOSER ADJUSTMENTS

SIZE	IDENTIFICATION	PART NO.
.060	NO GROOVE	123556
.065	1/32 CIRCULAR GROOVE	123460
.070	1/16 CIRCULAR GROOVE	123555



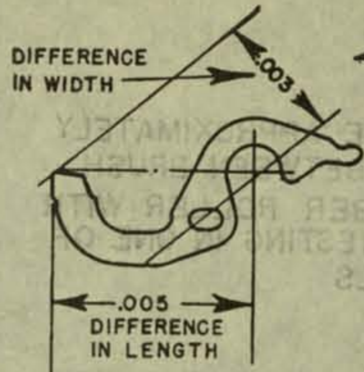


SECTION A-A TWICE SIZE

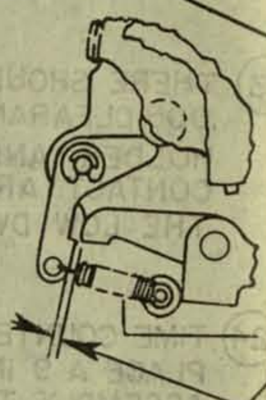


(17) ADJUST STUD FOR .010-.012 CLEARANCE WHEN CLUTCH ENGAGING ARM IS AGAINST STOP. SEE ADD GEAR DETENT SEATS FREELY. DETENT FURNISHED IN THREE LENGTHS TO AID IN MAKING THIS ADJUSTMENT

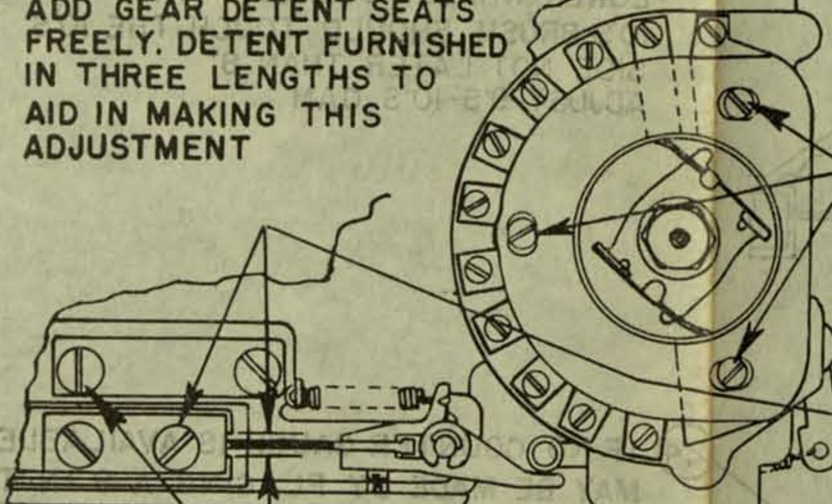
(18) BEND CONTACT ARM TO OBTAIN .004-.010 TRAVEL PAST LATCH POINT. CHECK ON BOTH CAMS



	UNMARKED OR	
LONG	STAMPED-L	123463
MEDIUM	STAMPED-M	129128
SHORT	STAMPED-S	129129



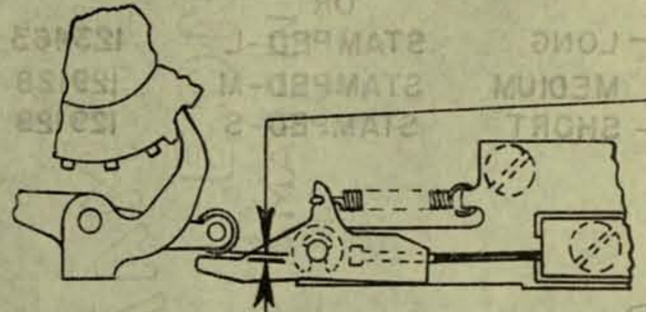
(19) 9 AND 10 CONTACT ARM LATCH TO HAVE AT LEAST .010 UNLATCHING CLEARANCE WHEN ON HIGH POINT OF CAM.



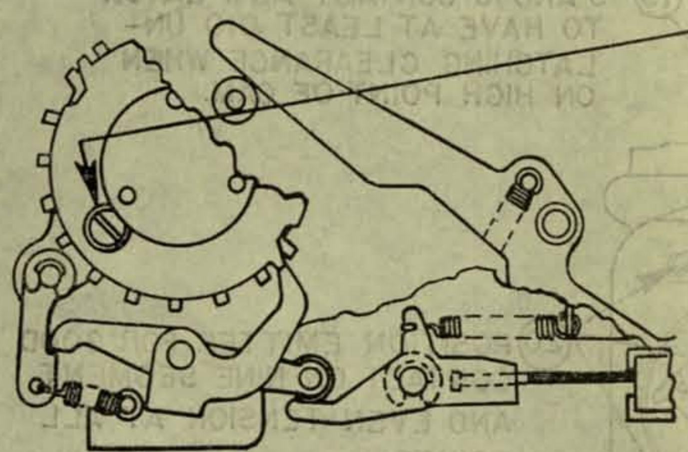
(20) POSITION EMITTER FOR GOOD CONTACT ON NINE SEGMENT AND EVEN TENSION AT ALL POINTS

(21) ADJUST BRASS CONNECTORS FOR 7/64" AIR GAP

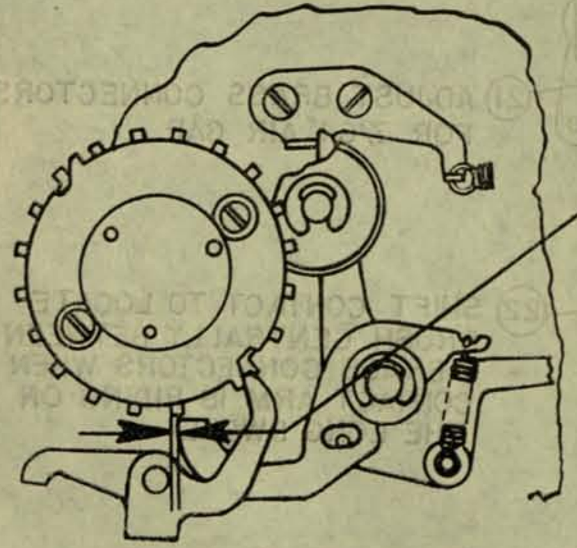
(22) SHIFT CONTACT TO LOCATE BRUSH CENTRALLY BETWEEN 2 BRASS CONNECTORS WHEN CONTACT ARM IS RIDING ON THE LONG DWELL



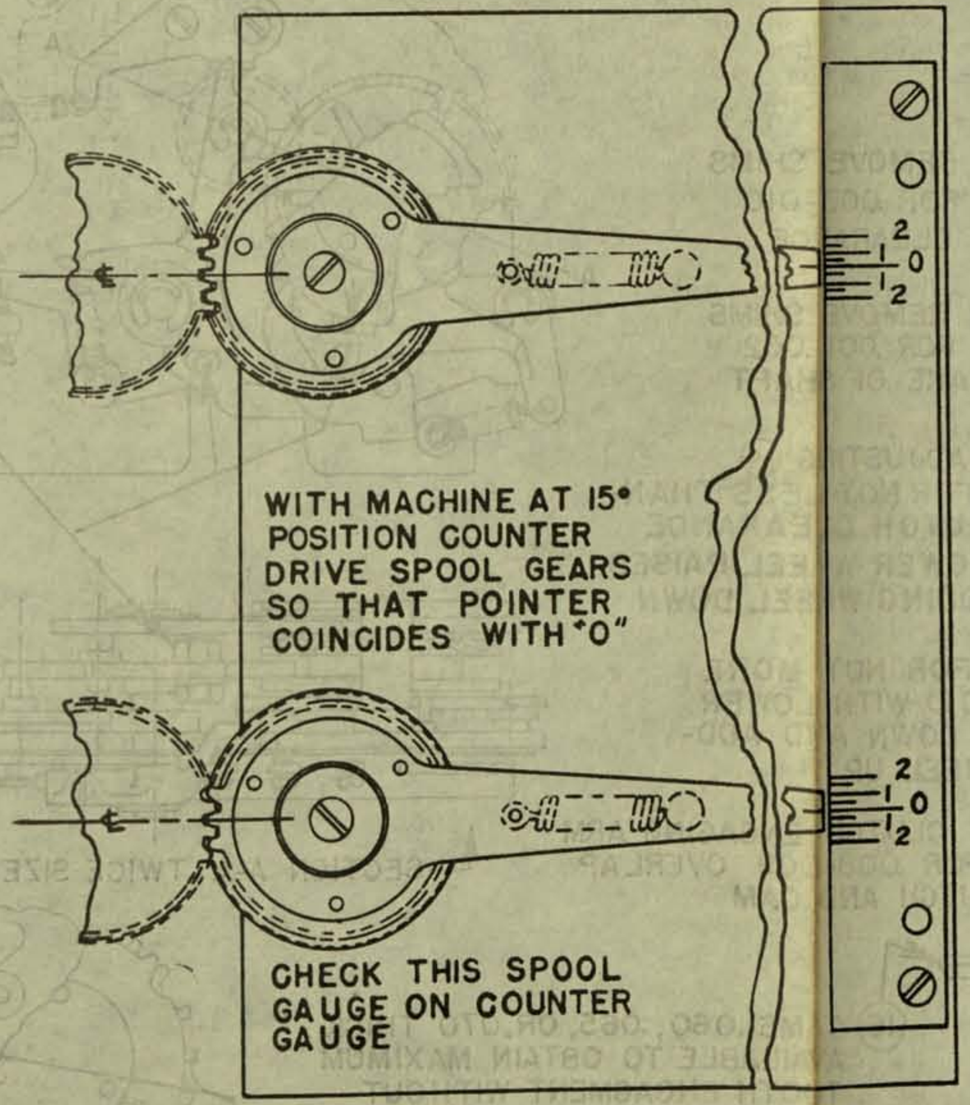
(23) THERE SHOULD BE APPROXIMATELY .005 CLEARANCE BETWEEN BRUSH HOLDER AND FIBER ROLLER WITH CONTACT ARM RESTING IN ONE OF THE LOW DWELLS



(24) TIME COUNTER TO COUNTER GAUGE. PLACE A 9 IN THE ADDING WHEEL ASSEMBLY. TRIP OFF ADD MAGNET ARMATURE AT 351° AND REVOLVE LOWER WHEEL ASSEMBLY. THE 9'S-10'S BRUSH SHOULD TOUCH THE 10'S SIDE NOT LATER THAN 8°. ADJUST 9'S-10'S CAM



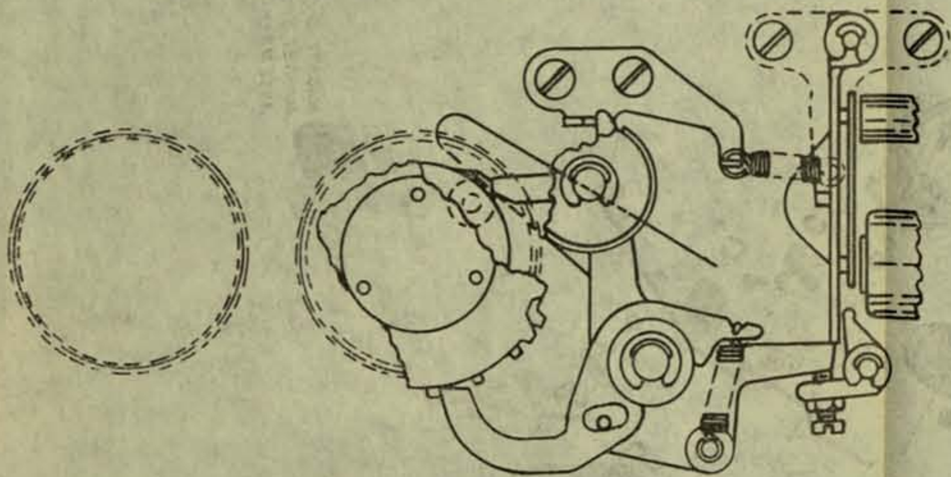
(24) IF NO COUNTER GAUGE IS AVAILABLE, A CHECK MAY BE MADE BY PLACING A 9 IN THE COUNTER, ATTRACT THE ADD MAGNET AND TURN THE COUNTER WHEEL UNTIL THE 9'S-10'S BRUSH JUST SWINGS OVER AND TOUCHES THE 10'S SIDE. THE ADDING WHEEL DETENT SHOULD BE WITHIN 1/64" OF LINING UP WITH THE DETENT TOOTH.



TIMING OF COUNTER LOWER WHEEL ASSEMBLY

CAM TYPE

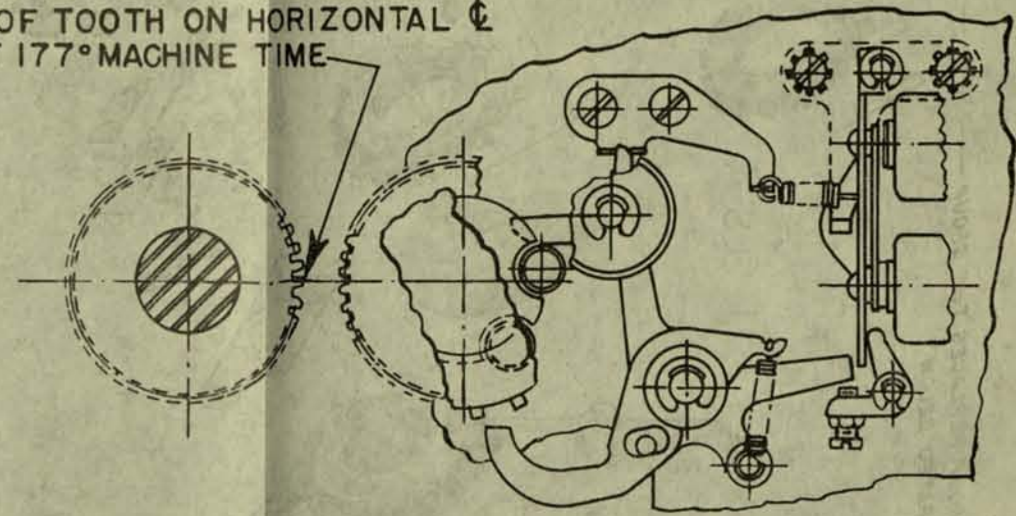
RELATION OF PARTS WHEN INSERTING COUNTER IN MACHINE AT 209°



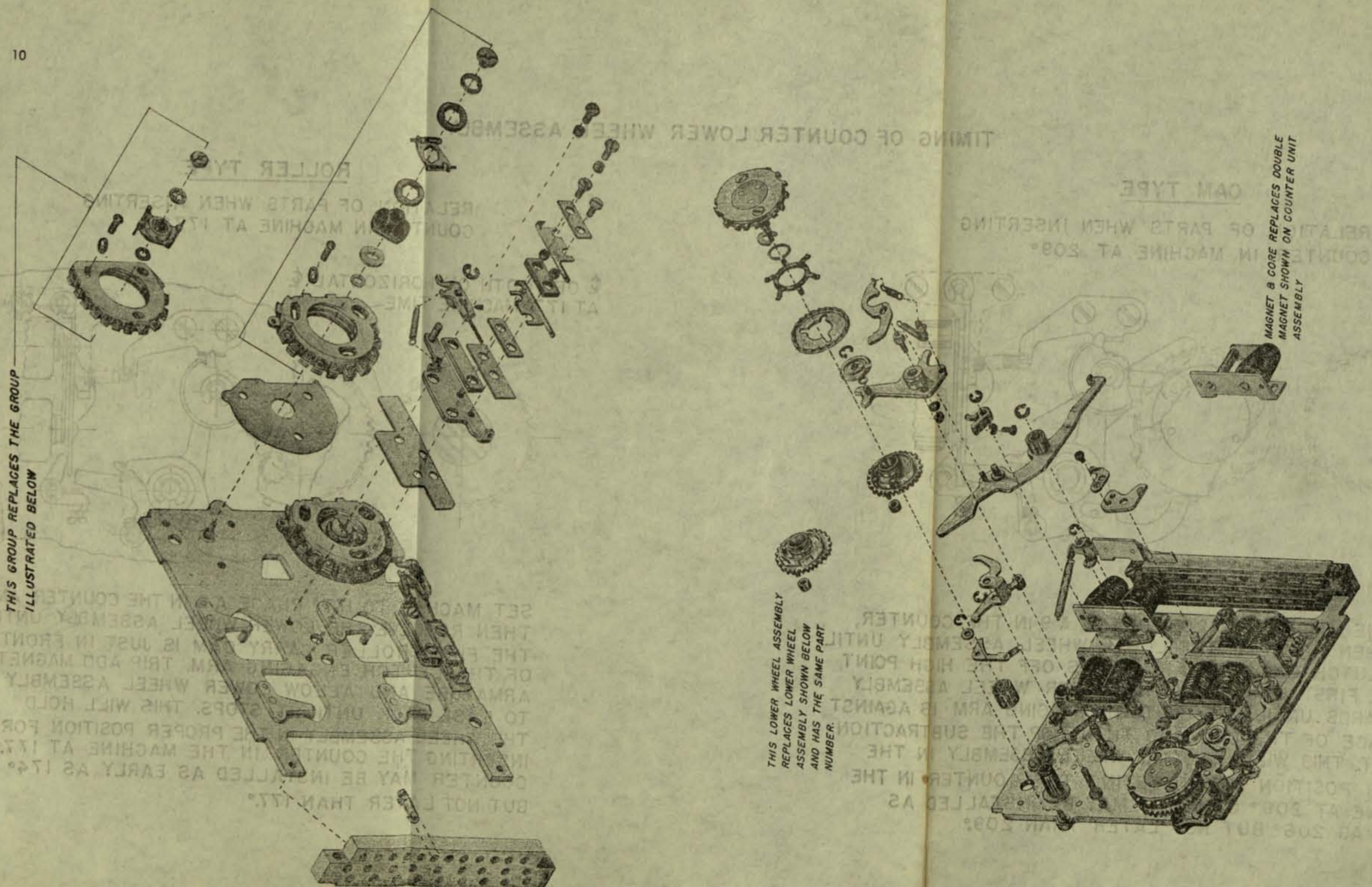
SET THE MACHINE AT 209° PLACE A 9 IN THE COUNTER, AND THEN REVOLVE THE LOWER WHEEL ASSEMBLY UNTIL THE CLUTCH ENGAGING ARM DROPS OFF THE HIGH POINT OF THE FIRST CAM. TURN THE LOWER WHEEL ASSEMBLY BACKWARDS UNTIL THE CLUTCH ENGAGING ARM IS AGAINST THE FACE OF THE CAM AND THEN TRIP THE SUBTRACTION MAGNET. THIS WILL HOLD THE WHEEL ASSEMBLY IN THE PROPER POSITION FOR INSERTING THE COUNTER IN THE MACHINE AT 209.° COUNTER MAY BE INSTALLED AS EARLY AS 206° BUT NOT LATER THAN 209.°

ROLLER TYPE

RELATION OF PARTS WHEN INSERTING COUNTER IN MACHINE AT 177°



SET MACHINE TO 177° PLACE A 9 IN THE COUNTER AND THEN REVOLVE THE LOWER WHEEL ASSEMBLY UNTIL THE FIRST ROLLER CARRY CAM IS JUST IN FRONT OF THE CLUTCH ENGAGING ARM. TRIP ADD MAGNET ARMATURE AND ALLOW LOWER WHEEL ASSEMBLY TO EASE BACK UNTIL IT STOPS. THIS WILL HOLD THE WHEEL ASSEMBLY IN THE PROPER POSITION FOR INSERTING THE COUNTER IN THE MACHINE AT 177.° COUNTER MAY BE INSTALLED AS EARLY AS 174° BUT NOT LATER THAN 177.°

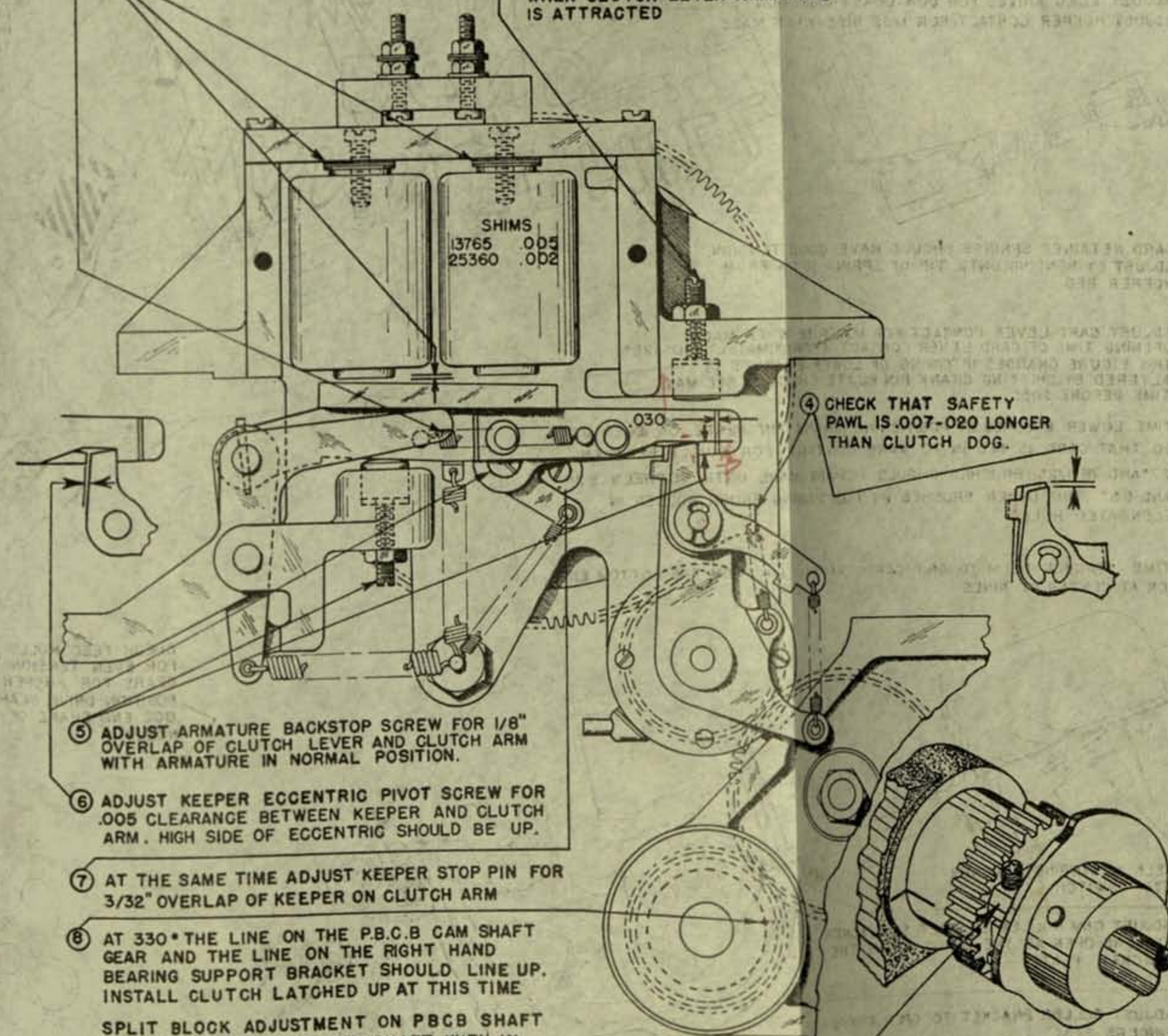

THIS GROUP REPLACES THE GROUP ILLUSTRATED BELOW
THIS LOWER WHEEL ASSEMBLY REPLACES LOWER WHEEL ASSEMBLY SHOWN BELOW AND HAS THE SAME PART NUMBER.
MAGNET B CORE REPLACES DOUBLE MAGNET SHOWN ON COUNTER UNIT ASSEMBLY

CARD FEED CLUTCH UNIT

(1) THIS SPRING MUST BE STRONG ENOUGH TO MAINTAIN .030 CLEARANCE OF SPLIT ARMATURE WHEN DOG IS LATCHED.

(2) ADD OR REMOVE SHIMS TO OBTAIN .010-.014 CLEARANCE BETWEEN ARMATURE AND CORES WITH ARMATURE ATTRACTED

(3) ADJUST THIS SCREW FOR .008-.010 UNLATCHING CLEARANCE BETWEEN CLUTCH LEVER AND SAFETY PAWL, WHEN CLUTCH LEVER ARMATURE IS ATTRACTED



(4) CHECK THAT SAFETY PAWL IS .007-.020 LONGER THAN CLUTCH DOG.

(5) ADJUST ARMATURE BACKSTOP SCREW FOR 1/8" OVERLAP OF CLUTCH LEVER AND CLUTCH ARM WITH ARMATURE IN NORMAL POSITION.

(6) ADJUST KEEPER ECCENTRIC PIVOT SCREW FOR .005 CLEARANCE BETWEEN KEEPER AND CLUTCH ARM. HIGH SIDE OF ECCENTRIC SHOULD BE UP.

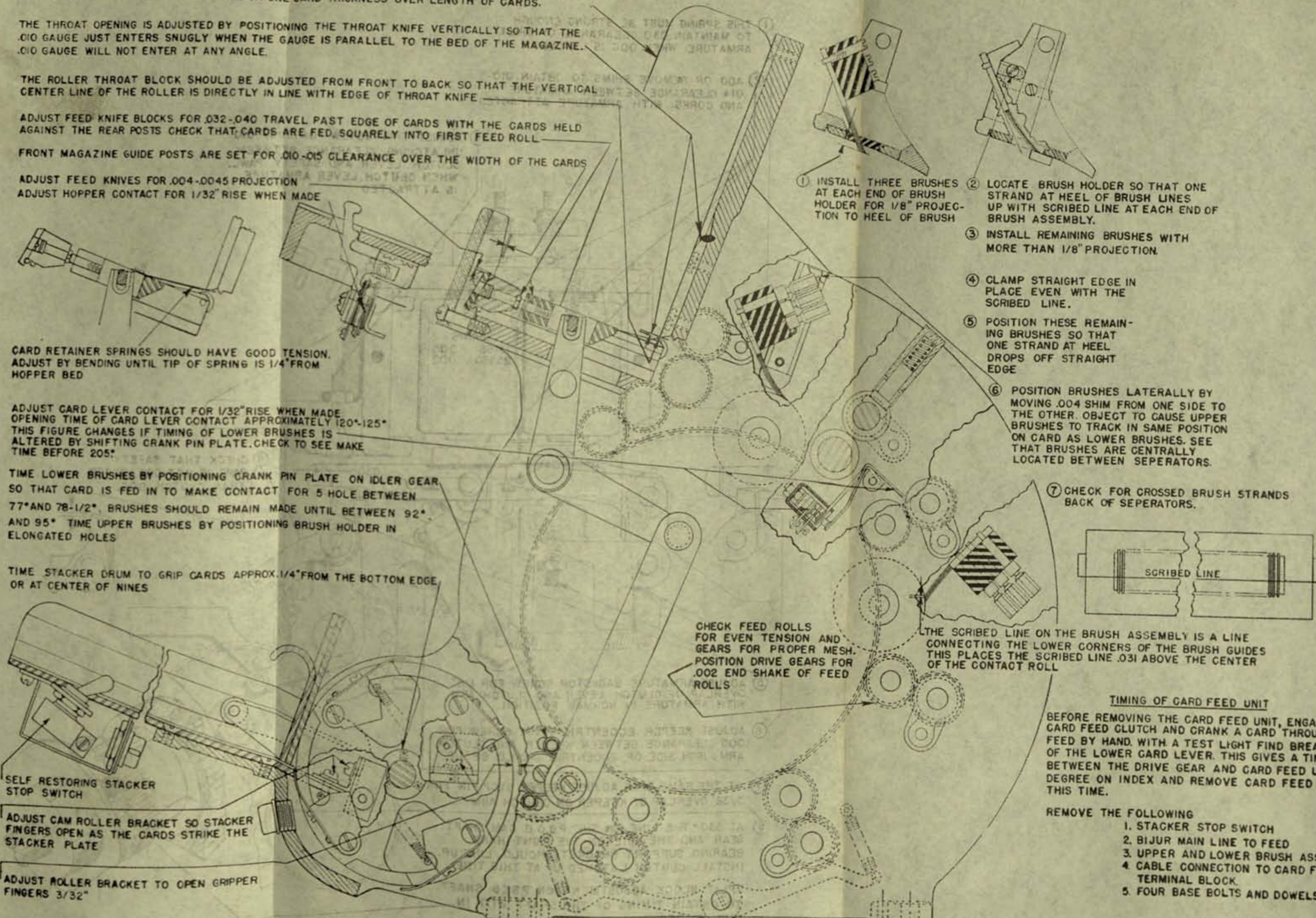
(7) AT THE SAME TIME ADJUST KEEPER STOP PIN FOR 3/32" OVERLAP OF KEEPER ON CLUTCH ARM

(8) AT 330° THE LINE ON THE P.B.C.B CAM SHAFT GEAR AND THE LINE ON THE RIGHT HAND BEARING SUPPORT BRACKET SHOULD LINE UP. INSTALL CLUTCH LATCHED UP AT THIS TIME

SPLIT BLOCK ADJUSTMENT ON PBCB SHAFT TO OBTAIN TIMING OF THE SHAFT WITH IN ONE DEGREE

PBCB SHAFT BEHIND PLATE 2*

CARD FEED UNIT



TIMING OF CARD FEED UNIT

BEFORE REMOVING THE CARD FEED UNIT, ENGAGE THE CARD FEED CLUTCH AND CRANK A CARD THROUGH THE FEED BY HAND. WITH A TEST LIGHT FIND BREAKING TIME OF THE LOWER CARD LEVER. THIS GIVES A TIMING POINT BETWEEN THE DRIVE GEAR AND CARD FEED UNIT. NOTE DEGREE ON INDEX AND REMOVE CARD FEED UNIT AT THIS TIME.

REMOVE THE FOLLOWING

1. STACKER STOP SWITCH
2. BIJUR MAIN LINE TO FEED
3. UPPER AND LOWER BRUSH ASSEMBLY
4. CABLE CONNECTION TO CARD FEED TERMINAL BLOCK.
5. FOUR BASE BOLTS AND DOWELS

USE THE SAME ADJUSTMENT PROCEDURE ON THE C.B. UNIT

1. CLEAN POINTS
2. ALIGN POINTS FOR FULL CONTACT
3. SET POINTS FOR CORRECT AIR GAP
4. SET CAM FOR CORRECT TIMING. REFER TO CORRECT TIMING CHART FOR THE MACHINE.

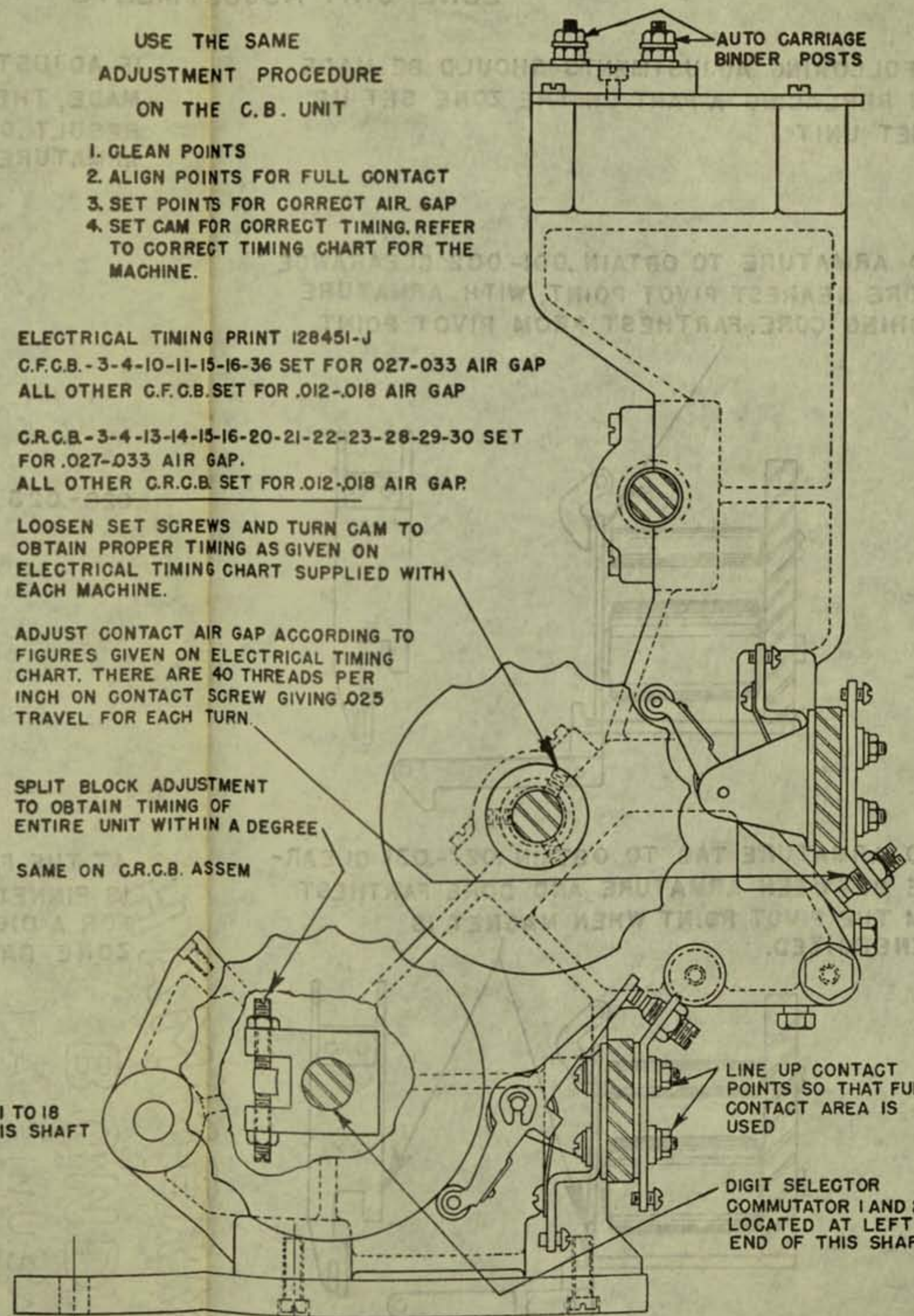
ELECTRICAL TIMING PRINT 128451-J

C.F.C.B.-3-4-10-11-15-16-36 SET FOR 027-033 AIR GAP

ALL OTHER C.F.C.B. SET FOR .012-.018 AIR GAP

C.R.C.B.-3-4-13-14-15-16-20-21-22-23-28-29-30 SET FOR .027-.033 AIR GAP.

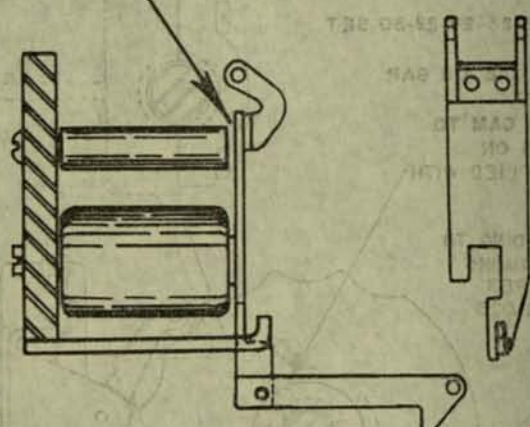
ALL OTHER C.R.C.B. SET FOR .012-.018 AIR GAP.



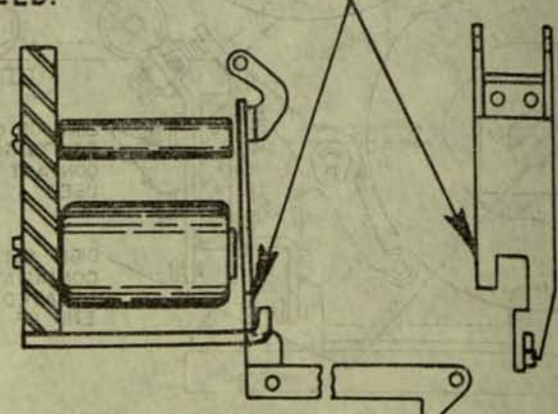
CARD FEED CIRCUIT BREAKER ASSEMBLY

(1) THE FOLLOWING ADJUSTMENTS SHOULD BE MADE WHEN REPLACING A PART ON THE ZONE SET UP MAGNET UNIT

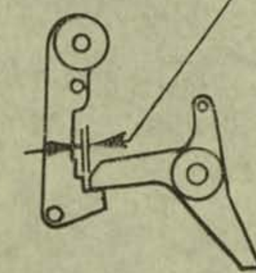
BEND ARMATURE TO OBTAIN .001-.002 CLEARANCE AT CORE NEAREST PIVOT POINT, WITH ARMATURE TOUCHING CORE. FARTHEST FROM PIVOT POINT.



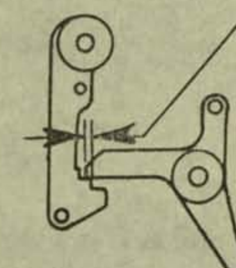
(2) BEND ARMATURE TAB TO OBTAIN .027-.031 CLEARANCE BETWEEN ARMATURE AND CORE FARTHEST FROM THE PIVOT POINT WHEN MAGNET IS DE-ENERGIZED.



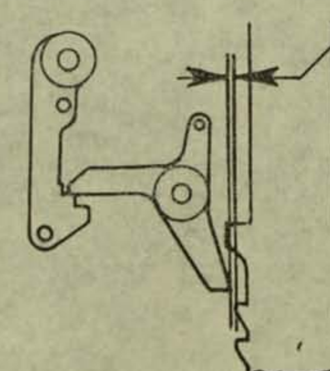
IF ADJUSTMENTS 1 AND 2 HAVE BEEN PROPERLY MADE, THE FOLLOWING CLEARANCES SHOULD RESULT .005-.008 UNLATCHED CLEARANCE WHEN ARMATURE IS ATTRACTED



.020-.023 OVERLAP OF THE STOP PAWL ON THE LATCH.



AT THE FACTORY THE ZONE SET-UP MAGNET UNIT IS PINNED TO THE ZONE SET-UP UNIT AND LOCATED FOR A .016 CLEARANCE BETWEEN STOP PAWLS AND ZONE BARS WHEN PAWLS ARE LATCHED.

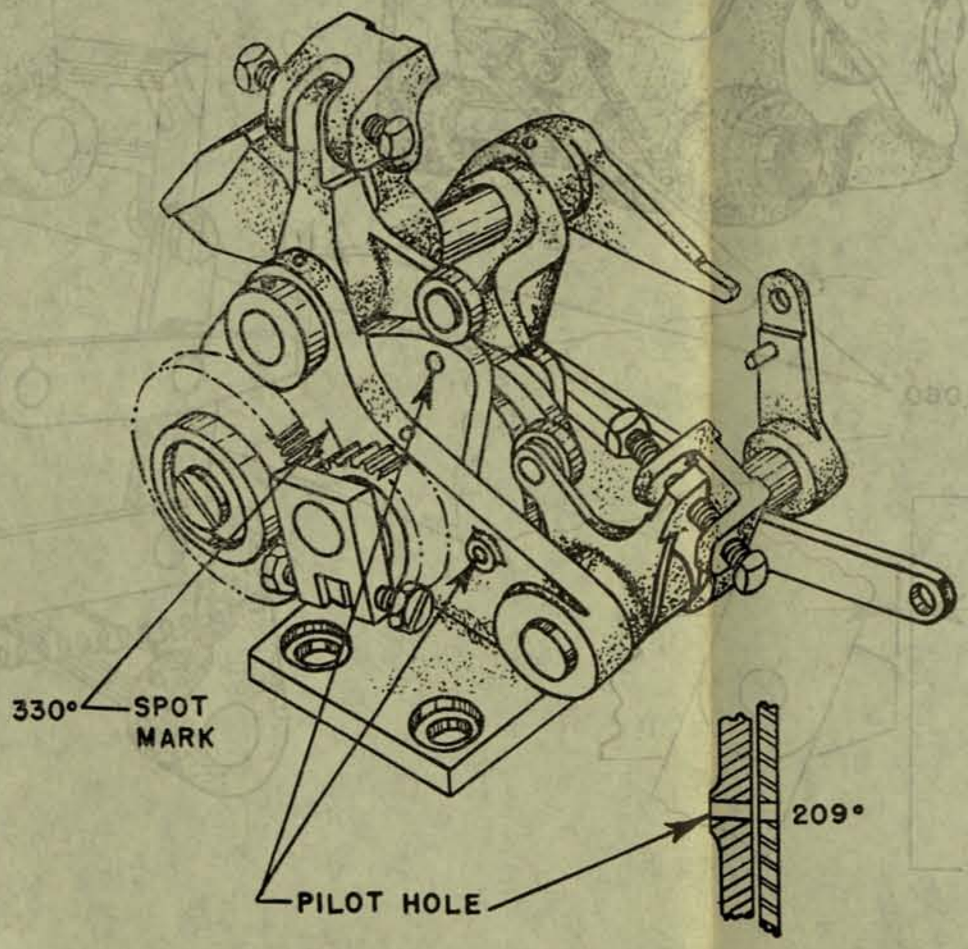


CHECK TIMING OF THE ZONE DRIVE UNIT

ZONE CONTROL DRIVE UNIT WITH THE ADJUSTING BLOCK

ENGAGE CARD FEED CLUTCH AND TURN INDEX TO 209° THE PILOT HOLE IN NUMBER I. CAM SHOULD BE IN LINE WITH THE PILOT HOLE IN THE SUPPORT CASTING.

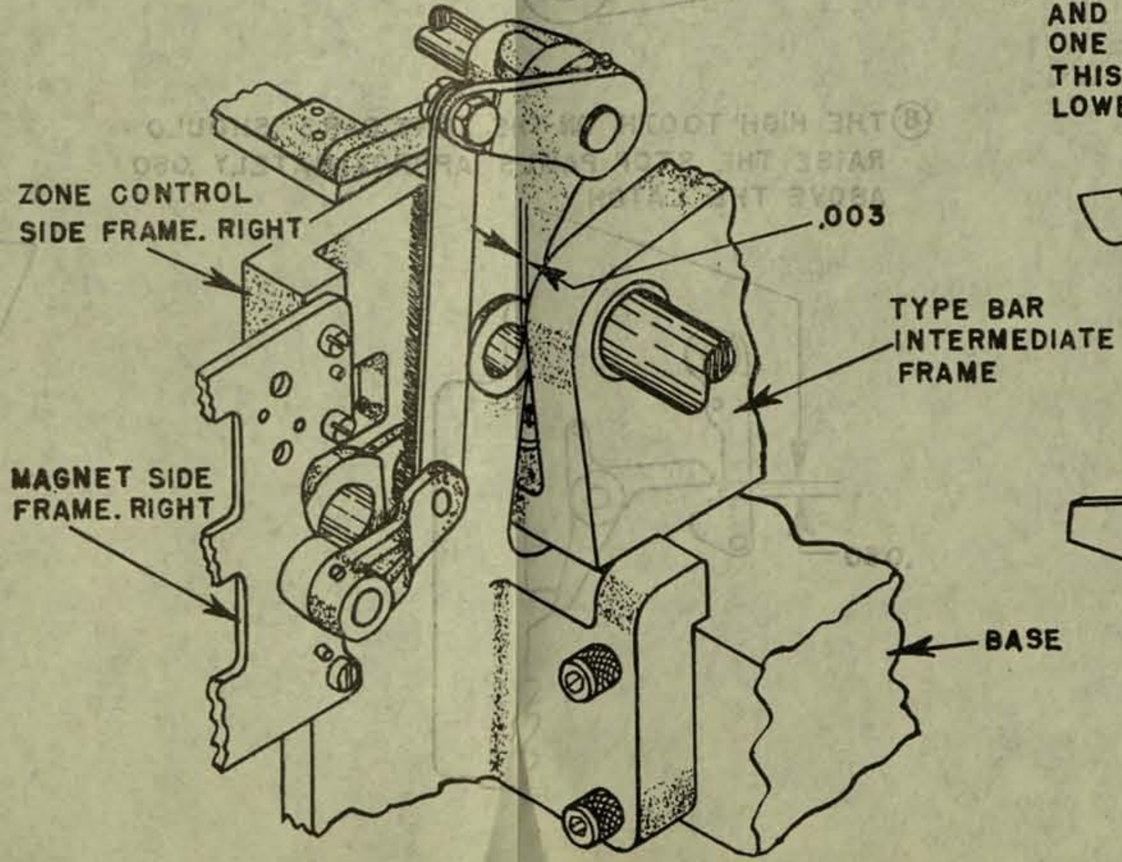
EARLIER ZONE CONTROL DRIVE UNITS INSTALLED WITH THE SPOT MARK ON CAM SHAFT GEAR IN LINE WITH THE MARK ON THE SUPPORT CASTING AT 330° WITH THE CARD FEED CLUTCH LATCHED UP



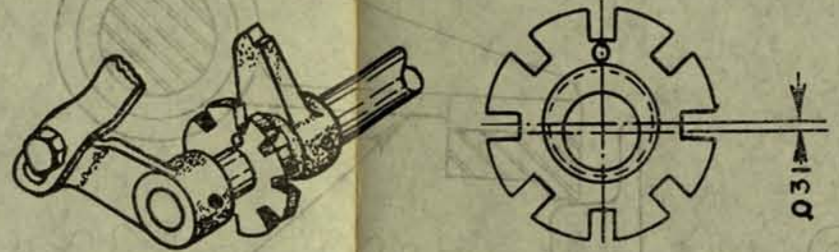
③ REMOVE TOGGLE LATCH OPERATING LINK TO PREVENT BREAKING UNTIL READY TO MAKE ADJUSTMENT 14.

LOCATING ZONE UNITS NOT DOWELLED TO BASE

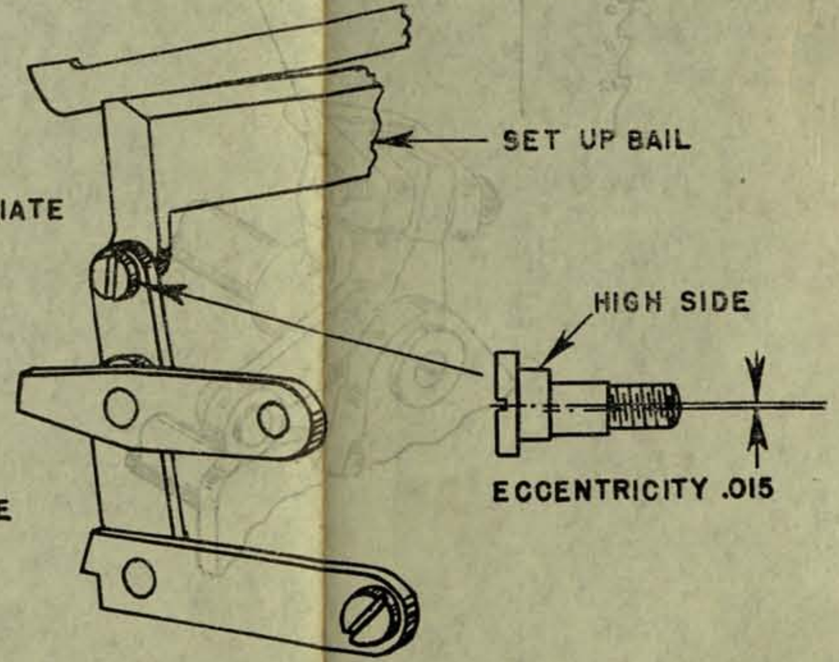
1. CLEAN BASE SURFACES.
2. SUPPORT ZONE UNIT WITH FOUR SCREWS.
3. HOLD ZONE UNIT DOWN AGAINST BASE AND TO THE RIGHT SO THAT A .003 GAUGE WILL NOT ENTER BETWEEN THE ZONE UNIT AND THE TYPE BAR INTERMEDIATE FRAME.
4. TIGHTEN SUPPORT SCREWS.



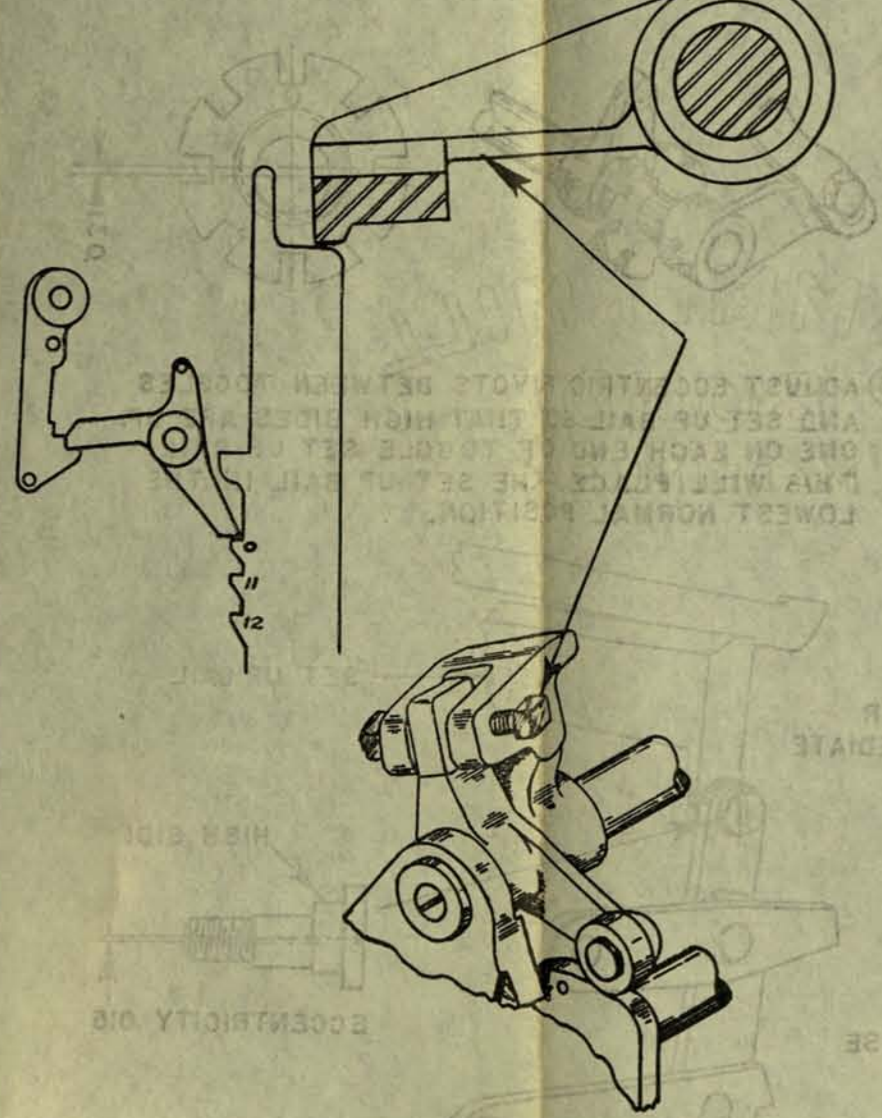
④ CHECK TO SEE THAT BOTH TOGGLE LATCH SHAFT ECCENTRIC BUSHINGS ARE SET WITH "O" MARKS UP IN A VERTICAL PLANE. TOTAL AMOUNT OF ECCENTRICITY OF BUSHING IS 031.



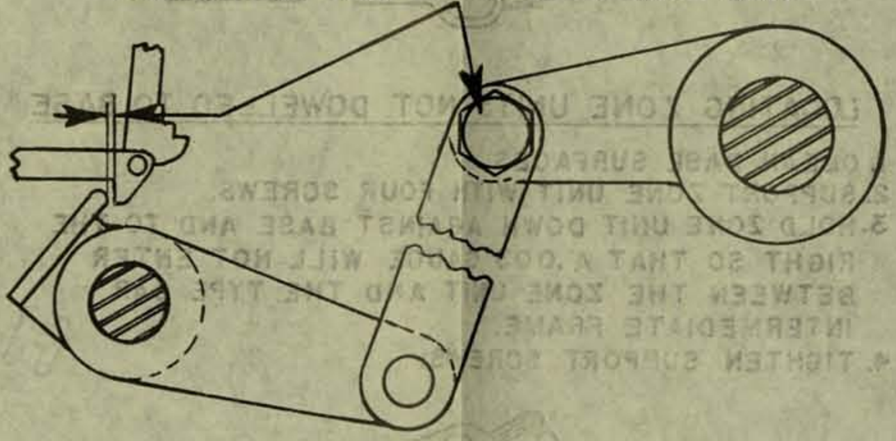
⑤ ADJUST ECCENTRIC PIVOTS BETWEEN TOGGLES AND SET UP BAIL SO THAT HIGH SIDES ARE UP. ONE ON EACH END OF TOGGLE SET UP BAIL. THIS WILL PLACE THE SET UP BAIL IN THE LOWEST NORMAL POSITION.



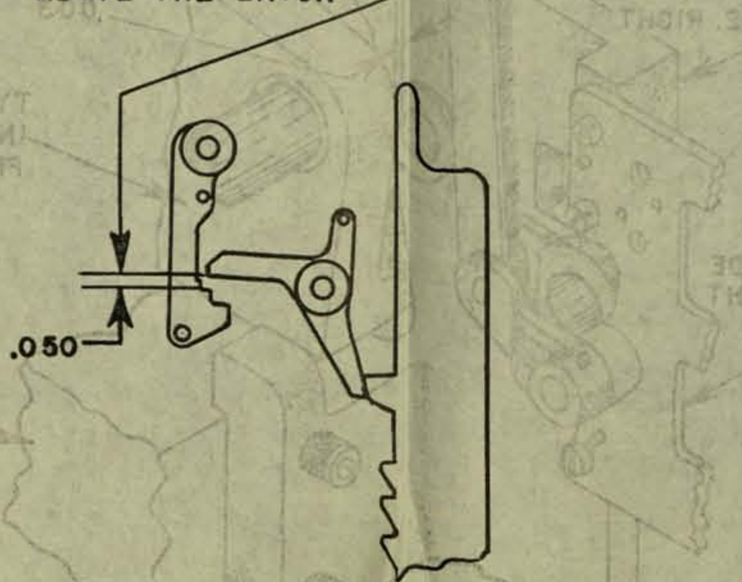
⑥ ADJUST ZONE BAR RESTORING BAIL CAM FOLLOWER, NO.1 CAM, SO THAT THE ZONE BAR COMES TO REST AT 186° WHEN STOPPED BY THE STOP PAWL ON THE "O" ZONE TOOTH.



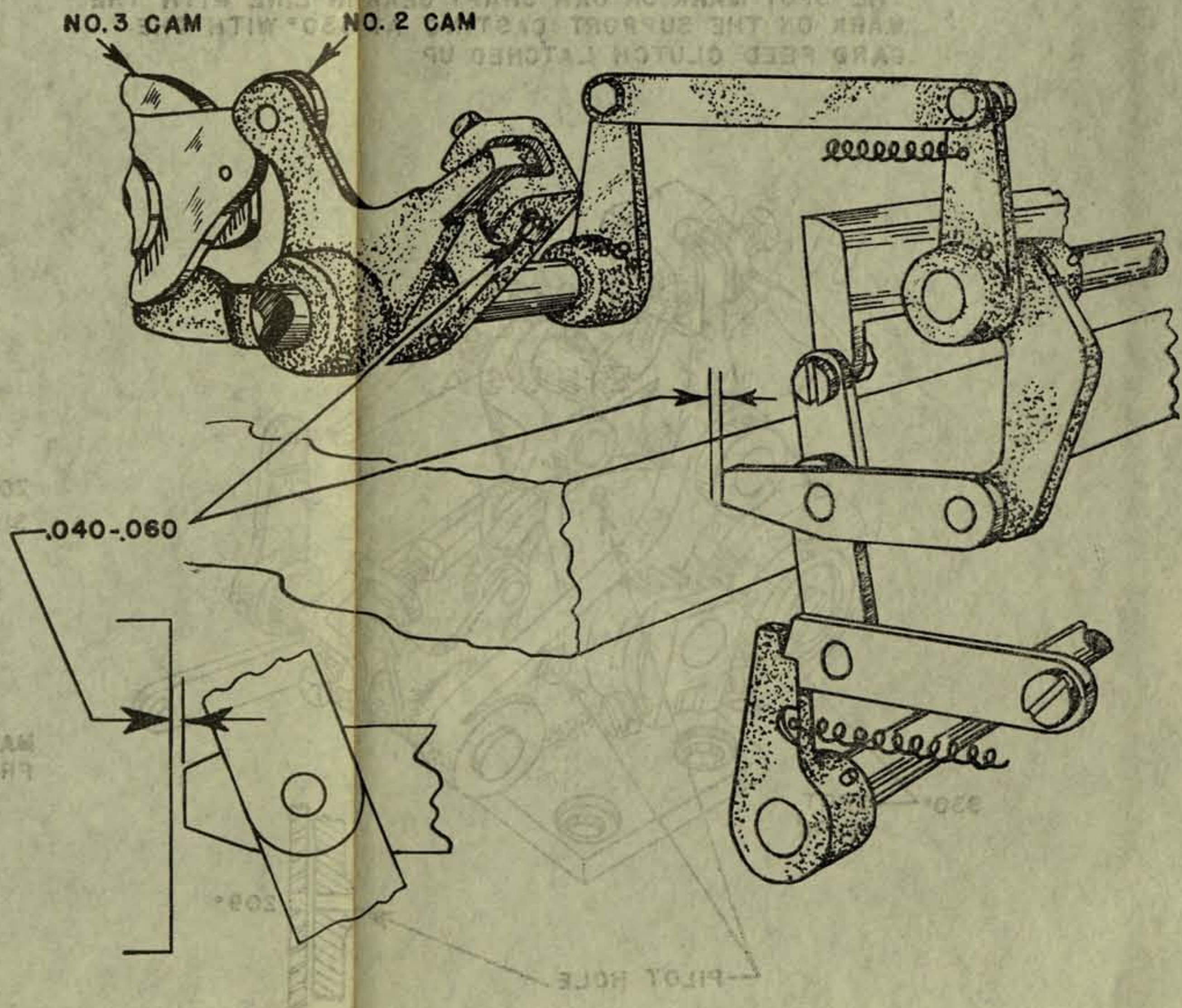
⑦ TURN ZONE DRIVE UNIT TO 126° WHERE NO.1 CAM IS ON ITS HIGHEST POINT. ADJUST THE LATCH RESTORING BAIL ECCENTRIC SCREW ON RIGHT END OF BAIL FOR .005 CLEARANCE BETWEEN KNOCKOFF END OF PULL ROD WHERE FASTENED TO ARMATURE AND LIP OF RESTORING BAIL.



⑧ THE HIGH TOOTH ON THE ZONE BARS SHOULD RAISE THE STOP PAWLS APPROXIMATELY .050 ABOVE THE LATCH



⑨ TURN ZONE DRIVE UNIT TO 22° WHERE NO.2 CAM IS ON ITS HIGH POINT. ADJUST NO.2 CAM FOLLOWER TO BRING THE TOGGLE WITHIN .040-.060 OF THE BASE WHEN SUPPORTED BY TOGGLE LATCHES.



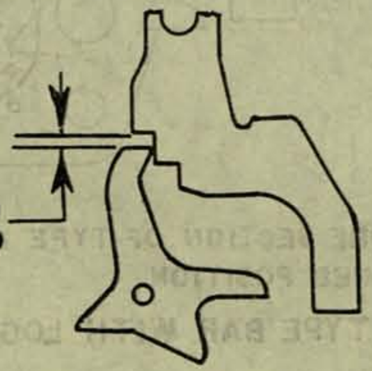
(10) LIST LAP MUST BE CORRECTLY SET BEFORE PROCEEDING WITH THE FOLLOWING ADJUSTMENT AS ANY CHANGE IN LIST LAP WILL ALTER THIS CLEARANCE.

BLOCK BOTH MACHINE AND CARD FEED CLUTCHES. TURN MACHINE BY HAND, AND AT 207° TRIP THE ZONE MAGNET ARMATURE IN POSITION I. AT APPROXIMATELY 280° TRIP THE ZONE BAIL CONTROL MAGNET ARMATURE, CONTINUE CRANKING UNTIL 13° AT THIS POINT THE ZONE SECTION OF THE TYPE BAR SHOULD BE HELD .030-.040 ABOVE THE SETUP PAWL. CHECK FOR AT LEAST .020 CLEARANCE UNDER FULL LOAD.

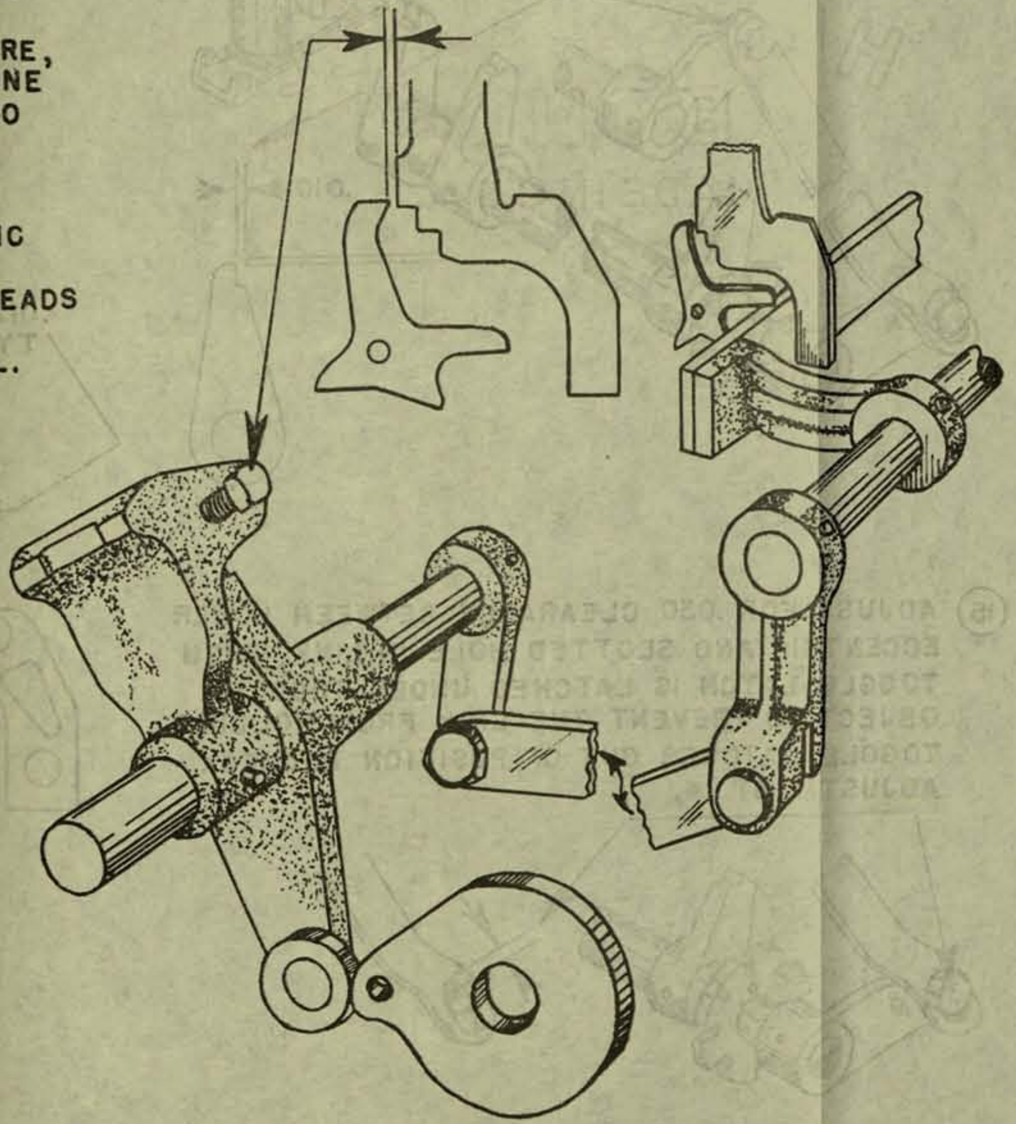
OBTAIN THIS CLEARANCE BY TURNING THE ECCENTRIC SCREWS AT TOP OF THE TOGGLE LINK AS SHOWN IN ADJUSTMENT 5. SPOT MARK HIGH SIDE OF SCREW HEADS SO THAT SCREW AT EACH END OF SETUP BAIL IS IN SAME RELATIVE POSITION AND BAIL IS KEPT LEVEL.

IF MORE RISE IS NEEDED, TURN THE ECCENTRIC BUSHINGS, AS SHOWN IN ADJUSTMENT 4, FORWARD ONE POSITION. THEN RE-ADJUST ECCENTRIC SCREWS IN TOGGLE LINK. ANY CHANGING OF THE ECCENTRIC BUSHINGS WILL REQUIRE THAT THE ZONE BAIL MAGNETS BE RE-ADJUSTED.

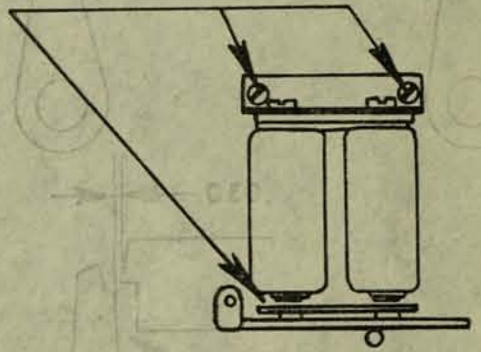
CHECK TYPE BARS 40-43 BY MARKING SIDE OF BAR AT 13°. CONTINUE TO TURN CRANK AND SEE WHAT CHANGE TAKES PLACE IN THE MARK ON THE TYPE BAR AND ZONE SECTION WHEN ZONE SECTION COMES TO REST ON SETUP PAWL.



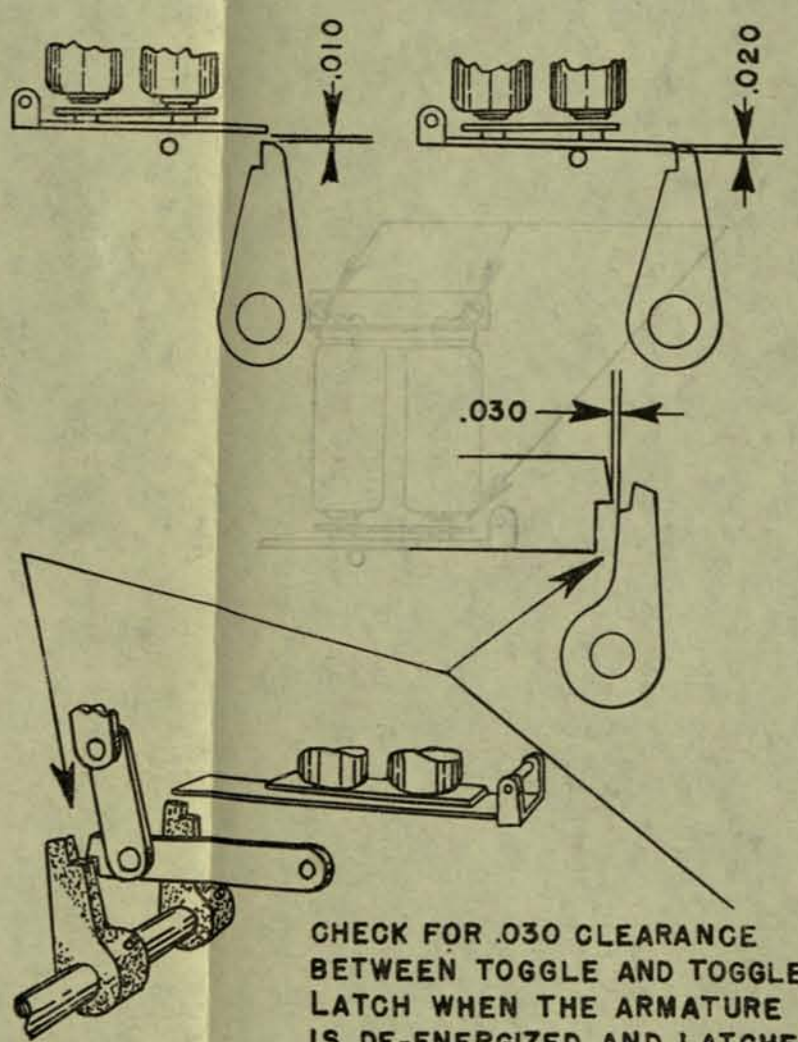
(11) ADJUST NUMBER #4 CAM FOLLOWER SO THAT SET UP PAWL IS RESTORED .020 BEYOND THE ZONE SECTION OF TYPE BAR. THE CAM IS ON THE HIGH POINT FROM 330° TO 340°.



(12) ADJUST THE ZONE BAIL CONTROL MAGNET CORE BRACKET FOR .003 CLEARANCE BETWEEN ARMATURE AND CORE NEAREST PIVOT WHEN THE ARMATURE IS ATTRACTED AND .018-.021 CLEARANCE BETWEEN ARMATURE AND CORE FARTHEST FROM PIVOT POINT WHEN ARMATURE IS DE-ENERGIZED.

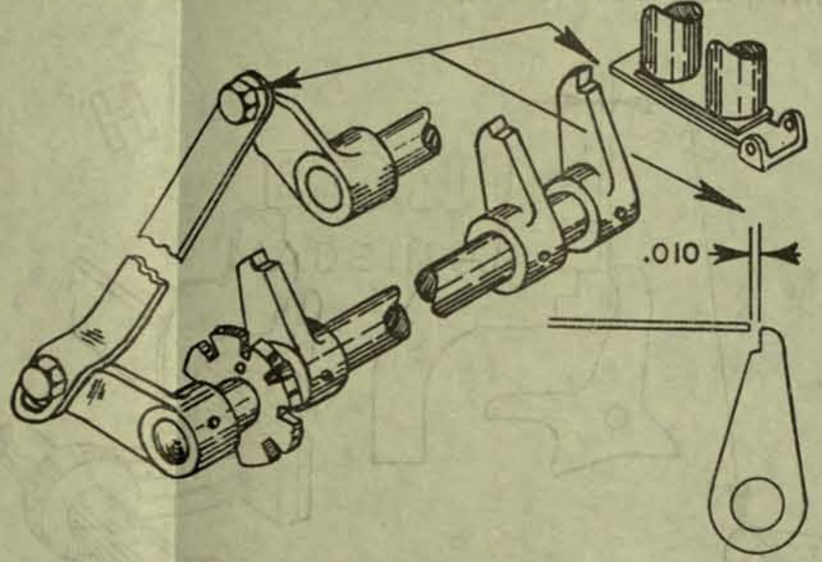


(13) ADJUST THE ENTIRE ZONE BAIL MAGNET ASSEMBLY FOR APPROXIMATELY .010 UNLATCHING CLEARANCE WHEN THE ARMATURE IS ATTRACTED. CHECK FOR OVERLAP OF .020 OF CONTROL MAGNET ARMATURE ON LATCH WHEN DE-ENERGIZED.

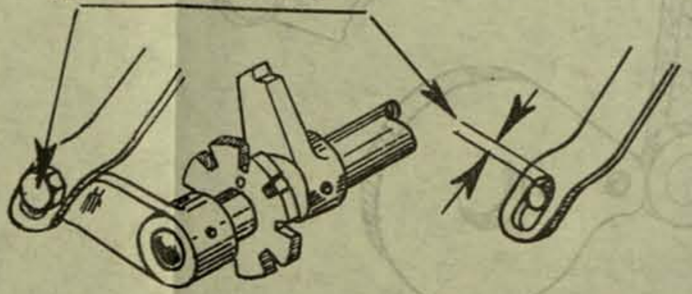


CHECK FOR .030 CLEARANCE BETWEEN TOGGLE AND TOGGLE LATCH WHEN THE ARMATURE IS DE-ENERGIZED AND LATCHED

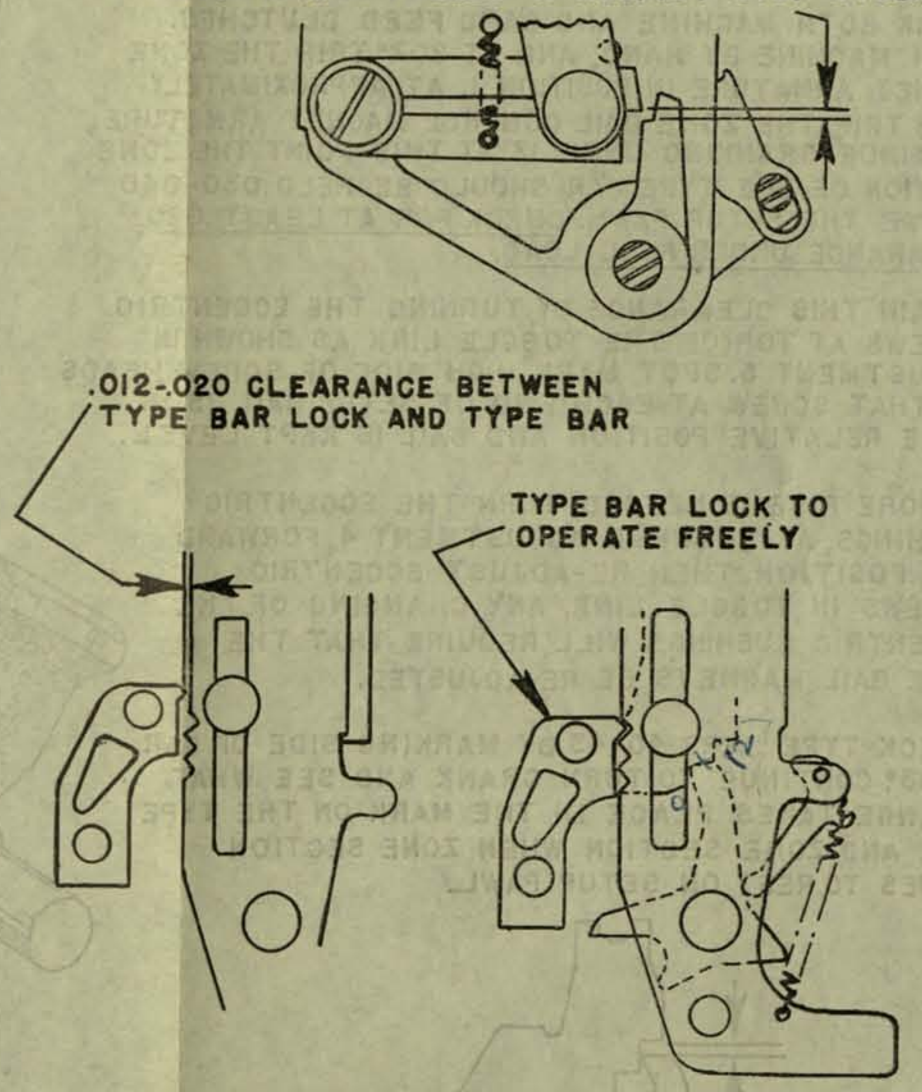
(14) RE-INSTALL TOGGLE LATCH OPERATING LINK ADJUST BAIL ARMATURE LATCH ECCENTRIC ADJUSTING SCREWS FOR AT LEAST .010 CLEARANCE BETWEEN TIP OF ZONE BAIL ARMATURE AND LATCH AT 240°



(15) ADJUST FOR .030 CLEARANCE BETWEEN LOWER ECCENTRIC AND SLOTTED HOLE IN LINK, WHEN TOGGLE LATCH IS LATCHED UNDER TOGGLES. OBJECT TO PREVENT THE LINK FROM HOLDING TOGGLE LATCHES OUT OF POSITION RECHECK ADJUSTMENT 14.



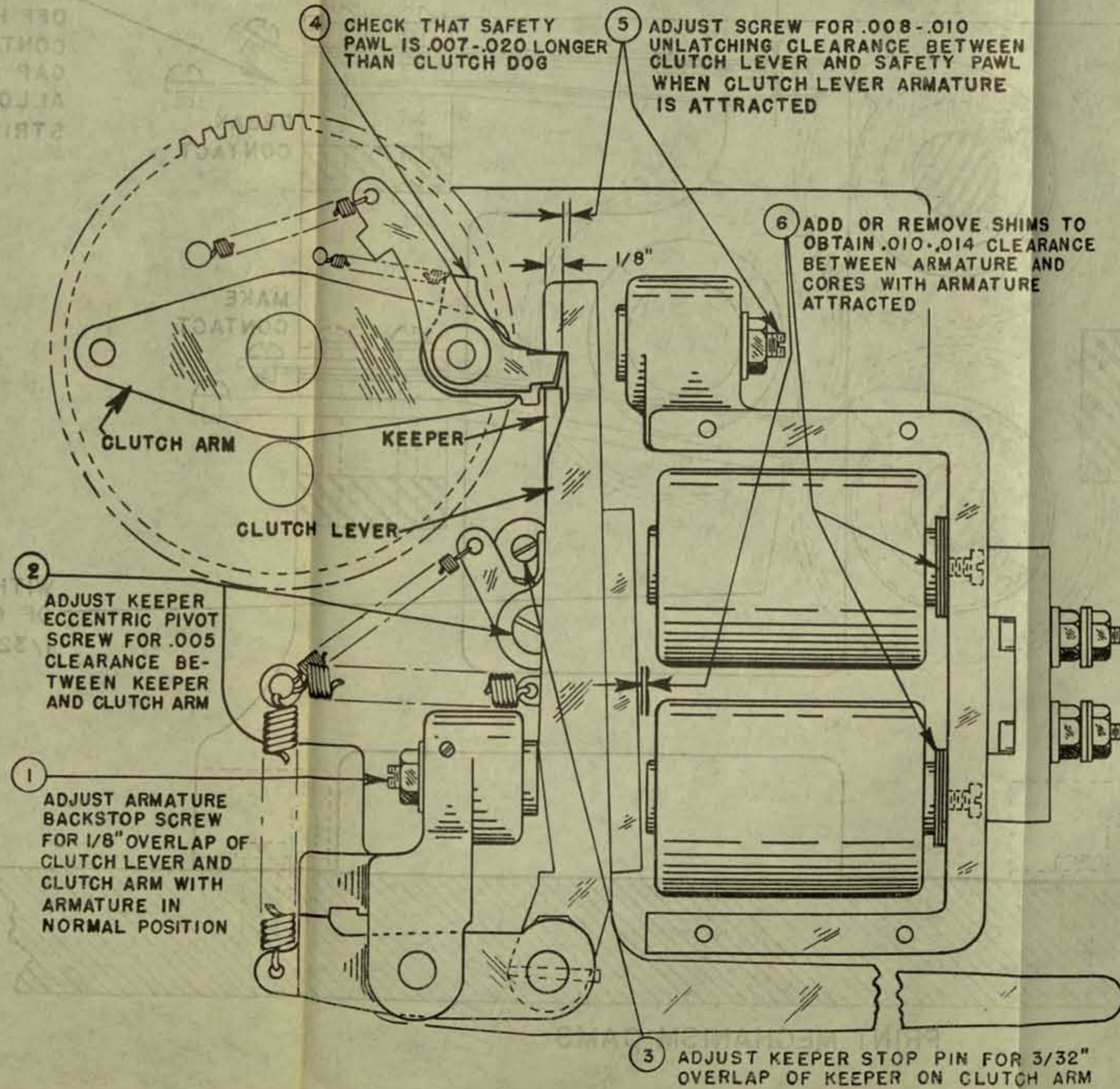
(16) WITH TOGGLES IN NORMAL POSITION THERE SHOULD BE .070 CLEARANCE BETWEEN TOGGLE LATCH ARM AND LATCH. CHECK TO SEE TOGGLE LATCH ARM IS PULLED UP AGAINST STOP STUD.



ZONE SECTION OF TYPE BAR IN ZONED POSITION

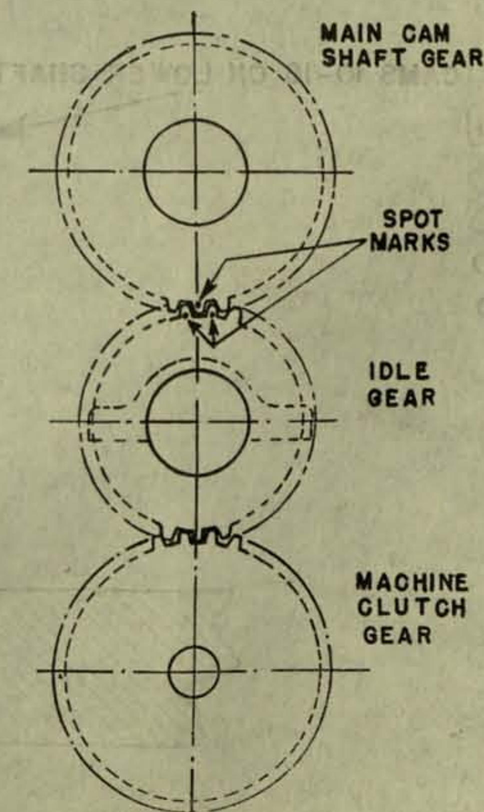
ALPHABETICAL TYPE BAR WITH LOCK

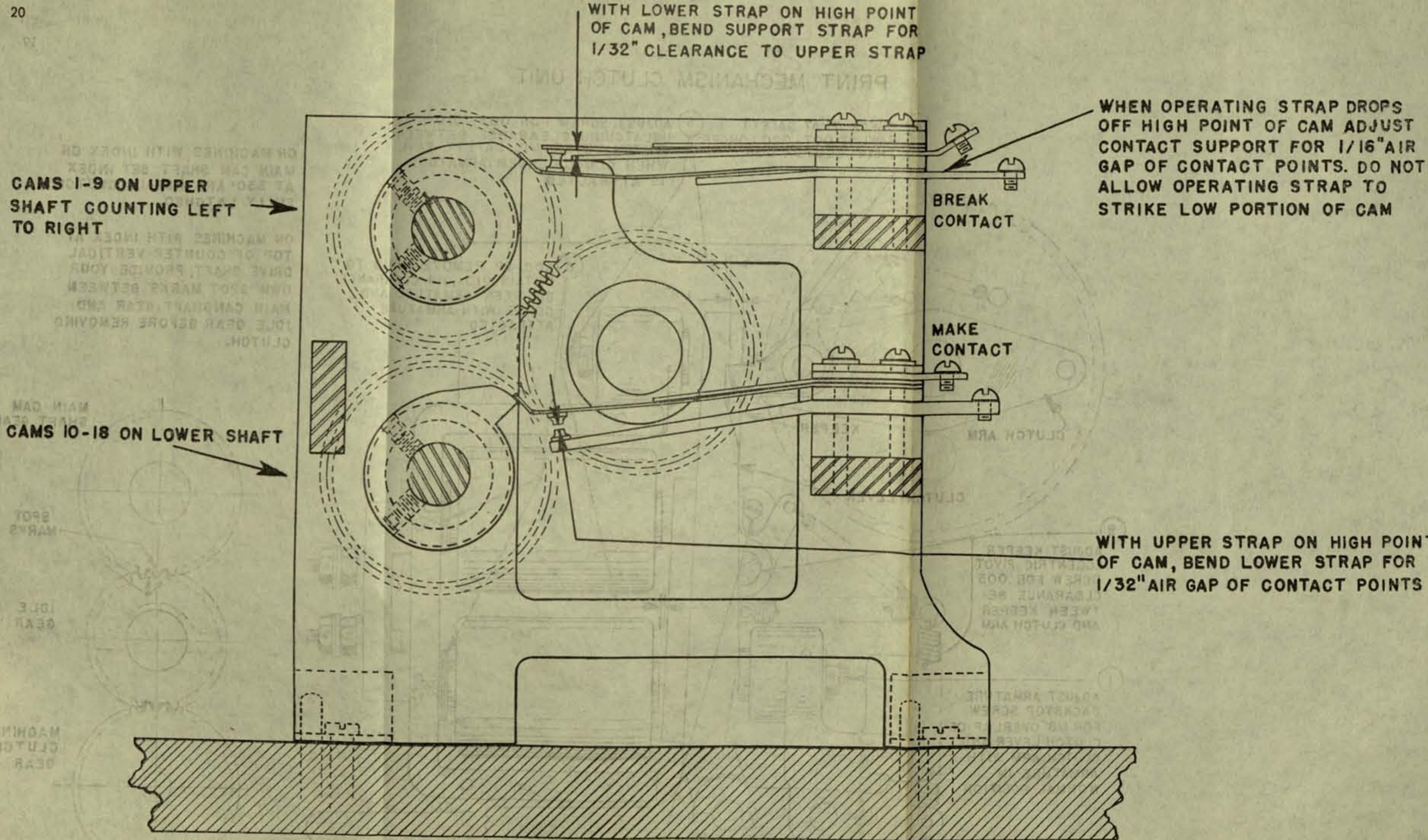
PRINT MECHANISM CLUTCH UNIT



ON MACHINES WITH INDEX ON MAIN CAM SHAFT, SET INDEX AT 330° AND INSTALL CLUTCH FULLY LATCHED.

ON MACHINES WITH INDEX AT TOP OF COUNTER VERTICAL DRIVE SHAFT, PROVIDE YOUR OWN SPOT MARKS BETWEEN MAIN CAMSHAFT GEAR AND IDLE GEAR BEFORE REMOVING CLUTCH.



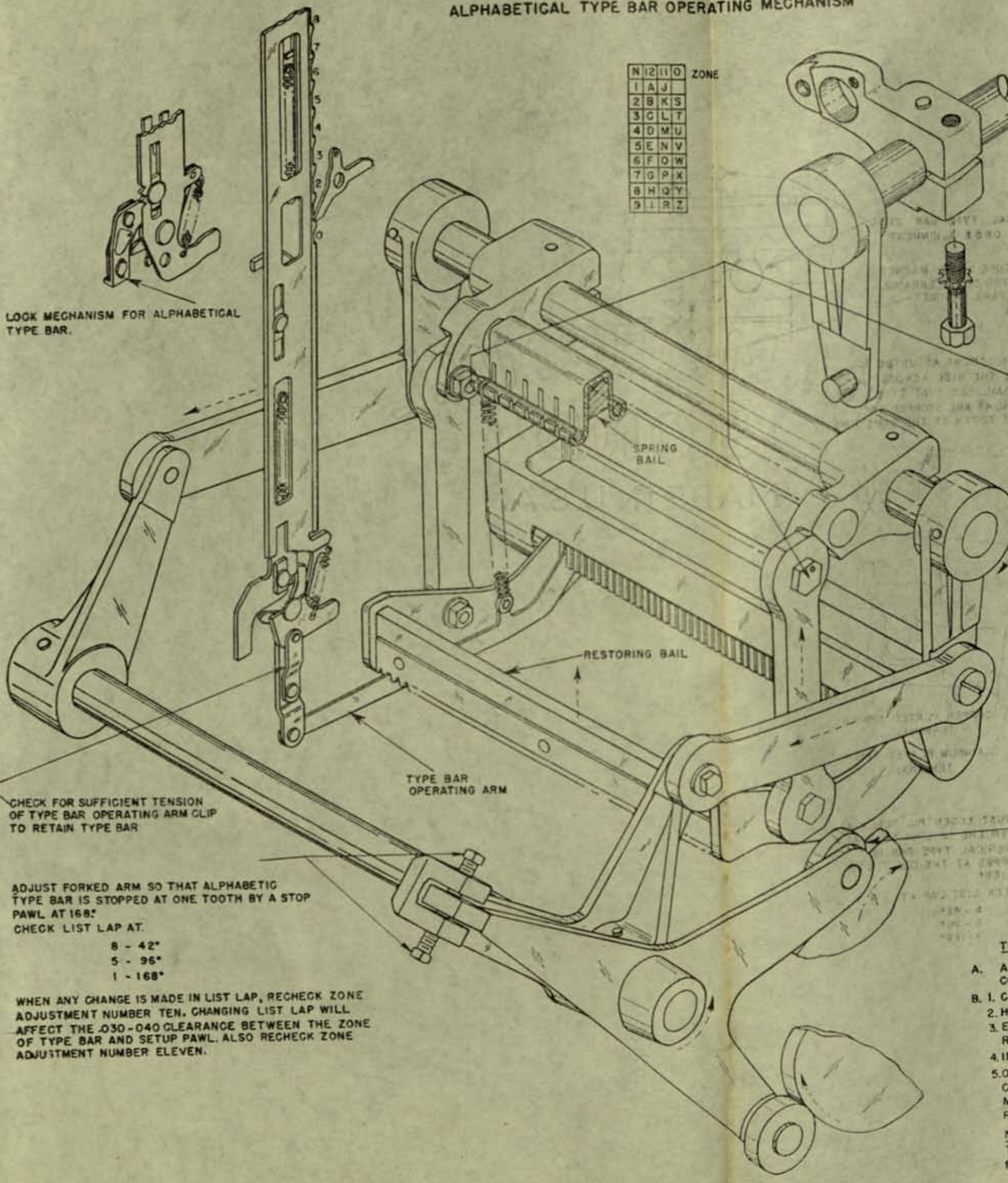


PRINT MECHANISM CAMS

ALPHABETICAL TYPE BAR OPERATING MECHANISM

N	12	11	0
1	A	J	
2	B	K	S
3	C	L	T
4	D	M	U
5	E	N	V
6	F	O	W
7	G	P	X
8	H	Q	Y
9	I	R	Z

ZONE



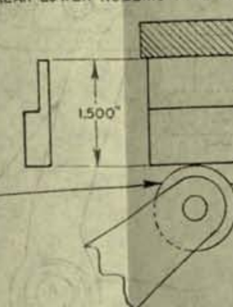
ECCENTRIC SCREWS ADJUSTED TO EQUALIZE THE RISE ACROSS THE ENTIRE BAIL. SEE THAT TYPE BARS 1 TO 43 ARE STOPPED BY THE TOOTH AT THE SAME TIME.

CHECK FOR SUFFICIENT TENSION OF TYPE BAR OPERATING ARM CLIP TO RETAIN TYPE BAR

ADJUST FORKED ARM SO THAT ALPHABETIC TYPE BAR IS STOPPED AT ONE TOOTH BY A STOP PAWL AT 168°.
CHECK LIST LAP AT:

8 - 42°
5 - 96°
1 - 168°

WHEN ANY CHANGE IS MADE IN LIST LAP, RECHECK ZONE ADJUSTMENT NUMBER TEN. CHANGING LIST LAP WILL AFFECT THE .030-.040 CLEARANCE BETWEEN THE ZONE OF TYPE BAR AND SETUP PAWL. ALSO RECHECK ZONE ADJUSTMENT NUMBER ELEVEN.



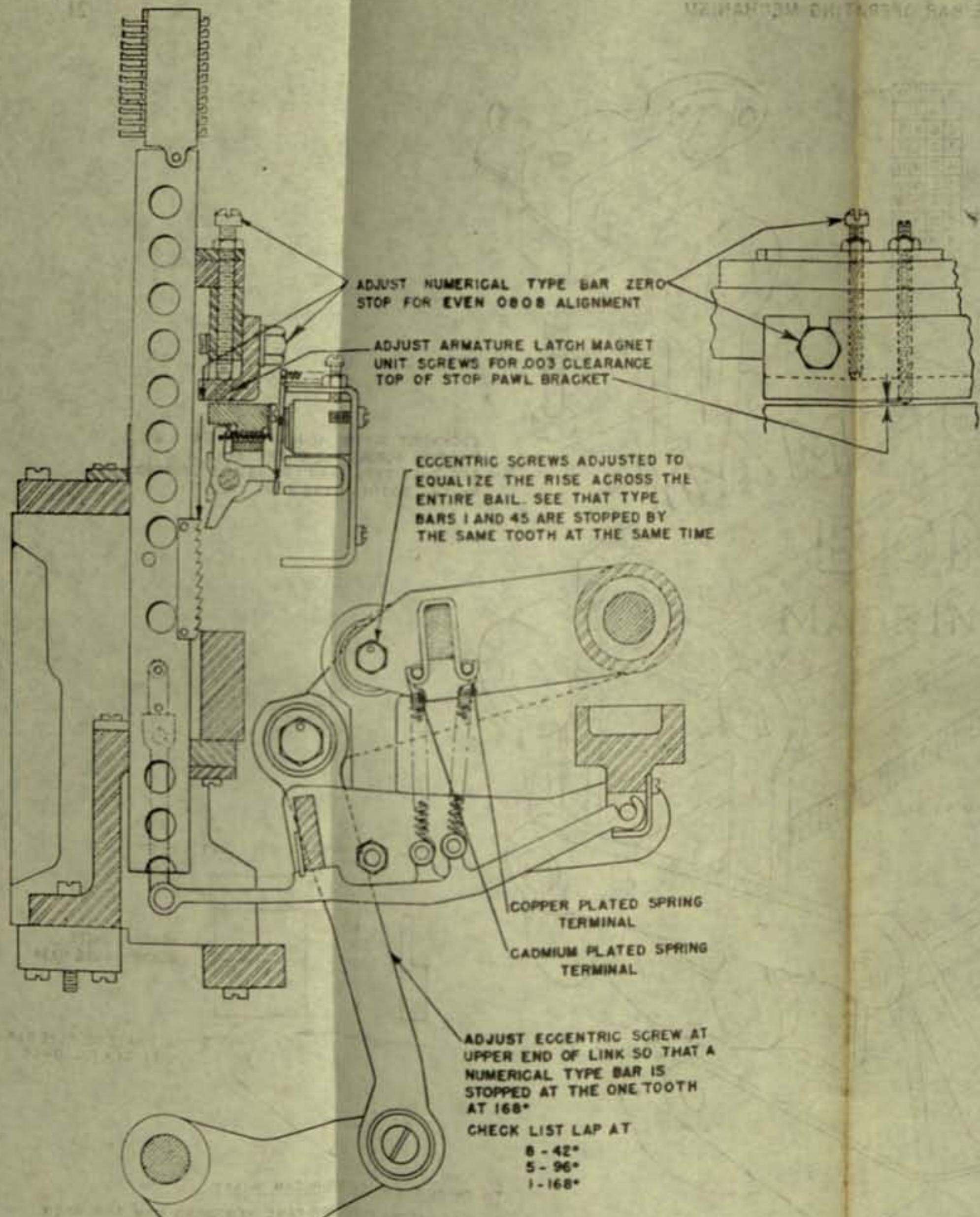
TO CHECK TIMING OF MAIN CAM SHAFT

A. A QUICK CHECK - TYPE BAR PAWL RESTORING CAM ARM WHEN CORRECTLY SET WILL DROP OFF CAM AT 351°.

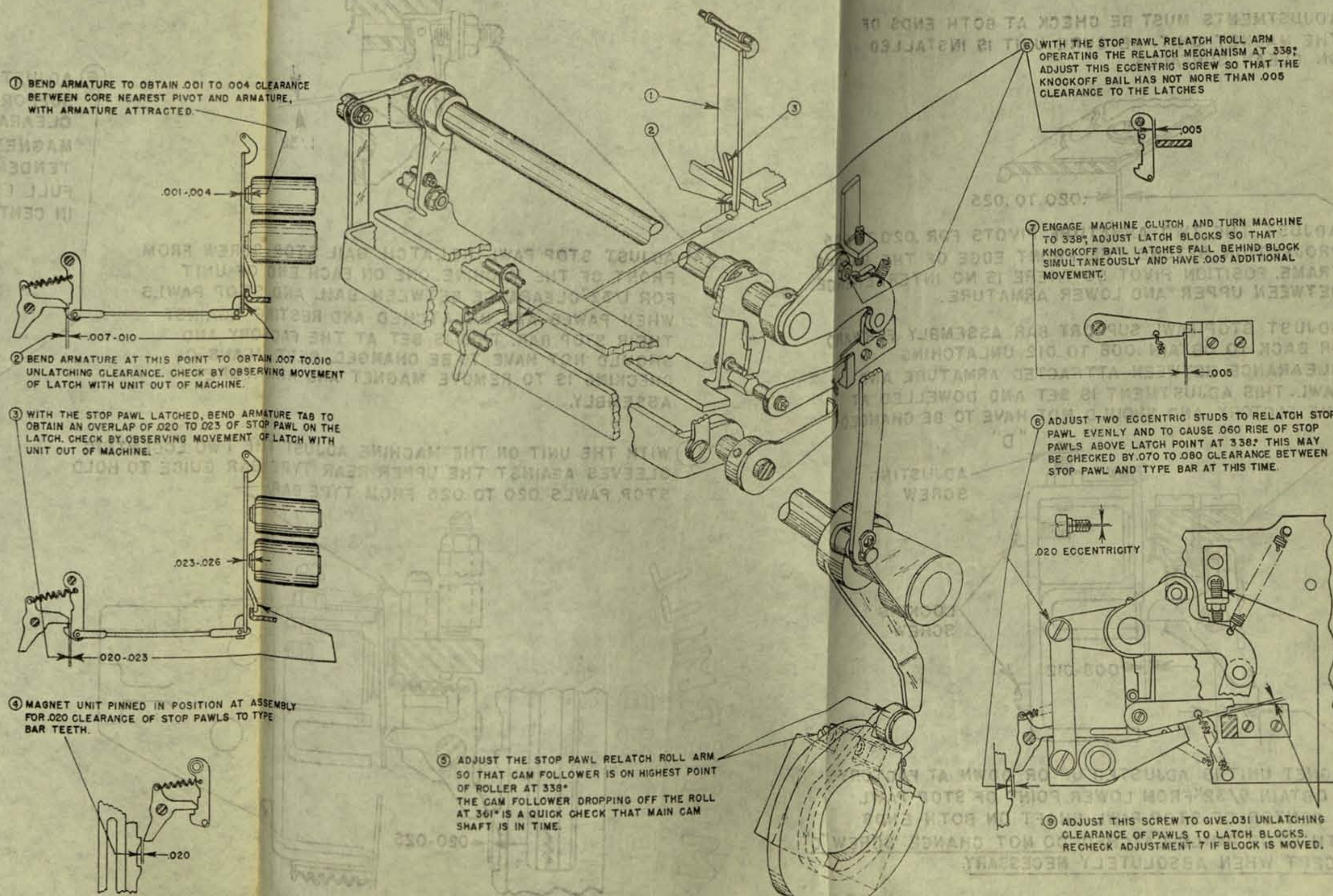
B. 1. CHECK SORTER CHUTE BLADE GAUGE FOR 1.500" HEIGHT.
2. HOLD GAUGE ON TOP OF ALPHABETIC TYPE BAR LIFT CAM FOLLOWER
3. ENGAGE MACHINE CLUTCH AND TURN CRANK UNTIL GAUGE COMES TO REST AGAINST REAR NUMERIC TYPE COMB.
4. INDEX SHOULD READ 46° ± 1°
5. ONLY AFTER A CAREFUL CHECK SHOULD THE RELATION BETWEEN MAIN CAM SHAFT AND DRIVE GEAR BE CHANGED. LOOSEN SLEEVE NUT ON MAIN CAM SHAFT GEAR RELEASE SERRATIONS. WHEN RELOCATED, RELOCK NUT AND CHECK WITH GAUGE

NOTE:
THIS METHOD NOT TO BE USED TO CORRECT ERRORS IN TIMING BETWEEN P.M CLUTCH GEAR AND MAIN CAM SHAFT GEAR.

NUMERICAL TYPE BAR OPERATING MECHANISM

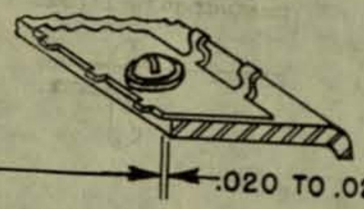


MAGNET UNIT - PULL ROD TYPE



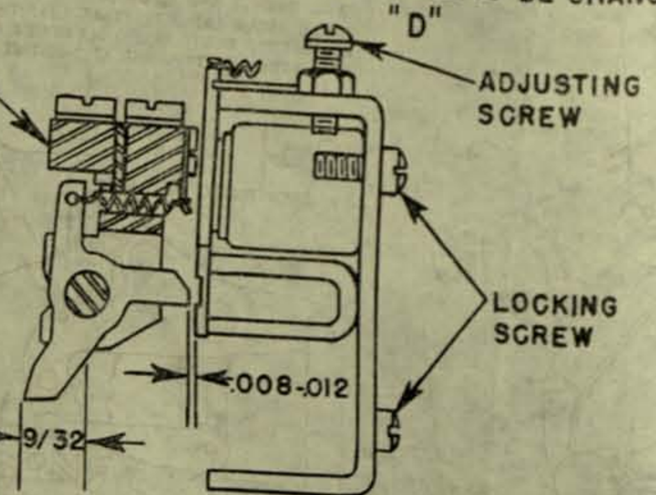
NOTE:

ADJUSTMENTS MUST BE CHECK AT BOTH ENDS OF THE MAGNET UNIT. BE SURE UNIT IS INSTALLED ON CLEAN SURFACES.



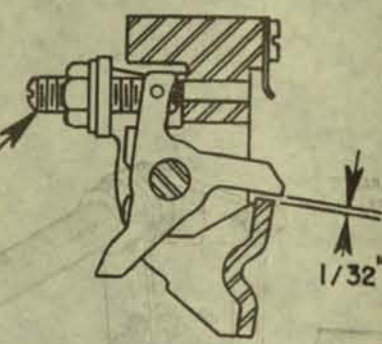
(1) ADJUST THE TWO ARMATURE PIVOTS FOR .020 TO .025 PROJECTION BEYOND THE FRONT EDGE OF THE MAGNET FRAME. POSITION PIVOT SO THERE IS NO INTERFERENCE BETWEEN UPPER AND LOWER ARMATURE.

(2) ADJUST STOP PAWL SUPPORT BAR ASSEMBLY FORWARD OR BACK TO OBTAIN .008 TO .012 UNLATCHING CLEARANCE BETWEEN ATTRACTED ARMATURE AND PAWL. THIS ADJUSTMENT IS SET AND DOWELLED AT THE FACTORY AND SHOULD NOT HAVE TO BE CHANGED.



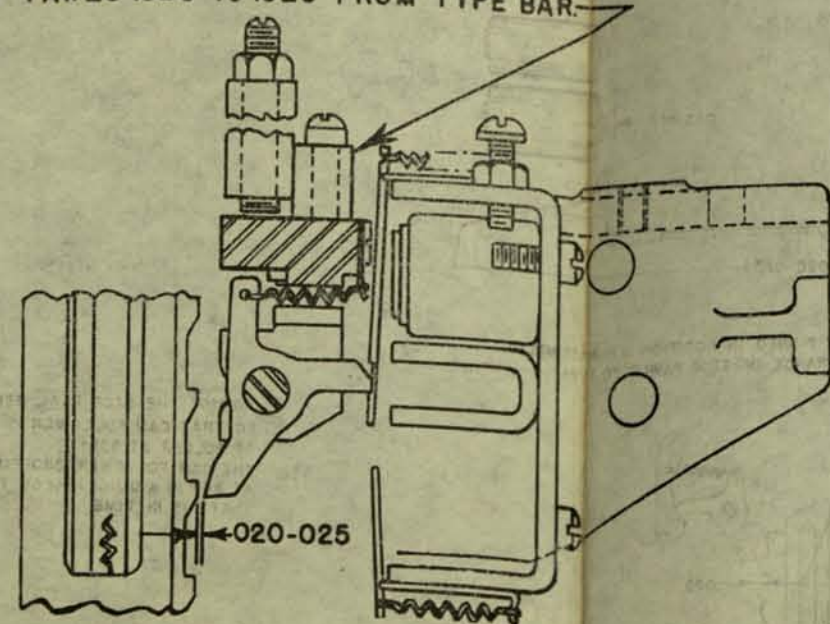
(3) MAGNET UNIT IS ADJUSTED UP OR DOWN AT FACTORY TO OBTAIN 9/32" FROM LOWER POINT OF STOP PAWL TO CENTER OF STOP PAWL SHAFT ON BOTH ENDS WITH STOP PAWLS LATCHED. <u>DO NOT CHANGE SCREW "D" EXCEPT WHEN ABSOLUTELY NECESSARY.</u>

MAGNET UNIT - ARMATURE LATCH TYPE

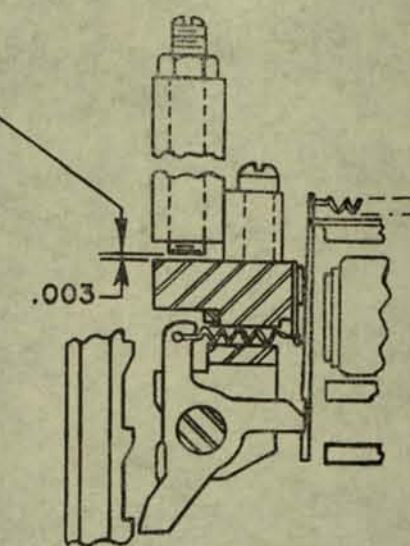


(4) ADJUST STOP PAWL RELATCH BAIL STOP SCREW FROM FRONT OF THE MACHINE. ONE ON EACH END OF UNIT FOR 1/32" CLEARANCE BETWEEN BAIL AND STOP PAWLS WHEN PAWLS ARE UNLATCHED AND RESTING AGAINST THEIR STOP BAR. THIS IS SET AT THE FACTORY AND SHOULD NOT HAVE TO BE CHANGED. BEST MEANS OF CHECKING IS TO REMOVE MAGNET AND ARMATURE ASSEMBLY.

(5) WITH THE UNIT ON THE MACHINE ADJUST THE TWO ECCENTRIC SLEEVES AGAINST THE UPPER REAR TYPE BAR GUIDE TO HOLD STOP PAWLS .020 TO .025 FROM TYPE BAR.

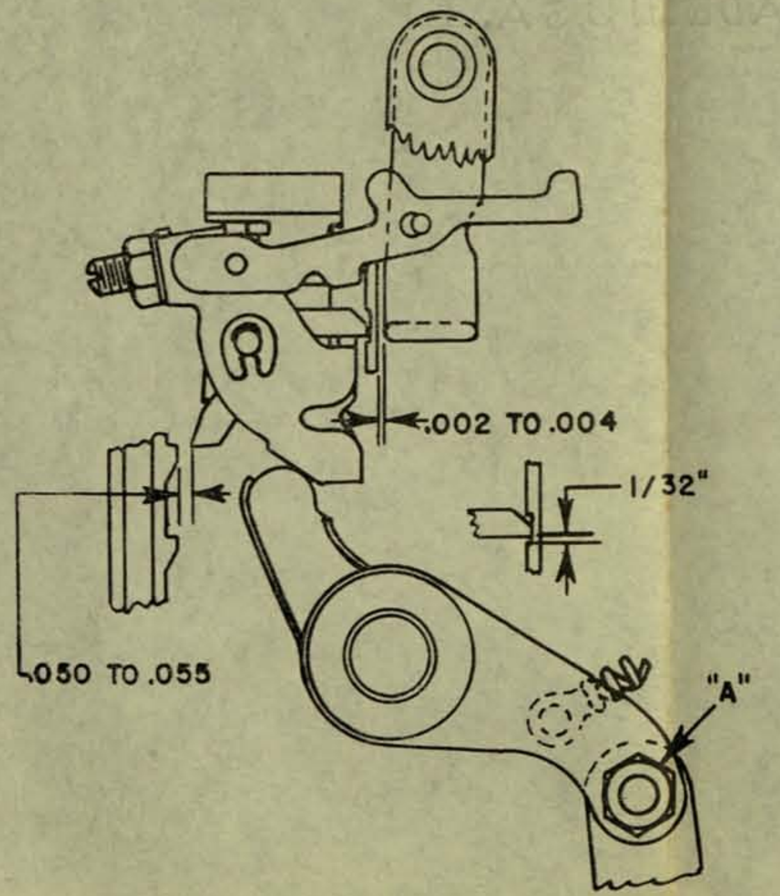


(6) ADJUST 6 ADJUSTING SCREWS ON SUPPORT BAR REAR UPPER FOR .003 CLEARANCE BETWEEN SCREW AND MAGNET UNIT. THIS WILL OVERCOME TENDENCY OF UNIT TO BOW UNDER FULL LOAD, THROWING LIST LAP OFF IN CENTER OF UNIT.

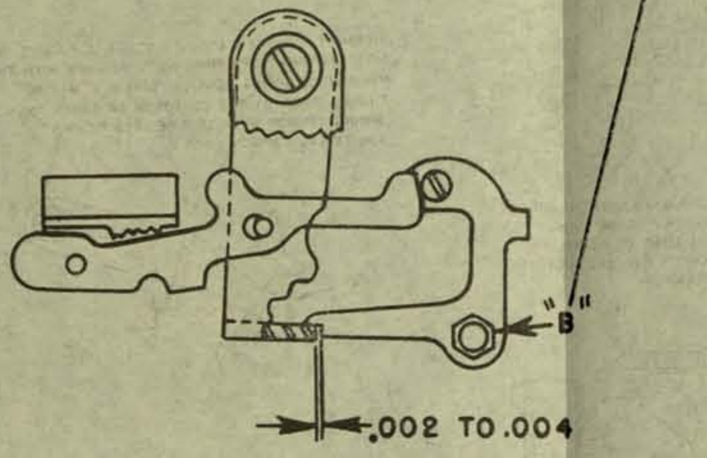


⑦ WITH PRINT CLUTCH ENGAGED AND MACHINE SET AT 338° ADJUST ECCENTRIC SCREW "A" FOR .002 TO .004 CLEARANCE BETWEEN ARMATURE KNOCKOFF BAIL AND REAR SURFACE OF ARMATURE. THIS MAY BE CHECKED FROM THE TOP ON EACH END AND A FEW ARMATURES SHOULD BE REMOVED SO THAT IT MAY BE CHECKED IN THE MIDDLE OF THE UNIT.

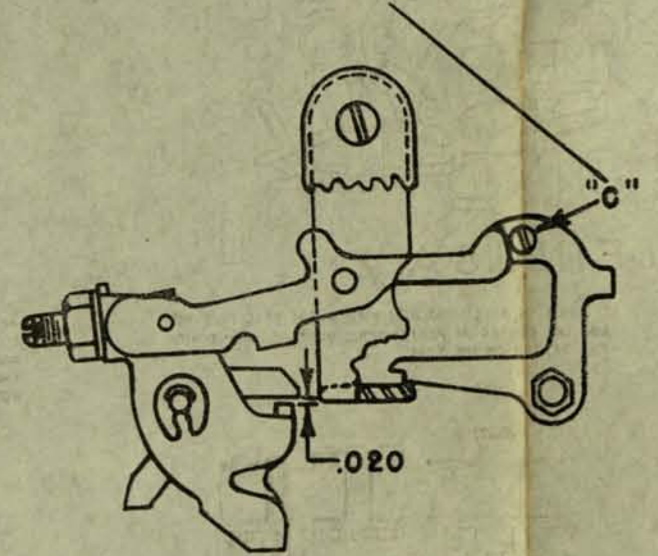
AT THIS SETTING THE STOP PAWLS SHOULD BE AT LEAST 1/32" PAST THEIR LATCHING POINT. THIS CONDITION CAN NOT BE SEEN EXCEPT BY REMOVING THE ASSEMBLY FROM THE MACHINE. AT 338° OBSERVE THE .050-.055 CLEARANCE BETWEEN THE STOP PAWL AND THE TYPE BAR. CONTINUE TO CRANK THE MACHINE AND NOTICE THE PAWL COMING TO REST WITHIN .020 TO .025 OF THE TYPE BAR. THIS WILL SATISFY THE ABOVE CONDITION.



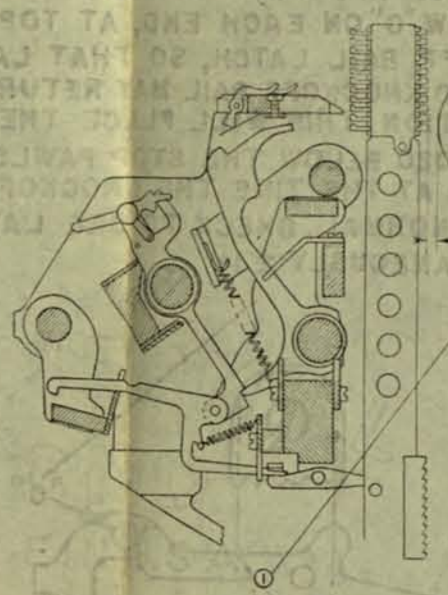
⑧ WITH THE CLUTCH ENGAGED AND MACHINE SET AT 334°, ADJUST THE ARMATURE KNOCKOFF BAIL LATCH PIVOT ECCENTRIC SCREWS "B" SO THAT LATCHES JUST DROP BEHIND THE BAIL. CHECK TO SEE THEY DROP AT SAME TIME ON ON EACH END. WHEN THE MACHINE IS TURNED TO 338° THE LATCHES WILL HAVE .002 TO .004 CLEARANCE BEHIND THE ARMATURE BAIL.



⑨ ENGAGE CLUTCH AND TURN MACHINE TO 349° ADJUST SCREW "C" ON EACH END, AT TOP OF THE KNOCKOFF BAIL LATCH, SO THAT LATCH RELEASES AND KNOCKOFF BAIL MAY RETURN TO NORMAL POSITION. THIS WILL PLACE THE PAWL RESET BAIL .020 BELOW THE STOP PAWLS THAT ARE LATCHED AT THE TIME THE KNOCKOFF BAIL RETURNS TO NORMAL, CHECK TO SEE LATCHES TRIP SIMULTANEOUSLY ± 1°

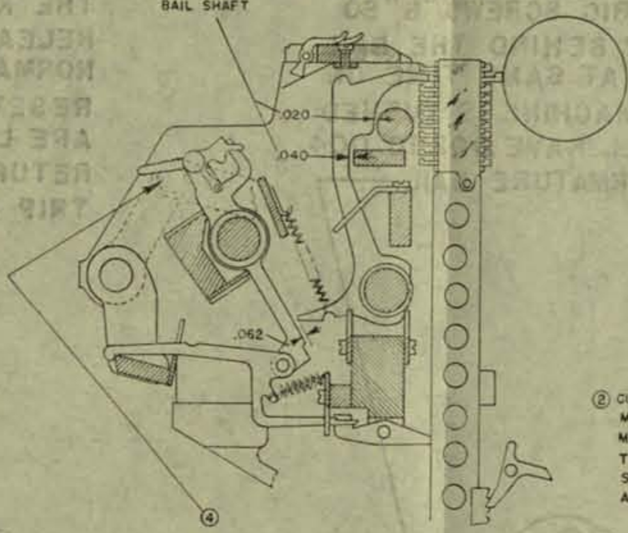


HAMMER UNIT

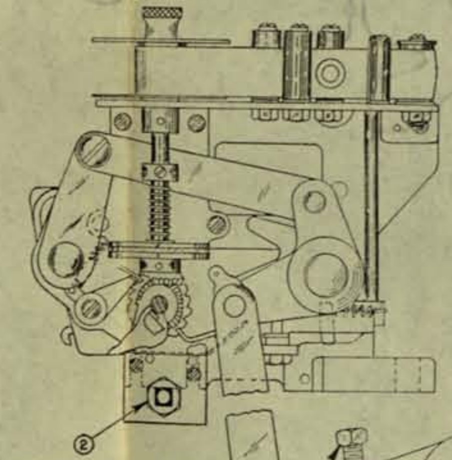


THE PLATEN ROLL MUST BE 1/8" FROM THE FACE OF TYPE AND THE CENTER OF PLATEN ROLL MUST BE IN LINE WITH THE CENTER OF THE TYPE

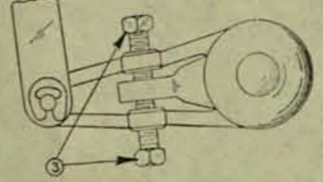
AFTER ADJUSTING HAMMER CAM FOLLOWER SPLIT ARM CHECK FOR .040 CLEARANCE BETWEEN HAMMERS AND RESTORING BAIL WHEN THE HAMMER IS HOLDING THE TYPE TO THE PLATEN, ALSO CHECK FOR .020 BETWEEN HAMMERS AND HAMMER SPRING BAIL SHAFT



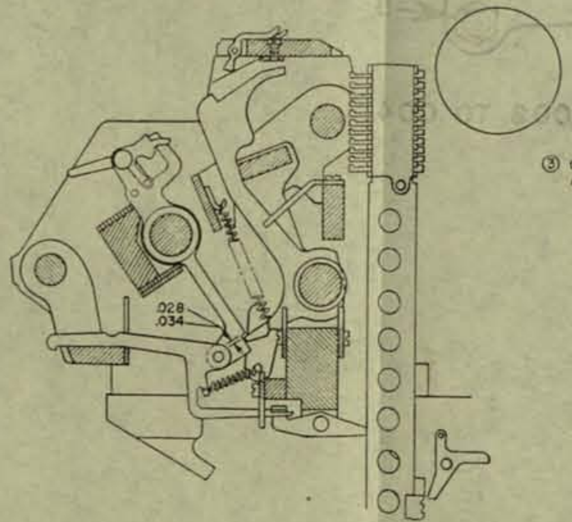
AFTER SETTING HAMMER RESTORING ADJUSTMENT, ADJUST ECCENTRIC SCREWS SO HAMMERS TRIP AT 196° EVENLY ACROSS THE ENTIRE UNIT. AT THE LIMIT OF TRAVEL OF THE HAMMER LATCH TRIP BAR CHECK FOR .062 CLEARANCE BETWEEN HAMMER LATCH AND HAMMER



ADJUSTING SCREWS, ONE AT EACH END OF UNIT, TO ALIGN HAMMERS WITH TYPE



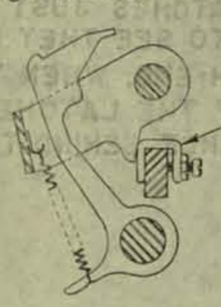
ADJUST HAMMER CAM FOLLOWER SPLIT ARM SO THAT HAMMERS ARE RESTORED 1/16" FROM THE TYPE TAILS WHEN THE TYPE BARS START DOWN



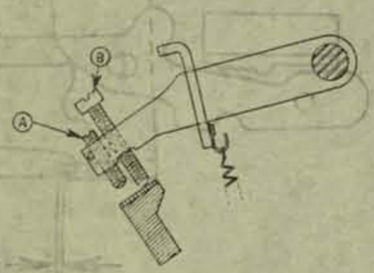
HAMMERS AND TYPE BARS IN NORMAL POSITION AT 330° AS A RESULT OF ADJUSTMENT 3, THE HAMMER RESTORING BAIL SHOULD HOLD THE HAMMERS .028-.034 PAST THE LATCHING POINT. CHECK IN MIDDLE OF HAMMER ASSEMBLY, AS WELL AS END HAMMERS. IF IT IS NECESSARY TO CHANGE ADJUSTMENT 3 IN ORDER TO IMPROVE THE LATCHING CONDITION, RECHECK ADJUSTMENT 4 FOR HAMMER TRIPPING TIME FOR 196° TO CORRECT FAINT PRINTING, CHECK TO SEE THAT THE HAMMER RESTORING BAIL STARTS TO THE REAR AS CLOSE TO 171° AS POSSIBLE, ALL OTHER CONDITIONS BEING SATISFIED

THREE TYPES OF SPRING TENSION DEVICES

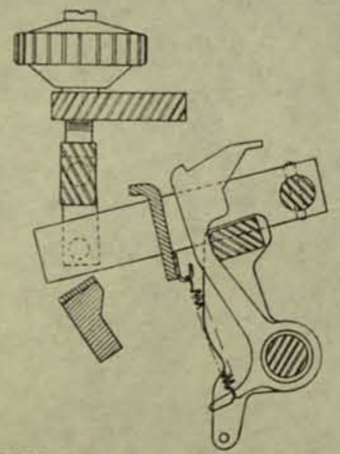
① NO ADJUSTMENT



② CUSTOMER ENGINEER ADJUSTS SCREW "A" TO GIVE THE MOST SATISFACTORY PRINTING IMPRESSION WITH THE MINIMUM OF SPRING TENSION. SCREW "B" MAY BE TURNED DOWN BY THE CUSTOMER IN ORDER TO INCREASE SPRING TENSION WHEN IT IS DESIRED TO PRINT ADDITIONAL CARBON COPIES

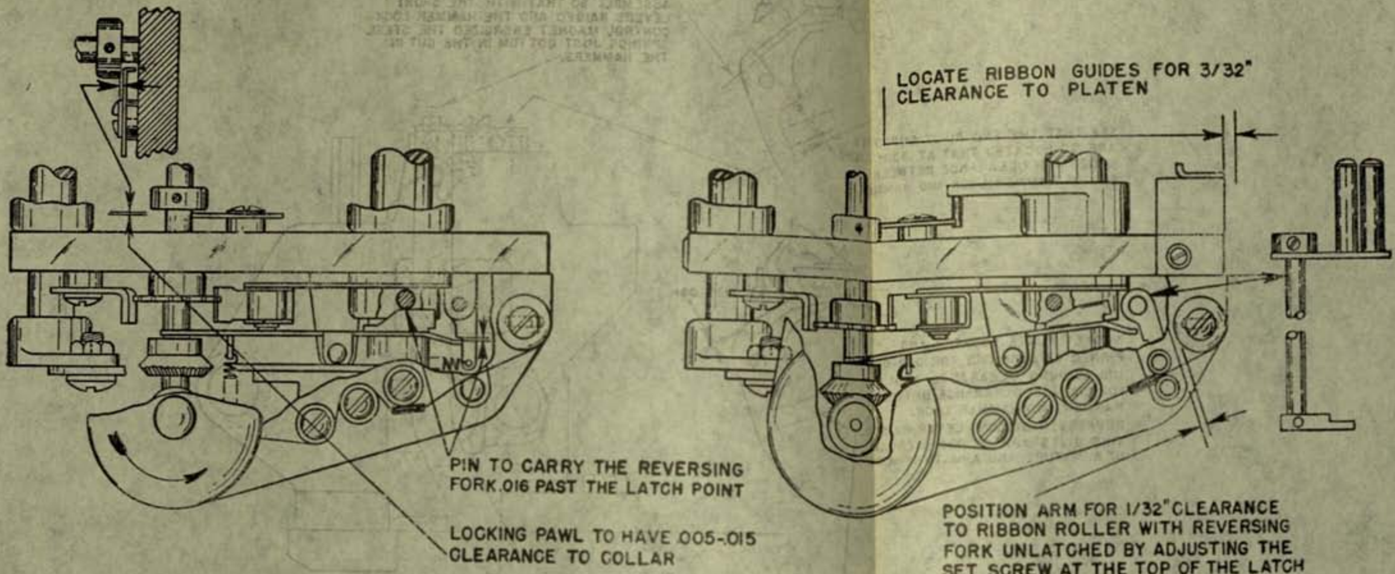


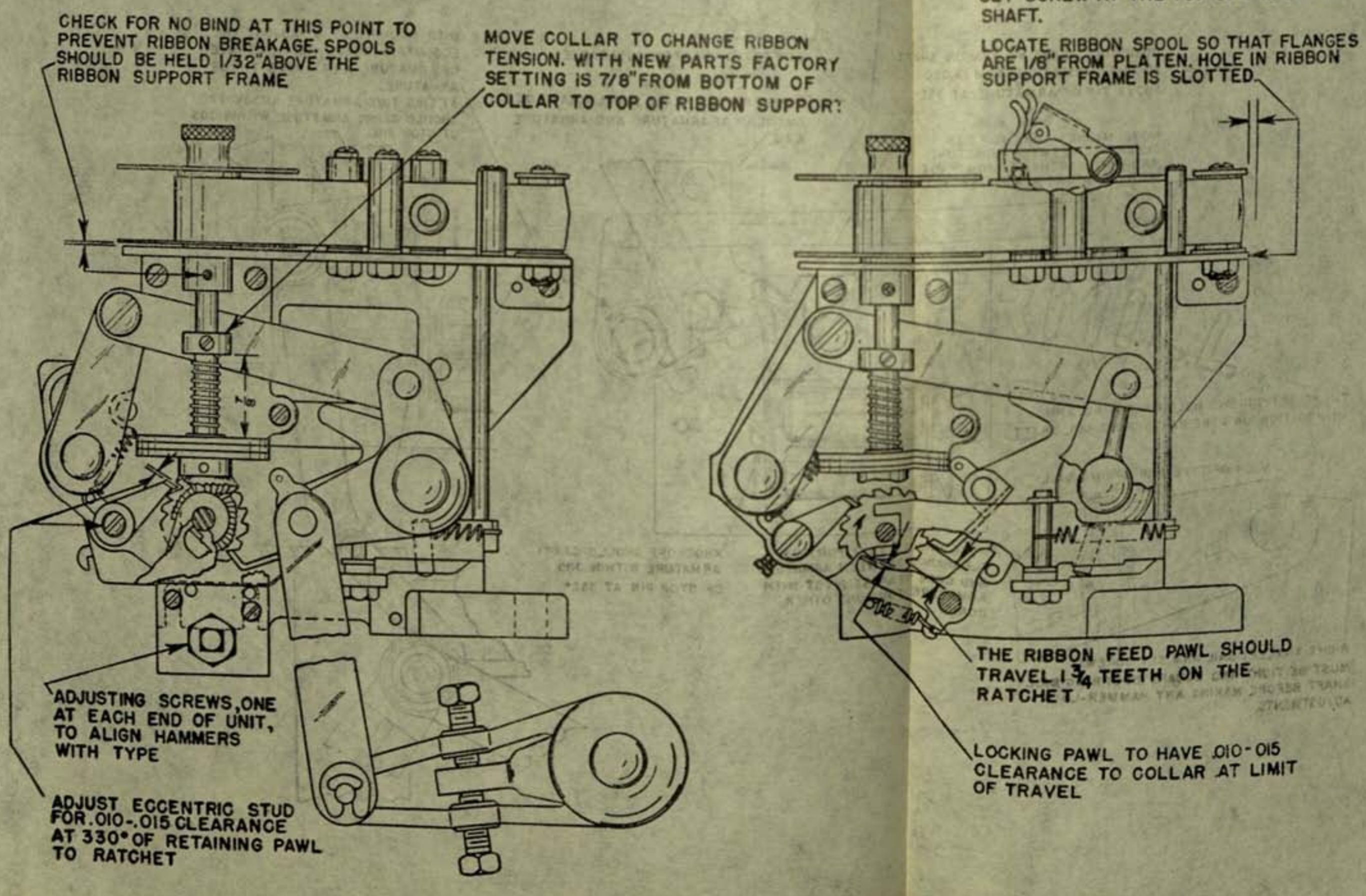
③ OPERATOR INCREASE SPRING TENSION BY TURNING KNOB ABOVE HAMMER LOCK ASSEMBLY TO GIVE DESIRED IMPRESSION

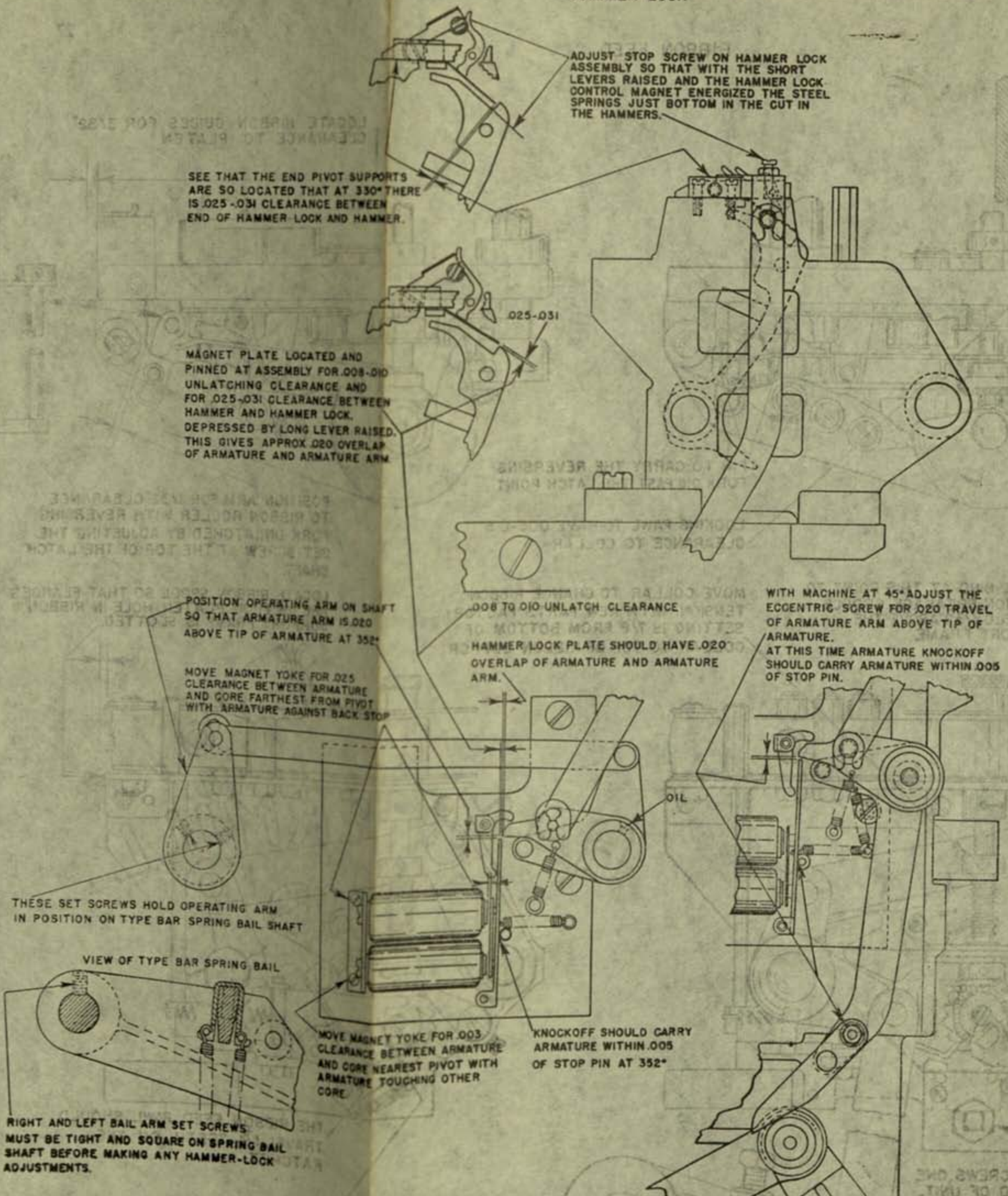


WHERE SPRING TENSION DEVICE IS USED IT IS ADVISABLE TO SET HAMMER TRIPPING TIME AT 198°

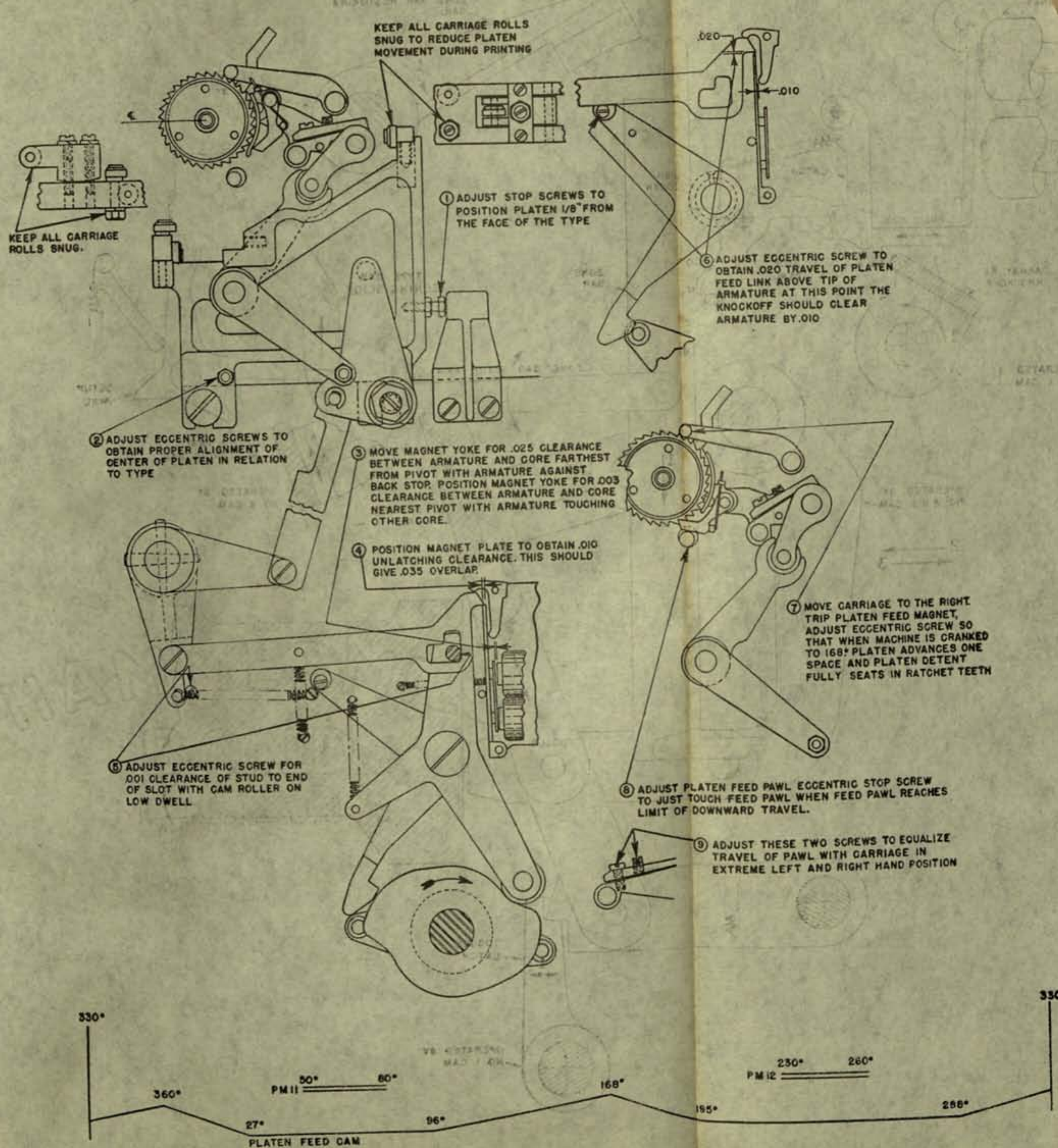
RIBBON FEED


LOCATE RIBBON GUIDES FOR 3/32" CLEARANCE TO PLATEN
PIN TO CARRY THE REVERSING FORK .016 PAST THE LATCH POINT
LOCKING PAWL TO HAVE .005-.015 CLEARANCE TO COLLAR
POSITION ARM FOR 1/32" CLEARANCE TO RIBBON ROLLER WITH REVERSING FORK UNLATCHED BY ADJUSTING THE SET SCREW AT THE TOP OF THE LATCH SHAFT.

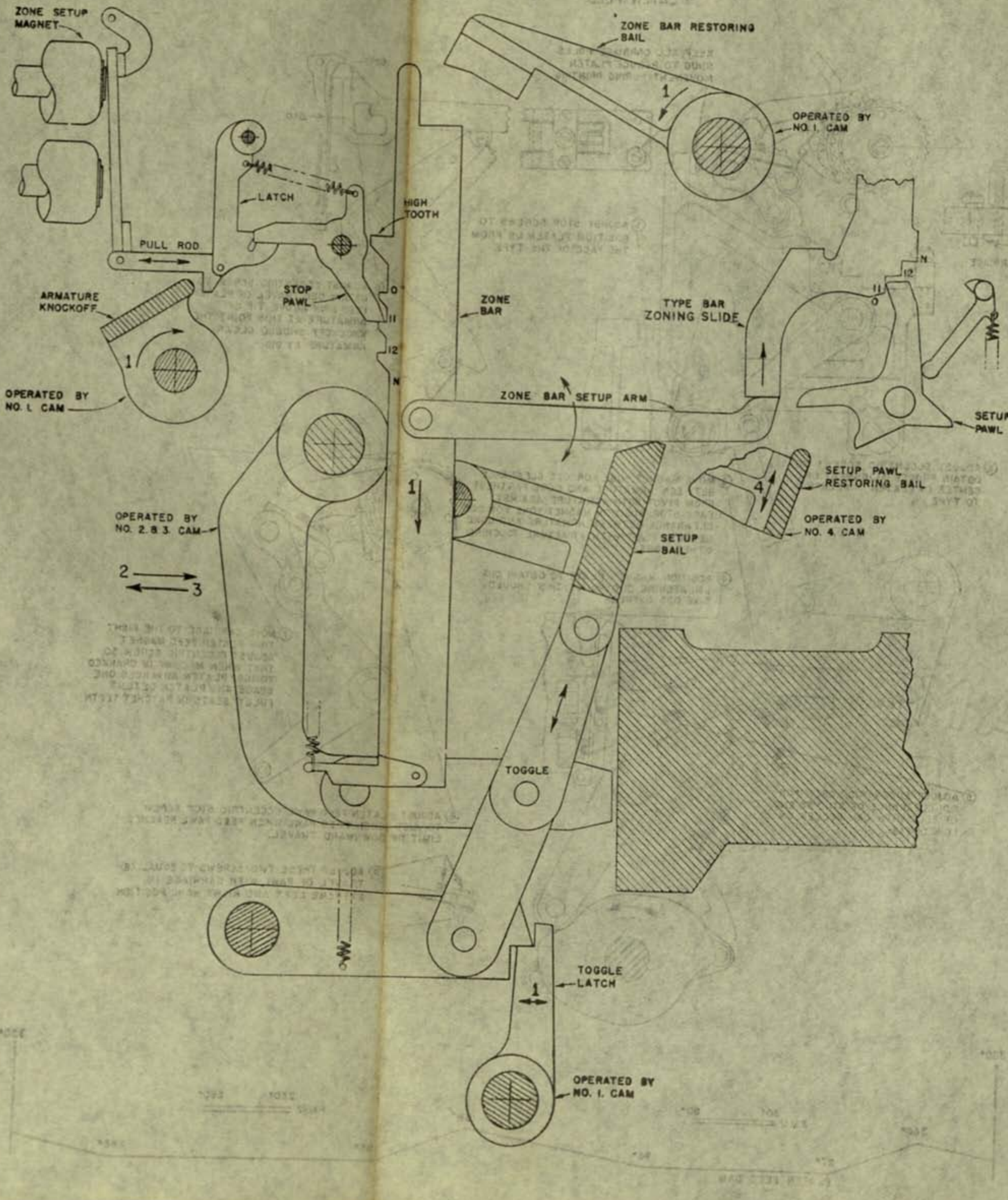

CHECK FOR NO BIND AT THIS POINT TO PREVENT RIBBON BREAKAGE. SPOOLS SHOULD BE HELD 1/32" ABOVE THE RIBBON SUPPORT FRAME
MOVE COLLAR TO CHANGE RIBBON TENSION. WITH NEW PARTS FACTORY SETTING IS 7/8" FROM BOTTOM OF COLLAR TO TOP OF RIBBON SUPPORT
LOCATE RIBBON SPOOL SO THAT FLANGES ARE 1/8" FROM PLATEN. HOLE IN RIBBON SUPPORT FRAME IS SLOTTED.
7/8
ADJUSTING SCREWS, ONE AT EACH END OF UNIT, TO ALIGN HAMMERS WITH TYPE
ADJUST ECCENTRIC STUD FOR .010-.015 CLEARANCE AT 330° OF RETAINING PAWL TO RATCHET
THE RIBBON FEED PAWL SHOULD TRAVEL 1 3/4 TEETH ON THE RATCHET
LOCKING PAWL TO HAVE .010-.015 CLEARANCE TO COLLAR AT LIMIT OF TRAVEL


ADJUST STOP SCREW ON HAMMER LOCK ASSEMBLY SO THAT WITH THE SHORT LEVERS RAISED AND THE HAMMER LOCK CONTROL MAGNET ENERGIZED THE STEEL SPRINGS JUST BOTTOM IN THE CUT IN THE HAMMERS.
SEE THAT THE END PIVOT SUPPORTS ARE SO LOCATED THAT AT 330° THERE IS .025-.031 CLEARANCE BETWEEN END OF HAMMER LOCK AND HAMMER.
.025-.031
MAGNET PLATE LOCATED AND PINNED AT ASSEMBLY FOR .008-.010 UNLATCHING CLEARANCE AND FOR .025-.031 CLEARANCE BETWEEN HAMMER AND HAMMER LOCK. DEPRESSED BY LONG LEVER RAISED. THIS GIVES APPROX .020 OVERLAP OF ARMATURE AND ARMATURE ARM.
POSITION OPERATING ARM ON SHAFT SO THAT ARMATURE ARM IS .020 ABOVE TIP OF ARMATURE AT 352°
.008 TO .010 UNLATCH CLEARANCE
HAMMER LOCK PLATE SHOULD HAVE .020 OVERLAP OF ARMATURE AND ARMATURE ARM.
WITH MACHINE AT 45° ADJUST THE ECCENTRIC SCREW FOR .020 TRAVEL OF ARMATURE ARM ABOVE TIP OF ARMATURE.
AT THIS TIME ARMATURE KNOCKOFF SHOULD CARRY ARMATURE WITHIN .005 OF STOP PIN.
MOVE MAGNET YOKE FOR .025 CLEARANCE BETWEEN ARMATURE AND CORE FARTHEST FROM PIVOT WITH ARMATURE AGAINST BACK STOP
OIL
THESE SET SCREWS HOLD OPERATING ARM IN POSITION ON TYPE BAR SPRING BAIL SHAFT
VIEW OF TYPE BAR SPRING BAIL
MOVE MAGNET YOKE FOR .003 CLEARANCE BETWEEN ARMATURE AND CORE NEAREST PIVOT WITH ARMATURE TOUCHING OTHER CORE.
KNOCKOFF SHOULD CARRY ARMATURE WITHIN .005 OF STOP PIN AT 352°
RIGHT AND LEFT BAIL ARM SET SCREWS MUST BE TIGHT AND SQUARE ON SPRING BAIL SHAFT BEFORE MAKING ANY HAMMER-LOCK ADJUSTMENTS.

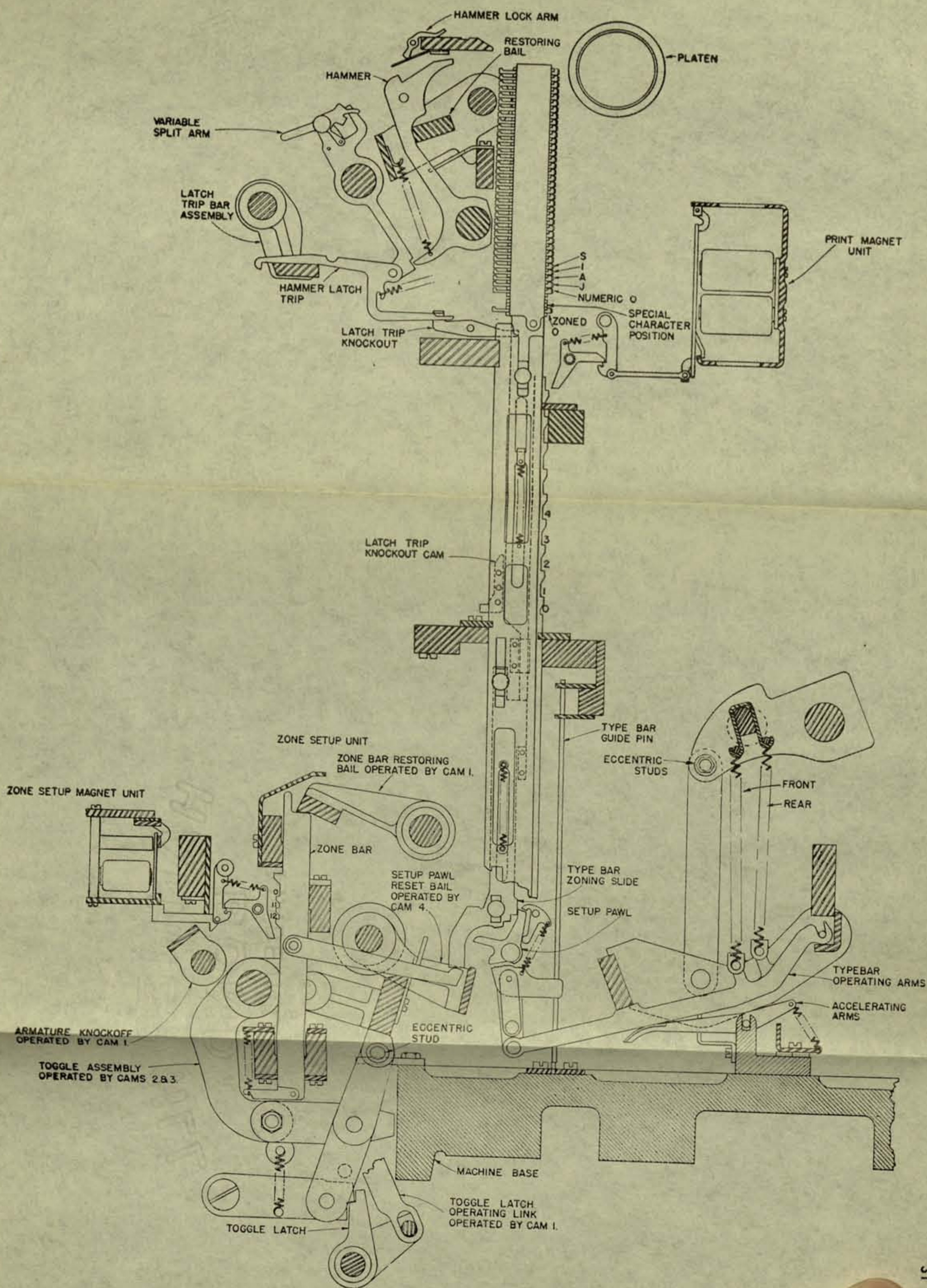
PLATEN FEED

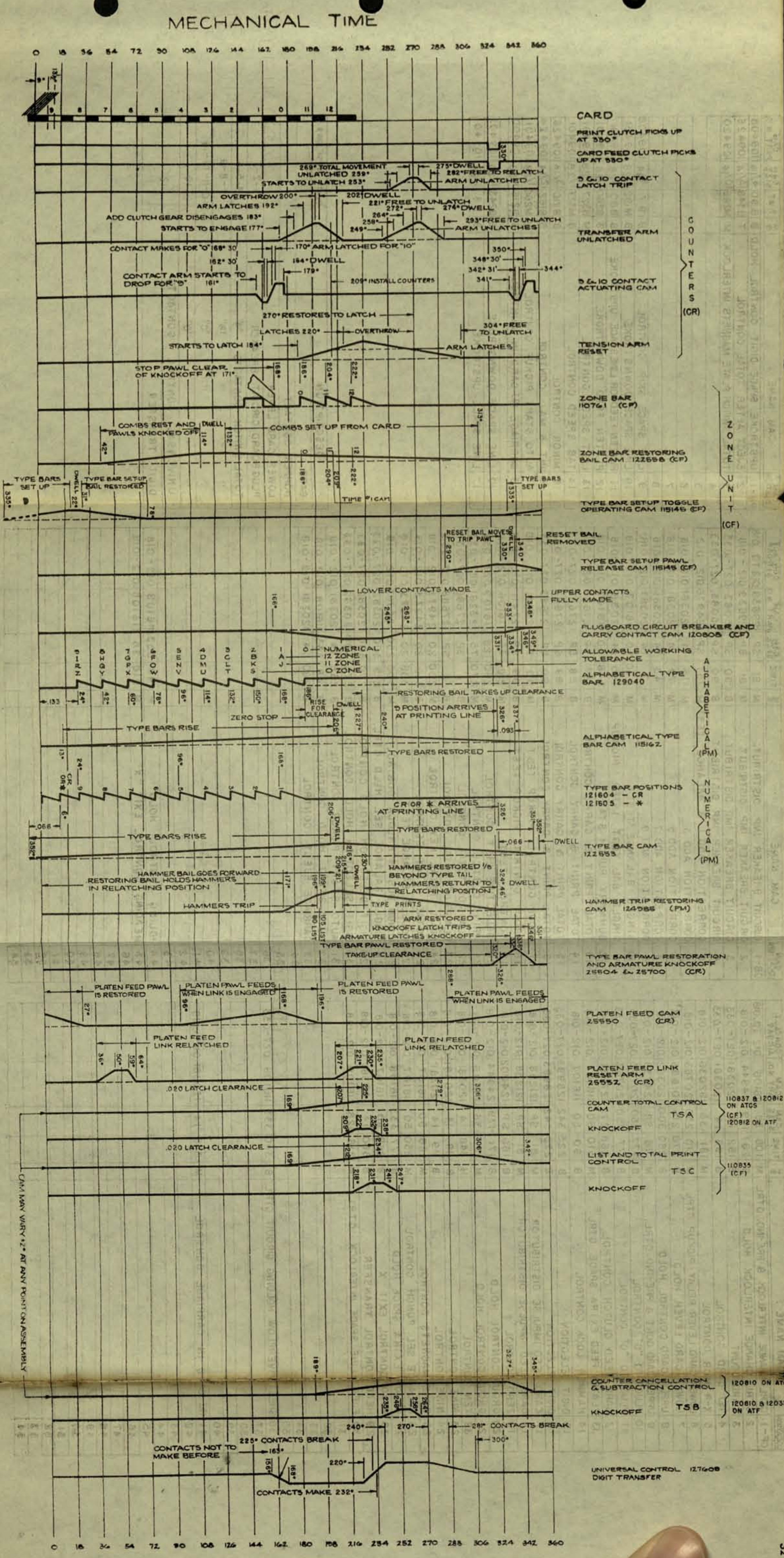

KEEP ALL CARRIAGE ROLLS SNUG TO REDUCE PLATEN MOVEMENT DURING PRINTING
KEEP ALL CARRIAGE ROLLS SNUG.
① ADJUST STOP SCREWS TO POSITION PLATEN 1/8" FROM THE FACE OF THE TYPE
② ADJUST ECCENTRIC SCREWS TO OBTAIN PROPER ALIGNMENT OF CENTER OF PLATEN IN RELATION TO TYPE
③ MOVE MAGNET YOKE FOR .025 CLEARANCE BETWEEN ARMATURE AND CORE FARTHEST FROM PIVOT WITH ARMATURE AGAINST BACK STOP. POSITION MAGNET YOKE FOR .003 CLEARANCE BETWEEN ARMATURE AND CORE NEAREST PIVOT WITH ARMATURE TOUCHING OTHER CORE.
④ POSITION MAGNET PLATE TO OBTAIN .010 UNLATCHING CLEARANCE. THIS SHOULD GIVE .035 OVERLAP.
⑤ ADJUST ECCENTRIC SCREW FOR .001 CLEARANCE OF STUD TO END OF SLOT WITH CAM ROLLER ON LOW DWELL
.020
.010
⑥ ADJUST ECCENTRIC SCREW TO OBTAIN .020 TRAVEL OF PLATEN FEED LINK ABOVE TIP OF ARMATURE AT THIS POINT THE KNOCKOFF SHOULD CLEAR ARMATURE BY .010
⑦ MOVE CARRIAGE TO THE RIGHT. TRIP PLATEN FEED MAGNET, ADJUST ECCENTRIC SCREW SO THAT WHEN MACHINE IS CRANKED TO 168° PLATEN ADVANCES ONE SPACE AND PLATEN DETENT FULLY SEATS IN RATCHET TEETH
⑧ ADJUST PLATEN FEED PAWL ECCENTRIC STOP SCREW TO JUST TOUCH FEED PAWL WHEN FEED PAWL REACHES LIMIT OF DOWNWARD TRAVEL.
⑨ ADJUST THESE TWO SCREWS TO EQUALIZE TRAVEL OF PAWL WITH CARRIAGE IN EXTREME LEFT AND RIGHT HAND POSITION
330°
360°
PM 11
50°
80°
27°
96°
168°
195°
PM 12
230°
260°
288°
330°
PLATEN FEED CAM

PRINCIPLE OF ZONING



COMPLETE TYPE BAR ASSEMBLY




MECHANICAL TIME
CARD
PRINT CLUTCH PICKS UP AT 330°
CARD FEED CLUTCH PICKS UP AT 330°
9 & 10 CONTACT LATCH TRIP
TRANSFER ARM UNLATCHED
9 & 10 CONTACT ACTUATING CAM
TENSION ARM RESET
COUNTERS (CR)
ZONE BAR 110761 (CF)
ZONE BAR RESTORING BAIL CAM 122698 (CF)
TYPE BAR SETUP TOGGLE OPERATING CAM 119146 (CF)
RESET BAIL REMOVED
TYPE BAR SETUP PAWL RELEASE CAM 119146 (CF)
ZONE UNIT (CF)
UPPER CONTACTS FULLY MADE
LOWER CONTACTS MADE
PLUGBOARD CIRCUIT BREAKER AND CARRY CONTACT CAM 120805 (CF)
ALLOWABLE WORKING TOLERANCE
ALPHABETICAL TYPE BAR 129040
ALPHABETICAL TYPE BAR CAM 118162
ALPHABETICAL (PM)
TYPE BAR POSITIONS 121604 - CR 121605 - *
TYPE BAR CAM 122853
NUMERICAL (PM)
HAMMER TRIP RESTORING CAM 124986 (PM)
TYPE BAR PAWL RESTORATION AND ARMATURE KNOCKOFF 25604 & 25700 (CR)
PLATEN FEED CAM 25550 (CR)
PLATEN FEED LINK RESET ARM 25552 (CR)
COUNTER TOTAL CONTROL CAM
TSA
KNOCKOFF
110837 & 120812 ON ATOS (CF) 120812 ON ATF
LIST AND TOTAL PRINT CONTROL
TSC
KNOCKOFF
110835 (CF)
COUNTER CANCELLATION & SUBTRACTION CONTROL
TSB
KNOCKOFF
120810 ON ATOS
120810 & 120331 ON ATF
UNIVERSAL CONTROL 127608 DIGIT TRANSFER
CONTACTS NOT TO MAKE BEFORE
225° CONTACTS BREAK
281° CONTACTS BREAK
CONTACTS MAKE 232°
CAM MAY VARY ±2° AT ANY POINT ON ASSEMBLY

127797

CAM LOCATION	CAM NAME	M B	TIME	CAM SIZE	CAM PART NO.	CONTACT AIRGAP
CF-1	CTRL. CHANGE INTERLOCK & PRE-IND. CTRL	M	108	36	116106	.012 TO .018
2	CTRL. CHANGE INTERLOCK HOLD	B	287	179	24944	.012 -.018
3	CARD COUNT	B	162	14	120381	.027-.033
4	1ST CARD CONTROL	B	198	14	120381	.027-.033
5	X-R MCR CONTROL	M	181	36	182036	.012-.018
6	LOWER CARD LEVER RELAY PICKUP CTRL.	M	210	250	120763	.012-.018
7	LOWER CARD LEVER HOLD	B	270	216	101686	.012 -.018
8	UPPER CARD CONTROL HOLD	B	280	300	120382	.012-.018
9	UPPER CARD CONT. & PRE-IND. CTRL.	M	76	SP.	124735	.012 -.018
10	PLUG TO "C" CONTROL	B	177	250	120763	.027-.033
11	PLUG TO "C" CONTROL	B	177	250	120763	.027-.033
12	CARD FEED CLUTCH CONTROL	B	268	275	127631	.012-.018
13	PLATEN FEED EXTRA SPACE CTRL.	M	310	50	116107	.012 -.018
14	HAMMER LOCK CONTROL	B	90	50	116107	.012-.018
15	DIGIT SELECTION	B	225	342	128993	.027-.033
16	DIGIT SELECTION	B	225	342	128993	.027-.033
17	CARD FEED IMPULSE DISTRIBUTOR	M	81	SP	121258	.012-.018
18	CARD FEED IMPULSE DISTRIBUTOR	M	81	SP	121258	.012-.018
19	ZERO CONTROL	B	160	SP	124002	.012-.018
20	GROUP CONTROL HOLD	B	171	179	24944	.012-.018
21	GROUP CONTROL HOLD	M	193	36	116106	.012-.018
22	TEN CONTROL	M	348	14	120381	.012-.018
23	NINE CONTROL	B	19	14	120381	.012-.018
24	NINE CONTROL	B	19	14	120381	.012-.018
25	ZONE MAGNETS CONTROL	M	168	50	116107	.012-.018
26	BALANCE SEL. PUNCH CONTROL	M	250	50	116107	.012-.018
27	MAJOR EXTRA SPACE HOLD	B	177	333	116108	.012-.018
28	HEAD CONTROL EXIT X	B	268	50	116107	.012-.018
29	HEAD CONTROL TRANSFER	B	360	14	120381	.012-.018
30	EJECT LINE SPACE INTERLOCK CTRL.	M	216	128	116109	.012-.018
31						
32						
33						
34						
35						
36	SHEET OVERFLOW HOLDING CIRCUIT CTRL.	B	340	333	116108	.027-.033
37						
38						
39						
40						
41	1ST CARD IN CARRIAGE CONTROL	M	348	14	120381	.012 -.018
42						
43						
44						
45						
46						
47						
48						
49						
50						
51						
52						
53						
54						

CAM LOCATION	CAM NAME	M B	TIME	CAM SIZE	CAM PART NO.	CONTACT AIRGAP
CB-1	CIRCUIT BREAKER IMP. DISTRIBUT.	M	81	SP	129639	.012 TO .018
2	CIRCUIT BREAKER IMP. DISTRIBUT.	M	81	SP	129639	.012 -.018
3	CIRCUIT BREAKER IMP. DISTRIBUT.	B	90	SP	115083	.027-.033
4	CIRCUIT BREAKER IMP. DISTRIBUT.	B	90	SP	115083	.027-.033
5	CORRECTION ADD 1 & BALANCE TEST	M	151	SP	124976	.012-.018
6	CORRECTION ADD 3	M	115	14	120381	.012 -.018
7	CORRECTION ADD 5	M	79	14	120381	.012 -.018
8	CORRECTION ADD 7	M	43	14	120381	.012 -.018
9	CORRECTION ADD 9	M	7	14	120381	.012 -.018
10	SINGLE BALANCE TEST	M	230	50	116107	.012 -.018
11	SINGLE BAL. TEST INTER. PICKUP	M	195	14	120381	.012 -.018
12	SUMMARY PUNCH START	M	348	50	116107	.012 -.018
13	TOTAL PRINT & CARRY CONTROL	B	87	SP	127683	.027-.033
14	TOTAL PRINT & CARRY CONTROL	B	88	SP	127683	.027-.033
15	TOTAL PRINT & CARRY CONTROL	B	89	SP	127683	.027-.033
16	TOTAL PRINT & CARRY CONTROL	B	90	SP	127683	.027-.033
17	GROUP CONTROL PICKUP TEST	M	90	SP	122411	.012 -.018
18	GROUP CONTROL PICKUP TEST	B	99	SP	122411	.012 -.018
19	CONTROL TEST	M	210	36	116106	.012 -.018
20	SELECTIVE LIST CONTROL	M	260	128	116109	.027-.033
21	PRINT CLUTCH CONTROL	M	270	75	123261	.027 -.033
22	CLASS OF TOTAL CONTROL	B	1	SP	127688	.027-.033
23	CLASS OF TOTAL CONTROL	B	1	SP	127688	.027-.033
24	FINAL TOTAL KEY CONTROL	M	200	20	24973	.012 -.018
25	TOTAL RELAY CONTROL	B	316	20	24973	.012 -.018
26	DOUBLE BALANCE TEST	M	306	20	24973	.012 -.018
27	PUNCH BUS INTERLOCK CONTROL	M	300	250	120763	.012 -.018
28	SINGLE BALANCE SEL. HOLD CTRL.	B	215	300	120382	.027 -.033
29	DIGIT SELECTION HOLD CONTROL	B	270	300	120382	.027-.033
30	DIGIT SELECTION HOLD CONTROL	B	270	300	120382	.027-.033
31	AUTO START PICKUP CONTROL	B	268	14	120381	.012 -.018
32	AUTO START HOLD CONTROL	B	48	333	116108	.012-.018
33	CARRIAGE EJECT CONTROL	B	280	14	120381	.012 -.018
34						
35						
36						
37						
38						
39						
40						
41						
42						
43						
44	IDLING CONTROL HOLD	M	48	333	116108	.012 -.018
45	HEADING CONTROL EXIT "X"	M	210	36	116106	.012 -.018
46						
47						
48						
49						
50						
51						
52						
53						
54						

CAM LOCATION	CAM NAME	M B	TIME	CAM SIZE	CAM PART NO.
PM-1	UPSTROKE SPACE DIGIT CONTROL HOLD	B	B 90	4/14	109408
2	EJECT AFTER TOTAL CONTROL	T	B348	13/14	109426
3	TOTAL SWITCH PLATE MAGNETS INTERLOCK	M	M268	10/14	109420
4					
5					
6					
7					
8					
9	LINE SPACE SKIP CONTROL	B	B 7	4/14	109408
10	LINE SPACE DOWNSTROKE	B	M192	1/28	109401
11	PLATEN FEED OR LINESPACE UPSTROKE	B	B80	1/28	109401
12	PLATEN FEED DOWNSTROKE	B	B260	1/28	109401
13	LIST SPEED CONTROL	M	B327	1/28	109401
14	TAB SPEED CONTROL	B	M327	1/28	109401
15	MINOR CONTROL	B	B210	13/14	109426
16	INT. & MAJ. CONTROL	B	B162	12/14	109424
17	AUTO START PICKUP CONTROL	M	M260	1/28	109401
18	CARRIAGE 1ST CARD IN CONTROL	B	B216	1/56	109400
10	LINE SPACE DOWNSTROKE	B	B243	1/28	109401
17	LINE SPACE UPSTROKE	B	B8	1/28	109401

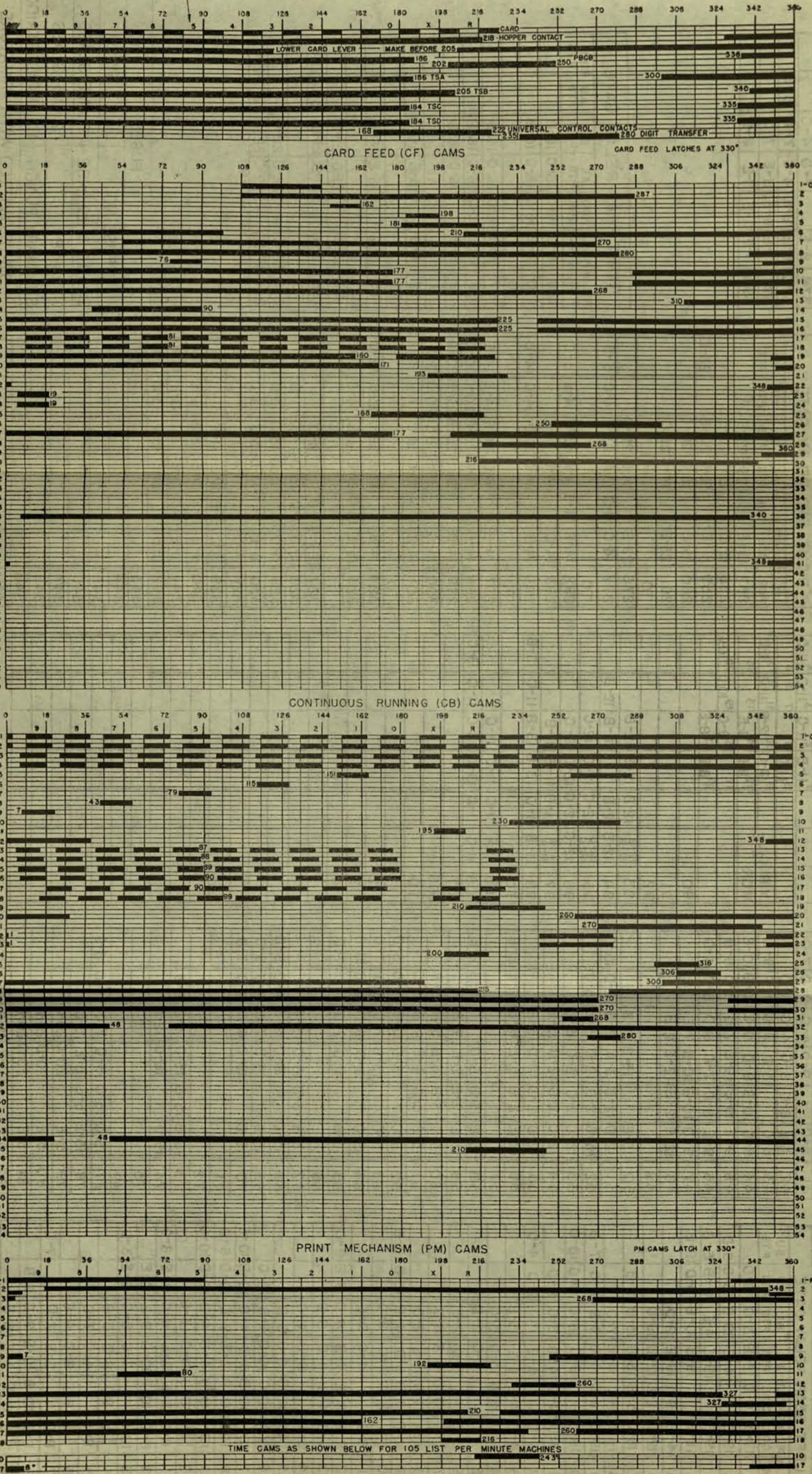
DESCRIPTION	PLATE POSITIONS
CARD	
HOPPER CONTACT	
LOWER CARD LEVER	
PLUGBOARD CIRCUIT BREAKER	1-2-3
TOTAL SWITCH CONTACTS "A"	4-5-6
" " " "B"	7-8-9
" " " "C"	10-11-15-16
" " " "D"	16
UNIVERSAL CONTROL CONTACTS	12
DIGIT TRANSFER	

BRUSHES TO START MAKING AT 77° AND ALL ARE TO BE MADE AT 79°-30' FOR A "5" HOLE

ELECTRICAL TIME CHART

(124851-J)

ALL PBCB & TOTAL SWITCH PLATE TIMINGS APPROXIMATE



LEFT REAR RELAY GATE

RELAY POS	PICKUP COIL	HOLD COIL	AL PTS	BL PTS	AU PTS	BU PTS
1	19-0	19-D	12-E	3-C	19-C	
2	19-0		4-E	19-B	15-C	6-D
3	19-E		19-E	4-E	6-B	15-B
4	19-E		19-B	10-E	19-D	19-B
5	4-E	19-E	19-E	12-D		
6	12-D	12-D	12-D	19-C		
7	19-C	15-B	15-B	15-B	2-B	
8	19-C	8-E	8-E	7-D		
9	19-D	19-D	19-D	9-B	9-C	7-B
10	19-D		9-C	18-B	18-C	18-C
11	4-D	4-C	4-C	3-C	2-D	
12	4-E		4-E		2-D	4-D
13	4-E	4-E	4-E	15-B		
14	4-D	15-C	15-C	5-C		
15	4-E		6-C	2-D		
16	6-E		5-D	2-E		
17	9-C 9-C	10-B	10-B	8-C		
18	4-E 15-C	11-B	11-B	2-D		
19	10-D	10-B	8-B	4-B	10-B	10-E
20	9-C 9-C	8-C	8-C	9-D		
21	8-C		4-C	9-E		
22	9-E	9-E	7-B	4-D	9-E	9-C
23	4-C	4-C	4-C	5-B		
24	9-B		9-B	4-C		
25	10-C 10-C	10-C	10-C	9-B		
26	10-C 10-C	10-C	10-C	4-B	10-C	
27	10-C	10-B	8-B	4-B	10-B	10-E
28	10-D	10-D	12-E	9-E	10-D	6-B
29	10-D	10-D	4-B	4-B	10-D	10-C
30	10-E 10-D	10-D	10-D	15-B		
31	8-C	9-E	9-E	8-C	9-E	8-C
32	8-C	10-E	10-E	9-B	10-E	
33	10-E		8-C	8-C	19-E	3-D
34	8-E 8-E	8-D	8-D	5-B		
35	8-D		4-C	7-C		
36	8-E 8-E	8-D	8-D	4-C		
37	8-D		5-B	7-C		7-C
38	8-D	10-B	10-B	9-C	6-B	
39	8-D 8-D	8-E	8-E	8-E		
[illegible]	8-D 9-B	8-C	8-C	4-B		
41	8-C		9-D	4-C	9-D	7-C
42	9-C 9-C	8-C	8-C	4-C	3-D	
43	8-C		3-D	9-C	8-C	9-D
44	8-C	10-B	8-D	9-E	10-B	10-E
45	9-E	19-E	19-E	7-C	8-D	8-B
46	9-E	8-D	7-C	9-D	8-D	4-D
47	9-D	10-B	10-B	7-E		
48	12-E	12-E	12-E	2-B		
49						
50	15-E		15-B	3-B		
51	12-D	12-D	3-A	2-B	12-D	15-C
52	15-C	12-D	12-D	15-B	15-C	
53	12-C	12-C	12-C	15-B		
54	12-C	12-C	12-C	15-B		
55	12-D	12-D	12-D	15-B		
56	12-E	12-E	18-E	6-B	12-E	2-B
57						
58	15-B	15-B	15-0		15-B	2-E
59	12-E	12-E	12-E	7-B		
60	15-B	15-B	15-B	5-B	2-B	
61	15-B	15-C	4-E	4-D	15-C	
62	15-C		18-C	12-E	15-D	5-D
63	15-C		13-B	7-C	3-D	7-C
64	15-D		9-C	9-D	18-C	18-C
65	15-D		4-C	2-D		7-D
66						
67	15-B	15-D	15-D	15-B		
68	15-D		18-C	12-E	4-D	5-D
69	15-D		13-B	7-C	9-C	9-D
70	15-D		19-D	4-C	2-D	7-D
71						
72						
73	15-B	15-D	15-D	15-B	15-B	
74	15-D		18-C	12-E		
75						
76						
77	15-C	15-D	15-D	7-C	15-C	18-C
78	15-E	15-E	15-E	15-C		
79	5-E		20-C	20-C		
80	5-E		20-D	20-D		
81	5-E		20-D	20-D		
82	5-E		11-E	11-D	11-D	11-D
83	5-E		12-E	12-C		

			[1] 11-B	[2] 11-C	[3] 11-C	[4] 11-C
			[5] 11-C	[6]	[7]	[8]
X-R MCR	12-E		[9] 12-C	[10] 12-B	[11] 11-D	[12] 11-D
			[13] 11-E	[14] 11-E	[15]	[16]
			[17]	[18] 9-C	[19] 10-D	[20] 10-C
			[21] 8-E	[22] 8-E		
90						
91						
92						
93	12-B 12-B	12-B	12-B	12-B		
94	12-B	12-B		6-B	12-B	
95	12-D 12-C	12-C	12-C	12-C		
96	12-C	12-C	12-C	6-C		
97	11-B 11-B	11-B	11-B	11-B		
98	11-B	11-C	13-B	13-B	11-C	13-B
TO						
105	11-C 11-C	11-C	11-C	11-C		
106	11-C	11-C	13-C	13-C	11-C	13-C
107						
108						
TO						
111						
112						
113						
114						

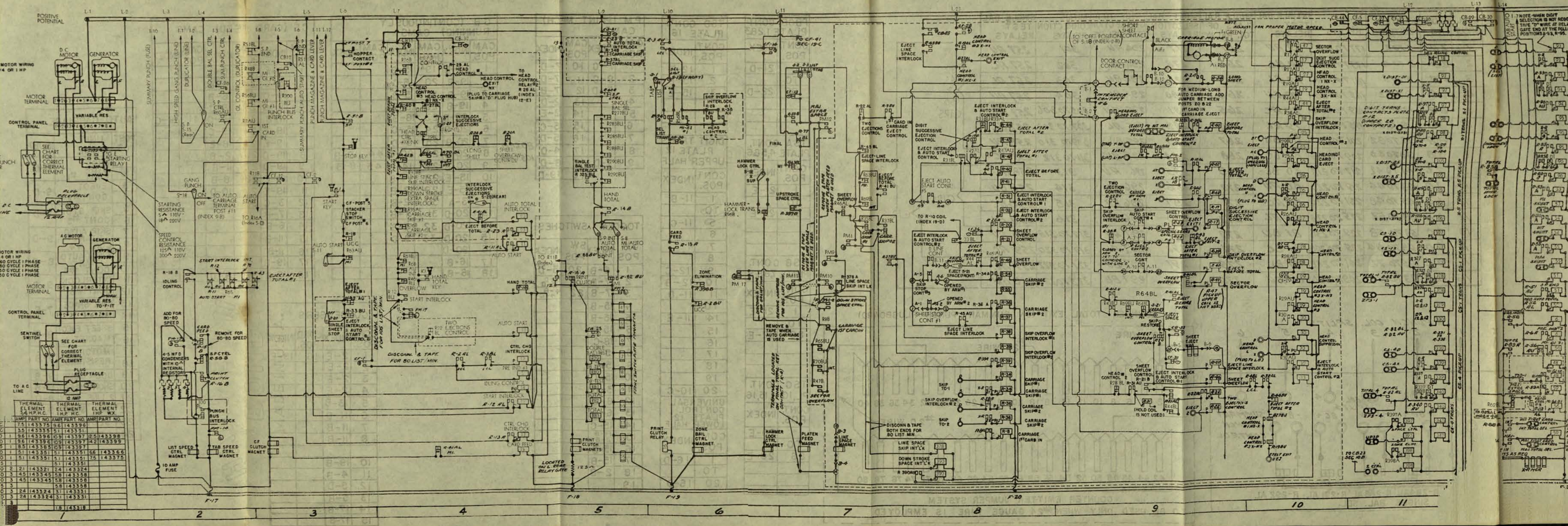
RIGHT END RELAY GATE

RELAY POS	PICKUP COIL	HOLD COIL	AL PTS	BL PTS	AU PTS	BU PTS
257	15-E		23-E	23-E		
258	15-E		23-E	23-E		
259	15-E		23-E	20-B		23-E
260	15-E		18-C	20-C		
261	23-E		14-C	21-D		
TO						
276	23-E		14-E	22-D		
277	14-C	14-C	13-A	23-E	14-C	5-B
TO						
292	14-E	14-E	14-A	23-E	14-E	5-C
293	14-C		14-B			
294	14-B		14-C	14-D	14-C	14-D
TO						
297	14-B		14-D	14-E	14-D	14-E
298	14-B		20-C	20-C	20-C	20-C
299	14-C		20-B	20-B	20-B	20-B
300	14-C		20-B	2-E	20-B	3-A
301	14-C		21-C	21-C		
TO						
324	14-E		22-C	22-C	22-C	22-C
325	15-E	14-C	15-E	14-B	14-C	5-C
327	11-D 11-D	11-D	11-D	11-D		
328	11-D	11-D	13-D	13-D	11-D	
329	11-D		13-D	13-D	13-D	13-D
330	11-D		13-D	13-D	13-D	13-D
TO						
339	11-E 11-E	11-E	11-E	11-E		
340	11-E	11-E	13-E	13-E	11-E	
341	11-E		13-E	13-E	13-E	13-E
342	11-E		13-E	13-E	13-E	13-E
343						
344						
345						
346						
347						
348						
349						
350						
378	8-E		7-D	4-C		
390	8-E	8-E	4-C	7-D	8-E	
397	11-E	11-E	11-E	7-C		
398	11-E	11-E	11-E	6-D		

RIGHT REAR RELAY GATE

RELAY POS	PICKUP COIL	HOLD COIL	AL PTS	BL PTS	AU PTS	BU PTS
129	16-D	16-C	16-C	16-B		
130	16-E	16-C	16-C	16-B		
TO						
167	16-D	16-C	16-C	16-B		
168	16-E	16-C	16-C	16-B		
169	16-B		16-D	16-D		
TO						
172	16-B		16-E	16-D		
TO						
175	16-C		16-E	16-E		
177	17-B		21-C	21-C		
178	17-B		21-D	21-D	21-C	21-C
TO						
255	17-E		22-C	22-C		
256	17-E		22-D	22-D	22-C	22-C

FUSES	
FUSE NO.	SIZE
1 to 16 & 29 to 32	3 AMP GLASS
17 to 28	2 AMP GLASS
SUMMARY PUNCH	10 AMP CARTRIDGE
13-16 OMITTED WITH ARMATURE LATCH MAGNET UNIT	



		THERMAL ELEMENT 3/4 H.P. H.C.		THERMAL ELEMENT 1 H.P. H.C.		THERMAL ELEMENT 1 H.P. W.X.	
		AMP	PART NO.	AMP	PART NO.	AMP	PART NO.
C		7.5	143375	9.6	143396		
C		3.5	143335	5.1	143351		
0	1	9.6	143396	10.9	143397	12.5	143398
0	1	9.6	143396	10.9	143397	14.2	143399
5	1	8.5	143365	10.9	143397		
0	1	5.1	143351	5.1	143351	6.6	143366
0	1	5.1	143351	5.1	143351	7.5	143375
5	1			5.1	143351		
0	2	21	143321	24	143324		
0	3	4.5	143345	5.8	143358		
0	3	4.5	143345	5.8	143358		
5	3			5.8	143358		
0	3	24	143324	3.1	143331		
0	3	24	143324	3.1	143331		
[illegible]	3						
				1.8	143318		

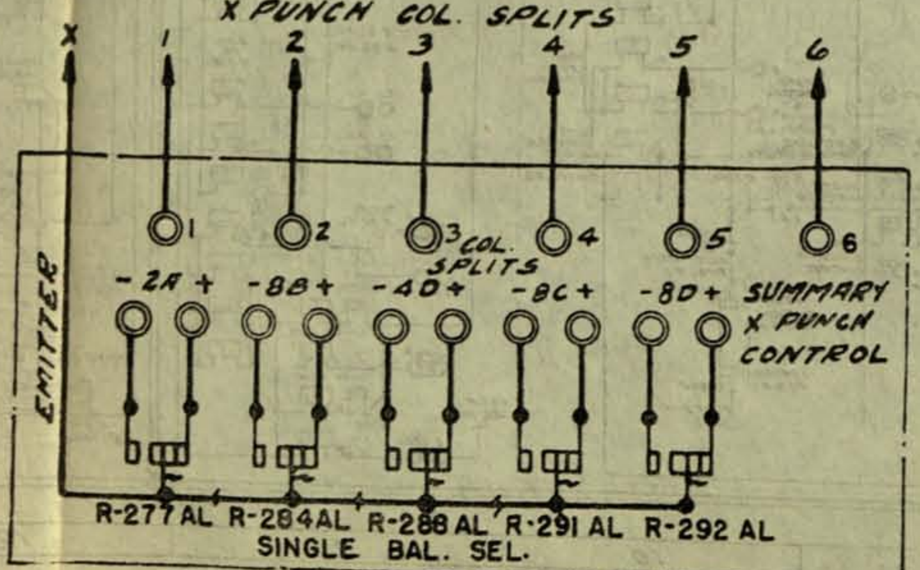
CTR. GROUP	GROUP NO	COUNTER POSITIONS	+ & - RELAYS	DOUBLE BAL TEST RELAYS	SINGLE BAL CLASS OF TOT. RELAYS	SINGLE BAL SELECTION RELAYS	MINUS TOT. CORRECTION CTRL. RELAYS	MINUS CORRECTION RELAYS	SINGLE BAL TEST RELAYS
1	2A	1 TO 2	177 TO 178	79 BU	261	277	294 AU	301	257 AU
2	2B	3 TO 4	179 TO 180	79 BC	262	278	294 AL	302	257 AC
3	4A	5 TO 8	181 TO 184	79 BL	263	279	294 BU	303	257 AL
4	4B	9 TO 12	185 TO 188	79 AU	264	280	294 BL	304	257 BU
5	6A	13 TO 18	189 TO 194	79 AC	265	281	295 AU	305 TO 306	257 BC
6	6B	19 TO 24	195 TO 200	79 AL	266	282	295 AL	307 TO 308	257 BL
7	8A	25 TO 32	201 TO 20	80 BU	267	283	295 BU	309 TO 310	258 AU
8	8B	33 TO 40	209 TO 216	80 BC	268	284	295 BL	311 TO 312	258 AC
9	2C	41 TO 42	217 TO 218	80 BL	269	285	296 AU	313	258 AL
10	2D	43 TO 44	219 TO 220	80 AU	270	286	296 AL	314	258 BU
11	4C	45 TO 48	221 TO 224	80 AC	271	287	296 BU	315	258 BC
12	4D	49 TO 52	225 TO 228	80 AL	272	288	296 BL	316	258 BL
13	6C	53 TO 58	229 TO 234	81 BU	273	289	297 AU	317 TO 318	259 AU
14	6D	59 TO 64	235 TO 240	81 BC	274	290	297 AL	319 TO 320	259 AC
15	8C	65 TO 72	241 TO 248	81 BL	275	291	297 BU	321 TO 322	259 AL
16	8D	73 TO 80	249 TO 256	81 AU	276	292	297 BL	323 TO 324	259 BU

32, 44 & 56 CTRS

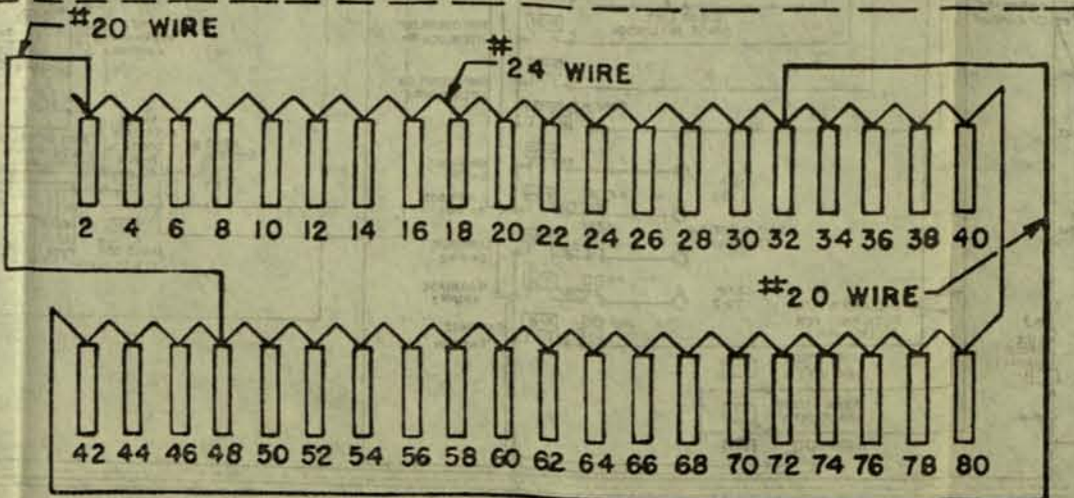
44 CTRS

CTR

80 CTRS



COUNTER TOTAL EXIT (ON SUMMARY PUNCH PLUGBOARD)



COUNTER EMITTER JUMPER SYSTEM
TO BE USED ONLY WHEN #24 GAUGE WIRE IS EMPLOYED

PBCB CONT PLATE 1,2&3	
CONT. POS.	INDEX
1	21-D
TO	
80	22-D

TSA CONT. PLATE 4,5&6	
CONT. POS.	INDEX
1	21-E
TO	
80	22-E

TSB CONT. PLATE 7,8&9	
CONT. POS.	INDEX
1	21-E
TO	
80	22-E

TSC CONT. PL. 10,11,15,16	
CONT. POS.	INDEX
	20-E
TO	
88	20-E

TSD CONT. PLATE 16	
CONT. POS.	INDEX
1	12-E
2	15-B
3	15-E

DIGIT TRANS PLATE 12 UPPER HALF	
CONT. POS.	INDEX
1	11-B
TO	
5	11-C
6	
7	
8	
9	12-C
10	12-B
11	11-D
TO	
14	11-E
15	
16	
17	
18	
19	
20	10-C

UNIVERSAL CONTROL PLATE 12 LOWER HALF	
CONT. POS.	INDEX
1	16-D
TO	
20	16-D

PM (PRINT MECH) CAMS				
CAM POS.	INDEX	CAM POS	INDEX	
1	7-C	10	7-D	
2	9-C	11	7-D	
3	5-D	12	7-B	
4		13	2-D	
5		14	2-E	
6		15	15-C	
7		16	15-D	
8		17	4-D	80 CPM
9	7-D	17	6-D	105 CPM
		18	19-D	

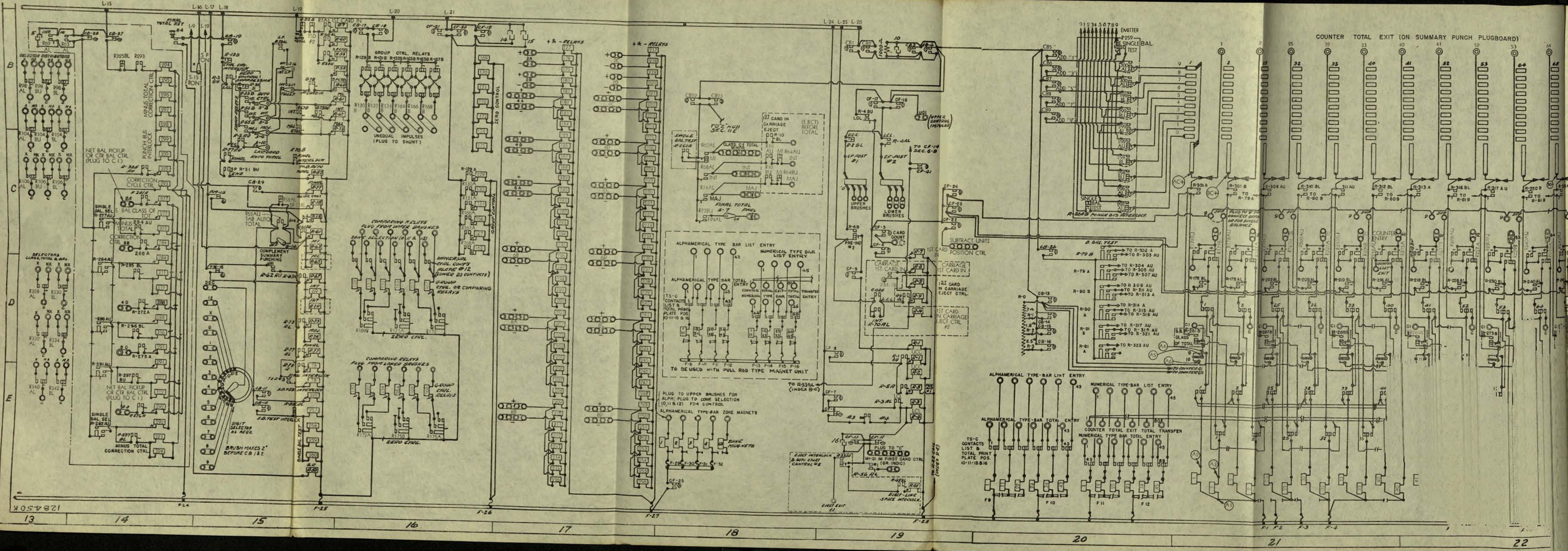
TOGGLE SWITCHES			
SW. POS.	INDEX	SW. POS.	INDEX
1	6-B	20	3-D
2	7-B	21	8-D 5-D
3	7-B	22	4-B 4-C
4	15-B		
5	15-B		
6	15-B		
7	18-C		
8	5-C		
9	5-C		
10	15-C		
11	3-D		
12	6-C		
13	6-B		
14	15-C		
15	14-B 2-B		
16	15-B		
17	15-B		
18	2-B		
19			

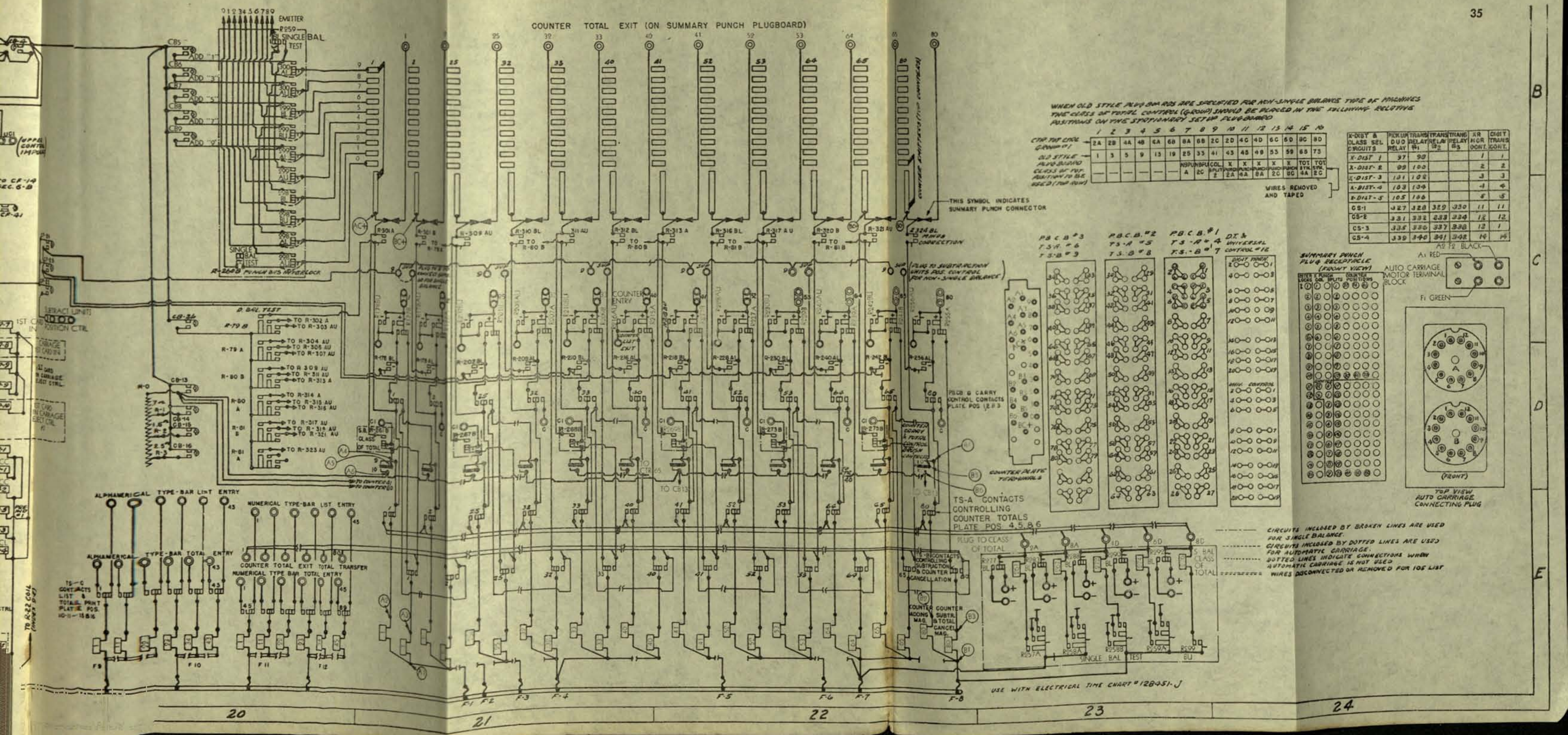
CB (CONTINUOUSLY RUNNING) CAMS					
CAM POS.	INDEX	CAM POS.	INDEX	CAM POS.	INDEX
1	19-B	19	15-B		
2	19-B	20	6-C		
3	19-B	21	5-B		
4	19-B	22	18-B		
5	20-B	23	18-B		
6	20-B	24	15-C		
7	20-B	25	5-D		
8	20-B	26	20-C	44	10-B
9	20-B	27	14-B	45	8-B
10	15-E	28	14-B		
11	15-E	29	12-B		
12	3-A	30	12-B		
13	20-D	31	4-B		
14	20-D	32	4-B		
15	20-D	33	9-D		
16	20-D				
17	16-B				
18	16-B				

CF (CARD FEED) CAMS					
CAM POS.	INDEX	CAM POS.	INDEX	CAM POS.	INDEX
1	3-E	19	16-B		
2	3-C	20	16-B		
3	19-C	21	16-B		
4	19-C	22	19-C		
5	11-B	23	19-C	41	19-C
6	19-E	24	19-C		
7	19-E	25	18-E		
8	19-D	26	2-B		
9	19-D	27	11-B		
10	19-E	28	8-B		
11	19-E	29	10-D		
12	3-C	30	9-E		
13	7-B				
14	6-B				
15	11-B				
16	11-B				
17	19-B				
18	19-B	36	8-C		

CONDENSERS			
COND POS.	INDEX	COND. POS.	INDEX
1	2-E	16	19-E
2	2-E		
3	2-E		
4	2-E		
5	13-B		
6	11-B		
7	11-B		
8	11-B		
10	19-B		
11	4-B		
12	5-D		
13	5-B		
14	17-B		
15	17-B		

AUTO CARRIAGE		
POST POS.	UNIT NAME	INDEX
1, 2	SHEET STOP CONT #1	8-D
3, 4	EJECT CONT #2	9-D
5, 6	SKIP STOP CONT #3	8-D
7, 8	SKIP AUTO START CONT #4	9-D
9, 10	EJECT AUTO START CONT #5	8-C
11, 12	INTERLOCK CONT #6	9-B
13, 14	LINE SPACE MAGNET	7-E
15, 16	SHEET EJECT MAGNET	9-E
17, 18	MOTOR RESISTANCE	9-B
19	DOOR CONT.	9-B
20	SHORT SHEET	9-B
21	2 LINE CONT.	8-D
22	LONG SHEET	9-B
23, 24	SECTOR CONT.	9-D


COUNTER TOTAL EXIT (ON SUMMARY PUNCH PLUGBOARD)
EMITTER
SINGLE BAL TEST
SELECTOR DISTRIBUTORS
NET BAL PICKUP OR CTR BAL CTRL (PLUG TO C.I.)
CORRECTION CYCLE CTRL
MINUS TOTAL CORRECTION CTRL
PUNCH BUS INTERLOCK
SELECTORS CLASS, TOTAL & BAL.
SINGLE BAL SEL
MINUS TOTAL
COMPLEMENT SUMMARY PUNCHING
GROUP CTRL. RELAYS
UNEQUAL IMPULSES (PLUG TO SHUNT)
COMPARING RELAYS PLUG FROM UPPER BRUSHES
COMPARING RELAYS PLUG FROM LOWER BRUSHES
ZERO CTRL.
ZERO CONTROL
GROUP CONTROL
DIGIT SELECTOR
BRUSH MAKES 2° BEFORE C.B. 12
+ B - RELAYS
ALPHAMERICAL TYPE BAR LIST ENTRY
NUMERICAL TYPE BAR LIST ENTRY
ALPHAMERICAL TYPE BAR TOTAL ENTRY
TS-C CONTACTS LIST & TOTAL PRINT PLATE POS. 10-11-15 & 16
TO BE USED WITH PULL ROD TYPE MAGNET UNIT
PLUG TO UPPER BRUSHES FOR ALPH; PLUG TO ZONE SELECTION (0,11 & 12) FOR CONTROL
ALPHAMERICAL TYPE-BAR ZONE MAGNETS
ZONE MAGNETS
FINAL TOTAL
UPPER BRUSHES
LOWER BRUSHES
CARD COUNT
SUBTRACT UNITS POSITION CTRL
CARRIAGE 1ST CARD IN
1ST CARD IN CARRIAGE EJECT CTRL.
PLUG TO "C"
FIRST CARD CTRL (GR. INDIC)
EJECT-LINE SPACE INTERLOCK
COUNTER TOTAL EXIT TOTAL TRANSFER
NUMERICAL TYPE BAR TOTAL ENTRY
D. BAL. TEST
128450K
13
14
15
16
17
18
19
20
21
22



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
CTR. TOT. CIRCL GROUP #1	2A	2B	4A	4B	6A	6B	8A	8B	2C	2D	4C	4D	6C	6D	8C	8D
OLD STYLE PLUGBOARD	1	3	5	9	13	19	25	33	41	43	45	49	53	59	65	73
CLASS OF TOT. POSITION TO BE USED (TOP ROW)	—	—	—	—	—	—	NSPU A	NSPU 2C	COL. SPLIT 2	X PUNCH 2A	X PUNCH 4A	X PUNCH 8A	X PUNCH 2C	X PUNCH 8C	TOT. SYN. 4A	TOT. SYN. 2C

X-DIST & CLASS SEL CIRCUITS	PICKUP DUO RELAY	TRANS RELAY #1	TRANS RELAY #2	TRANS RELAY #3	XR HOR CONT.	DIGIT TRANS CONT.
X-DIST 1	97	98			1	1
X-DIST-2	99	100			2	2
X-DIST-3	101	102			3	3
X-DIST-4	103	104			4	4
X-DIST-5	105	106			5	5
CS-1	327	328	329	330	11	11
CS-2	331	332	333	334	12	12
CS-3	335	336	337	338	13	1
CS-4	339	340	341	342	14	14

PREVENTIVE MAINTENANCE

Accounting Machine, Type 405

CARD FEED UNITS

IF, UNDER NORMAL operating conditions, the feed unit has not been removed from the machine for approximately a year or more, it should be removed when time is available so that all bearings and setscrews in the feed roll gears on the right-hand side, as well as the lower feed roll pressure arms on the bottom of the unit may be checked. If the machine is receiving harder usage, the feed should be removed more frequently. Feed roll pressure shoe supports should be removed so that all feed rolls may be tested for wear and end shake in the bearings.

In removing these, a band of scotch tape can be used advantageously in holding the springs compressed to facilitate anchoring to the side frames. The tape should be wrapped around the shoe and the pressure shoe bracket with the emulsion side away from the shoe and bracket. By overlapping an excess of one revolution of tape, the overlapping ends will adhere to each other to provide a solid band. After the bracket is mounted in the machine, the scotch tape can be removed, and the shoe will be released against its respective feed roll.

At the time the feed is removed for cleaning, it is well to clean the zone control drive unit of all old grease.

I. Cleaning

Brush out all dust and dirt collected in the feed. See cleaning instructions on each unit listed under *General Section.*

II. Inspection

1. Brush Assemblies (see *General Section*).
   - (a) CLEANING. Be sure to remove any powdered metal that has fallen on the brush holder from the pressure shoe just above it.
   - (b) BRUSH SEPARATORS.
   - (c) BRUSHES.
   - (d) 1/8" PROJECTION.
   - (e) BRUSH ALIGNMENT TO SCRIBED LINE.
   - (f) BRUSHES EVENLY SPACED BETWEEN SEPARATORS.
   - (g) BRUSH TRACKING. Set hopper side plates for lower brushes and change shims from one side to the other for upper brushes.
   - (h) CONTACT ROLL for tightness on shaft. These are held in place by setscrews.
   - (i) BRUSH TIMING. Set by changing crank pin plate for lower brushes and by shifting brush holder for the upper brushes.

2. Feed (see *General Section*).
   - (a) CLEANING. If the unit has been removed from the base, it should be thoroughly cleaned with cleaning fluid.
   - (b) FEED ROLL GEARS for loose setscrews and end shake in feed rolls.
   - (c) IDLER FEED ROLL GEAR STUDS for dryness. If these are not getting proper lubrication, check the oil lines feeding them. Be sure and test the fit of the gear to see that it will not freeze.
   - (d) FEED KNIFE ADJUSTMENTS.
   - (e) FEED KNIFE GUIDE SLIDES.
   - (f) EVEN FEEDING OF CARDS.
   - (g) HOPPER SIDE PLATES.
   - (h) ROLLER THROAT.
   - (i) FEED ROLL TENSION.
   - (j) TIMING OF FEED KNIVES.
   - (k) HOPPER POSTS.

3. Stacker
   - (a) FINGERS for wear and broken springs.
   - (b) OPERATING ROLLERS for wear or loose on stud.
   - (c) TIMING.
4. CF Clutch
   - (a) CLUTCH PAWL ARM for looseness or shake. Loosen the lock nut and check the key and keyway which positions the clutch pawl arm drive gear to the shaft for wear.
   - (b) LOOSE PIVOTS AND BROKEN SPRINGS.
   - (c) FREEDOM OF OPERATION.
5. Lower Card Lever (see *General Section*).
6. CF Cams (see *General Section*).

In order to clean the points it is unnecessary to remove the wires from the contacts, but it is well to remove the support bar as an assembly. Remove two dowels and four support screws in order to work on the bar. The two screws in the left end of the CF contact mounting bars are difficult to remove due to the left relay gate hinge and cover mounting post. An easy method for removing these screws is to remove the left relay gate cover and then close the gate. This will leave room to reach the screws with the 10" screwdriver inserted between the gate and the cover strip. The timing of CF 17 and 18 should be checked on every inspection as well as any others that appear to need correction. The value of the portable dynamic timer unit in checking brushes and cam contacts under operating conditions during an inspection cannot be overemphasized. Full instructions for its use are included with the timer. It is not necessary to remove the right end relay gate case and cover to install the timer. For convenience in timing a large number of CF cams, the following table is made up in degree sequence:

CF CAMS

Degree		Cam	Degree		Cam	Degree		Cam	Degree		Cam
19	B	23	162	B	3	198	B	4	270	B	7
19	B	24	168	M	25	210	M	6	280	B	8
76	M	9	171	B	20	216	M	30	287	B	2
81	M	17	177	B	10	225	B	15	310	M	13
81	M	18	177	B	11	225	B	16	340	B	36
90	B	14	177	B	27	250	M	26	348	M	22
108	M	1	181	M	5	268	B	28	360	B	29
160	B	19	193	M	21	268	B	12			

III. Lubrication

IBM 6
- (a) ROLLER THROAT.
- (b) CF CAM FOLLOWER ROLLER followed by IBM #17.

IBM 9
- (a) Feed roll pressure shoe lubricating felt.
- (b) All feed roll bearings and linkages not lubricated by Bijur System.
- (c) Pivot points of CF cam follower arms.
- (d) Pivot points of CF clutch.

IBM 17
- (a) Light coat on all gears.
- (b) CF cam follower roller.
- (c) Very light film on linen dilecto CF cams.
- (d) CF clutch dog latch.

IBM 21
- (a) CF clutches.

ZONE UNIT

I. Cleaning

At the time the feed is removed for cleaning, it is well to clean the zone control drive unit of all old grease.

II. Inspection

1. **Zone Control Drive Unit** for loose pins and wear.

2. **Zone Unit**

It is unnecessary to remove the zone unit when cleaning and oiling, except to replace parts.

(a) ZONE BARS for freedom of movement with no sticky or binding conditions. If a sticky or binding condition is present, it must be removed before spraying the zone bars with an atomizer, using lubricant 6.

(b) TOGGLE LATCHES to see that they will move freely to support the zone lever bail without the aid of the spring.

(c) ZONE BAIL CONTROL MAGNET ARMATURE for overlap on the armature latch.

(d) LIST LAP of zone unit.

III. Lubrication

IBM 6

(a) Zone drive unit cam followers (followed by IBM 17).

(b) Spray zone bars with atomizer.

(c) Armature pivot points.

IBM 9

(a) All zone linkages and pivot points.

IBM 17

(a) Zone drive unit cam followers.

(b) All zone unit cams.

CONTINUOUS RUNNING UNITS

I. Cleaning

This will be covered under each unit in *Inspection*.

II. Inspection

1. **Two-Speed Clutch**

(a) CLEANING. Keep the drive surfaces free of oil and scrub with carbon tetrachloride to remove all gumming oil. This will reduce the tendency of the pulleys to be slow in changing from high to low speed.

(b) ADJUSTMENTS. Difficulty in obtaining proper adjustment of the clearance between the two-speed clutch friction arm and the clutch disc on the list speed side can be traced to the method of assembly of these parts. Since a right-hand thread is used on the pivot screw and the nut is on the bottom, it is obvious that after the correct adjustment is obtained, tightening of the nut forces the adjusting screw away from the casting, thus altering the clearance between the friction arm and the clutch disc.

In order to facilitate making correct adjustment, it is suggested that these be assembled so that the nut is on top. Tightening of the nut in this position will force the adjusting screw against the casting, thus maintaining the proper clearance once it has been set.

2. **Drive Housing**

(a) IDLER GEAR on side of drive housing to see that there is no slack between the drive gear on the side of the drive housing and the driven gear on the continuously running shaft. The means of keeping this snug is by doweling the idler gear support plate to the housing.

On early machines this idler gear support was not doweled. The holding screws on the bracket came loose quite frequently, resulting in the shifting of the bracket and allowing the gears to slip out of mesh, damaging the teeth of the gears. If the surface of the drive housing and the surface of the idler gear bracket were free from oil when the holding screws were tightened, the possibility of slippage was reduced to a minimum. It is suggested that carbon tetrachloride be used to clean these surfaces whenever the bracket is removed.

(b) OIL LEVEL. Remove the check plug and see that lubricant 15 is level with the bottom of the check plug hole and covers the worm gear. Add lubricant when necessary through port in top of the housing.

3. **CB Unit** (see *General Section*).

In order to clean the points it is unnecessary to remove the wires from the contacts, but it is well to remove the support bar as an assembly. Remove two dowels and four support screws in order to work on the bar. The timing of CB 1-2-3-4 should be checked on every inspection, as well as any others that appear to be off. Be sure that CB 1 and 2 break between 90½° and 91° as well as making at 81°.

Give special attention to CB 3 and 4 as these receive a heavy arc. A quick check of the timing of these 4 cams as a unit may be taken without removing any covers. With no power on the machine, plug one end of a test light in the UC1 hub and connect the other end to the "L" side of the line below the fuse blocks. Crank the machine over by hand until the light comes on indicating all four CB's are made. This may be used as a test of the four cams as a unit while servicing, or after having changed one or more of the contacts. Where possible on inspection adjust the contacts and time the cams with the use of the dynamic timing device.

For convenience in timing a large number of CB cams the following table is made up in degree sequence:

CB CAMS

Degree		Cam	Degree		Cam	Degree		Cam
1	B	22	89	B	15	215	B	28
1	B	23	90	B	3	230	M	10
7	M	9	90	B	4	268	M	20
43	M	8	90	B	16	268	B	31
48	B	32	90	M	17	270	M	21
48	M	44	99	B	18	270	B	29
79	M	7	115	M	6	270	B	30
81	M	1	151	M	5	280	B	33
81	M	2	195	M	11	300	M	27
87	B	13	200	M	24	306	M	26
88	B	14	210	M	19	316	B	25
			210	M	45	348	M	12

III. Lubrication

IBM 6

(a) CB cam follower roller followed by IBM 17.

IBM 9

(a) Pivot points of CB cams.

(b) Pivot points of 2 speed clutch.

IBM 15

(a) In drive housing.

IBM 17

(a) CB cam follower roller.

(b) Light film on linen dilecto cams.

PM UNITS

I. Cleaning

This will be covered under each unit in *Inspection.*

II. Inspection

1. PM Clutch

(a) Loose pivots and broken springs.
(b) Freedom of operation.
(c) Loose weld of armature face.

2. Main Drive Shaft

For wear and loose pins in any cams or gears mounted on shaft.

3. Hammer Unit

(a) CLEANING. The hammer unit should be removed for proper cleaning, inspection and lubrication. If type bars are also to be inspected, do not replace the hammer unit until after type bars have been cleaned and lubricated.

Remove hammerlock support bar so that the accumulated dust and paper staples may be cleaned from the hammer unit.

(b) LINKAGES AND BAILS for loose pins and red rust at pivot points.

(c) HAMMERS for freedom on shaft and that none are sticky or binding in the combs.

(d) HAMMER SPRING BAIL SHAFT for wear. A coating of IBM 17 on this shaft will aid in reducing the cutting action of the hammers hitting the shaft when the alphamerical bars are in the blank position and have been released because the zero split arms were not raised.

(e) HAMMER LOCK BLUE STEEL SPRINGS for correct position after hammerlock out support bar has been replaced.

4. Standard Carriage

Remove as an assembly and clean out all paper dust and form staples. Use lubricant 9 on all rollers and operating bails, and also on feed pawl and detent roller under carriage cover at left end of the assembly. While the carriage is removed, an inspection of the print magnet unit and the type bars may be made. When replacing carriage check for clearance between type bars and platen; also alignment of platen to center line of type when stopped for printing.

5. Print Magnet Unit

Remove for complete inspection and to check type bar lift arms.

(a) CLEANING. Clean all dust and staples from the unit. Check for paper clips among terminal posts.

(b) PULL WIRE TYPE. Pawls for freedom and, after cleaning, oil stop pawls and latches with lubricant 6. All operating linkages and heavy bearings should be oiled with lubricant 9.

(c) ARMATURE LATCH TYPE pawls for freedom and, after cleaning, oil stop pawls with lubricant 6. All operating linkages and heavy bearings should be oiled with lubricant 9. Use grease 17 on the camming surfaces of the restoring bail.

(d) STOP PAWL RELATCH BAR for proper adjustment.

(e) ARMATURE RESTORING BAIL for proper adjustment.

6. Type Bars

(a) CLEANING. If the face of the type is dirty and filled with ink, crank the machine so that the type bars rise to their upper limit of travel, and clean them with a plastic type cleaner. The type may be

cleaned by rolling the cleaner over the face of the type. This operation will remove all ink and dirt in the type character.

If the type face and type tail are loaded with ink, the type bars should be removed by removing the hammer unit and the two front type bar guide bars and dropping the type bars forward without unhooking them at the bottom. (This method of not unhooking applies only to May 1st machines; on old type machines the bars will have to be removed completely.) By using a three-panel permanent board cover setting on zone unit, one can clean all bars thoroughly without unhooking them. Once the bars are removed, it is best to use a brush and completely clean the entire bar with carbon tetrachloride. At the same time, compress the type springs so that the ink may be *thoroughly* washed from the interior of the type case. Whenever type is washed with carbon tetrachloride it is essential to lubricate it with IBM lubricant 6 to eliminate the possibility of sticking type. Care should be exercised in lubricating type to insure its not being lubricated to excess.

(b) TYPE BARS BEFORE REPLACING for broken or weak type springs, worn type cases, loose rivets, bent type, etc.

(c) TYPE BARS AFTER REPLACING for binds or sticky conditions.

(d) TYPE BAR LIFTING CAMS AND SHAFTS for loose pins. Check all pins in cams and shafts to see that they are tight and not broken or bent. Likewise, a check should be made for any excessive play in type bar operating linkage or in forked arm cam follower hub and shaft. This is very important. There have been many cases where a loose pin was the main source of a long existing unsatisfactory printing condition. A quick method of checking for lost motion in the linkage is to note the difference in zone lap between zoning one bar, and zoning all 43 bars. The difference should not be excessive.

(e) LEVEL TYPE BARS in the alphamerical section by adjusting the eccentrics at the forward end of the spring bail arms so that type bar 1 and 43 are stopped at the same time. In machines which are equipped with the turnbuckle adjustment, loosen the locking screws and turn the center section to level the restoring bail. In the numerical section the restoring bail is leveled by turning the eccentric screws at the forward end of the numerical spring bail assembly. The restoring bails with the eccentric screw adjustments should position the type bars so they are stopped on the #1 tooth by the stop pawls at $168° \pm 1/2°$, #5 tooth at $96° \pm 1/2°$, and #9 tooth at $24° \pm 1/2°$ on both sides of the print unit. If this check reveals that the stopping time varies for these three settings, the eccentrics on the spring bail must be adjusted. These eccentrics can be set with the high side in various positions and still keep the bars level. However, considerable variation in the total movement of the type bars is possible by moving the high side of eccentric from the rear to the front. Therefore, the adjusting of these eccentrics must be made to keep the stopping time correct at "one" and "nine" time as well as keeping the type bars level.

(f) STARTING POSITION of the alphamerical type bars is determined by measuring the type bar travel from their lowest position until the bar is stopped at the 9 tooth by a stop pawl. The low position of the alphamerical section may be determined by adjusting the forked arm of the alphabetic cam follower. The total rise from the low position until stopped by a stop pawl must be .133" or 1/8".

In the numerical section this dimension should be .066" or slightly more than 1/16". To obtain this distance the position of the eccentric screw at the top of the link to the numerical spring bail should be altered, keeping the high side of the eccentric to the front of the machine.

(g) LIST LAP is determined for both the alphamerical and numerical section by timing the main cam shaft. With the test light, impulse several type bar print magnets. Crank the machine until the type bars stop and note the index time. If it is not 24° ± ½°, determine the number of degrees that the cams are timed early or late. Crank the machine until the type bars are all the way down and all the spring tension is released. Loosen the sleeve nut on the serrated hub of the main cam shaft drive gear, then turn the crank so that the index moves in the direction of the correction plus or minus the desired number of degrees, one serration being equal to one degree. If any change is made in the main cam shaft timing, check the timing of the following units: the PM cams, the hammer trip, the hammer restoring, latching and releasing of the print magnet armature knockoff bail. Also check, when zoning and the follower for cam 2 of the zone control drive unit is on the high point, that there is .030"-.040" clearance between the setup pawl and the zone slide section of the type bar.

If the variation in the stopping time between the alphamerical and numerical type bars exceeds the ±½°, recheck all adjustments and check for loose pins.

An easy way to check the list lap on the alphamerical side is to wire a board to list several positions at each end of the unit. With the drive belts removed and power on, trip both clutches and crank the machine by hand, feeding in a card punched with "1", "5" or "9" holes. As soon as the stop pawls trip off, turn the main line switch off to prevent an overload of the generator. Continue cranking and observe if type bars stop at the proper point on the index as indicated above. It is permissible to crank machine backwards a degree or two to raise and lower the type bar slightly to give a more accurate check of just where the bar stops. Care must be taken not to turn the machine backwards more than a degree or two, or damage to the PM cams and brushes will result.

7. Ribbon Feed

(a) CLEANING. Clean out all dust and old grease.

(b) FREEDOM OF MOVEMENT. Crank machine to a point between 200° and 210°, at which time the locking pawls are clear of the ribbon feed shaft, and check for freedom of all moving parts. Oil all pivot points with lubricant 9 and use grease 17 to lubricate the camming surfaces of the reversing forks.

(c) RESTORING STUDS for wear.

(d) REVERSING. See that when the ribbon reaches the end of the spool, the operating rivet in the ribbon will cause the latches to clear their respective reversing forks.

8. PM Contact Cams (see *General Section* on "Make and Break Cam Contacts"). Also check for looseness of gears driving PM cam unit.

For convenience in timing a large number of PM cams the following table is made up in degree sequence:

PM CAMS

Degree		Cam	Degree		Cam
7	B	9	260	B	12
80	B	11	262	M	17
90	B	1	268	M	3
162	B	16	327	B	13
192	M	10	327	M	14
202	B	18	348	B	2
210	B	15			

III. Lubrication

IBM 6

(a) Bronze oilite spacers in hammer unit.
(b) Type bar combs and type tails.
(c) Stop pawls and latches of print magnet unit.

IBM 9

(a) Pivot points of bails and operating arms in hammer unit.
(b) Rollers and operating bails of standard carriage.
(c) Feed pawl and detent roller under cover at left end of standard carriage.
(d) Operating linkage and heavy bearings on armature type print magnet unit.
(e) Pivot points of ribbon feed.
(f) Pivot points of PM clutch.

IBM 17

(a) PM clutch dog latch.
(b) Very light film on linen dilecto PM cams.
(c) Hammer spring bail shaft.
(d) Camming surfaces of restoring bail in print magnet unit.
(e) Camming surfaces of reversing forks on ribbon mechanism.

COUNTERS

TO INSPECT COUNTERS, it is not necessary to remove the wires from the counters, as there is sufficient cable so that counters may be removed from the machine and either be placed on top or allowed to hang by the cable.

Remove only the number of counters that may be inspected in the time available, allowing approximately 5 to 10 minutes for each counter plate. Be sure to test counters after inspection.

I. Cleaning

All old oil and grease should be removed by washing thoroughly with cleaning fluid.

II. Inspection

1. Counter Spools. With counters removed, turn the machine to 15° and insert the counter spool jig, at which time the indicator arms should coincide with the 0 on the scale. Two marks on the gauge equal one degree on the index, and on any machine where the spools are out ± 1½°, the spool should be retimed.

2. 9-10 Brush Holder for freedom of movement.

3. 9-10 Brush for central location or slightly on the 9 side when the operating arm is on the long dwell of 9-10's cam. If the machine has been giving counter trouble the timing of the 9-10 brushes should be checked to make sure that they make on the "10" side at least one degree before CB 1-2-3-4.

4. Counter Emitter Brush for riding to the center of the 9 spot when the 9-10's cam follower arm is in its low dwell.

5. All Pivot Points and Operating Studs for wear and looseness. All of these should be lubricated by dipping the end of a small screwdriver in IBM 6 and just touching the screwdriver to the point to be lubricated.

6. Add Magnet Armature by attracting it and revolving the counter, checking for a .010" minimum clearance at the detent arm and detent, and an unlatching clearance of .005" at the add magnet armature and the clutch arm. Also check for knockoff and latching clearance.

7. 9-10's Latch. When the counter revolves to the 10 side of the 9-10's operating cam and with arm on the high point, check for a .006" latch clearance of 9-10's latch. Continue revolving the counter and check for .010" unlatching clearance.

8. Cancellation Magnet Armature for knockoff and clearance. When the cancellation magnet is tripped, the add magnet armature should be clear of the latch arm also.

9. 9-10 Brush Assembly Holding Screws for tightness. These will sometimes loosen on new machines due to shrinkage of the linen dilecto.

10. Counter Wheel Detent for moving in and out freely without any binding action at the time the engaging cam is being brought clear of the clutch gear.

III. Lubrication

IBM 6

(a) All pivot points and operating studs.

IBM 17

(a) On all latching surfaces, behind lower wheel clutch, on engaging cam and a small amount on clutch gear teeth and 1st and 2nd lobe carry cam.

SWITCH PLATES

DO NOT disconnect wires from the plates when removing them from the machine.

While the plates are out of the machine, the bearings of the continuously running shaft should be checked for wear and to see that oil is reaching each bearing. Dryness or powdered metal is an indication that they are not being correctly lubricated.

I. Cleaning

Whenever contacts are cleaned with cloth or card stock, make a second cleaning with a burnishing tool. It may be best to clean only those contacts which need attention rather than to clean complete plates, as the contacts seldom give trouble when correctly adjusted.

II. Inspection

1. Operating Arm for freedom of operation.

2. Insulator Pile Support Block for being loose.

3. Contact Alignment so that the bottom and top straps are in line with the center strap and with the other groups.

4. Air Gap on Points. The following procedure provides a simple and quick method of obtaining a correct adjustment for CPCB plates:

   With the card feed clutch latched, remove the CPCB plate. The washer and screw which position the operating arm on the pivot stud and the bail operating spring are then removed. A washer, similar to the packing case washer or the relay gate fastener washer is placed against the operating arm and the original washer and screw replaced. The screw is tightened until the added washer puts a bind in the operating arm and the contact operating bail is then pressed down. The plate is then replaced in the machine. The operating cam will then be in its latched position at 330°, and the cam follower contacting it will move the bail to its 330° position. The bind in the operating arm will hold the bail in this position when the plate is removed from the machine and the exact contact adjustment at 330° may be obtained.

   The contact position at any degree of index may be obtained by tripping the card feed clutch, turning the machine to the required index point, and then following the above procedure.

   On total switch plates, check for rise of the contact straps when latched and unlatched.

5. Knockoff Adjustments for total switch plates. This should be checked with the plate in the machine, but with one or two plates alongside of it removed so that the movement can be observed.

   Use grease on the support stud of the contact operating bar where lifted by the cam follower arm.

   Oil magnet armatures, latch and knockoff pivot points with lubricant 9.

III. Lubrication

IBM 6

(a) Switch plate cam follower roller followed by IBM 17.

IBM 9

(a) Switch plate magnet armature, latch and knockoff pivot points.

IBM 17

(a) Switch plate cam follower roller and operating cams.
(b) Support stud of contact operating bar.

BASE

I. Cleaning

Clean out oil pan at base of machine and insert paper towels to cover bottom of pan. These will absorb any oil that will drop down and make for an easier cleaning job in the future.

II. Inspection

1. Relays (see *General Section*). Pay particular attention to burnt R16-A points and to the XR-MCR adjustments.

2. Motor Generator (see *General Section*).
   (a) BELTS for wear.
   (b) IDLER PULLEYS on belt tightness for wear and excessive play.

3. Control Panel (see *General Section*). Also check condition of summary punch connector.

4. Bijur System (see *General Section*).

REPRODUCING PUNCH
Type 513

DOCUMENT-ORIGINATING MACHINE
Type 519

CONTENTS

New York, New York
Printed in U.S.A.
Form 22-5699-0

Reproducing Punch, Type 513

Document-Originating Machine, Type 519

CURRENT REQUIREMENTS—WEIGHT

TYPE 513

COMPARING REPRODUCER (80 columns)

Volts	Start Amps	Run Amps
110 AC	35.0	9.2
110 DC	15.0	7.5
220 AC	17.0	4.6
220 DC	10.0	3.8

Weight 945 lbs. packed; weight 735 lbs. unpacked. Dimensions: length 47", width 21", height 48".

TYPE 519

Current values given are running currents.

CURRENT REQUIREMENTS

Voltage	Phase	Frequency	Current
115 AC	1	60	13.0 amp.
		50	15.6 "
		25	11.8 "
115 AC	3	60	7.5 "
		50	9.0 "
		25	6.8 "
230 AC	1	60	6.5 "
		50	7.8 "
		25	5.9 "
230 AC	3	60	3.7 "
		50	4.5 "
		25	3.4 "
115 DC			10.5 "
230 DC			5.2 "

WEIGHT

Unpacked	1341 pounds
Packed	1561 pounds

DIMENSIONS

Length 53"
Width 24½"
Height 49½"

HEAT DISSIPATED IN BTU'S PER HOUR

AC	4090
DC	4110

ADJUSTMENTS

FEED ADJUSTMENTS

THE FOLLOWING adjustments apply to both the Type 513 and Type 519 Reproducing Punches unless otherwise specified.

Read Magazine Side Plates

Adjust forward or backward so punched holes line up with grooves in first feed roll and provide .005" to .008" clearance over length of cards.

Punch Magazine Side Plates

Adjust punch magazine front and rear side plates through elongated holes so cards are punched in proper horizontal alignment on card registration gauge. This should result in punched holes lining up with grooves in first upper feed rolls and proper tracking of X brushes. X brush holder may be filed or shimmed to allow for aligning X brush to card. Set magazine side plates for .005" to .008" clearance over length of cards.

Feed Roll Tension

Adjust feed roll pressure bracket for even tension across length of roll. Springs for the first and second feed rolls of punch feed are heavier than others.

Feed Knife Guides

Position for a minimum of play of the racks between the guides, without causing any binds.

Feed Knives

The card feed knives are adjustable and should be set evenly on each side for a projection of .004" to .0045". To adjust a feed knife, remove the feed knife block from the feed knife rack. This may be done without changing the position of the knife holder adjusting screw if it is held with a 1/4" open end wrench while the knife block holding screw is removed.

Adjust the screw that holds the feed knife holder to the feed rack so that the feeding edge of the knives travels .020" to .040" beyond the left edge of the card in the magazine.

Check to see that both are adjusted evenly so that the card is fed parallel to the first feed roll.

BRUSH ADJUSTMENTS

Reproducing and Comparing Brush Alignment and Timing

Adjust the reproducing brush holder and separator to front or rear by loosening the three holding screws in the slide assembly, so brushes align with holes in card. Check tracking with soft substance such as carpenter's chalk. Adjust, comparing brushes in like manner for proper tracking.

Adjust both sets of brushes for 1/8" projection. Align reproducing brushes to scribed line on brush separators. Adjust feed knives so brushes make at 2 teeth before line of index and remain made until 5 teeth past the line. Shift comparing brushes right or left in holder to make at the same time.

Punch Brush Alignment and Timing

Punch brushes should project 1/8" above separators which require a measurement of 27/32" from brush block to toe of brush. Adjust knives for even feeding so that brushes make 3/4 to 1/2 tooth before line of index. Align as indicated under ***Reproducing and Comparing Brush Alignment***.

X Brush Timing

Move X brushes in holders so X brushes in punch unit make contact through an X hole 3/4 to 1/2 a tooth before 13 and not break before 3/4 tooth after D. X brushes in read unit should make contact at 1 tooth before 13 and should not break before 2 teeth after D. Brushes may be stoned to provide this duration.

Move X brush holder up or down on mounting screws to provide .010" to .012" clearance between the X brush holder and X contact bar.

Common Brushes

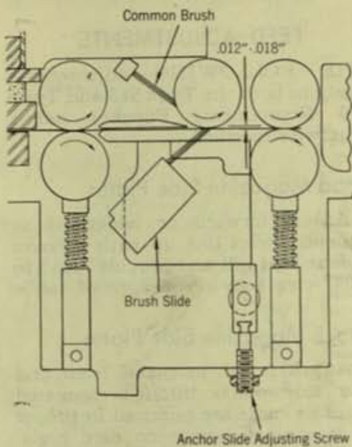
Remove burrs by drawing across fine oil stone before installing. Adjust for good tension.

Summary Punch Emitter

1. Center emitter with respect to shaft on which brush is mounted. The radius is approximately 1 inch.
2. Using beveled brush, part 109339, time brushes to make 1 tooth before line of index and break not before 4 1/2 to 5 teeth after index line.

Anchor Slide Adjustment

The clearance between the contact roll and the brush separators must be .012" to .018". Adjust the brush slide unit up or down by means of the anchor slide adjusting screws in the front and rear support castings.



Anchor slide adjustment

MOTOR ADJUSTMENTS

Drive Motor Belt Tension

Adjust by moving motor pedestal up or down for enough tension to prevent slippage; excessive tension will cause motor bearings to overheat. After adjusting, be sure to secure motor support binding screw so that motor pedestal will not slip due to vibration.

Speed of the machine is varied by the adjustable pulley on drive motor. To increase speed move flanges together; to decrease, move flanges apart.

Adjust belt tension on generator drive motor by adding or removing open shims beneath motor mount.

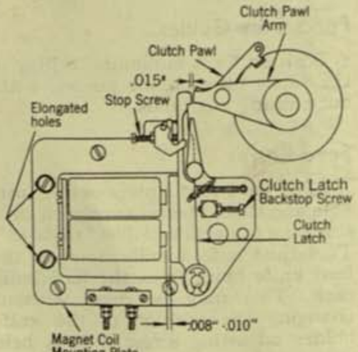
Motor and Generator Mounting Bracket

This mounting bracket is supported by rubber mounts. Check at intervals to be sure that rubber is preventing support bracket from contacting frame and causing vibration and noise.

CAM CONTACTS

Cam Contacts and Stacker Roll Contact

1. Clean points; stone pitted points; check all contacts for loose points.
2. Align points by shifting straps, so full area of points makes contact.
3. Bend non-operating strap of make contact for $\frac{1}{32}$" air gap and for sufficient tension to assure good contact when closed.



Clutch adjustment

TO TIME DYNAMIC CONTACT TIMING DEVICE ON 519

1. Turn machine index to D.
2. Turn inner disc so slot in bulb shield is at top and mesh the drive gear. Tighten holding nut.
3. Turn outer plastic disc so D lines up with slot.

CLUTCH ADJUSTMENTS

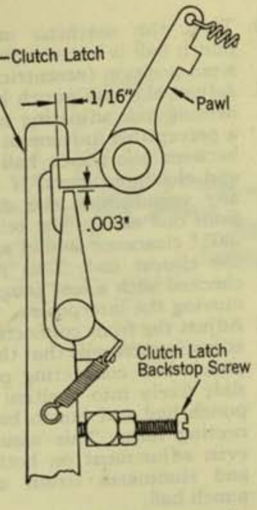
Punch, Read and Mark Sensing Clutches

Set the clutch latch stop screw for .015" clearance between the latch point and the tail of the clutch pawl when the latch is against the latch stop screw. Move the magnets if necessary.

Move the magnet coil mounting plate in elongated holes to provide for .008" to .010" clearance between the armature and cores when the latch is against the stop screw.

Set the clutch latch backstop screw for approximately 1/16" overlap of the latch over the tail of the pawl when latched up.

There should be .003" clearance between keeper and clutch pawl arm when pawl is latched.



Clutch adjustment

PUNCH UNIT ADJUSTMENTS

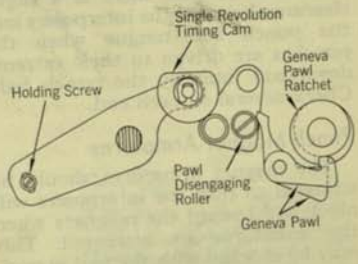
Single Revolution Timing Cam Bracket

Move bracket up or down until cam holds pawl disengaging roller in position to prevent pawl from nipping ratchet when punch clutch is latched at D and machine is operated by hand. On earlier machines the pawl disengaging roller was also adjustable up or down to cause the Geneva pawl to engage and disengage at 14.1 or slightly before.

When the punch clutch is latched, the single revolution timing cam should be timed so that flat side of cam is up and in a horizontal position.

Punch Bail Tongue Adjustment

Loosen the four holding screws; then position the tongue in relation to the bail by means of the two adjusting screws, so that it is $2\frac{21}{32}$" from the front edge of the tongue to the back of the punch bail pivot shaft. This should not require adjustment unless a punch bail or punch bail tongue is replaced.



Single revolution timing cam and bracket

Punch Bail Connecting Links Adjustment

There must be a perceptible movement between the punch bail tongue and the interposers when the bail is in its uppermost position. This condition prevents binds and also provides for a minimum travel of the punches into the die. Adjust as follows:

1. Remove the front punch bail connecting link pin.

2. Turn the machine until the punch bail is in the extreme upward position (eccentric up).
3. Adjust the rear punch bail connecting link adjusting screw for a perceptible movement (.003") between the punch bail tongue and the interposers. If there is any variation in the clearance from one end to the other, the .003" clearance should apply to the closest end. This may be checked with a leaf gauge or by moving the interposers.
4. Adjust the front connecting link adjusting screw so that the front punch bail connecting pin will slide freely into position in the punch bail and punch bail connecting links. This assures an even adjustment on both links and eliminates strain on the punch bail.

After adjusting the connecting link adjusting screws, check to see that the punches are not driven down against the punch at its extreme downward limit of travel. Press on the top of the interposer with a screwdriver and check for a slight additional downward movement.

The punch stop bar should be set as near the punch as possible but should not interfere with the movement of the punch.

Interposer Spring Bail

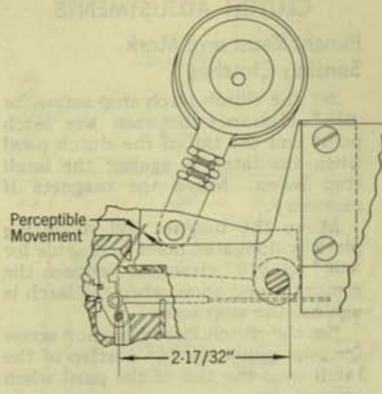
The interposer spring bail should be positioned so that there is a slight clearance between the interposers and the punch bail tongue when the punches are driven to their extreme downward limit by the punch bail. Check several on each end.

Punch Magnet Armatures

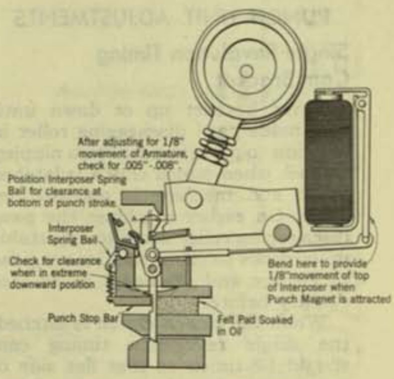
The magnet armatures should be adjusted so that the interposers will move ⅛" toward the magnets when the armatures are attracted. This may be checked with the bail in position to engage the interposer but may be more accurately checked with the bail removed. The ⅛" travel is obtained by increasing or decreasing the armature-core air gap by bending the armature just above the point where the pull wire connects. The interposers shoud line up when in a normal position and should move freely.

Die Adjustment

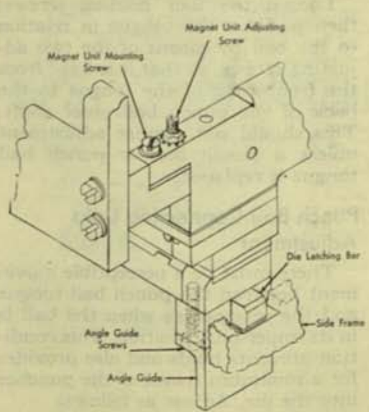
Loosen magnet unit mounting screws before installing die assembly,



Punch bail tongue and connecting links adjustment



Punch magnet armature adjustment



Die assembly adjustment

then adjust magnet unit adjusting screw to provide slight drag between the die latching bars and side of frame, keeping magnet mounting screws just snug while making this adjustment.

Install die with angle guide screws loose, then press the angle guides evenly outward against the frame and tighten screws. This adjustment is made to guide the die assembly properly and make removal and insertion relatively easy without binding.

Die Lifter — Type 519

Adjust the setscrew in the rear for a .010" clearance between the stop screw and the rear frame when the die is fully in position. This provides a positive stop for the die lifter to prevent springing the magnet unit support blocks with the leverage obtained through the die lifter.

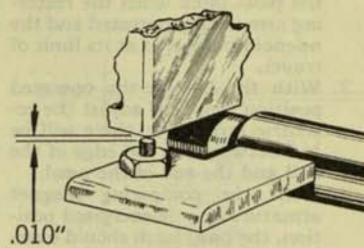
Vertical Registration

To change the registration, loosen the four magnet unit mounting screws and adjust the two magnet unit aligning screws to position the magnet unit assembly toward the right or left for proper vertical registration of the holes punched in the card. (Move the aligning screws evenly and only when the magnet unit mounting screws are loosened, otherwise the unit may be strained and incorrect horizontal registration may result.) Be sure the aligning screws and mounting screws are tight after making this adjustment. The vertical registration should be set with the magazine half full of cards. With a full magazine a slight variation may be noted in one direction, and with a nearly empty magazine a slight variation in the other direction may be noted.

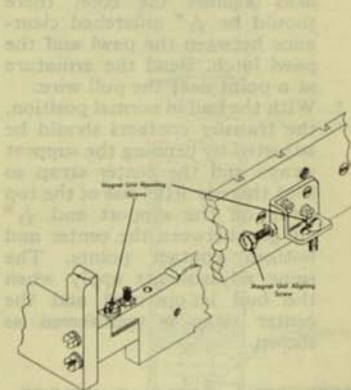
After repositioning the magnet unit for the proper vertical alignment as in the above adjustment, recheck for the slight clearance between the punch bail tongue and interposers when the punch bail is at its upward limit, because repositioning the magnet unit will affect that adjustment.

COMPARING UNIT ADJUSTMENTS

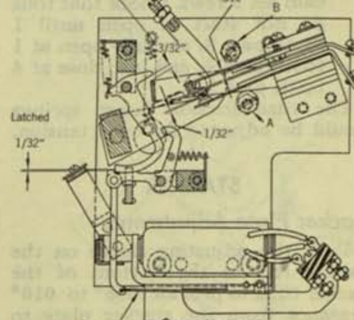
1. Adjust the eccentric screw A so that with the bail in normal position there will be $\frac{3}{32}$" between the top edge of the bail and the end of the pawl.



Die lifter

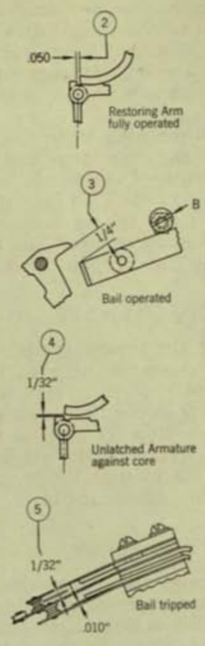


Vertical registration adjustment



Comparing unit adjustment

2. Screw C is adjusted to give .050" clearance between the pawl and the pawl latch when the restoring arm is fully operated and the solenoid plunger is at its limit of travel.
3. With the bail in the operated position (tripped) adjust the eccentric screw B so there will be 1/4" between the top edge of the bail and the end of the pawl.
4. With the comparing magnet armature in a de-energized position, the pawl latch should overlap the pawl by 1/32". With the comparing magnet armature held against the core, there should be 1/32" unlatched clearance between the pawl and the pawl latch. Bend the armature at a point near the pull wire.
5. With the bail in normal position, the transfer contacts should be adjusted by bending the support straps and the center strap so that there is .010" rise of the top strap off the support and 1/32" air gap between the center and bottom contact points. The same adjustments apply when the bail is operated and the center strap is transferred as shown.

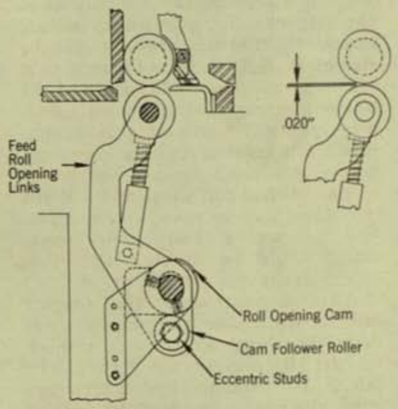


Comparing unit adjustments

FEED ROLL OPENING DEVICE

1. Adjust eccentric studs to provide for feed rolls opening .020" at both ends, and a minimum of .015" clearance at the center of the rolls when on high dwell of opening cams at 1 tooth past 4.
2. To time roll opening cam, loosen cams on shaft and turn machine to 4 teeth past 5. Turn roll opening cams back against cam follower rollers and tighten cam set screws. Check that rolls do not start to open until 1 tooth past 3, are fully open at 1 tooth past 4, and just close at 4 teeth past 5.

The card friction finger springs should be adjusted for even tension.



Feed roll opening device

STACKER

Stacker Plate Adjustments

Turn the adjusting sleeve on the stacker rod in the bottom of the stacker tube to provide .006" to .010" clearance from the stacker plate to the face of the rubber rollers when the rubber rollers are in the extreme downward position. Tighten lock nut.

To increase the braking action of the felt washer use $1/4$" end wrench on the bottom of the adjusting sleeve to keep it from turning and tighten the compression nut.

Stacker Timing

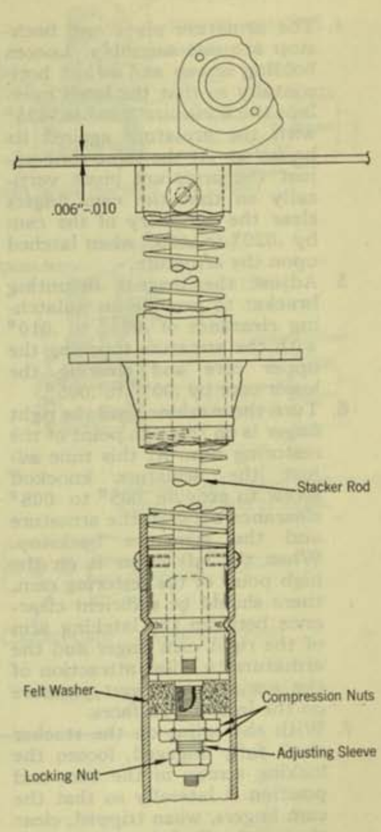
To time the punch stacker roll:

1. Remove the blue steel clip from the stud of the idler gear.
2. Disengage the idler gear.
3. Engage the punch clutch and turn the machine to 8.2 on the index.
4. Turn the stacker roll so that the high side is down and remesh the idler gear. (The read stacker roll is timed for the same condition at 4 on the index.) This timing should result in the card being carried completely into the stacker. The roller should be above the stacker top lining when the punch clutch is latched.

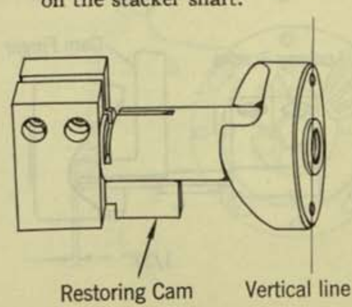
Offset Stacker Adjustments

The following adjustments apply to the offset stacker mechanism in both the read and punch feeds. The stacker roll in the punch feed is not split but is driven by a wide gear.

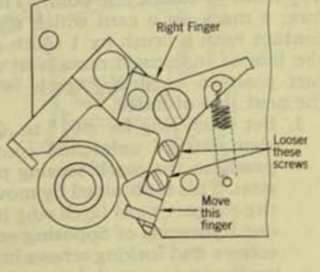
1. Time stacker so that the high side of the stacker roll is down at 4 on the index for the read feed, and at 8.2 for the punch feed. The high side should be up at D for the read feed.
2. Set cam stacker shaft so that the restoring cam is down, and the center lines of the holes in the cam are in a vertical position at 6.3 for the read feed and at 13.9 on the index for the punch feed.
3. Loosen the two screws in the right cam finger and adjust the finger so that it strikes the cam surface at the same time as the left finger to insure an even pull on the stacker shaft.



Stacker plate



Offset stacker adjustment



Offset stacker adjustment

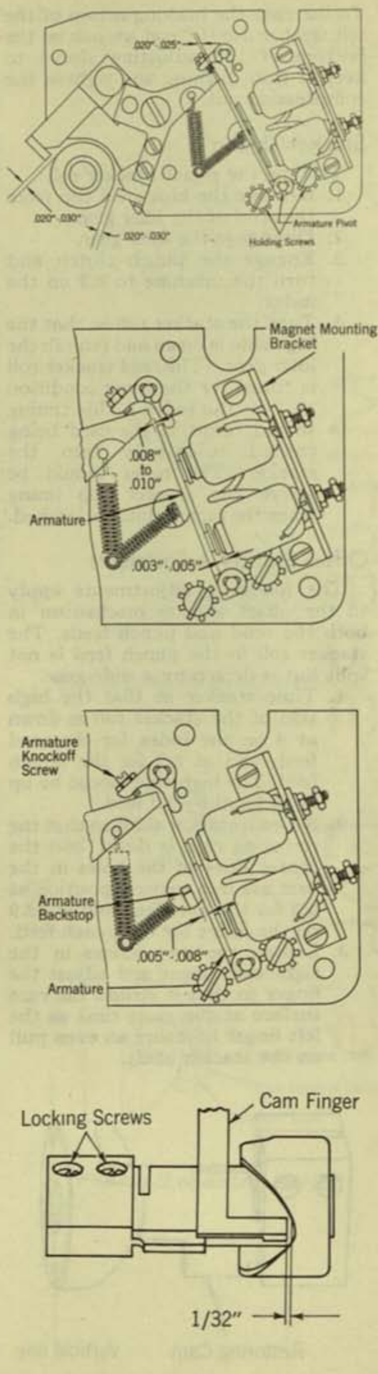
4. The armature pivot and backstop are one assembly. Loosen holding screws and adjust horizontally so that the latch overlaps the armature .020" to .025" with the armature against its backstop. At the same time adjust the armature pivot vertically so that the cam fingers clear the periphery of the cam by .020" to .030" when latched upon the armature.
5. Adjust the magnet mounting bracket to provide an unlatching clearance of .008" to .010" with the armature touching the upper core and clearing the lower core by .003" to .005".
6. Turn the machine until the right finger is on the high point of the restoring cam. At this time adjust the armature knockoff screw to provide .005" to .008" clearance between the armature and the armature backstop. When the left finger is on the high point of the restoring cam, there should be sufficient clearance between the latching arm of the right cam finger and the armature to allow attraction of the armature without pressure on the latching surfaces.
7. With the spline on the stacker shaft fully engaged, loosen the locking screws in the cam and position it laterally so that the cam fingers, when tripped, clear the low dwell of the cam by $\frac{1}{32}$".

MARK SENSING ADJUSTMENTS

Mark Sensing Brush Timing

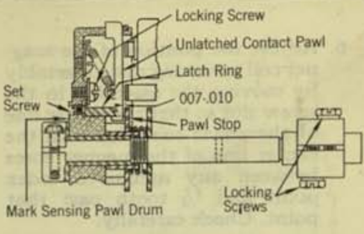
When studying the limits of the mark sensing brush, it must be remembered that the cards in the punch unit move intermittently. All motion takes place between $2\frac{1}{2}$ teeth before a line of index and 1 tooth past a line of index, or a total of $3\frac{1}{2}$ teeth on the index. The cards are stationary for $6\frac{1}{2}$ teeth of each cycle point. Therefore, a mark on a card which makes contact with a brush by 1 tooth past the line of index will remain in contact position until $2\frac{1}{2}$ teeth before the next line of index.

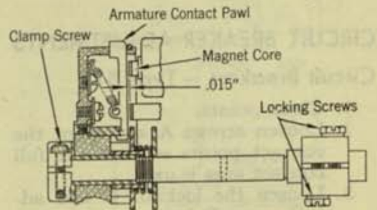
1. Set latch ring for .007" to .010" clearance of unlatched contact pawls to the mark sensing pawl stop. This is obtained by moving the magnet pawl latch ring in or out by means of opposing set of screws and locking screws in the mark sensing pawl drum assembly.

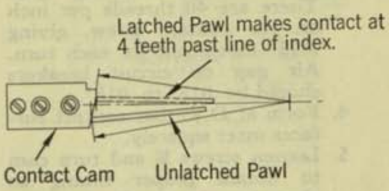


Offset stacker adjustments

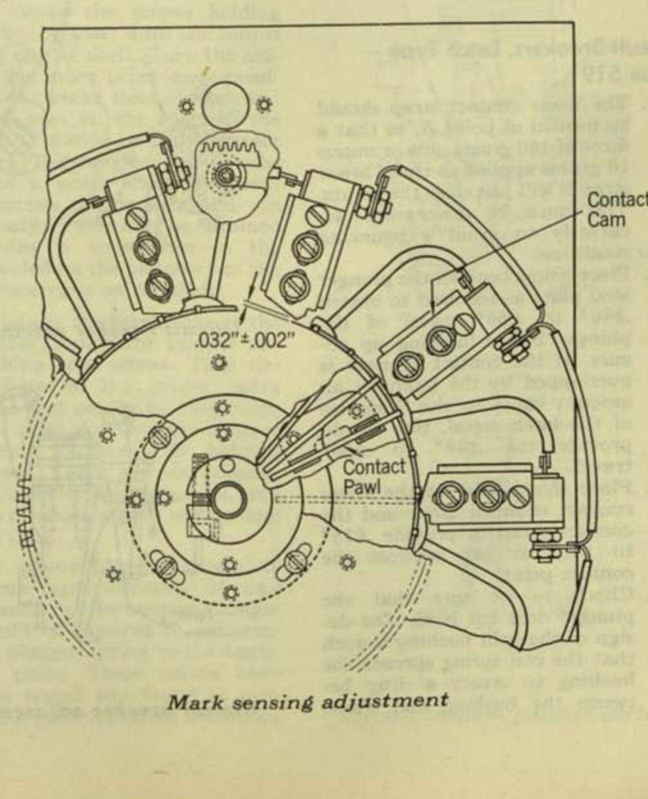
2. Loosen the clamp screw on the rear end of the drum mounting hub. With all pawls latched, turn in the contact drum until there is no clearance between the pawls and magnet cores; then back off the contact drum 3/10 of a turn. This provides .015" clearance between the unlatched pawls and the magnet cores. Lock the clamp screw.
3. With the unit on the machine, loosen the locking screws at the clutch end of the drum shaft and time the drum so that latched pawls make contact at 4 teeth after the line of index. Tighten the locking screws.
4. Adjust each contact cam for .032" plus or minus .002" clearance to the outer surface of the contact drum. This provides for proper relatching clearance.
5. To time the pawls on unit 2 and 3, move the drum in elongated holes in the drive gears.





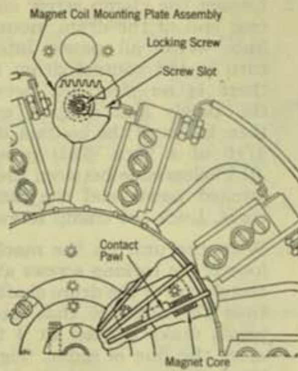


Mark sensing adjustments



Mark sensing adjustment

6. Adjust the position of the magnet coil mounting plate assembly by moving the assembly in the screw slot so that the center line of the pawls coincides with the center line of the magnet cores between any numbered index point and $\frac{1}{4}$ tooth past that point. Check carefully.

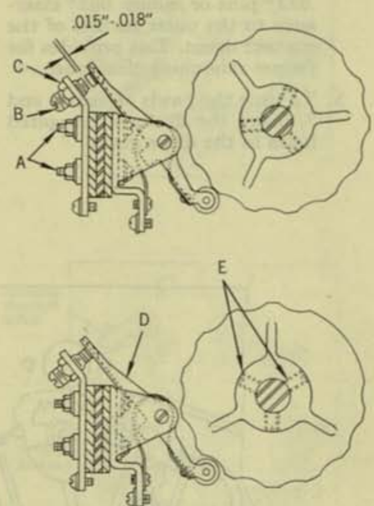


Mark sensing adjustment

CIRCUIT BREAKER ADJUSTMENTS

Circuit Breakers — Type 513

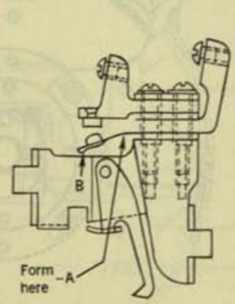
1. Clean points.
2. Loosen screws A and align the contact points so that the full contact area is used.
3. Loosen the locknut C and adjust screw B for correct air gap. There are 40 threads per inch on the contact screw, giving .025" movement for each turn. Air gap on circuit breakers should be .015" to .018".
4. Form at D so that contact surfaces meet squarely.
5. Loosen screws E and turn cam to obtain proper timing as given on the electrical timing chart supplied with each machine.



Circuit breaker assembly

Circuit Breakers, Latch Type — Type 519

1. The lower contact strap should be formed at point A, so that a force of 160 grams plus or minus 10 grams applied at tip of lower strap B will just close the points. This must be maintained accurately to avoid a bouncing condition.
2. Place shims beneath the plunger stop plate as required to obtain .040" to .050" travel of the plunger before latching up occurs. If the contact plunger is overlapped by the latch by an amount equal to the thickness of the latch metal, this should provide the .040" to .050" travel.
3. Place shims between the lower contact terminal block and the contact strap to provide .015" to .018" air gap between the contact point.
4. Check to be sure that the plunger does not bind. The design of the split bushing is such that the coil spring spreads the bushing to create a drag between the bushing and frame



Circuit breaker adjustment

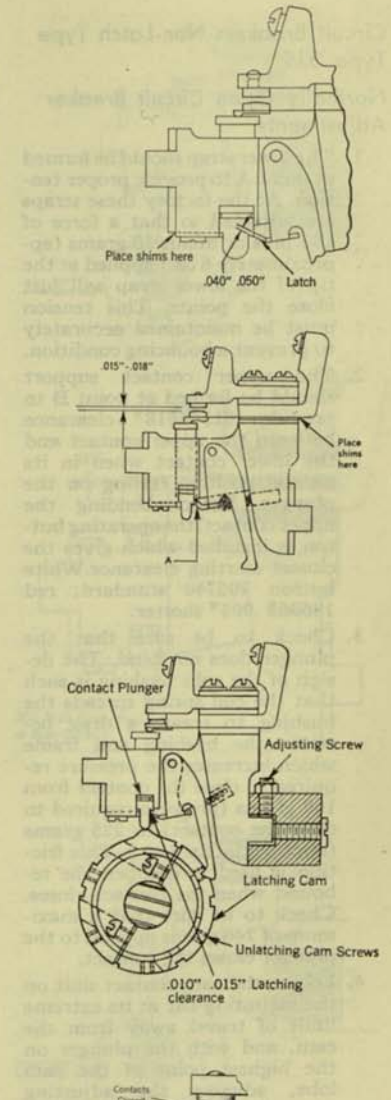
which increases the pressure required to close the contact from 160 grams (pressure required to compress the spring) to 225 grams (approximately 8 oz.). This friction is used to dampen the rebound when the contact closes. Check to be sure that a maximum of 240 grams applied to the plunger should close the contact.

5. Locate the cam contact unit on the mounting bar at its extreme limit of travel away from the cam, and with the plunger on the highest point of the cam lobe, advance the adjusting screw until the plunger latches; then advance the screw one-half turn additional to obtain .010" to .015" movement of the plunger beyond the latch point. This will provide clearance between the low dwell of the cam and the plunger. On the non-latch type there should be a .003" minimum clearance between the low dwell of the cam and the contact plunger when the plunger is against its stop.

To adjust the make time of the contact, loosen the screws holding the cam to the shaft until the cam is just snug on the shaft. Turn the machine to the index point corresponding with the make time of the cam. Move the cam on the shaft in the direction of rotation until the contact just closes. The machine may now be turned to a point where the cam holding screws can be tightened. An accurate adjustment may be obtained by inserting a screwdriver in the slots provided on the periphery of the cam for moving it on the shaft.

6. To adjust the break time of the contact, loosen the contact unlatching cam screws. Turn the machine to the proper index point and move the unlatching cam in its slot until the contact opens. Tighten the holding screws. There are six possible positions for holding screws, only two of which will be used at any one time.

7. 600 grams plus or minus 20 grams (approximately 21 oz.) pressure on the contact plunger should be required to compress the plunger spring to the latching point. These values have been tested and found to provide a good operating condition.

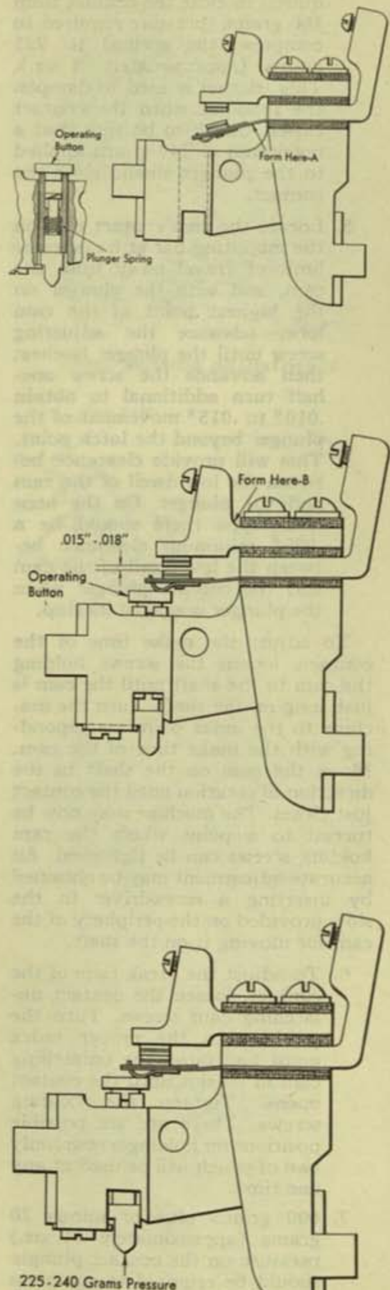


Circuit breaker adjustments

Circuit Breakers Non-Latch Type Type 519

Normally Open Circuit Breaker Adjustments

1. The lower strap should be formed at point A to provide proper tension. At the factory these straps are adjusted so that a force of 160 plus or minus 10 grams (approximately 6 oz.) applied at the tip of the lower strap will just close the points. This tension must be maintained accurately to prevent a bouncing condition.
2. The upper contact support should be formed at point B to provide .015"-.018" clearance between the upper contact and the lower contact when in its normal position resting on the plunger. Before bending the upper contact, the operating button is installed which gives the closest starting clearance. White button 205740 standard; red 186862 .005" shorter.
3. Check to be sure that the plunger does not bind. The design of the split bushing is such that the coil spring spreads the bushing to create a drag between the bushing and frame which increases the pressure required to close the contact from 160 grams (pressure required to close the contact) to 225 grams (approximately 8 oz.). This friction is used to dampen the rebound when the contact closes. Check to be sure that a maximum of 240 grams applied to the plunger closes the contact.
4. Locate the cam contact unit on the mounting bar at its extreme limit of travel away from the cam, and with the plunger on the highest point of the cam lobe, advance the adjusting screw ½ turn to obtain .010"-.015" additional movement to the plunger.
5. To adjust the make time of the contact, loosen the screws holding the cam to the shaft until the cam is just snug on the shaft. Turn the machine to the index point corresponding with the make time of the cam. Move the cam on the shaft in the direction of rotation until the contact just closes. The machine may now be turned to a point where the cam holding screws can be tightened.



Circuit breaker adjustments

The circuit breaker cam clamp is provided with notches and accurate adjustment of the cam may be obtained by tapping lightly against the notch with a screwdriver.

When the cam time duration is of a number of degrees not supplied by a standard cam, an additional adjustment must be made. It will be necessary to raise or lower the contact assembly until the desired condition is satisfied. Check the duration with a dynamic timer after adjustment is changed.

Normally Closed Circuit Breaker

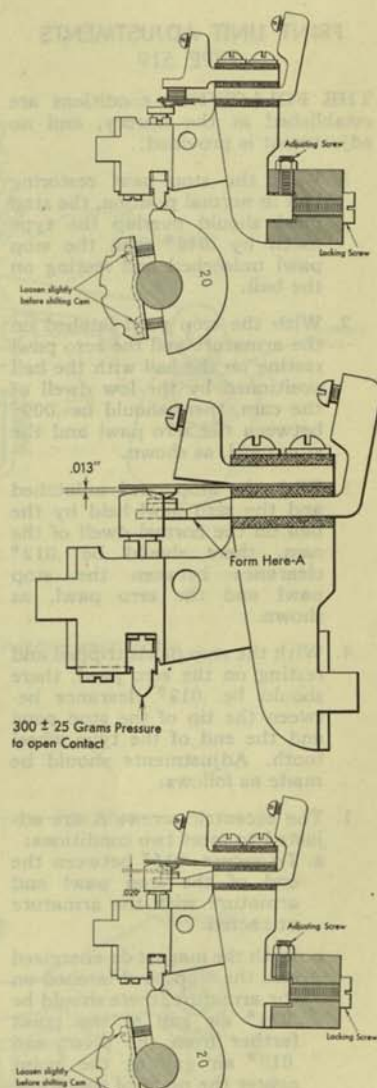
6. The lower contact support should be formed at the point A to provide .013" clearance between the upper contact strap when in its normal position and the operating plunger.

7. 300 plus or minus 25 grams (approximately 10.6 oz.) pressure on the contact plunger should be required to open the contact points.

8. Locate the cam contact unit on the mounting bar at its extreme limit of travel away from the cam. With the plunger on the highest point of the cam lobe, advance the adjusting screw until the air gap at the contact points is a minimum of .020" when the plunger is raised to its limit of travel.

Cams

The side of all cams are stamped with the number of degrees of duration of their high point.



Circuit breaker adjustments

Part No.	°	Part No.	°	Part No.	°	Part No.	°	Part No.	°
217006	6°	217030	30°	217070	70°	217110	110°	217145	145°
217008	8°	217035	35°	217075	75°	217112	112°	217150	150°
217010	10°	217040	40°	217080	80°	217115	115°	217155	155°
217012	12°	217045	45°	217085	85°	217120	120°	217160	160°
217015	15°	217050	50°	217090	90°	217125	125°	217165	165°
217018	18°	217055	55°	217095	95°	217130	130°	217170	170°
217020	20°	217060	60°	217100	100°	217135	135°	217175	175°
217022	22°	217065	65°	217105	105°	217140	140°	217180	180°
217025	25°								

PRINT UNIT ADJUSTMENTS TYPE 519

THE FOLLOWING conditions are established at the factory, and no adjustment is provided:

1. With the stop pawl restoring bail in normal position, the stop pawl should overlap the type tooth by .040" with the stop pawl unlatched and resting on the bail.

2. With the stop pawl latched on the armature and the zero pawl resting on the bail with the bail positioned by the low dwell of the cam, there should be .009" between the zero pawl and the stop pawl, as shown.

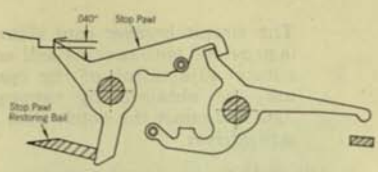
3. With the stop pawl unlatched and the zero pawl held by the bail on the normal dwell of the cam, there should be .012" clearance between the stop pawl and the zero pawl, as shown.

4. With the stop pawls tripped and resting on the zero pawl, there should be .012" clearance between the tip of the stop pawl and the end of the type wheel tooth. Adjustments should be made as follows:

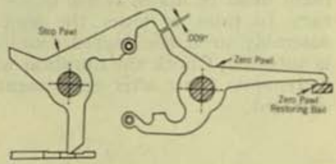
1. The eccentric screws A are adjusted to meet two conditions:
   a. To secure .015" between the end of the stop pawl and armature with the armature attracted.
   b. With the magnet de-energized and the stop pawl latched on the armature, there should be .024" air gap at the point farther from the pivot and .010" air gap at the point nearer the pivot of the armature. The eccentrics on both sides of the unit should be set for the same conditions.

2. Adjust the eccentric screws B to provide .020" clearance between the tip of the stop pawl and the teeth of the type wheel.

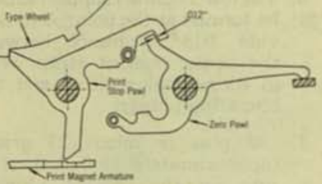
3. Loosen the locking screw and adjust the restoring bail to obtain .003" clearance between the armature latch surface and the latch point of the stop pawl with the latch restoring bail at its extreme limit of travel.



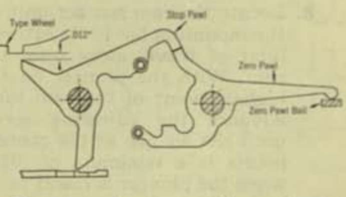
Print stop pawl—operating position



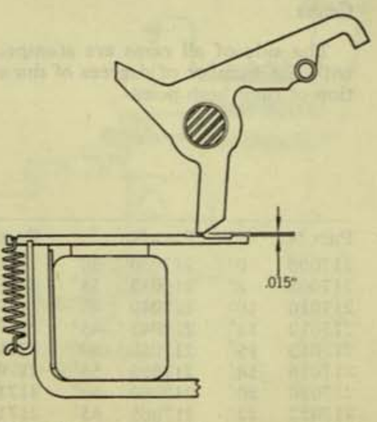
Zero pawl—operating position



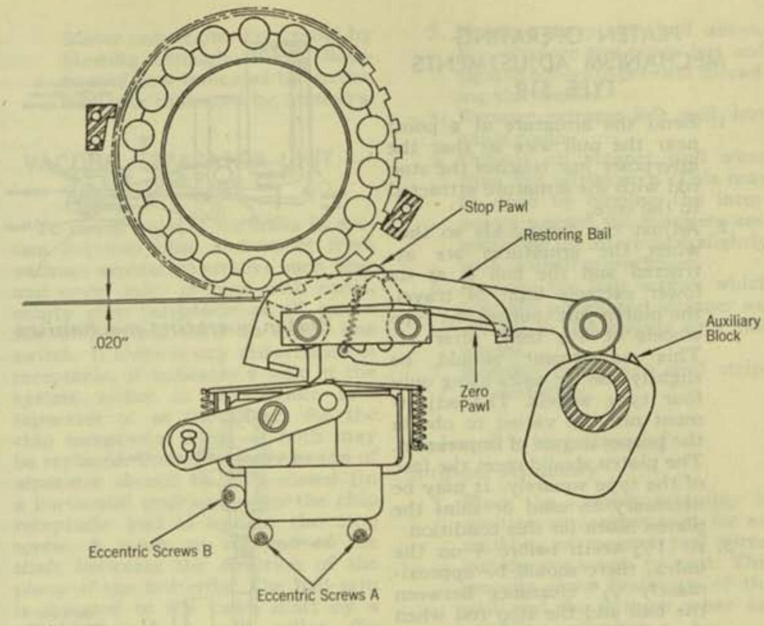
Print stop pawl—armature attracted



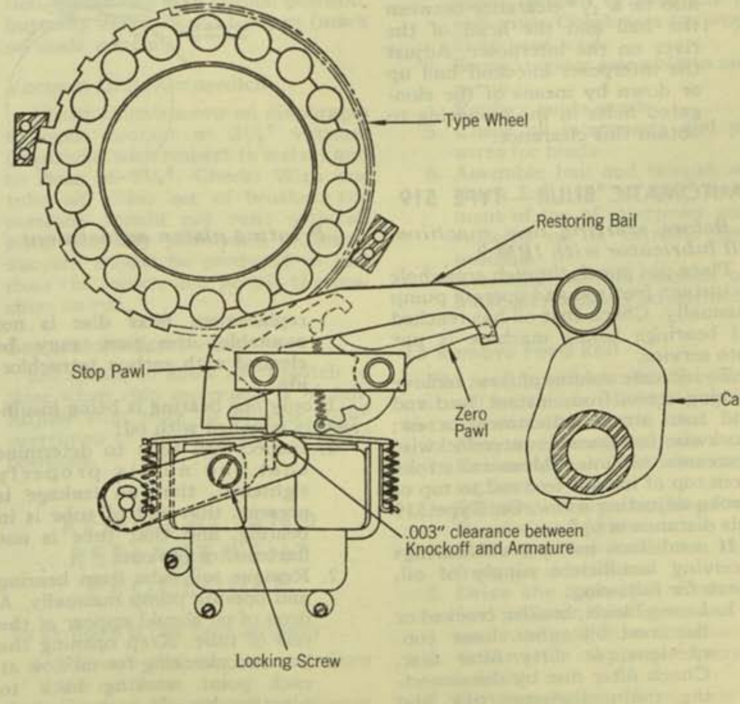
Zero pawl—supporting print stop pawl



Selection mechanism—zero time



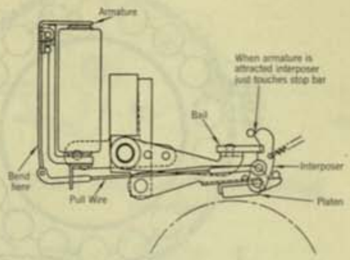
Selection mechanism—zero time



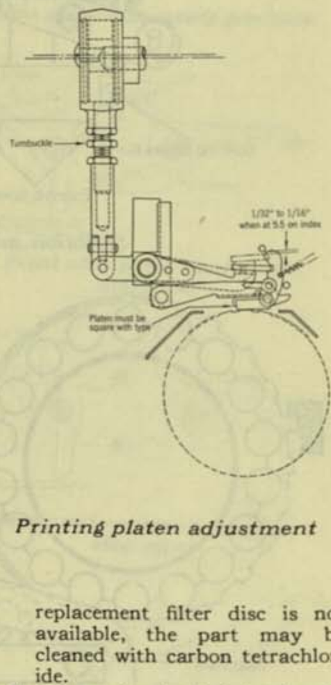
Selection mechanism—restored position

PLATEN OPERATING MECHANISM ADJUSTMENTS TYPE 519

1. Bend the armature at a point near the pull wire so that the interposer just touches the stop rod with the armature attracted to the core.
2. Adjust the turnbuckle so that when the armatures are attracted and the bail is at its lower extreme limit of travel, the platen just touches the type wheels at $4\frac{1}{2}$ teeth after 11. This adjustment should be slightly less for units using only four type wheels. The adjustment may be varied to obtain the proper degree of impression. The platen should meet the face of the type squarely. It may be necessary to sand or shim the platen block for this condition.
3. At $1\frac{1}{2}$ teeth before 4 on the index, there should be approximately $\frac{1}{32}$" clearance between the bail and the stop rod when the bail is at its upward limit of travel. When the bail is at the lower limit of travel there should also be a $\frac{1}{32}$" clearance between the bail and the head of the rivet on the interposer. Adjust the interposer knockoff bail up or down by means of the elongated holes in the mounting to obtain this clearance.



Platen operating mechanism



Printing platen adjustment

AUTOMATIC BIJUR — TYPE 519

Before starting new machine, fill lubricator with IBM 9.

Place pin punch through cross hole in instant feed rod and operate pump manually. Check that oil has reached all bearings before machine is put into service.

To increase volume of flow, remove locking screw from instant feed rod and turn stroke adjustment screw; clockwise increases, counterclockwise decreases volume. Measure stroke from top of instant feed rod to top of stroke adjusting screw. On Type 519 this distance is $\frac{1}{2}$".

If conditions indicate all bearings receiving insufficient supply of oil, check for following:

1. Low oil level, broken, cracked or flattened oil tubes, loose connections, or dirty filter disc. Check filter disc by disconnecting main discharge line and operating pump manually. If a replacement filter disc is not available, the part may be cleaned with carbon tetrachloride.

If only one bearing is being insufficiently supplied with oil:

1. Inspect tail tube to determine that the nut is properly tightened, that no leakage is present, that end of tube is in bearing, and that tube is not flattened or broken.
2. Remove tail tube from bearing and operate pump manually. A drop of oil should appear at the end of tube. Keep opening the line and checking for oil flow at each point working back to junction bar. If meter unit is cause of oil stoppage, replace it.

Meter units cannot be tested by blowing through them. Direction of flow indicated by arrow; flow rate indicated by numbers.

VACUUM SEPARATOR UNIT — TYPE 519

To check quickly for leaks in system between base and outlet from vacuum separator, remove each hose and cover inlet in base with cards, empty chip receptacle of all but a few chips, and turn on main line switch. If there is any disturbance in receptacle, it indicates a leak in the system either at the intake into separator or at the gasket for the chip receptacle; either or both may be replaced. Butterfly valve in top of separator should be fully closed (in a horizontal position) when the chip receptacle bail is against the stop screw. A mark on the end of the shaft indicates the direction of the plane of the butterfly. The bail arm is clamped to the valve shaft by a screw through a split collar. To change position of butterfly, loosen screw and turn shaft to proper position. When bail is in normal position, butterfly valve should be open (mark on shaft vertical).

Vacuum Unit Microswitch

Adjust thumb screw on diaphragm to open contact at $3\frac{1}{4}$" vacuum (measured with respect to water) and to close at $3\frac{3}{4}$". Check: With one tube off either set of brushes, the machine should not run; with all hoses properly positioned, sufficient vacuum should be produced to just close the switch and permit the machine to run.

Separator Microswitch

Set spring to allow microswitch to close when chip receptacle is $\frac{3}{4}$ full. Adjust stop nuts to provide .010" overthrow of switch in OFF and ON positions.

REMOVAL AND REPLACEMENT PROCEDURE

To Remove a Die and Stripper

1. Remove the magnet unit from the machine.
2. Remove the punch interposer knockoff bar.
3. Remove the punch bail assembly. Replace the pivot bar and tighten screws to prevent spreading side frames.
4. Remove extreme left pull wire guide comb.
5. Unhook all magnet pull wires from the interposers. This may be done by moving the interposers toward the magnets and spreading the interposers slightly with a small screwdriver.
6. Remove the four screws which hold the punch and stripper assembly to the magnet unit side frames.
7. Remove the punch and stripper assembly.

To Install a New Die and Stripper Assembly

1. Place the stripper assembly in position on magnet unit for assembling of magnet pull wires, but do not screw to unit. This permits more flexibility of the unit and the stripper when assembling pull wires.
2. Assemble pull wires to pawls. It is necessary only to move the pawls forward to assemble the pull wires. Check wire for proper fit to pawl stud.
3. Screw stripper assembly to magnet unit.
4. Replace guide comb.
5. Check all interposers and pull wires for binds.
6. Assemble bail and tongue, and check for .015" to .020" movement of top of interposer when engaged in its extreme lower position.
7. Assemble unit to machine and make all necessary adjustments.

To Remove Feed Roll

The first upper feed roll in the punch unit will be considered, for it requires the most disassembly and care.

1. Remove the magnet unit.
2. Remove punch X brush mounting bar.
3. Remove drive housing and Geneva mechanism.
4. Pull the picket knife cam shaft from the side frame.
5. Drive the taper pin from the feed roll rear drive gear and remove the gear from the shaft.
6. Remove the oil pump—2 screws hold it.
7. Remove screws from bearing plate.

8. Remove dowel screws from punch feed back plate which supports the punch X brushes and center bearing for the feed roll. There are two screws in front and two in back.
9. Remove front gear cover.
10. Relieve the pressure from the lower feed roll.
11. Drive pin from the front drive gear of the feed roll.
12. Tap the front end of the upper feed roll shaft to loosen the bearing plate. Use a hammer and brass rod. When the bearing plate is loose, it may be turned to clear the latch cam roller arm, and the shaft may be removed from the machine. Take care in passing the feed roll through the hole in the casting to prevent chipping the linen dilecto.

The first lower feed roll in the punch feed is heavier than the others. This is to minimize bowing of the shaft when the feed roll opening device operates. The feed roll pressure shoes for this roll are cut with a greater radius because the diameter of the feed roll shaft is greater than that of the other feed rolls in the machine.

The feed roll pressure springs in the first and second feed roll pressure shoes are heavier than on the other feed rolls of the machine. Take care that these pressure shoes and springs are not interchanged if more than one feed roll is removed.

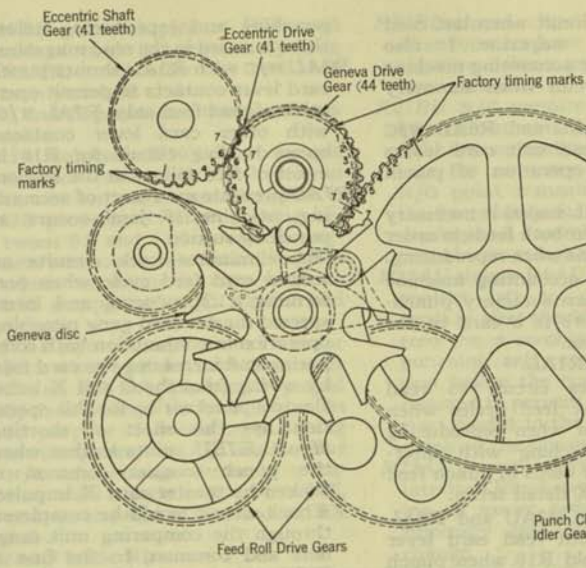
To replace the feed roll, reverse the above procedure.

13. The second and third upper feed rolls may be removed, after removing the drive gear pin, without removing the drive housing. If the front bearings are loosened so that the feed roll shaft may be driven forward far enough, the rear drive gear can be removed from the shaft.

To Replace the Geneva Mechanism

In order that the Geneva clutch pawl may clear the two upper feed roll drive gears, it is necessary to turn the gears so that the factory-scribed marks do not line up. However, if the following reference marks are made, these may be lined up to assure that the Geneva mechanism is properly timed when it is replaced in the machine:

1. On the eccentric shaft gear (41 teeth) pencil mark the 7th tooth space in a counter-clockwise direction from the tooth space already marked. (A red pencil is recommended.)
2. Mark the 7th tooth in a clockwise direction from the present marked tooth of the eccentric drive gear (41 teeth). Also, mark the 7th tooth space in a clockwise direction from the present marked tooth space of Geneva disc drive gear (44 teeth). Both of these gears are pinned to the drive pulley shaft.
3. Mark the 7th tooth in a counter-clockwise direction from the present marked tooth of the punch clutch idler gear (110 teeth).
4. Turn the feed roll shafts until the flat side of the single revolution timing cam is on the right in a vertical position.
5. Turn the eccentric shaft and the punch clutch idler shaft until the new marks point toward the drive pulley shaft center.
6. Turn the key slot in the oil pump so that it lines up with the key tongue on the hub of the punch clutch idler gear.
7. Be sure the Geneva pawl is engaged in its ratchet.
8. Place the roller in the slot of the Geneva drive gear that lines up with the one-tooth ratchet (the one to the left of the pawl pivot).
9. Work the three gears forward into position while matching the pencil marks, and position the three shafts into their respective bearings in the side frame. The punch clutch idler gear shaft, being the longest, should enter the hole in the rotor of the pump first. Next, the Geneva disc shaft should enter its bearing, and then the pulley shaft bearing should enter its housing. After the punch clutch idler gear shaft is in the rotor of the pump, the shaft should be raised vertically about 1/4" so that it will line up with the bearing in the side frame. If the Geneva disc shaft seems to bind just after it enters the bearing, check to see that it meshes properly with the two upper feed roll drive gears. It may be necessary to turn either one or both of these gears a part of a tooth to mesh with the gear on the shaft of the Geneva disc. Note: These shafts must not be forced in place. If any of the



Timing the geneva mechanism

mechanism does not properly seat, check to see that all gears are properly meshed, that all shafts are aligned with their bearings and that the key is aligned with the oil pump rotor.

10. Insert the crank stud and turn the machine over until the factory marks (scribed lines) line up. At this time the Geneva drive gear roller should be half way out of its slot and the tail of the pawl should strike the pawl disengaging roller.
11. Replace the drive housing.
12. If the drive pulley oil seal is removed, the outer discs should be replaced with the concave surface facing out.

PURPOSES OF CAMS AND CONTACTS

TYPE 513

R1AL operates with R4AL to control circuits to clutches to keep the feeds in step in the event of feed failure in either unit; that unit in which the failure occurred will operate.

R1AU is a die interlock contact which allows continuous operation only if a card is under the die C.L.

R1BL completes circuit to punch X common and R2 when cards are feeding; when cards are not feeding, it opens to prevent circuits to X control relays.

R1BU completes circuit to R10 for first cycle when summary punching, reproducing, and comparing to permit feeding without restoring comparing unit. This permits cards to be run out of summary punch, replaced in proper order and run in again without restoring comparing unit.

R2AL provides circuit to O and X hubs when card is in punching position on the second and each succeeding punching cycle.

R2AU holds R2H coil through die card lever after R2 is energized at end of first punch feed cycle.

R2BL N/C (summary punching) causes punch to take two feed cycles when cards are first placed in machine and start key closed.

R2BU prevents accounting machine auto start when summary punching unless a card is at the die station.

R3AL N/C operates with R7AL N/C to shunt out punch card lever contacts and permit operation of read feed only. R3AL N/O, with other card lever contacts, holds R10, opening the circuit when last card leaves punch magazine. It also enters into the accounting machine auto start circuit when summary punching.

R3AU with R4BL and R6AL N/C shunts out read unit card levers and permits operation of punch unit alone.

R3BL with R6BL makes it necessary to have cards in both feeds in order to start machine when reproducing.

R3BU prevents accounting machine auto start when summary punching unless there is a card in the punch magazine.

R4AL—refer to R1AL.

R4AU completes circuit to read clutch for first feed cycles when starting a run when reproducing and gang punching with interspersed master cards in punch feed and using an X detail setup.

R4BL N/C, with R3AU and R6AL N/C, shunts out read card lever contacts to hold R10 when punch unit only is operated. R4BL N/O enters R10 hold circuit when cards are in read feed.

R4BU completes circuit to R-X common when cards are feeding. When cards are not feeding, it opens to prevent completion of circuits to X control relays.

R5B with other card lever contacts, provides an automatic start circuit to the accounting machine when summary punching. It prevents an accounting machine auto start unless there is a card under read card lever No. 1 when performing a combination reproducing and summary punching operation.

R6AL N/C, with 3AU and 4BL N/C, shunts out reading card lever contacts to hold R10 when punch unit only operates. R6AL N/O, with 4BL N/O, opens circuit to R10 when last card leaves read magazine. It operates with other card lever contacts to provide an auto start impulse to the accounting machine when summary punching.

R6AU, when reproducing and comparing, permits machine to be cleared of cards after an error without restoring the comparing unit if cards are removed from both magazines.

R6BL operates with 3BL so that when reproducing it is necessary to have cards in or out of both feeds in order to start the machine.

R6BU prevents an accounting machine auto start when summary punching and reproducing unless there is a card in the read magazine.

R7AL N/C with R3AL shunts punch card lever contacts to permit operation of read feed only. R7AL N/O, with other card lever contacts, opens holding circuit for R10 in event of feed failure at die station.

R7AU prevents auto start of accounting machine if jam occurs at punching station.

R7BL eliminates back circuits on second card feed cycle when performing a reproducing and interspersed master card gang punching operation in conjunction with comparing and increasing the card field by wiring from the O and X hubs. Control panel wiring for this operation has the effect of shorting around R7BU points so that when the punch magnet common is broken by master card X impulse, a back circuit would be completed through the comparing unit magnets and common, to the fuse if R7BL N/O were not in the line.

R7BU completes circuit to punch brush contact roll when cards are at brush station; when open, it prevents energization of magnets connected to punch brushes.

R8AL provides hold circuit for R8 long enough so R8B may prevent a second start impulse from reaching R10 when summary punching.

R8BL opens punch auto start from accounting machine to eliminate the possibility of more than one punching cycle for each summary punch operation.

R9AL holds R9 after R10 drops.

R9AU holds R9 during time R10 is energized and C3 is open.

R9BL picks R8 after R10 is energized to assure only one cycle of operation for each summary punch operation.

R9BU operates in conjunction with R10BL to control circuits to punch and read clutches. The pick time of R9 under the control of R13B is such as to prevent the clutch magnets from receiving a short impulse when restarting in case the machine had stopped during the time C1 or C2 had already closed.

R10AL picks HD1 and R9.

R10AU has two separate points to prevent a back circuit which would permit starting machine with comparing contact open.

R10BL, with R9BU, opens circuit to clutches (at time C1 and C2 are open) when machine stops for any reason.

R10BU prevents pick of R25 until end of cycle to prevent opening R25BL until after the card has been punched.

R11 and 12 points function as column splits.

R13A maintains R10 hold to permit machine to complete its cycle in case either stacker switch opens.

R13B prevents R9 from picking between 9.6 and 13.9 so clutch magnets may not receive short impulse when restarting in case machine had stopped when C1 or C2 had closed.

R14AL N/O provides pick circuit for R15 when switch is set to master X and PX hub has been impulsed by hole in card under PX brushes for purpose of preventing punching or comparing master cards. The N/C side provides the same operation when switch is set to detail X, and no impulse is received at PX hub.

R14AU holds R14.

R14BL controls read clutch on X or no X cards, depending upon the setting of the master X, detail X switch.

R15AL on machines with punch magnet relays, prevents their pick when R15 is impulsed; on machines without punch magnet relays, it opens the punch magnet circuit directly.

R15AU holds R15.

R15BL opens summary punch end circuit to allow another punch cycle when master card passes die.

R15BU permits an extra cycle on summary punching to get master card past die.

R16A holds R16.

R16B completes circuit to P D Out hub.

R17A holds R17.

R17B completes circuit to R D Out hub.

R18A holds R18.

R18B N/C, with reproduce switch 1 OFF and switch set to master X, opens common to comparing magnet when X card is sensed; the N/O point, when switch is set to detail X, closes the circuit to comparing magnets when an X card is sensed.

R19A holds R19.

R19B opens circuit to comparing magnets when master card is passing comparing brushes.

R21AL and AU operate in pick circuit through T hub for selectors 1 and 2, respectively, so this circuit can be completed only on a control change in the accounting machine.

R21BL opens clutch circuits until after counters have been tested for negative balance on balance selection machines.

R21BU N/C permits the 9 impulse from the summary punch emitter to be transmitted to counter mouldings for summary punching. The N/O point transmits a circuit to the 9 mouldings for balance control sensing on a control change to pick the selector relays if so wired.

R22AU shunts R6AU and comparing contact left to permit running cards in after checking a comparing error on a combination summary punching and reproducing operation before the comparing unit is restored to prevent getting an auto start circuit to the accounting machine on the run in cycles.

R23AL permits energization of cycle interlock R8 when summary punching to assure punching only one summary card for each control change.

R23AU permits the summary punch emitter to send impulses through the counters of the accounting machine only on summary punching operations.

R23BL permits summary punch start circuit to be completed only after R60 in the accounting machine is energized.

R24B has the effect of an R cam in the circuit. It functions to prevent the machine from continuing in operation under the following conditions: When a jam occurs in the read feed, R4 and R6 drop back to normal. The operator remakes the card or straightens it, replaces it in the read magazine, and depresses the start key to pick R10. The read feed only will feed. If it should happen that this first card again jams at the throat, R10 would continue to hold through P6 because the punch feed does not operate on this cycle. However, R24B in the R10 hold circuit opens and stops the feed.

R25AL holds R25 when R10 is energized to permit feeding cards without restoring the comparing unit.

R25AU permits cards to be run from machine when comparing unit is tripped, thus eliminating the necessity for relatching the comparing unit and thereby maintaining the error indication until after feed is cleared so that it may be checked against the cards. It also permits clearing the feed without punching additional errors.

R25BL eliminates punching while error cards are cleared from the machine provided the comparing unit is not restored.

R25BU opens start circuit on combination reproducing, comparing and summary punching operation, when a comparing error is sensed. R25BU works with R1BU to permit proper handling of cards on a summary punch comparing error. It forces the operator to remove cards from both feed hoppers before running out cards. Then the die CL opens R1BU N/C and permits feed-in before comparing unit is restored.

R28B same as R25BL, added to reduce arcing.

R33 and R34BU and BL are so arranged that either will be effective to transfer the class selector C hub in the two left hand positions from NX to X depending upon whether the R or P hub of the selector is impulsed.

R33AL and R34AL provide a pick and hold for class selector 1, relays 35, 36 and 37.

R33AU and R34AU hold R33 through P2 and R2, respectively, for the card reading portion of the cycle.

R35 through R41 points are class selector transfer points.

R37AL and R42AL points provide + and − punching control for indicating positive and negative totals when balance selecting or net balancing.

Points of Relays 43-56 eliminate back circuits at punching time on summary punching machines.

MARK SENSING RELAYS

R88B N/C point provides a pick circuit to number 1 delay unit magnet. The N/O point picks R89 for MX operation.

R89AL holds R89.

R89AU provides an impulse to the MX EXIT hub 1 to punch an X hole for a marked 12.

R89B provides a circuit to the MX OUTLET hub and with P3 provides an impulse for operation of relays normally controlled by a punched X.

R90A holds R90.

R90B permits energization of R89 in parallel with R11, 12 and 13 in the standard circuits to provide a hold circuit for R89 through X time on the index.

Relays 91-107 points transfer the circuits from those used on comparing or summary punching to those used for the mark sensing application.

OFFSET STACKER RELAYS

SR1AL holds SR1.

SR1B picks SR2 to delay the circuit to the stacker magnet.

SR2A holds SR2 through P2 until the end of the cycle in which the card is stacked.

SR2B picks the offset stacker magnet when the stacker roll contact makes.

DOUBLE PUNCH AND BLANK COLUMN DETECTION RELAYS

R87AL holds R87 and the double punch error light until the double punch reset switch is depressed.

R87B N/C drops R10 when double punch or blank column occurs.

R109A points provide a pick circuit for R110 in the first position and a hold circuit for R109 in the same position. The A points of relays 65-77 and 109-149 serve the same function for other positions.

R109B permits an impulse to R87P2 and the error lamp if relay 109 has not been previously energized. This indicates a blank column.

R110A N/C provides a pick circuit for R109 in the first position. This circuit is completed by the first impulse read into this position. It opens to prevent a second impulse read into this position from deenergizing R110. The A points of relays 110-150 and 66-78 serve the same function for other positions.

The N/O points of R110 provide a circuit to pick R87P1 if a second impulse reaches the entry hub. The N/O points of the other relays mentioned previously serve the same purpose for other positions.

R110B N/C same as R110A N/C.

R19AL N/C permits a shunt circuit around the master card punching switch right in the OFF position. R19AL opens to prevent blank column check for master cards. The N/O point permits a blank column check for X detail cards.

C-CAMS

1. Controls the punch clutch timing and eliminates arcing of the relay points in the circuit by making the circuit after the relay points are closed and breaking the circuit before the relay points are opened.

2. Controls read clutch timing and eliminates arcing of relay points in that circuit.
3. Controls the drop out time of motor hold relay 9. It should be timed to cause the machine to coast to a point between 6 and 9.
4. Controls the pick and drop out time of column split relays and R13.
5. Provides proper timing hold for delay circuit relays.
6. Controls impulses to the read and punch delay OUT hubs and to delay circuits for other devices.
7. Controls impulse to O and X hubs and emits impulse to the MS EXIT hub 1 to punch an X hole.
8. C8 in conjunction with the stacker roll contact assures that the movement of the card is synchronized with the punch emitter. If the Geneva pawl failed to engage on the first cycle, the card and the punch emitter would be out of step. If the two are in step, the accounting machine auto start will be completed.
9. Provides a circuit to energize the zone control transfer relays for alphabetic summary punching.

P-CAMS

1. Controls the circuit to the circuit breakers so that the reading brush and emitter circuits are completed only when the punch unit operates. It also controls the pick of the punch magnet relays.
2. Controls the holding circuit for relays which must be held during the punching period and X control relay for double punch and blank column detection.
3. Completes a circuit to the punch X brush at X time only and to the MX outlet for mark sensing.
4. Provides a pickup for PX delay R16.
6. Provides a hold circuit for R10. It opens once during each cycle to test the condition of the card lever relays to determine if the machine should stop.

R-CAMS

1. Controls the circuit to the reproducing brushes to complete circuits to them only when the read feed operates.
2. Controls the holding circuit to the relays which must be held throughout the reading portion of the cycle under the control of read feed.
3. Completes circuit to the read X brushes at X time only.
4. Pickup for RX master delay R18.

STANDARD MACHINE RELAYS

R1AL operates in conjunction with R4AL to control circuits to clutches to keep feeds in step in event of a feed failure in either unit; that unit in which the failure occurred will operate.

R1AU, when closed, holds R19 in conjunction with other card lever contacts to continue machine operation. When open, it breaks circuit to R19 hold coil to stop machine in case it fails to feed a card from punch magazine.

R1BL completes circuit to punch X brush common and relay 2 when cards are feeding. When cards are not feeding, it is open to prevent circuits to X control relays.

R1BU completes circuit to R19 for first cycle when summary punching, reproducing and comparing to permit feeding without restoring comparing unit. In this manner the cards may be run out of the summary punch, replaced in proper order and run in again without restoring the comparing unit.

R2AL provides circuit to O and X hubs when a card is in punching position on the second and each succeeding punching cycle.

R2AU holds R2 through the die card lever after R2 has been energized at end of first punch feed cycle.

R2BL N/C causes machine to take 2 feed cycles when cards are first placed in machine and start key is depressed, when summary punching. R2BL N/O, in conjunction with other card lever contacts, allows auto start circuit to be completed from accounting machine.

R2BU prevents accounting machine automatic start when summary punching unless a card is at die station.

R3AL N/C operates in conjunction with R8AL N/C to shunt punch card lever contacts to permit operation of the read feed only. R3AL N/O, in conjunction with other card lever contacts, completes a holding circuit for R19. It opens the R19 hold circuit when last card leaves punch magazine. It also operates in conjunction with other card lever contacts to complete accounting machine auto start circuit when summary punching.

R3AU operates in conjunction with R4BL and R6AL N/C to shunt read unit card levers to permit operation of the punch unit alone.

R3BL operates in conjunction with R6BL so that when reproducing, it is necessary to have cards in or out of both feeds in order to start the machine.

R3BU prevents an accounting machine auto start when summary punching unless there is a card in punch magazine.

R4AL—refer to R1AL.

R4AU, when reproducing and gang punching with interspersed master cards in the punch feed and using an X detail setup, this point completes circuit to read clutch for first feed cycle when starting a run.

R4BL N/C operates in conjunction with R3AU and R6AL N/C to shunt read card lever contacts to complete holding circuit to R19 when the punch unit only is being operated. R4BL N/O operates in conjunction with R6AL N/O to open circuit to R19 in case it fails to feed a card from read magazine.

R4BU completes a circuit to the RX common when cards are feeding. When cards are not feeding, it is open to prevent circuits to X control relays.

R5A operates in conjunction with R7A to prevent a circuit to read clutch to prevent operation of read feed when read unit is not being used. It provides a circuit to read clutch for first cycle after cards run out of the read feed magazine.

R5B operates in conjunction with other card lever contacts to provide an auto start circuit to accounting machine when summary punching. Prevents an accounting machine auto start unless there is a card under read card lever 1 when performing a combination reproducing and summary punching operation.

R6AL N/C operates in conjunction with R3AU and R4BL N/C to shunt reading card lever contacts to complete R19 hold circuit when the punch unit only is being operated. R6AL N/O operates in conjunction with R4BL N/O to open the circuit to R19 when last card leaves read magazine. Operates in conjunction with other card lever contacts to provide start circuit to accounting machine when summary punching.

R6AU. This point, when reproducing and comparing, permits the machine to be cleared of cards after an error without restoring comparing unit, if cards are removed from both magazines.

R6BL operates in conjunction with R3BL so that when reproducing, it is necessary to have cards in or out of both feeds in order to start machine.

R6BU prevents accounting machine auto start when summary punching and reproducing unless there is a card in read magazine.

R7A operates in conjunction with R5A to prevent a circuit to read clutch and prevent operation of read feed when read feed is not being used. It opens when the cards run out of read feed magazine.

R8AL N/C operates in conjunction with R3AL to shunt punch card lever contacts to permit operation of read feed only. R8AL N/O in conjunction with other card lever contacts opens R19 hold circuit in event of a feed failure at die station.

R8AU prevents an automatic start circuit to accounting machine if a jam occurs at punching station.

R8BL eliminates back circuits on second card feed cycle when performing a reproducing and interspersed master card gang punching operation in conjunction with comparing and increasing the card field by wiring from the O and X hubs. Control panel wiring for this operation has the effect of shorting around R8BU points so that when the punch magnet common is broken by master card X impulses, a back circuit would be completed through comparing unit magnets and common, to the fuse if R8BL N/O were not in the circuit.

R8BU completes circuit to punch brush contact roll when cards are at that station. When open, it prevents energization of magnets connected to punch brushes.

R9AL shunts start interlocks when not reproducing.

R9AU allows a circuit to be completed to R26 pick coil only when reproducing. It prevents interruption of punching when an error is sensed while performing a double punch and blank column detection operation without comparing. This allows following cards to be punched and eliminates the necessity for removing cards from the punch feed and replacing them before continuing the operation.

R9BL N/C shunts card lever contact interlock R1AL and R4AL to permit read clutch to operate on every cycle when gang punching and gang punch checking. The N/O point completes circuits to read clutch through X controlled and card lever interlocks when reproducing.

R9BU shunts card lever contact interlocks R1AL and R4AL to permit operation of punch clutch on every cycle when gang punching and gang punch checking.

R10AU places the comparing circuit under the control of R8BL when reproducing. When gang punch checking, it allows comparing to be independent of punch card lever.

R10BL permits running cards out of machine without restoring comparing unit when performing a reproducing operation, provided cards are removed from magazine to prevent further errors.

R10BU shunts reading card lever contacts in accounting machine start circuit when performing a summary punch operation without reproducing.

R11A controls in conjunction with R29B, circuit to common side of punch magnets to complete this circuit on X or No X cards depending upon position of punch direct control switch.

R12AU operates at P4 time. Picks punch offset stacker relay 143.

R12BU operates in pick circuit of punch relay 32.

R13A controls, in conjunction with R34B, circuit to common of comparing magnets; it completes this circuit for an X or No X card depending upon setup of comparing control.

R14A controls, in conjunction with R27B, operation of read clutch on X or No X cards depending upon setting of read feed control.

R15AL opens R19 hold circuit to stop machine when stop key is depressed.

R15AU holds stop relay through start key N/C points to eliminate necessity for holding the stop key until R19 drops.

R15B breaks holding circuit for HD1 through summary punch single card motor control points to stop motor when stop key is depressed.

R16A operates in conjunction with magazine card lever contacts to complete pick circuit to R19 to start machine when start key is depressed.

R17A holds R17.

R17B opens the punch automatic start circuit from accounting machine to eliminate possibility of more than one cycle of the punch for each control change.

R18AL N/O completes circuit to motor heavy duty relay to hold motor relay energized after R19AL opens. C3 is timed to drop R18 at a time to allow machine to coast to a point between 6 and 9.

R18AU holds R18.

R18BL N/C picks summary punch single card motor control relay 79 when R18 drops and C10 makes. *R18BL* N/O picks R17 to assure a single punch cycle on each control change.

R18BU operates in conjunction with R19BL to control circuits to clutches. The pick time of R18 under control of C8 is such as to prevent clutch magnets from receiving a short impulse when restarting in case machine had stopped during time when C1 or 2 had already closed.

R19AL N/C completes a circuit to machine idling light. R19AL N/O completes circuit to pick heavy duty motor relay.

R19AU holds R19.

R19BL operates in conjunction with R18BU to open circuit to the clutches (at time C1 and C2 are open) when machine stops for any reason.

R19BU N/C, in conjunction with R25BL, completes circuit to pick R26 after an impulse to stop hub so that cards may be run out of machine without punching or comparing. It delays pick of R26 until all punching has been completed for that card.

R20, 21, 22, column split points.

R24A opens R19 hold circuit to stop machine when a discrepancy in comparing or double punch and blank column detecting is sensed if machine is wired to stop.

R24B opens accounting machine start interlock circuit to prevent an auto start when a comparing discrepancy is sensed during a summary punching operation.

R25AL shunts card lever relay contacts in accounting machine start circuit to provide a means of operating accounting machine without cards in punch and without restoring comparing unit when summary punching.

R25AU picks HD3 so reset key is operative only when stop hub of comparing unit is wired.

R25BL, N/O operates in connection with R19BU to pick comparing stop control relay 26 when "stop" hub is impulsed on a reproducing operation. It also completes circuit to R26 hold until comparing unit is restored.

R25BU operates, when open, in conjunction with R1BU to prevent starting machine after comparing unit has been tripped until cards are removed from the magazines.

R26AL and R26BL open after an impulse to the "stop" hub when reproducing, so cards may be run out of machine without punching or comparing.

R26AU holds R26.

R26BU permits operation of clutches to run cards out of machine without restoring comparing unit.

R27A holds R27.

R27B controls, in conjunction with R14A, operation of read clutch on X or No X cards depending upon setting of read feed control.

R29A holds R29.

R29B controls, in conjunction with R11A, circuit to common side of punch magnets to complete circuit on X or No X cards depending upon position of punch direct control.

R30A holds R30.

R30B completes circuit to punch magnet control relays under control of an impulse into P Tfr hub.

R31A holds R31 and completes pick for R32.

R32A holds R32.

R32B completes circuit to "PD OUT" hub.

R33AL ground interlock—opens circuit to die assembly when machine is stopped to prevent possible shock or injury to operator when removing die assembly.

R33AU holds R33 through C5.

R33B opens the circuit to cathode when machine stops to prevent lacing card should a marked 12 be on card at die station.

R34A holds R34.

R34B controls, in conjunction with R13A, circuit to common of comparing magnets; it completes this circuit for an X or No X card depending upon setup of comparing control.

R35A holds R35 and picks R36.

R36A holds R35.

R36B completes circuit to "RD OUT" hub.

R43 and 44BU and BL are class selection points. R43 and 44 BU and BL points are so arranged that either one will be effective depending upon which of the two pick hubs R or P is used.

R43AL provides a hold circuit for 43H coil and a pick and hold circuit for R45 and 46.

R43AU holds R43.

R44AL provides a hold circuit for R44 H coil and a pick and hold circuit for R45 and 46.

R44AU holds R44.

R45 and 46 are class selection points.

R47-50 same as R43 through 46 for class selector 2.

R51-54 same as 43 through 46 for class selector 3.

R55-58 same as R43 through 46 for class selector 4.

R59-78 transfer points for NX and GP and during balance test time X and SP hubs. These points eliminate back circuits.

R79AL allows circuit to be completed to R80 pick coil when C11 makes. It should be noted that the timing of the pick circuits for relays 79, 80 and 81 is such that they will pick on successive machine cycles.

R79AU holds R79.

R79B holds, in conjunction with R80 and R81B, heavy duty motor relay energized for 4 or 5 cycles after a card has been summary punched so that the punch drive motor does not stop between single card groups.

R80-81 function in the same manner as described for R79.

R83A operates in pick circuit from "B" hub for selector 4 so that this circuit can be completed only on a control change in the accounting machine.

*R84*AL, *AU*, BL operates in pick circuits through "B" hubs for selectors 1, 2, and 3, respectively, so that these groups can be picked only through B hubs on a control change in the accounting machine.

R84BU, N/C allows the 9 impulse from summary punch emitter to be transmitted to counter mouldings for summary punching. R84BU N/O transmits an impulse to the 9 mouldings for balance control sensing on a control change to pick selector relays if so wired.

R85AL makes summary punch single card motor control circuit to heavy duty motor relay operative when summary punching.

R85AU shunts R24AL to provide circuit to R19, in conjunction with R1BU, when summary punching, reproducing, and comparing to permit feeding without restoring comparing unit.

R85BL causes R19 hold circuit to be controlled by R2BL so that when summary punching, the machine takes two cycles on initial depression of start key to carry a card to punch brush station.

R85BU provides a pick circuit for R79 to initiate operation of relays 79 through 82 for summary punch single card motor control.

R87AL operates in conjunction with R18BL to pick one cycle control relay 17 on a summary punching operation.

R87BL allows start circuit to be completed to punch when summary punch cycle is required. Prevents extraneous impulses from accounting machine when performing operations other than summary punching.

R87BU provides a circuit to energize punch magnet control relays when summary punching.

MARK SENSING RELAYS

R89B N/C provides pick circuit to number 1 delay unit magnet. R89 N/O provides a circuit to pick R90 for MX operation.

R90AL provides a hold for R90.

R90AU provides an impulse to the MS EXIT hub 1 to punch X hole for a marked 12.

R90B provides a circuit to the MX OUTLET hub and, in conjunction with P3, provides an impulse for operation of relays normally controlled by a punched X.

R91AL provides a circuit for the MS clutch.

R91BL prevents the completion of a circuit to R19 until the thermal delay relay BU points close.

Thermal Delay Relay

BL, the N/C points provide a circuit to the heater coil. The N/O points provide a hold circuit for the relay.

BU prevents energization of R19 until there is sufficient time for the tubes to "warm up".

OFFSET STACKER RELAYS

R139A provides a hold circuit for R139. This relay is picked if the comparing contact bail is tripped.

R139AU picks R-141 and HD3 to allow the comparing unit to be reset.

R139B prevents a circuit to the punch and read clutches for one cycle to provide time for the comparing unit to be restored.

R140A provides a hold circuit for R140 and a pick circuit for R142.

R140B provides a pick circuit for R141 to restore comparing unit when the punch offset stacker is impulsed to instigate offset stacking in the punch unit.

R141B opens the circuit to the double punch blank column light and the R98 hold coil after an impulse has been emitted from the DPBC hub to the offset stacker pick hub.

R142A provides a hold circuit for R142 and a pick for R143.

R143A holds R143.

R143B provides, in conjunction with C6 pick circuit for R144 at the proper time to cause punch offset stacker to be impulsed on the correct cycle.

R144A holds R144.

R144B allows the punch offset stacker magnet to be impulsed by P11 at correct time on the correct cycle.

R145A provides a hold circuit for R145 and a pick circuit for R147.

R145B provides a pick circuit for HD3 when read offset stacker is impulsed to cause the comparing unit to be reset.

R147A holds R147.

R147B allows the read offset stacker to be impulsed by P10 at correct time on correct cycle.

R148A—all points on R148 operate at P13 time to pick relays in conjunction with offset stacker delay circuits. Provides a pick circuit for R142.

R148B picks R147.

DOUBLE PUNCH AND BLANK COLUMN DETECTION RELAYS

R92A prevents pick of R98 on run-in before card is under punch brush station.

R93AL picks R96 delay setup.

R94A, in conjunction with R97B, provides X—No X control over blank column detection.

R95A holds R95; picks R96.

R96A holds R96.

R96B picks R97, with C6, at the proper time in the cycle to delay the operation of the X control to the proper cycle.

R97A holds R97.

R97B provides, in conjunction with R94A, X—No X control over blank column detection.

R98A holds R98; provides circuit to error lamp.

R98B provides a circuit to the DPBC outlet hub in case either a blank or double punched column has been sensed. Prevents R98 from being energized by a comparing error when both comparing and DPBC hubs are wired to the stop or same offset stacker hub.

R99A provides a pick circuit for relay 100 for the first position. This circuit is completed by the first impulse read into this position. It opens to prevent a second impulse read into this position from de-energizing R99.

R99B—the N/C points provide a circuit to the exit hub so that the information may also be gang punched. The N/O point provides a circuit to pick R98 if a second impulse reaches the entry hub. This separates each position to prevent a second impulse in any position from being fed to all wired columns.

R100A provides a path for the blank column detection test impulse for position 1 in case no impulse was entered into the number 1 entry hub.

R100B picks R99; holds R100.

R101, 103 to 137, and R170 to 188. A points operate in the same manner as R99A for positions 2-30, respectively. B points operate in same manner as 99B. For positions 2-30, respectively.

R102, 104 to 138, and R171, 173 to 189. A points operate in the same manner as R100A for positions 2-30, respectively.

PRINTING DEVICE RELAYS

R12AL operates in the pick circuit of the print device 2nd cycle X delay relay 165.

R12BL operates in the pick circuit of the print device 3rd cycle X delay relay 167.

R163A operates in conjunction with R168B to provide X—No X control over printing.

R164A holds R164 and picks R165 at the proper time in the cycle to delay the operation of the X control for the 2nd cycle.

R165A holds R165.

R165B provides, in conjunction with C6, a pick circuit for R166 at the proper time in the cycle to transfer the delay circuit to R166 for the second cycle.

R166A holds R166 and picks R167 for third cycle delay transfer.

R167A holds 167.

R167B—picks, in conjunction with C6, R168 at the proper time in the cycle to transfer the delay circuit to R168 for the third cycle.

R168B operates in conjunction with R163A to provide X—No X control over printing.

R244 1-4 and R245 1-4 allow card impulses 5 through 9 to be directed to the print magnets. When open, they prevent energization of print magnets during restoring time while storage relays are being set up.

R246 1-4 and R247 1-4 provide circuits to the 0 storage relays at 0 time on the card.

R248 1-4 and R249 1-4 provide circuits to the 1 storage relays at 1 time on the card.

R250 1-4 and R251 1-4 provide circuits to the 2 storage relays at 2 time on the card.

R252 1-4, R253 1-4, R254 1-4, and R255 1-4 provide circuits to both the 0 and 1 storage relays.

R256 1-4, R257 1-4, R258 1-4, and R259 1-4 provide circuits to both 0 and 2 storage relays.

R260-1 through R283-1 provide hold circuits for storage relays 260 through 283.

R260-3 and 4 through R283-3 and 4, the N/C points in combination provide a circuit from the entry hubs to the print magnets in the event the storage relay has not been picked. One N/O point, in combination with other N/C points, for each position provides a circuit for read out impulses from the emitter to the print magnets.

C — CAMS

1. Controls punch and mark sensing clutch timing and eliminates arcing of the relay points in the circuit by making the circuits after the relay points are closed and breaking the circuits before the relay points are opened.
2. Controls read clutch timing and eliminates arcing of the relay points in the circuit by making the circuit after the relay points are closed and breaking the circuit before the relay points are opened.
3. Controls the drop out time of motor control relay 18. Should

be timed to cause machine to coast to a point between 6 and 9.

4. Controls pick and drop out time of column split relays.
5. Provides properly timed hold for delay circuit relays.
6. Controls impulses to read and punch delay "out" hubs and to delay circuits for other devices.
7. Controls impulse to O and X hubs and emits impulse to the MS EXIT hub 1 to punch X hole.
8. Times pick of motor control relay 18 at time when it cannot energize one clutch without the other.
9. In conjunction with the punch interlock contact assures that the movement of the card is synchronized with the punch emitter. If the Geneva pawl failed to engage on the first cycle, the card and the punch emitter would be out of step. If the two are in step, the accounting machine auto start circuit will be completed.

10, 11, and 12. Time pickup of summary punch single card motor control.

C10 impulses R79. C11 impulses R80 before R79 drops. C12 impulses R81 before R80 drops.

This sequence provides a motor running circuit for at least four machine cycles to eliminate starting and stopping of the punch motor for single card totals.

13. Controls pickup of R148 which works in conjunction with offset stacker delay circuits.

23, 24, 25, 26 supply timed impulses to the card brushes.

P — CAMS

1. Controls the circuit to the circuit breakers so that reading brush and emitter circuits are completed only when the punch unit operates. Controls the pick of the punch magnet relays.
2. Controls the holding circuit for relays which must be held during the punching period and X control relays for double punch and blank detection as well as cycle delay relays for printing.
3. Completes circuit to the punch X brush at X time only and to the MX outlet for mark sensing.
4. Controls R12 to expand the number of circuits which can operate at P4 time.
5. Allows the machine to take one cycle if the start key is depressed. It opens once each cycle to test the R19 hold circuit through the card lever contacts to determine that cards are at each card lever station. In the event that one of the card lever contacts opens, R19 is held until the cycle is completed.
6. Permits R19 to be held to cause the machine to complete a cycle when R24AL is opened regardless of the time R24 is energized.
10. Provides an impulse to the read offset stacker magnet at the proper time.
11. Provides an impulse to the punch offset stacker magnet at the proper time.
12. Provides an impulse to the offset stacker holding relays.
13. Provides a pick circuit to the double punch detection relays through the N/O B points of the blank column detection relays.
14. Provides a blank column detection test impulse.
15. Provides a hold circuit for the double punch detection relays.
16. Provides timed impulses to the mark sensing brushes.
17. Provides a hold circuit for mark sensing relay 90 to hold it long enough to allow an X hole to be punched from the first position of the mark sensing unit.

20, 21. Provides timed impulses to the print unit read-in and read-out emitters.

22. Provides an impulse to the platen magnets.
23. Provides a hold circuit for the storage relay hold coils.
24. Provides an impulse to relays 244 and 245 so that the 5-9 holes may be read directly from the card into the print magnets.

R — CAMS

1. Controls the circuit to reproducing brushes to complete cr-i cuits to them only when the read feed operates.
3. Completes circuit to read X brushes at X time only.
4. Controls drop time of R19 motor hold circuit when the reading unit is operating alone. It provides a dropout of R19 and eliminates continued operation after a jam in the read feed.
5. Picks R36 in read delay circuit.

IBM CUSTOMER ENGINEERING

Geo Gualtney

REFERENCE MANUAL

IBM TRADE MARK

AUTOMATIC INTERPRETERS
Types 550, 551

CONTENTS

New York, New York
Printed in U.S.A.
Form 22-6113-0

AUTOMATIC INTERPRETERS
Types 550, 551

THIS reference manual is intended to condense and revise the adjustments previously published for the Types 550 and 551 machines. Preventive maintenance, lubrication, removal procedures and service hints have been added to the adjustments of each unit to provide the customer engineer with vital information concerning the service problem.

MACHINE SPECIFICATIONS

Weight

Packed—590 lbs.
Unpacked—468 lbs.

Dimensions

Length—37"
Width—22"
Height—47"

Running Current

110V 60 cycle AC—5.0A
230V 60 cycle AC—2.5A
115V DC —3.9A

Speed

Type 550 — 75 cards per minute
Type 551 — 60 cards per minute

Card Dimensions

.0065" or .009" — 80 column card
51 column post card size card.

BASE

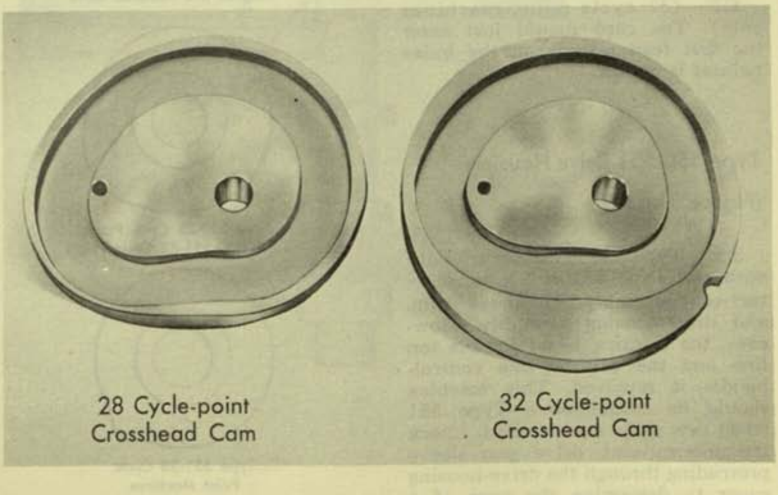
Cycle Points, Type 550-551

Type 550-551 machines now in operation can differ in the number of cycle-points per machine cycle. Some Type 550 and 551 machines operate on 32 cycle-points per machine cycle, while the majority operate on 28 cycle-points per machine cycle. *Do not use the wiring diagram and sequence chart to determine the number of cycle-points per machine cycle.*

The basic difference between a 28 or 32 cycle-point machine is the cut of the crosshead-cam (Figure 1). The outside circumference of a 32 cycle-point crosshead cam is round while a 28 cycle-point crosshead cam is oblong. The two cams are not interchangeable.

The following table can be used to determine the basic difference between the 28 and 32 cycle-point machines.

	28 Cycle-point		32 Cycle-point	
Cam Name	*Description*	*Part No.*	*Description*	*Part No.*
Crosshead Cam (Figure 1)	Outside circumference is oblong Type 550 Type 551	 19818 111658	Outside circumference is round Type 550-551	 192883
Card Picker Cam (Figure 2)	Cut of cam and outward dimensions are identical to 32 cycle-point cam. Index markings will differ in dimension. Type 550-551	17202	Cut of cam and outward dimensions are identical to 28 cycle-point cam. Index markings will differ in dimensions plus the CF timing mark. Type 550-551	192881
Circuit-breaker Cams	Type 550-551	14230	Type 550-551	192888
Magnet Unit Knockoff Cam (Figure 3)	Type 550–egg shape Type 551–sharp knockoff	17203 111659	Type 550-551 Egg shape	17203



28 Cycle-point Crosshead Cam

32 Cycle-point Crosshead Cam

Figure 1. 28 and 32 Cycle-point Crosshead Cams

Index Markings and Timings

(Figures 2 and 4)

28 cycle-point machines—12 and CC which coincide, 11, 10, 1, 2, 3, 4, 5, 6, 7, 8, 9, KC, 1F and H.C.

32 cycle-point machines—all the above markings plus CF.

The numbers are for the brush reading positions of the card.

KC—The hole in the knockoff cam should be away from the feed and in a horizontal plane with the center of the hammer-cam-shaft when the index-pointer is at KC.

IF—Set the printing control knob to print on the top or first line. The intermittent feed rolls should just stop when the pointer is on IF.

HC—The high point of the hammer cam should be away from the feed and in a horizontal plane with the center of the hammer-cam-shaft when the index pointer is on HC.

CC and 12—The hole in the crosshead-cam should be away from the feed and in a horizontal plane with the center of the hammer-cam-shaft when the index pointer is on CC or 12.

CF—(32 cycle-point machines only). The card should just enter the first feed rolls when the index pointer is on CF.

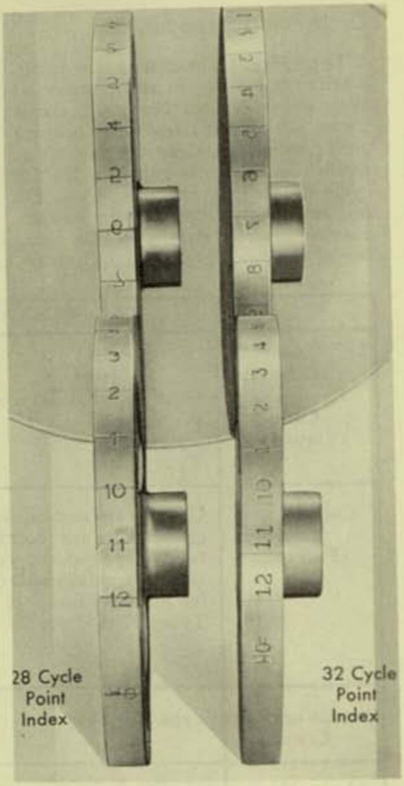
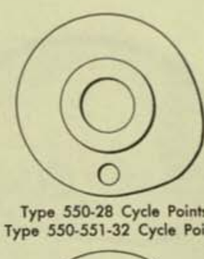
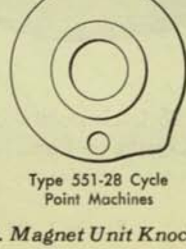


Figure 2. 28 and 32 Cycle-point Card Picker Cams

Magnet Unit Knockoff Cams



Type 550-28 Cycle Points
Type 550-551-32 Cycle Points



Type 551-28 Cycle Point Machines

Figure 3. Magnet Unit Knockoff Cam

Type 550-551 Drive Housing

(Figure 5 and 6)

Some Type 550 machines are built with the Type 551 brush and contact-roll assembly, crosshead cam, and drive-housing assembly. However, the printing is set for the top line and the printing-line control-handle is removed. This machine should be considered a Type 551 when new parts are required. Check the intermittent drive-gear-sleeve protruding through the drive-housing cover to determine the type of a particular machine.

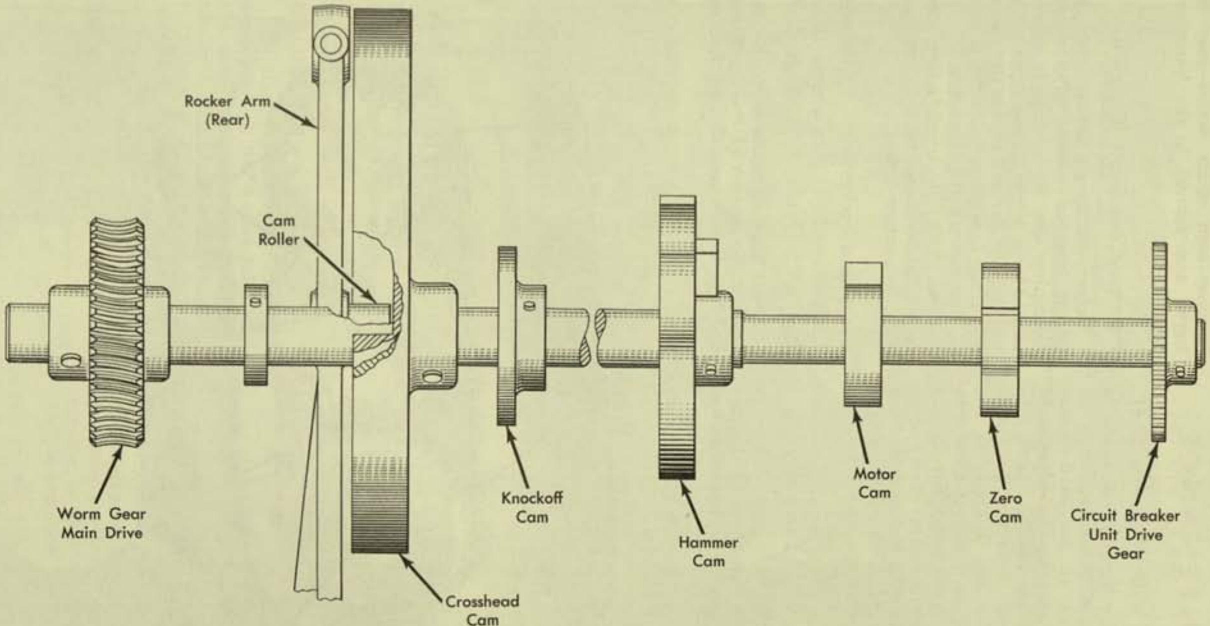


Figure 4. Hammer Cam Shaft

PREVENTIVE MAINTENANCE

Card Picker Cam Index (Figure 2)

All machine timings are made in relation to the index markings on the perimeter of the card picker cam. Before making any adjustment change such as list-lap, cam contacts, or circuit breakers, determine the cause for the change. Is the hammer-cam shaft out of time with the index or is the index out of time with the hammer-cam shaft? Lost motion in the card picker cam drive mechanism would change the relationship between the index and the hammer-cam shaft.

Type 550 and 551 Drive Housing (Figures 5 and 6)

Remove the top cover for inspection and lubrication. Check for lost motion and loose pins. NOTE: The hammer-cam shaft worm-gear is keyed and pinned to the hammer-cam shaft.

Hammer-Cam Shaft (Figure 4)

Before changing a list-lap, cam, or circuit breaker timing adjustment, determine why the change is necessary. Many times a loose pin or a worn cam-roller and stud is the cause and changing the adjustment would only aggravate the condition.

Intermittent electrical failures can be caused by loose contact points in the cam-contact straps.

Crosshead Rocker Arms, Crosshead Connecting Links, Crosshead Bearings and Guide Rods (Figure 7)

The above units develop the reciprocating motion of the crosshead and type-bars. Check this mechanism

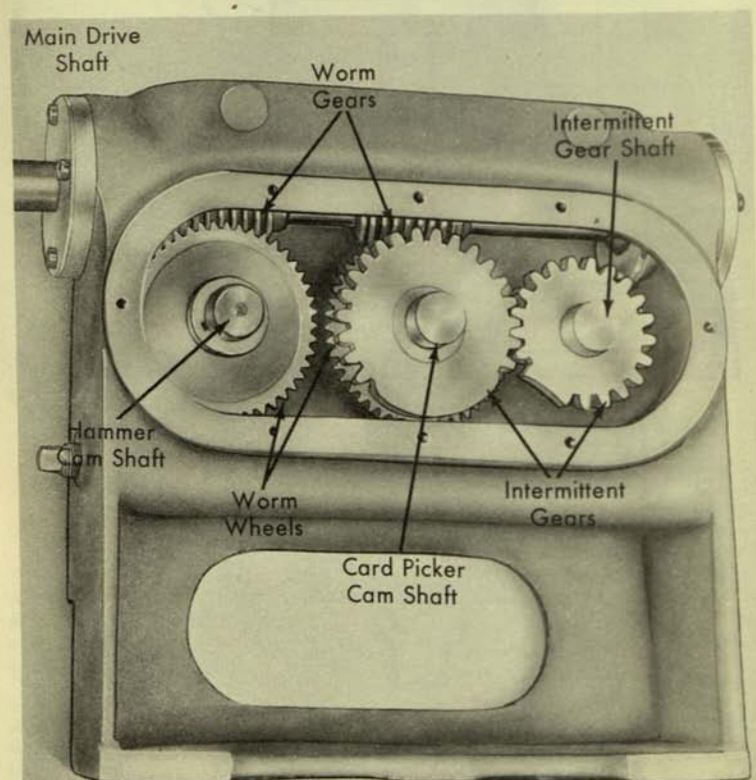


Figure 5. Drive Housing, Type 550

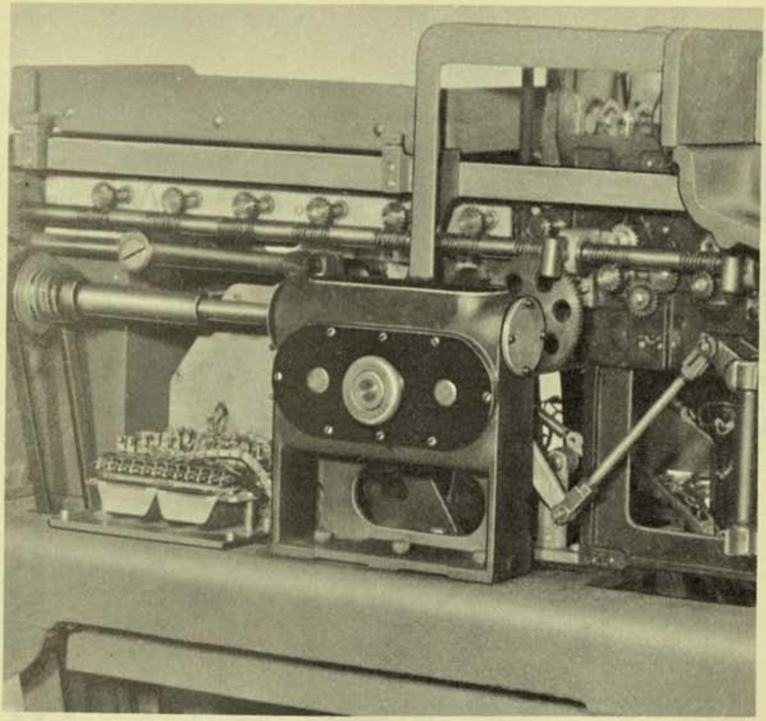


Figure 6. Drive Housing, Type 551

regularly because the accuracy of the list-lap adjustment is dependent on the operation of the mechanism.

Card Ejector Roll Assembly (Figure 8)

Friction between the 12 rubber feed-rolls and the 4 card rails, move the card from the printing station to the card stacker. When necessary, it is suggested to remove the glaze from the rubber feed-rolls with fine sandpaper.

Stacker

No machine can perform satisfactorily without a good operating stacker.

LUBRICATION

IBM 6 (Part pt. 223980, gal. 450315)

1. Drive motor—do not over lubricate.
2. Card ejector roll bearings.

IBM 9 (Part pt. 450668, gal. 450316)

1. Drive pulley clutch and shaft.
2. Card picker cam shaft bearings, rollers, and pivot studs.
3. Hammer cam shaft bearings and rollers.
4. Helical worm gear shaft bearings.
5. Hand wheel bearings.
6. Crosshead, rocker arms-crosshead connecting links and crosshead bearings, pivot studs and slides.

IBM 15 (Part pt. 450238, qt. 450052)

1. Drive housing — always keep the lower portion of the worm gears running in gear oil, never fill above the bearing level.

IBM 17 (Part 1 lb. 450556, 5 lb. 450635)

1. Drive pulley clutch teeth.
2. Main drive shaft bearings (it will be necessary to remove helical gear and gear retainer).
3. Card picker cam surface.
4. Crosshead, hammer and magnet unit cam surfaces.

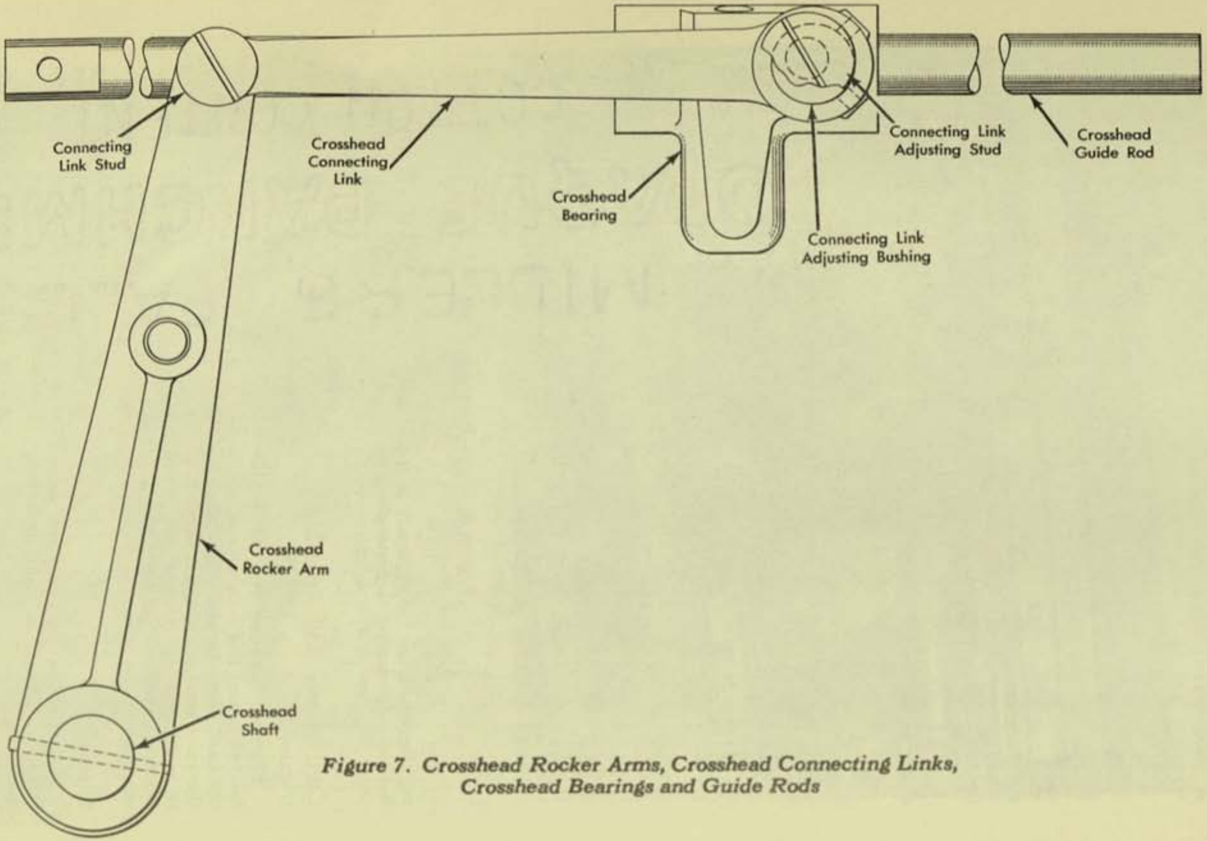


Figure 7. Crosshead Rocker Arms, Crosshead Connecting Links, Crosshead Bearings and Guide Rods

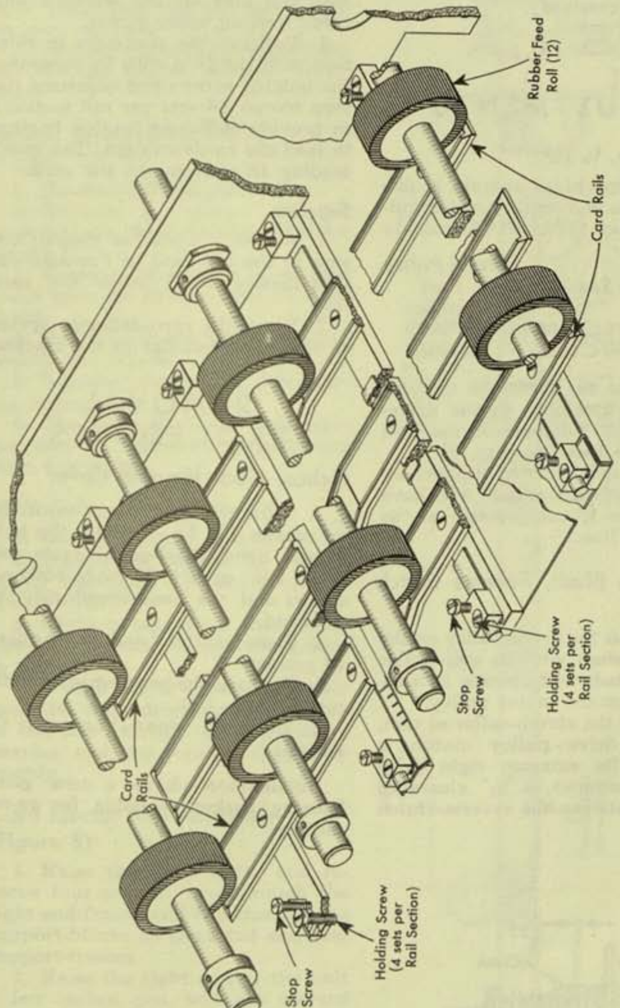


Figure 8. Card Ejector Roll Assembly

5. Helical gear, worm shaft, worm gears.
6. Worm shaft bearing (will be necessary to remove the helical gear and bearing retainer).
7. Helical gears.
8. Card ejector roll gears.

ADJUSTMENTS

Drive Motor, 1/4 HP

The two machines operate at different speeds and require motor pulleys as follows (1725 RPM motor):

Machine Type	*Speed*	*Motor Pulley Part Number*
550	75 C.P.M.	149979
551	60 C.P.M.	149980

1. Position the motor on the motor support assembly so the drive-belt does not rub against the belt guard or the base castings.
2. Position the motor support assembly so the drive belt will have about 3/4" to 1" compression at the upper base line.

Main Drive Shaft, Reverse Clutch (Figure 9)

1. Position the drive-pulley on the main drive-shaft with its stop collar so the "V" belt will operate in a direct line from the motor pulley.
2. Locate the clutch-collar so that, when the drive-pulley clutch is moved to its extreme right (slip coupling bottoms), a 1/32" clearance will exist between the reverse-clutch teeth.

Card-Ejector Roll Assembly (Figure 8)

Make the following adjustments with the unit on the machine and cards feeding under power.

1. Position the card-rails in relation with the feed rolls by loosening the holding screws and adjusting the stop screws (4 sets per rail section) to provide sufficient feeding friction to feed the cards straight. Too much feeding friction marks the card.

Stacker

1. Adjust the stacker spring tension so the top card will remain approximately 1½" below the card line.
2. Form the card-deflector spring so the cards fall flat in the stacker.

REMOVAL PROCEDURES

Helical Gear Housing Cover

1. Turn the hand-wheel until the set screws (2) line up with the hole in the hand-wheel-guard (two settings, 180° apart). Remove both set screws and the hand-wheel may be removed.
2. Remove the hand-wheel-guard (4 screws).
3. Remove the hand-wheel spindle pin.
4. Remove gear-housing (6 screws).

SUGGESTION—have a new gear-housing gasket available for re-assembly.

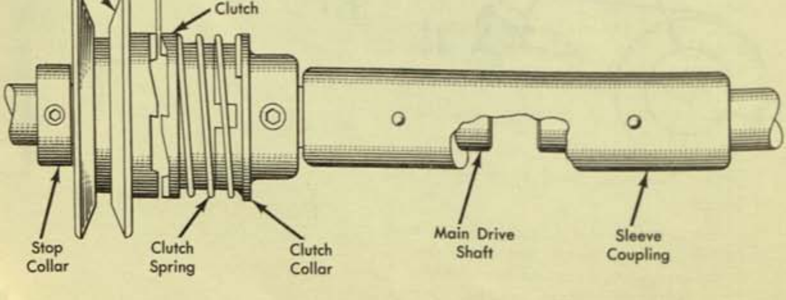


Figure 9. Main Drive Shaft—Reverse Clutch

Helical Gears (Figure 10)

1. Remove gear-housing cover as described above.
2. Helical gears are pinned to their respective shafts; drive pins for gear removal.
3. Remove bearing retainers for ball bearing inspection and lubrication.

Helical Worm Gear Shaft (Figure 10)

1. Remove helical gear.
2. Remove card-ejector roll assembly (see *Card-Ejector Roll-Assembly*).
3. Remove ribbon-unit drive gear (spur gear; for timing—see *Ribbon-Unit*).
4. Remove worm-shaft bearing dowels and screws.
5. Remove worm-shaft ball-bearing retainer.
6. The worm shaft and ball bearing may be removed through the right end frame.

Main Drive Shaft (Figure 9)

1. Remove helical gear housing.
2. Loosen set screws in driven-pulley stop-collar and driven-pulley clutch-collar.
3. Remove two main drive-shaft sleeve taper pins and slide the sleeve to the left.
4. With a pry or light tapping action, the main drive-shaft will slide to the left through the main drive bearing and the reverse clutch assembly.

Card Ejector Roll Assembly (Figure 8)

1. Raise the glass cover and remove four screws: two through the right end frame, and two through the support-blocks on the front and rear support-frames.
2. Raise the right end of the unit a few inches, and, with an upward and to the right motion, the unit can be removed from the machine without twisting or bending the card-rails.

Drive Housing and Hammer Cam Shaft

To remove the drive housing and hammer cam shaft assembly as a complete unit, proceed as follows:

1. Remove ribbon, platen, ejector roll assembly and type bar assemblies.

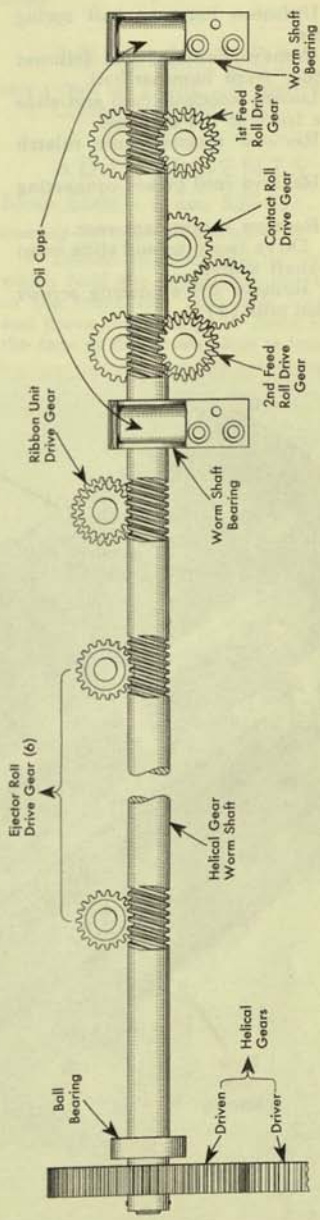


Figure 10. Helical Gear Worm Shaft

2. Loosen hammer-cam-shaft intermediate - bearing assembly from the machine base; 2 screws and pins.

3. Remove circuit-breaker drive-gear.

4. Unfasten hammer bail spring anchors.

5. Remove hammer-cam follower assembly from hammer-bail.

6. Loosen knockoff cam and slide to the front of the machine.

7. Remove magnet - unit relatch arm.

8. Remove card picker connecting rod.

9. Remove rocker-arm rear.

10. Drive two pins and slide main drive-shaft sleeve.

11. Remove drive-housing screws (3) and pins (2).

The complete assembly can be removed from the machine.

BRUSH SLIDE AND CONTACT ROLL ASSEMBLIES

TYPE 550 and Type 551 Brush Slides and Contact Roll Assemblies *are not* interchangeable. They differ in construction and distance relationship between the card feed and contact roll (Figures 11 and 12).

Some type 550 machines are built with 551 brush slides and contact roll assemblies and should be considered as Type 551 machines when parts are required (see *Drive Housing*, page 6).

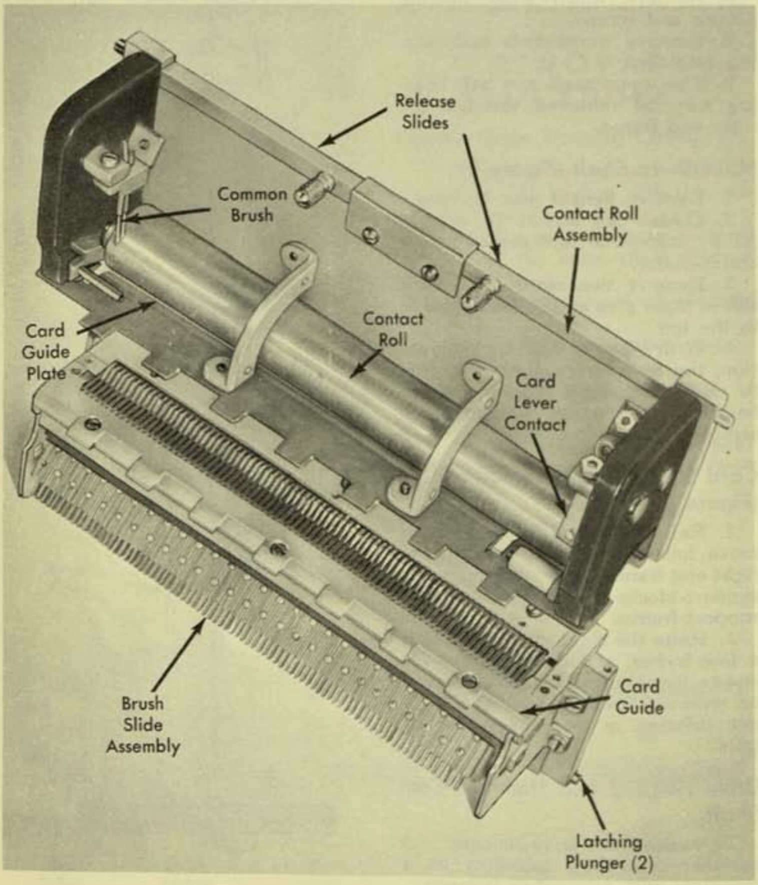


Figure 11. Type 550 Brush Slide and Contact Roll

PREVENTIVE MAINTENANCE

Brush Slide (Figures 11 and 12)

Check the plungers and plunger guides; they loosen and allow the brush slide to drop below the card line.

Check the card lever groove in the brush plate for card wear. Card lever tension caused by the card lever contacts has a tendency to force the card into the brush plate groove, resulting in damaged edges of the cards and faulty contact operation.

Contact Roll (Figures 11, 12 and 14)

Plunger contacts sometimes become bent and stick in the sleeve. This results in a poor electrical contact. Always wipe card dust off the plunger contacts before installing the unit.

Check for a binding or sticky card lever.

LUBRICATION

IBM 6 (Part pt. 223980, gal. 450315)

1. Contact Roll Bearings.

ADJUSTMENTS

Brush Slide — Types 550-551

Locating the Brush Slide (Figure 13)

1. Loosen the two holding screws which hold the adjustable brackets, in the front and rear side frames, and move the unit up or down until the face of the brush plate is located

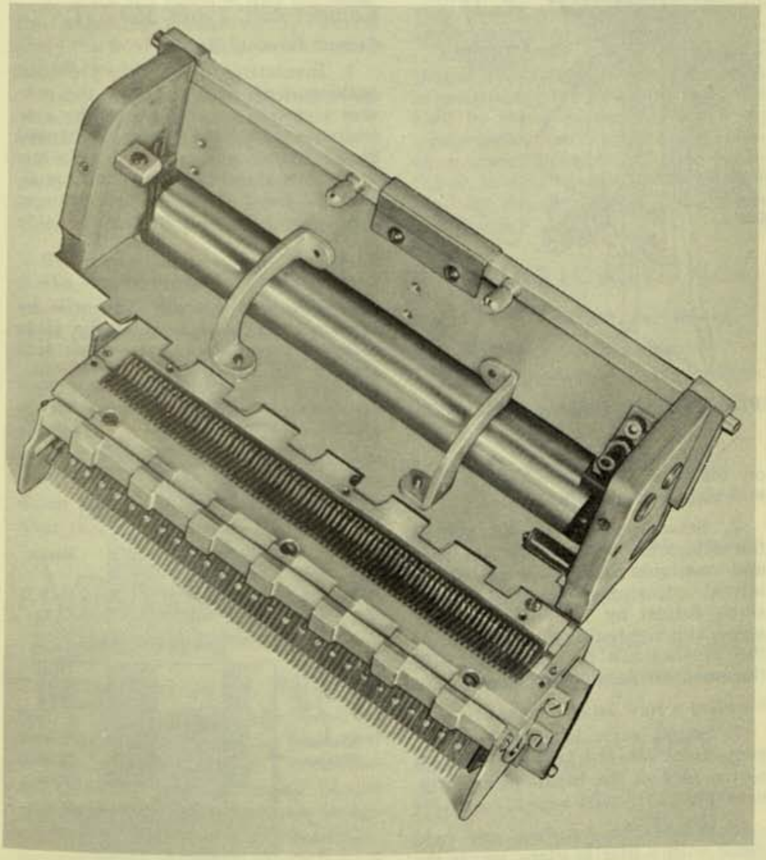


Figure 12. Type 551 Brush Slide and Contact Roll

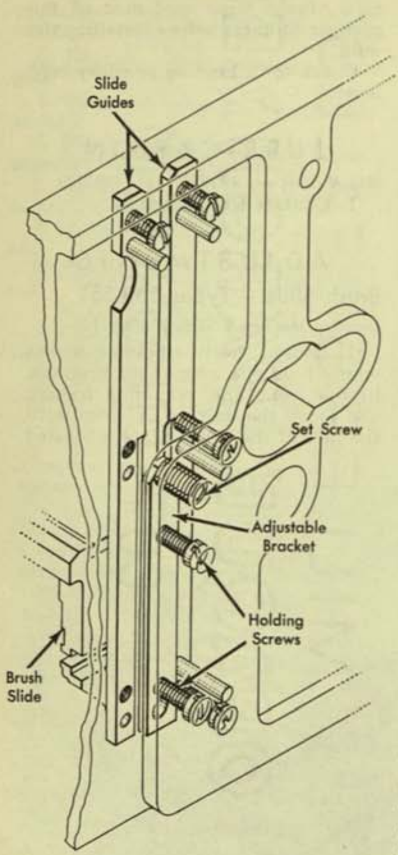


Figure 13. Locating the Brush Slide

on the card line between the first and second feed rolls.

2. Setscrews are located behind the adjustable brackets on the front and rear side frames to provide a lateral adjustment for the brush-slide. Adjust by loosening one set screw and tightening the other until the brushes are in alignment with the punched holes in the card.

Installing a New Set of Brushes

1. Install each brush for a 1/8" projection from the heel of the brush to the face of the brush plate (Figures 11, 12).

2. When the brushes are held down with a plastic plate, locate the brush holder so the heels of the brushes line up with the scribed line on the brush separators.

Brush Timing

Do not time the brushes until the feed knives and vertical printing line has been adjusted (see *Vertical Printing Line Adjustment*, pages 17 and 24).

1. As a starting point, position the brush holder so the heels of the reading brushes are on the scribed line. Place several alternately punched test cards (1-8-1-8, etc.) in the hopper and with a meter or test light; check to see that *all* brushes make contact through the holes in the card 1/32" before the line on the index.

To obtain the above condition, the brushes may be shifted away from the scribed line. *Never change the feed knives or the pickup time of the card.*

Contact Roll, Types 550-551

Contact Terminal (Figure 14)

1. Insulating washers are provided making it possible to install the contact terminal assemblies in the side frames so the head of the sleeve will be flush with the inside side frame.

2. This should automatically position the head of the contact plunger approximately 1/8" inside the side frame.

Contact-Roll Slide (Figures 11 and 12)

1. The contact-roll slide will be correctly positioned when the slide release pins engage in the side frames. No adjustment is provided.

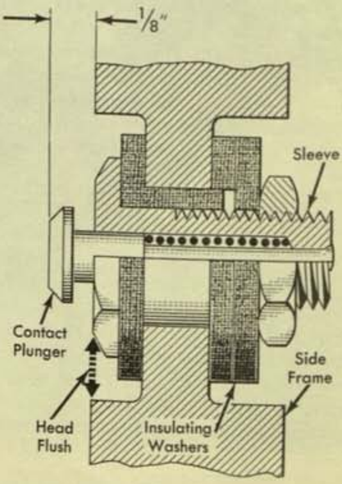


Figure 14. Contact Terminal

2. Check the location of the brush-slide in the following manner: with the contact-roll slide and brush-slide in position, check the contact-roll to brush-slide clearance with the .012"-.018" thickness gauge. A .012" thickness gauge should pass between the brush-slide and contact-roll and a .018" thicknes gauge should not pass.

Card Lever Contact (Figures 11 and 12)

1. With the contact-roll slide in the machine, adjust the contact spring support for 1/32" clearance between the contact points. The non-operating contact strap should be resting on its support with light tension, and the operating contact strap should follow the card lever with very light tension.

2. With the cards in the machine, the operating contact strap should raise the non-operating contact strap 1/32" off the support.

Keep the card lever contact strap tension as light as possible; thus preventing the card being forced into the card lever groove in the brush plate.

Contact Roll, Type 551 (Figure 12)

Setscrews are provided to hold the card lever contact, common brush assembly and contact roll bearings to their contact roll support.

1. The card-lever contact and common-brush assemblies are installed on their respective fiber contact-roll supports so the contact-supports project through the fiber-roll supports approximately 3/32". Use caution when tightening the set screws; the fiber threads strip very easily.

FEED UNIT AND FEED MECHANISM

THE FEED UNIT on the Types 550 and 551 is very similar in construction and operation to the feed unit on the horizontal sorter. Two different feed knives, feed-knife blocks and feed-knife slides are now in operation on both types of machines: narrow feed knives and blocks whose slides operate directly in the hopper bed casting and the wider feed-knives, blocks and slides that are standard on a large number of IBM machines. The adjustments on the two types of feed knife assemblies are basically identical.

PREVENTIVE MAINTENANCE

The feed unit is the heart of any machine. Always keep them clean, well lubricated and in correct adjustment.

Card Picker Cam (Figure 15)

The vertical printing line adjustments are *not* intended to correct printing legibility, but are given to locate the printing in the correct vertical plane. Once set correctly, they should never require a change under normal conditions.

Adjusting the length of the card picker connecting rod is the means of controlling the pickup time of the card by the feed knives; thus controlling the vertical printing line. Once this adjustment has been established, *never change it for brush timing* (see *Brush Timing*, page 14).

LUBRICATION

IBM 6 (Part pt. 223980, gal. 450315)

1. Roller throat bearings.
2. Intermittent ball bearing rollers.
3. Intermittent roller bracket pivot pins.

IBM 9 (Part pt. 450668, gal. 450316)

1. Feed roll bearings and pressure shoes.
2. Intermittent feed roll bearings.
3. Feed mechanism bearings.
4. Feed knife slides.

IBM 17 (Part 1 lb. 450556, 5 lb. 450635)

1. Intermittent feed roll gears.

ADJUSTMENTS

Hopper (Figure 15)

1. Set the hopper side plates for correct horizontal printing on the card. Check the lateral brush alignment (see *Locating the Brush Slide*, page 13).

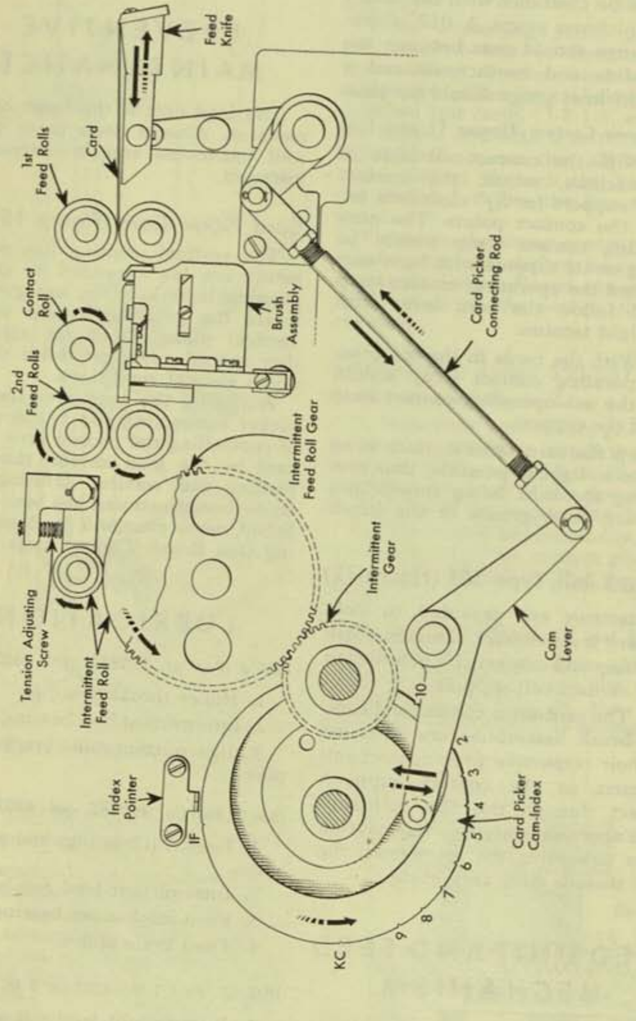


Figure 15. Card Picker Cam Index

2. Set the hopper side plates for .008" to .012" clearance over the length of the card. The plates should be parallel to each other and in a position to guide the card squarely to the first feed rolls.

3. Adjust the rear guide-posts by adding or removing shims for a .008" to .012" clearance between the guide posts and the cards.

Feed Knives, Blocks and Slides

Assemble the feed knife blocks to the slides with the knife-slide adjusting-stud screwed all the way into the slide. Slight alterations may be made to cause the feed knives to feed the card straight. Once straight card feeding has been established, *never alter the knife-slide adjusting studs.* Knife projection—standard .004" to .0045".

Throat Knife and Block

Standard .0095"-.0105" GO NO-GO adjustment.

First and Second Feed Rolls (Figure 15)

1. Adjust the three tension adjusting screws for the first and second upper feed rolls to provide for an even 6 lbs. feed roll pressure (approximate). Check for straight card feeding.

Intermittent Feed Rolls (Figure 15)

1. Adjust the tension of the upper feed rolls (ball bearings) to have sufficient and even tension to feed the card straight at printing station.

Card Picker Cam, Vertical Printing Line Adjustment (Figure 15)

1. Turn the machine until the index pointer is as follows:

28 cycle point machine—½" after IF.

32 cycle point machines—CF

Adjust the length of the card-picker connecting rod so a card will be held firmly (no buckle) between the first feed rolls and the feed knives. The feed knives will be on the forward stroke and the back lash should be removed.

2. Turn the machine until the feed knives are at the completion of the back stroke. Check for *at least* $\frac{1}{32}$" clearance between the feed knives and a card held against the guide posts. If this condition does not exist, check all the feed-knife drive-mechanism from the drive-housing worm-gear to the feed knives.

3. Check the brush timing (page 14).

4. Operate the machine under power and check the vertical printing alignment. If it is necessary to change the card-picker connecting rod to correct the vertical printing alignment, recheck adjustments 2 and 3.

PRINT AND RIBBON UNITS

Type Bar, Standard (550-551) (Figure 16)

The type assembly is as follows: 12 on top, 11, 10, 1, 2, 3, 4—8, 9, 0 and blank. A 0 (zero) may replace the 10 type.

Type return springs are heavy for blank type and light springs for the remaining 11 type. Control Panel Wiring that controls type bar printing as follows: common wired to print 10—the type bar may be set up to print all punchings of the card (12 through 9 plus the mechanical zero); common wired to print zero—the type bar may be set up to print characters 1 through 9 plus the mechanical zero.

Type Bar, Pin Type (551) (Figure 16)

The type characters are twice the width of standard type. Type from adjacent type bar must be removed.

Pin type is used only in numerical positions 0 through 9 and the mechanical zero. The pin-type asterisk (*) is sometimes used in the blank position. Standard type is sometimes used in the 12 and 11 positions.

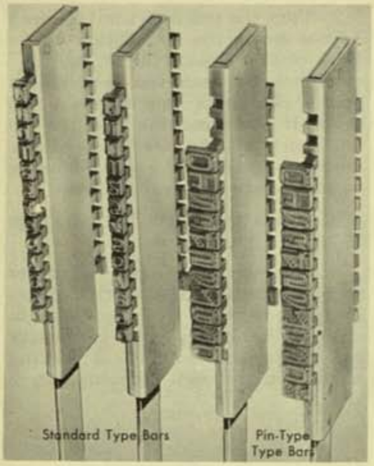


Figure 16. Standard and Pin-type Type Bars

Ribbon Guides

Spaces are provided for ribbon guides to be located between each type-bar equipped with standard width type. Ribbon guides cannot be used in the pin-type type-bar positions.

PREVENTIVE MAINTENANCE

Type Bars (Figure 16)

Always check for worn or battered type-tails and loose type-bar heads.

Crosshead, List Lap Adjustment

Always check the crosshead anchor screws for tightness. Check for loss motion between the type-bar and type-bar pawl when the pawl is holding the type-bar.

Ribbon Unit

Provide adequate ratchet-wheel friction-spring tension to keep the ribbon tight against the ribbon guides at all times.

Hammer Unit

Check this unit for loose screws, worn or binding hammers. Weighted hammers are required to satisfactorily operate the large pin type.

LUBRICATION

IBM 6 (Part pt. 223980, gal. 450315)

1. Platen bearings.
2. Zero pawl pivot points.
3. Type bars; wipe on lubrication with a saturated cloth.
4. Ribbon unit mechanism pivot points.
5. Hammer pivot surface.

IBM 9 (Part pt. 450668, gal. 450316)

1. Ribbon unit eccentric.
2. Hammer bail pivots.
3. Hammer bail connecting bracket bearings.

IBM 17 (Part 1 lb. 450556, 5 lb. 450635)

1. Ribbon unit worm gear.

ADJUSTMENTS

Zero Pawl Assembly (Figure 17)

The adjustments for this unit should not be made until the magnet unit has been located (page 24) and the crosshead-list lap adjustment (page 19) has been made.

1. Move the zero-pawl assembly to the left or right in the enlarged holes in the front and rear side

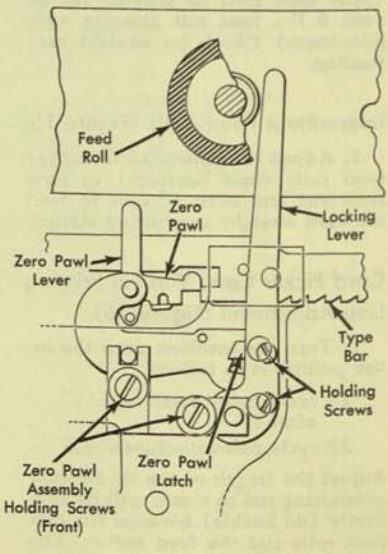


Figure 17. Zero Pawl Assembly

frames until the mechanical zeros are printed in alignment with the numerical characters. Test by printing an alternately punched test card (8-0-8-0, etc.) in all 45 type-bars.

2. The zero-pawl locking levers (2) should be adjusted by loosening the holding screws and moved in the enlarged holes until the zero pawl latch rests against the zero pawl levers all the way across. Check to see that the locking levers will release the zero pawl levers for manual operation, and will not touch the feed rolls during normal operation.

Platen

1. Shift the bearing-blocks up or down to provide for 1/8" clearance between the platen and the type face.

2. Align the bearing blocks so the platen is free and will turn with the movement of the cards.

Crosshead, List Lap Adjustment (Figure 18)

The following adjustments are not made directly on the crosshead, but determine the location of the crosshead and type-bars in relation to the stop pawls. All magnet unit adjustments listed under locating the magnet unit, page 24, *must* be checked before any of the following list-lap adjustments are made.

1. The eccentric bushings in the front and rear crosshead connecting links should be adjusted as follows:

A. Loosen the set screws in the crosshead-bearings so the large pivot studs may be loosened (do not remove).

B. Loosen the set screws in the connecting links so the eccentric bushings may be adjusted.

C. Turn the machine to "5" on the index, and adjust the front and rear eccentric bushings so the stop pawls overlap the 5 tooth on the type-bars 1/32". The high sides of the eccentrics *must be together and turned in the same direction.*

D. Turn the machine by hand checking to see the crosshead-bearings slide free on their slides-rods and the crosshead is operating at right angles with the slide-rods.

E. Check the stop-pawls for 1/32" overlap of the type-bar teeth at 11, 5 and 8 on the index.

Ribbon Unit

Mesh the ribbon eccentric gear with its drive gear so the eccentric is either up or down when the hammers fire. This adjustment provides for the minimum of ribbon movement when the hammers fire and the ribbon is operating in either direction

Hammer Unit

1. Install the front and rear hammer spring anchors in the one of the four positions provided that will cause a satisfactory printing impression. Keep the front and rear hammer spring tension even.

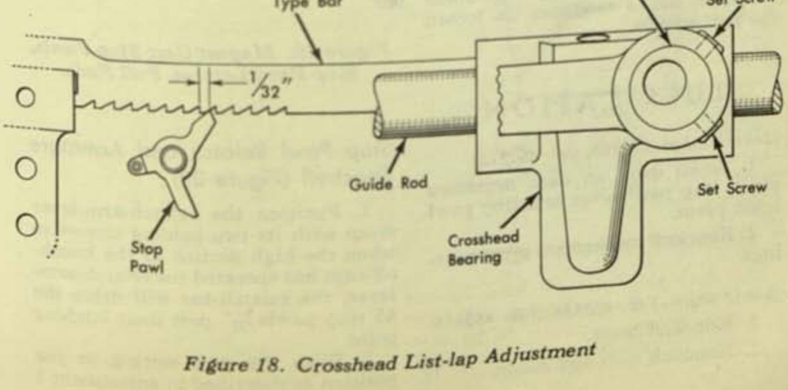


Figure 18. Crosshead List-lap Adjustment

REMOVAL PROCEDURE

Type Bar

1. Remove the card ejector roll assembly (page 11).

2. Remove type-bar ribbon-guide retainer (2 screws). Ribbon guides may be removed at this point.

3. Remove type-bar retainer (2 screws).

4. Any or all type-bars may be removed with an upward and to the right movement.

Zero Pawl Assembly

1. Turn the machine to a position where the crosshead cam will not interfere with the removal of the rear zero pawl assembly screws (2). A notch is provided in the perimeter of the 32-cycle crosshead-cam for this operation.

2. Remove the two front and rear (4) zero-pawl-assembly screws and the unit can be removed from the bottom of the machine.

MAGNET UNIT

Preventive Maintenance

KEEP ALL magnet unit and magnet unit mounting screws tight. Machine vibration has a tendency to loosen the unit screws.

LUBRICATION

IBM 6 (Part-pt. 223980, gal. 450315)

1. Small drop on each armature pivot, stop pawl pivot and stop pawl latch pivot.

2. Knockoff mechanism pivot bearings.

IBM 17 (Part—1 lb. 450556, 5 lb. 450635)

1. Knockoff lever.

2. Knockoff cam and roller.

ADJUSTMENTS

Magnet Unit Stop Pawls, Stop Pawl Latches, Pull Rods, Magnets and Armatures (Figure 19)

1. Form each armature so that, when the outer armature - residual strikes the magnet core, there will be .003" to .005" clearance between the inner magnet core and the armature residual.

2. Adjust the pull-rod turnbuckle so that when the armature is attracted, there will be .010" to .015" (preferably .010") clearance between the stop pawls and stop pawl latches. NOTE: Keep the pull rod turnbuckles tight and no binding condition between the pull rods, armatures or stop pawl latches.

3. Form the tips of the armatures so that, when they are resting against the magnet-unit tie-rods, the stop pawls will overlap its latch .020" to .025" (preferably .020"). Recheck adjustment 2.

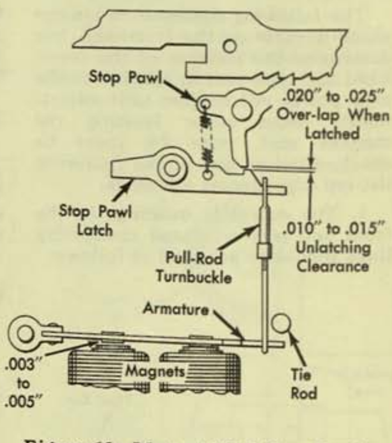


Figure 19. Magnet Unit Stop Pawls, Stop Pawl Latches, Pull Rods,

Stop Pawl Relatch and Armature Knockoff (Figure 20)

1. Position the relatch-arm-lever strap with its two holding screws so when the high portion of the knock-off-cam has operated the relatch-arm-lever, the relatch-bar will drive the 45 stop pawls 1/32" past their latching point.

2. With the unit setting in the position as described in adjustment 1

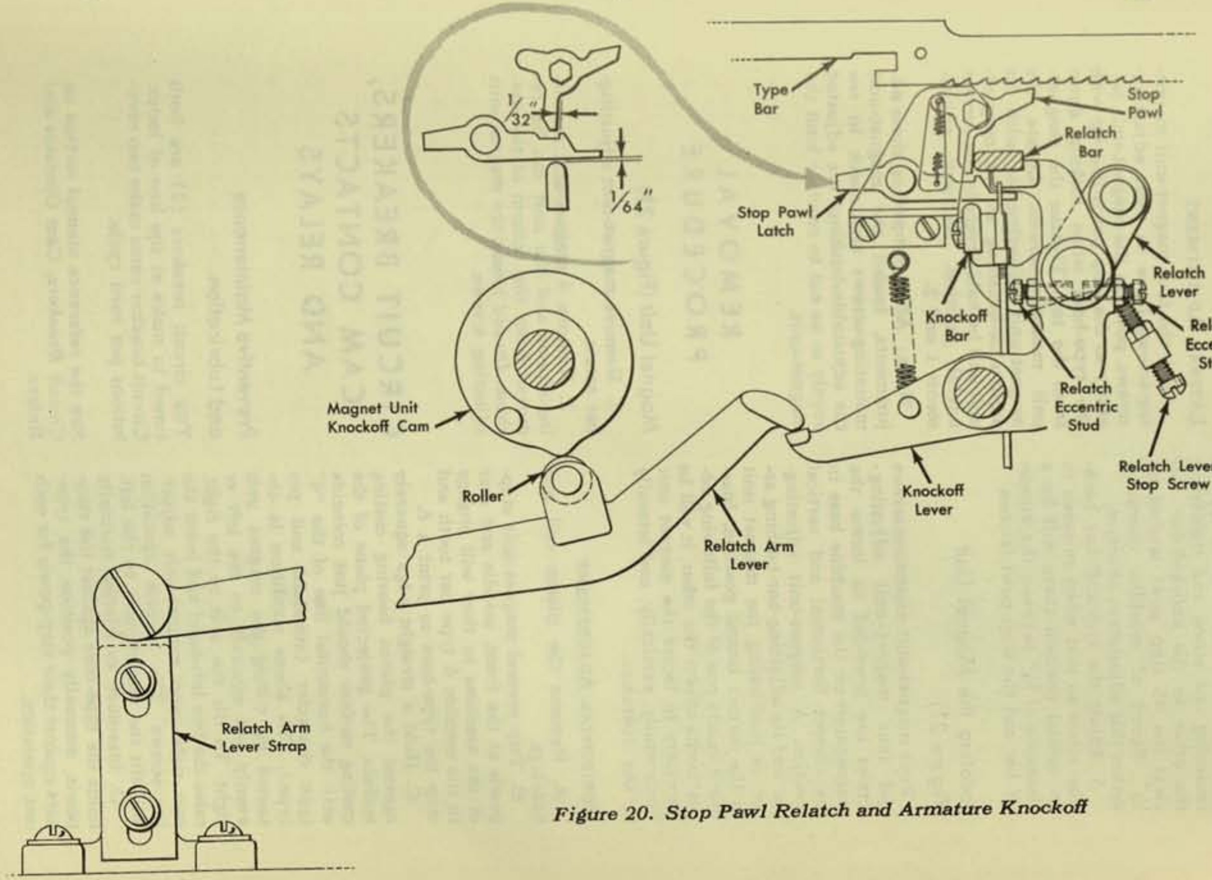


Figure 20. Stop Pawl Relatch and Armature Knockoff

and the magnet unit armatures attracted, adjust the front and rear relatch-eccentric studs (two adjusting screws for each eccentric) by loosening one screw and tightening the other so the knockoff-bar will clear the 45 stop pawl latches by 1/64". Speed of machine operation makes this adjustment effective.

3. Adjust the knockoff bar backstop screw so that when released in its normal position there will be a clearance of 1/16" between the knockoff bar and the stop pawl latches.

Locating the Magnet Unit (Figure 21)

Four magnet-unit mounting-screws and four magnet-unit adjusting-screws are provided to locate the magnet-unit on the machine base in the correct horizontal and vertical position. A magnet-unit adjusting-bar and its adjusting-bar-bushing assist in positioning the magnet unit in the correct lateral position. Inasmuch as any one of the following adjustments affects the other, it will be necessary to locate the magnet unit horizontally, vertically, and laterally in one operation.

Horizontal Adjustment

A. Remove the platen roll and bearings.

B. Trip several magnet-unit stop-pawls at the front, middle and rear of the machine so they will engage in the number 6 type bar tooth and stop the type-bars to print a 6.

C. Hold a straight edge squarely against the platen bearing casting surface. The projected plane of the casting surface should just coincide with the horizontal line of the "4" type character (standard and pin type). The above condition is obtained by tilting the magnet unit evenly and squarely to the left or right. To tilt the unit to the right, raise the two left-hand and lower the two right-hand magnet-unit adjusting-screws. The reverse operation will tilt the magnet-unit to the left.

D. Inasmuch as friction normally holds the type-bars against the stop-pawls, manually position the type-bars against their stop-pawls for each test operation.

Vertical Adjustment

At the same time the horizontal adjustment is being made, the same four adjusting screws should position the magnet unit so the latched stop pawls will clear the type-bars. .010" to .015".

Lateral Adjustment

With the four magnet-unit mounting-screws loose in their adjusting-screws, position the magnet-unit laterally so the stop pawls line up with the type-bars when looking down from the top. Tighten the magnet-unit mounting-screws. Locate the magnet-unit adjusting-bar with its adjustable-brushing so the magnet-unit will be held firmly in the correct lateral position. Recheck adjustments 1 and 2.

Note: After completing these adjustments, loosen the magnet-unit mounting-screws and check to see the adjustable-bushings are adjusted evenly so as not to twist or bind the magnet-unit.

REMOVAL PROCEDURE

Magnet Unit (Figure 21)

1. Remove magnet-unit adjusting-bar screw.

2. Remove 4 magnet-unit mounting-screws and the unit can be removed from the bottom of the machine. *Do not* loosen the magnet unit adjusting screws.

CIRCUIT BREAKERS, CAM CONTACTS AND RELAYS

Preventive Maintenance and Lubrication

The circuit breakers (2) are both timed to make at the line of index. Circuit breaker cams make two revolutions per card cycle.

See the reference manual section on *Circuit Breakers, Cam Contacts and Relays.*

Adjustments

See the wiring diagram and timing chart associated with the particular machine.

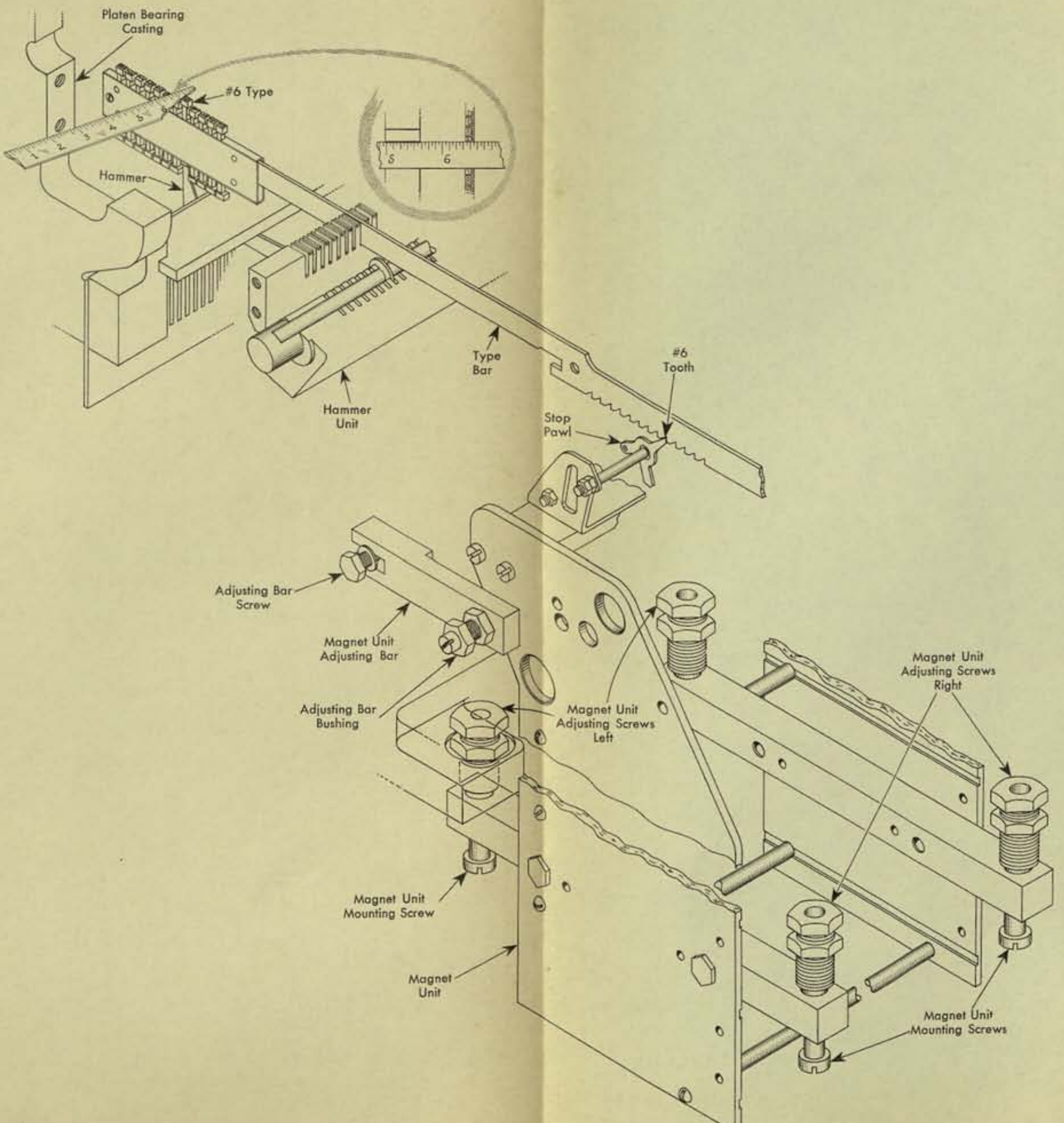


Figure 21. Locating the Magnet Unit

INTERPRETER

DESCRIPTION

The interpreter is a machine for printing numerals on the top of the tabulating card corresponding to the holes punched in the card. That is, if a five hole is punched in any particular column, a five will be printed directly above that column or above any column desired according to the plugging.

By an arrangement of plugging, it is possible to print either zero (0) or ten (10) for a hole punched in the zero position of card.

The plugboard on this machine is located in the front and right and left in the following instructions means right or left facing the plugboard. The feeding mechanism is located at the left and the start and stop key just to the right of the feeding mechanism. The main switch is to the left of the plugboard and must be turned "ON" before the machine is operated. The stacker is located at the right hand end of the machine. The fuses are located in the rear of the plugboard to the left.

The feeding magazine has a capacity of approximately 900 cards. The stacker will hold approximately 800 cards, however, it is not advisable to allow more cards to accumulate in the stacker than can be conveniently removed with one hand.

Cards are placed in the feeding mechanism face down, top edge first.

GENERAL

Card—The Interpreter is furnished to accommodate cards of the following capacities:

For cards 5-5/8"—5/32" (34 column) spacing.
For cards 7-3/8"—5/32" (45 column) spacing.
For cards 7-3/8"—3/32" (80 column) spacing.

Speed—This machine operates at a speed of approximately 75 cards per minute.

Current Requirements—The Interpreter operates on direct current 110 or 220 volts, and consumes 5.0 amperes for starting and 2.5 amperes for running loads at 110 volts.

Dimensions—Length—37". Width—22". Height—47".

Weight—Packed for shipment 590 lbs., unpacked 468 lbs.

OPERATION

The arrangement of plugging is as follows: The two upper rows of plug hubs represent the printing columns and should be wired to the next two lower rows of plug hubs which represent the columns of the card. This makes the machine flexible so that it is possible to print the figures punched in any column on the card in any position desired across the top of the card.

Directly below the hubs just described are located two rows of hubs and one set of special fibre plugs which should be inserted in all column positions of one row of hubs or the other as the machine will not function correctly if removed entirely. This plugging makes possible the printing of zeros (0) or tens (10) for the holes punched zeros. When inserted in the bottom row of hubs, zeros will be printed and when inserted in the next row above, tens will be printed.

PRINTING SET UP FOR ZEROS

This machine is equipped with a printing mechanism of a solid bank of type and the printing fields must be separated according to the fields on the card so that the zeros will only be printed in columns to the right of figures where desired.

If these printing fields are not separated zeros will be printed in all columns to the right of figures, either where no numerals appear or for columns not plugged.

Located between the third and fourth rubber feed rolls are two long upright locking levers, (one at the front and one at the rear of the machine). These lock the zero lever set up and must be depressed toward the stacker during the time the zero lever set up is being made.

The printing column index and zero levers are located between the second and third rubber feed rolls. All these levers should be in their right hand position

INTERPRETER

DESCRIPTION

The interpreter is a machine for printing numerals on the top of the tabulating card corresponding to the holes punched in the card. That is, if a five hole is punched in any particular column, a five will be printed directly above that column or above any column desired according to the plugging.

By an arrangement of plugging, it is possible to print either zero (0) or ten (10) for a hole punched in the zero position of card.

The plugboard on this machine is located in the front and right and left in the following instructions means right or left facing the plugboard. The feeding mechanism is located at the left and the start and stop key just to the right of the feeding mechanism. The main switch is to the left of the plugboard and must be turned "ON" before the machine is operated. The stacker is located at the right hand end of the machine. The fuses are located in the rear of the plugboard to the left.

The feeding magazine has a capacity of approximately 900 cards. The stacker will hold approximately 800 cards, however, it is not advisable to allow more cards to accumulate in the stacker than can be conveniently removed with one hand.

Cards are placed in the feeding mechanism face down, top edge first.

GENERAL

Card—The Interpreter is furnished to accommodate cards of the following capacities:

For cards 5-5/8"—5/32" (34 column) spacing.
For cards 7-3/8"—5/32" (45 column) spacing.
For cards 7-3/8"—3/32" (80 column) spacing.

Speed—This machine operates at a speed of approximately 75 cards per minute.

Current Requirements—The Interpreter operates on direct current 110 or 220 volts, and consumes 5.0 amperes for starting and 2.5 amperes for running loads at 110 volts.

Dimensions—Length—37". Width—22". Height—47".

Weight—Packed for shipment 590 lbs., unpacked 468 lbs.

OPERATION

The arrangement of plugging is as follows: The two upper rows of plug hubs represent the printing columns and should be wired to the next two lower rows of plug hubs which represent the columns of the card. This makes the machine flexible so that it is possible to print the figures punched in any column on the card in any position desired across the top of the card.

Directly below the hubs just described are located two rows of hubs and one set of special fibre plugs which should be inserted in all column positions of one row of hubs or the other as the machine will not function correctly if removed entirely. This plugging makes possible the printing of zeros (0) or tens (10) for the holes punched zeros. When inserted in the bottom row of hubs, zeros will be printed and when inserted in the next row above, tens will be printed.

PRINTING SET UP FOR ZEROS

This machine is equipped with a printing mechanism of a solid bank of type and the printing fields must be separated according to the fields on the card so that the zeros will only be printed in columns to the right of figures where desired.

If these printing fields are not separated zeros will be printed in all columns to the right of figures, either where no numerals appear or for columns not plugged.

Located between the third and fourth rubber feed rolls are two long upright locking levers, (one at the front and one at the rear of the machine). These lock the zero lever set up and must be depressed toward the stacker during the time the zero lever set up is being made.

The printing column index and zero levers are located between the second and third rubber feed rolls. All these levers should be in their right hand position

Printed in U.S.A.
Form 22-8311-0

toward the stacker with the exception of the levers for the first column of each field and they should be to the left toward the feeding mechanism.

To make zero lever set up proceed as follows: Move the locking levers located between the third and fourth feed rolls toward the stacker and move the individual zero lever for the first column of each field to the left or toward the feeding mechanism. That is, if one field occupies column 15 to 20, move column 15 zero lever toward the feeding mechanism which would prevent the preceding field carrying zeros into the field occupied by columns 15 to 20. After set up has been completed release the locking levers making sure they return to their extreme left hand position to lock the zero levers.

It is not possible to suppress the printing of zeros in single column fields where a number of single column fields are adjacent.

After the set up has been completed place the cards in the feeding mechanism and depress the start key. The information punched in the fields of the card will then be printed directly above that field or above another field if desired and then placed into the stacker face down.

CYCLE OF OPERATION

Two card feed knives oscillate by means of an internal cam driven from the worm gear housing. These feed knives pick a card from the bottom of the pack in the magazine and carry it to the two sets of feed rolls which serve to carry the card thru a contact roll feed. As the card passes thru the contact roll feed, contact is made thru the punched holes. This forms a means of completing the circuit thru the print magnets.

As the card starts under the brushes, the printing crosshead starts forward. The printing crosshead is operated by a second internal cam and timed so that the type bar stop pawls overlap the type bar teeth 1/32" when contact is made thru the corresponding punched holes in the card.

The type bar stop pawls are unlatched to stop the travel of the type bar by the print magnet armatures. The print magnet armatures are attracted by the print magnets when they are energized by the circuits thru the punched hole in the card.

As the card leaves the second set of feed rolls, it is advanced by two large feed rolls, operating against two small idler feed rolls. The large feed rolls are operated by an intermittent gear. The card advances until the top of the printing position is directly under the center of the platen roll and then stops. The crosshead is at this time at its extreme forward position and at rest. This external cam is also operating on the same shaft as the crosshead internal cam. This external cam is for tripping the printing hammers. It is so timed that the hammers trip when the crosshead and the card are at rest, or immediately after the intermittent feed rolls stop. The hammer trip cam is also designed so that it positively pulls the hammers away from the type tails. Immediately after the hammers have been tripped, the Intermittent gear again operates to drive the large feed rolls and causes the card to go forward to the rubber feed rolls which carry it into the stacker.

DRIVE

The machine is driven by a 1/4 h.p. motor. The motor is connected to the drive shaft by a "V" belt. The drive shaft is provided with a clutch which prevents the machine from being turned backward.

The main drive shaft is connected to the feed roll worm by helical gears. The feed rolls are similar and driven in much the same manner as the feed rolls on the horizontal sorter.

The worm housing is the main link in the drive mechanism. It contains two worms, two worm gears and intermittent gears. Attached to the one worm gear is a shaft on which is located three cams, viz. internal cam for operating the crosshead, external cam for tripping the printing hammers, and the external cam for operating the knockoff. The two contact cams are also located on this shaft. The other worm gear operates the internal cam for the card feed knives. The intermittent gears operate the large feed rolls which interrupt the travel of the card during the time the hammers are tripped.

INDEX

The outside perimeter of the internal cam for driving the card feed knives has scribed on it marks which make a very effective index. The markings are as follows:

12 and CC which coincide, 11, 10, 1, 2, 3, 4, 5, 6, 7, 8, 9, KC, KF and HC.

The numbers are for the diffrent positions on the card. CC is for the timing of the Crosshead cam. The hole in the crosshead cam should be away from the feed and in a horizontal plane with the center of the cam shaft when the pointer is at CC on the index.

KC is for timing the knockoff cam. The hole in the knockoff cam should be away from the feed and in a horizontal plane with the center of the knockoff cam shaft when the pointer is at KC on the index.

IF is for the intermittent feed timing. The intermittent feed roll should stop when the pointer is on the IF position of the index.

HC is for the timing of the hammer cam. The top of the hammer trip cam should be toward the stacker and in a horizontal plane with the center of the shaft when the pointer is at HC on the index.

FEEDING MECHANISM

The feed of this machine is very similar to the feed of the Horizontal Sorter, namely, two card feed knives oscillate by means of a crank shaft to pick a card from the bottom of the stack and carry it forward to the feed rolls. The card feed knives should be timed so that there is 2-23/32" from the card feed knife to the edge of the first feed roll at "2" on the index. Obviously the knives are on their forward stroke and the back lash is removed.

The throat knife and throat block should be adjusted so that an .008 and not a .010 thickness gauge will pass through the opening three ways. To obtain this adjustment proceed as follows: Raise the throat knife slightly and move the throat block until its point is directly in line with the outside surface of the throat knife, then tighten the throat block adjusting screw. Next move the throat knife down until the .008 and not the .010 thickness gauge will go through the opening horizontally. Then set the throat knife adjusting screws. If the throat block and throat knife has been properly set, the .008 and not the .010 thickness gauge will pass through the opening (1) horizontally, (2) at an angle of about 30 degrees, and (3) should follow through when held down on the radius of the throat block.

The card feed knives are adjustable and should be set evenly on each side for the projection of .004 to .0045. A gauge is provided with two notches in it at opposite ends, one notch is marked "Go" and is cut .0045 deep and the opposite end is marked "No Go" and cut .004 deep. When adjusting the card feed knives it is necessary to first remove the card magazine guides and then loosen the clamping screws that hold the knife in place and turn in or out on the adjusting screw as the case may be to raise or lower the feed knife. If the knife is properly adjusted the "Go" end of the gauge will pass over the feed knife on either side and the "No Go" end will not pass over the projection. The knife must project evenly all the way across and it is obvious that both knives must be adjusted alike.

Installing New Set of Brushes—Install each brush for 1/8" projection from the heel of the brush to the face of the brush plate. Move the brush holder up or down until the brushes line up with the scribed line on the brush plate. The brushes should remain in alignment with the scribed line on the brush plate at all times, the card is then timed to the brushes.

Timing Card to the Brushes—Loosen the card feed knives connecting link lock nuts and adjust the connecting link until the card knives feed the card so that the brushes make contact 1/32" before the scribed line on the index. Check the timing of the brushes with a card punched "1" in all columns and make sure lock nuts are tightened after the correct timing has been obtained.

NOTE: Place one lead of the test set on the impulse distributor the other lead to be connected to a brush plughub. Turn the machine until the test set lights and check each brush position at this point. All brush circuits must be completed at 1/32" before the scribed line on the index. Check the breaking point on the distributor and see that all brush circuits are still complete after the distributor brushes have passed the corresponding segment.

CARD GUIDE SLIDE ADJUSTMENTS

The lower guide slide or brush plate should be adjusted up or down until the brush plate is in the proper relation to the center of the feed rolls as follows. Loosen the two screws which hold the adjustable brackets and move in elongated holes until the brush plate lines up perfectly with the center of the upper and lower feed rolls.

The upper card guide slide or contact roll is not adjustable up or down but the previous adjustment of lower card guide slide should be checked with the .012" and .020" thickness gauges. The .012" thickness gauge should pass between both the card guides and contact roll with medium tension and the .020" gauge should not pass between the contact roll and the lower card guide plate.

The lower card guide slide (brush plate) should be adjusted laterally so that the brushes line up with the punched holes in the card as follows:

Located one on either side of the feed castings are two headless set screws which turn against the adjustable card guide brackets, and moves the lower card guide laterally to the front or rear. Adjust by loosening one and tightening the other until the brushes are in alignment with the punched holes in the cards. Before making this adjustment make sure that the punched holes on the card are in correct registration with the card gauge.

INTERMITTENT FEED ROLLS

Adjust the tension of the upper feed rolls or idler rolls which operate against the large intermittent rolls to have a medium and even tension so that the cards will feed straight.

RUBBER FEED ROLLS

Adjust the rubber feed roll tracks by loosening the holding screws and adjusting the stop screws until the cards feed straight and are not marked by the tracks. These should be adjusted very carefully and accurately.

STACKER

Adjust the stacker so the top of the cards will remain approximately 1-1/2" below the card line at all times.

PLATEN

The platen is of the cylindrical form and loose to revolve with the card so that each impression will be in a different position. Check to see that the platen is free from any binds.

RIBBON FEED MECHANISM

The ribbon feed mechanism is standard except that the feed pawl is now advanced by an eccentric attached to a worm gear. The worm gear is the same as the feed roll worm gear and operates from the same shaft. In this way the ribbon is positively advanced each cycle. The ribbon feed drive gear should be timed so the ribbon is at rest when the hammers trip.

PRINT MAGNET UNIT

This unit is arranged with 45 stop pawls in one solid bank. The stop pawls and latches are positively returned to their latching position by a mechanical relatch and knockoff bar at the end of the printing cycle. The adjustments are as follows:

1. Adjust the turn buckles so that there will be .010" to .015" preferably .010" clearance between the stop pawls and latches when the armatures are attracted and back lash taken out of the pull rod.
2. Adjust by bending the armature tips until the stop pawls overlap its latch .020" to .025" preferably .020" when the stop pawls are latched.
3. The knockoff and relatch bars should be adjusted in relation to each other as follows: Adjust the eccentric studs (one on each side, two adjusting screws for each bushing) by loosening one screw and tightening the other so that when operated the relatch bar drives the stop pawls past their latching points 1/32" and at this time the knockoff bar should have 1/64" clearance to the latches. Both bars should strike stop pawls and latches evenly all the way across.
4. Adjust the knockoff bar backstop screw so that when released in its normal position there will be a clearance of 1/16" between the knockoff bar and the stop pawl latches.

PRINT UNIT

This unit oscillates each card cycle by means of a cam and levers. The unit is guided and held rigid by bearings sliding over stationary guide bars.

The type bars are driven in one direction by the type bar carrying pawl and springs until stopped by the stop pawls. When the type bars are stopped the carrying pawls are moved out of position and the carrying pawl slides over the type bar. Type bars are positively returned by the crosshead returning to its normal position.

The type bars are equipped with 13 type and one blank as follows: 12, 11, 10, 1, 2, 3, 4, 5, 6, 7, 8, 9, 0, blank.

It will be readily seen that ten will be printed for a hole punched zero if a circuit is completed through the print magnet which is determined by the plugs being inserted in the second row of hubs from the bottom. If this circuit is opened at the zero position by the plugs being in the bottom of the plug hubs then zeros will be printed mechanically by the zero pawls.

ADJUSTMENTS OF PRINTING LAP

Note: These adjustments must be made in the following procedure or one adjustment will affect the adjustments previously made.

1. Remove the platen roll and bearings. Adjust the type to strike the center of the platen roll by tilting the magnet unit with four adjustable bushings located at the bottom. Lower the two left hand bushings and raise the two right hand bushings or vice versa he same number of turns each so that the type bars are stopped with the center of type to be printed 3/8" from the edge of casting that supports the bearings for the platen roll. Use straight edge and measure to center of type at both the front and rear of the printing unit.

2. Move the magnet unit up or down for a clearance of .010" to .015" between the type bar teeth and the stop pawls even all the way across when they are latched. This is obtained by turning all four bushings in the same direction with a like number of turns.

Note: This adjustment must be made very carefully so that it will not disturb #1 adjustment. . . . . .

3. With the adjustable bushings on the front side plate of the magnet unit, move the magnet unit to the front or rear so that the stop pawls line up with the type bars when looking down from the top.

NOTE: After making adjustments 1, 2, and 3 loosen the magnet unit holding screws and check to see that when tightened the bushings are adjusted evenly so as not to twist or bind the magnet unit.

4. Move the zero stop pawls in elongated holes by loosening the two screws in each end of the assembly until the zeros are printed in alignment with the numerals. Test by punching a card alternating eights and zeros all the way across.

NOTE: The locking levers (one at the front and one at the rear) which lock the zero pawls set up should be adjusted by loosening the two holding screws in each lever and move in elongated holes until the locking bars rest evenly against the zero pawl levers all the way across and at both ends. Check to see that the locking levers do not touch feed rolls.

5. The printing crosshead is driven by two links in which are eccentric bushings determining the overlap of the stop pawls and type bar teeth at the numerical line on the index. These eccentric bushings should be adjusted as follows:

A. Loosen the large pivot screw set screw on the under side of the reciprocating bearings so that the pivot screw may be loosened.

B. Loosen the large pivot screw until the eccentric bushings are accessible. (Do Not Remove Entirely).

C. Loosen the two eccentric bushing locking screws so that the eccentric bushings may be adjusted.

D. Turn the machine to "5" on the index.

E. Adjust the eccentric bushings so that the stop pawls overlap the #5 tooth on the type bar 1/32" with the high side of both eccentrics together.

NOTE: Check to see that both of the eccentrics are adjusted evenly and together so that the printing crosshead will not bind on the guide rods.

F. Check the stop pawls for 1/32" overlap on the type bar teeth at both "11" and "8" the same as at "5" on the index.

ADJUSTMENT OF ARMATURE KNOCKOFF LEVER

Adjust the pivot points of the knockoff lever up or down in the elongated holes so that the relatch bar will have sufficient travel on the high point of its cam to drive the stop pawls 1/32" past their latching points. At this same time check knockoff bar to see that it has 1/64" clearance to stop pawl latches and does not bind.

HAMMER BAIL AND SPRINGS

The hammer bail trip is not adjustable for timing and needs never to be changed. The hammer bail springs are provided with links with four holes for adjusting. Set the links over the studs in one of these four holes until a good impression is obtained. Make sure both sides are adjusted to have the same tension.

ADJUSTMENT OF RELAYS

Card Lever Relay—This relay has standard adjustments, Namely: .012" clearance between armature and cores when attracted and .012" air gap between contact points when de-energized with medium tension on the armature spring.

Motor Relay—This relay is adjusted to have .012" clearance between the armature and cores when attracted and 1/16" air gap between the contact points when de-energized with heavy tension on the armature return spring.

TIMING OF IMPULSE DISTRIBUTORS

The two impulse distributors are used for completing the circuits through the holes in the card. They are timed to complete the circuit just after the card brush makes contact through the hole in the card and to break the circuit just before the card brush leaves the hole in the card. The card brushes are timed 1/32" before line on index and impulse distributors at line on index. The brushes of impulse distributors are connected in series and must be timed with a test light so that the arc will be equally distributed between the four brushes when the machine is in operation.

The impulse distributors are driven so that they make two revolutions each cycle, one revolution on the cards and one between the cards. The card lever contact keeps the circuit open for one revolution of the impulse distributors.

PURPOSE AND TIMING OF CAMS AND CONTACTS

The purpose of the motor cam contact is to overlap the break in the card lever contact and is timed to break at "5" on the index. Standard adjustments.

The purpose of the zero cam contact is to open the print magnet circuit during the time the card is under the brushes at the zero position to eliminate the printing of tens, elevens and twelves when not desired. Time so that contact will open approximately 1/4 point before "12" on the index and close 3/4 point after "10".

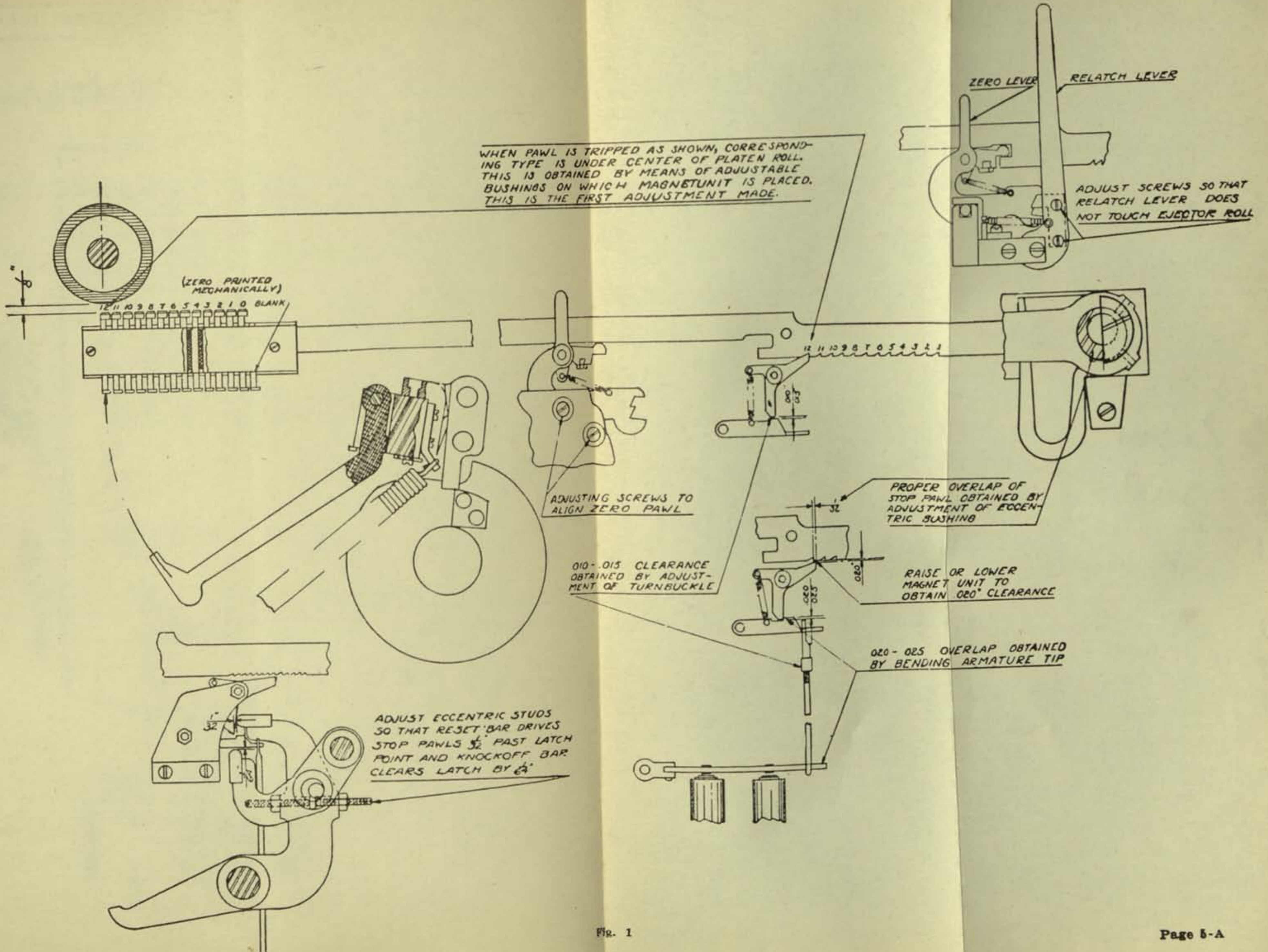
WIRING DIAGRAM

Figure 102179 is a complete wiring diagram of the Interpreter. There are two relays in the machine, the motor series relay and the card lever relay. The motor series relay prevents starting the machine by any other method than the start key. The card lever relay contacts overlap the break in the cam contacts and keeps the motor running as long as the cards are feeding.

The printing circuit is very simple. It is as follows:

From one side of the line, card lever contact, impulse distributor, common contact roll, brushes, plugwires, resistance, print magnet and then through one of the two parallel circuits, depending on whether the machine is plugged to print zeros or tens. In one of these parallel circuits is a cam contact which opens the circuit 3/16" before zero on the card or 10 on index and closes it 3/16" before "2" on index. When the machine is plugged to eliminate printing tens, the brush making contact through the zero hole will not complete its circuit as the cam contact is open, therefore the type bar will not stop at the 10 position and zero will be printed mechanically.

In the other parallel circuit, a circuit is completed through the zero hole in the card and ten is printed.



WHEN PAWL IS TRIPPED AS SHOWN, CORRESPONDING TYPE IS UNDER CENTER OF PLATEN ROLL. THIS IS OBTAINED BY MEANS OF ADJUSTABLE BUSHINGS ON WHICH MAGNETUNIT IS PLACED. THIS IS THE FIRST ADJUSTMENT MADE.
(ZERO PRINTED MECHANICALLY)
12 11 10 9 8 7 6 5 4 3 2 1 0 BLANK
ZERO LEVER
RELATCH LEVER
ADJUST SCREWS SO THAT RELATCH LEVER DOES NOT TOUCH EJECTOR ROLL
12 11 10 9 8 7 6 5 4 3 2 1
ADJUSTING SCREWS TO ALIGN ZERO PAWL
PROPER OVERLAP OF STOP PAWL OBTAINED BY ADJUSTMENT OF ECCENTRIC BUSHING
1/32
010-.015 CLEARANCE OBTAINED BY ADJUSTMENT OF TURNBUCKLE
RAISE OR LOWER MAGNET UNIT TO OBTAIN .020" CLEARANCE
.020"
.020 .025
020-025 OVERLAP OBTAINED BY BENDING ARMATURE TIP
ADJUST ECCENTRIC STUDS SO THAT RESET BAR DRIVES STOP PAWLS 1/32" PAST LATCH POINT AND KNOCKOFF BAR CLEARS LATCH BY 1/64"
1/32"

Fig. 1

OILING INSTRUCTIONS

1. Crosshead bearings are provided with oil wells and wicks. Keep oil wells filled with bearing oil at all times.

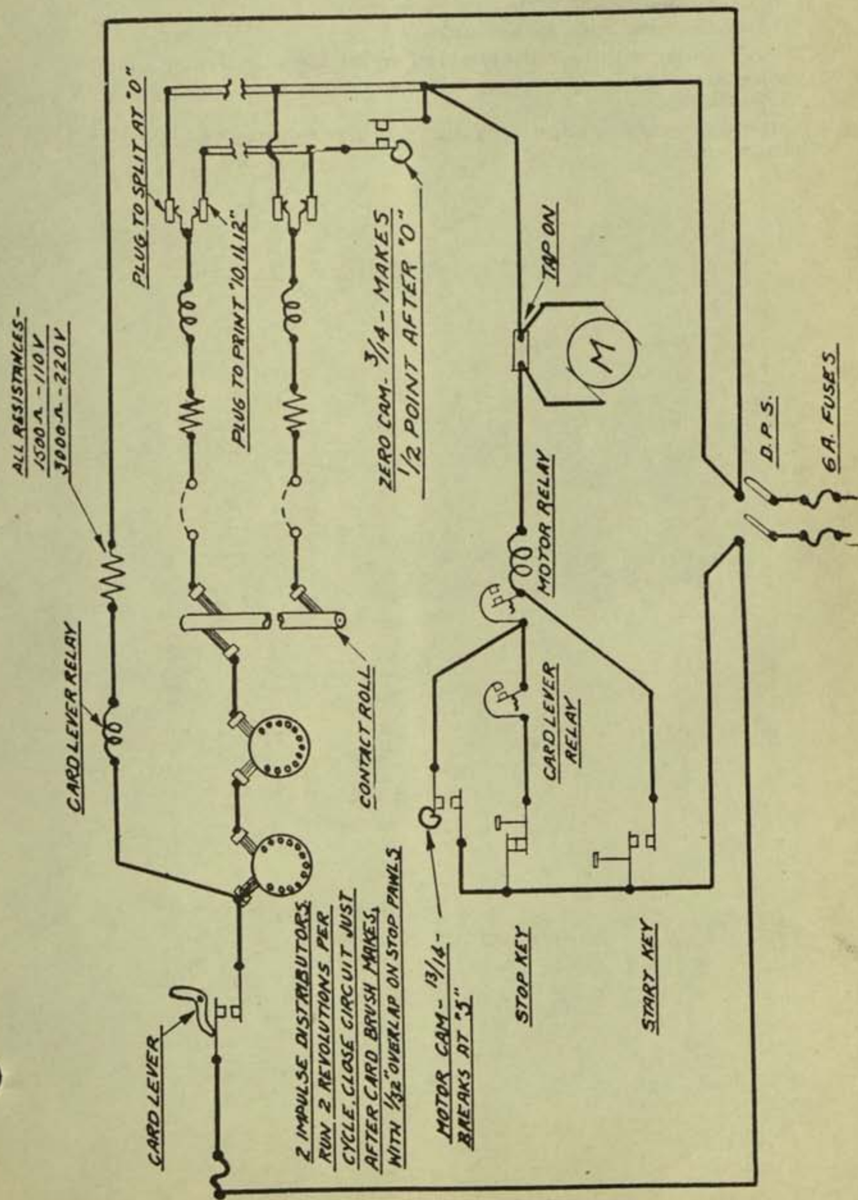


Fig 102179

2. The feed rolls should be oiled at least once each month.

3. Connecting rods for crossheads should be oiled at least once each month.

4. Motor should be oiled at least once each month.

5. Oil all cam rollers once each month.

6. Oil crosshead rocker arms once each month.

7. Oil worm shaft once each month.

8. Apply graphite to helical gears and worm gears once each month.

9. Keep worm housing filled up to bottom edge of worm gears with heavy motor oil or 600-W.

10. Lubricate gears in housing at the right hand end of horizontal shaft with motor bearing grease.

ALPHABETIC INTERPRETER

The Alphabetic Interpreter is used to print, on the face of a tabulating card, the interpretation of both the alphabetic and numerical information punched in the card.

GENERAL DESCRIPTION

The general appearance of the machine is somewhat similar to that of the Automatic Reproducing Punch, and it is approximately the same size.

The feed, which is of the horizontal type, is located at the right end of the machine. The stacker is located directly below the feed, and stacks the cards horizontally.

The main line switch and the start and stop keys are located on the front of the machine below the stacker.

The automatic plugboard is situated under the cover of the lower right end of the machine. Underneath the plugboard are located the motor terminals, and the variable resistance governing the output of the generator.

The front cabinet contains the fuses, the G. E. motor relays, the condensers, and the binding posts. The rear cabinet contains the MCR and the duo relays.

The drive motor is located at the left end of the lower base, and the motor generator is on the right end of the same base.

The machine is mounted on casters.

Current

The machine is equipped with its own motor-generator, and, therefore, may be specified to operate from either 110- or 220-volt alternating or direct current. The motor-generator supplies the necessary 40-volt direct current for the operation of all the electrical units of the machine with the exception of the drive motor.

The starting and running current for the drive motor and generator motor is as follows:

	Amperes			
	Start		Running	
Voltage	110	220	110	220
D. C.	22.0	11.0	3.6	1.8
A. C. 60 Cycle Single Phase	27.0	13.5	10.0	5.0
A. C. 50 Cycle Single Phase	27.0	13.5	10.0	5.0
A. C. 25 Cycle Single Phase	25.7	12.0	7.0	4.6

Machines are equipped with a signal light, which glows when the generator is delivering the proper voltage. The start key should not be depressed until this light glows. This light is located on the front of the machine near the main line switch.

Speed

The machine operates at a speed of 60 cards per minute, regardless of the number of columns interpreted.

Card Column Capacity

The machine is furnished for 80-column cards only.

The feed is similar to that of the Horizontal Sorter. The cards are placed in the feed hopper face up, and with the top edge (12's) toward the throat.

The approximate capacity of the feed hopper is 700 cards, and that of the card stacker 900 cards.

The machine is designed to automatically stop if the supply of cards in the feed becomes exhausted, a card fails to feed, a jam occurs in the machine, or the stacker fills to capacity.

Bijur System

This machine is equipped with a standard Bijur lubricating system. The pump is located under the base at the left end of the machine, and is accessible through the left end cover. Directions for the proper care and servicing of this lubricating system are identical to that of the system on the ATFS machine, which is fully explained on Pages 69 and 70 of TM Section 405 of the Customer Service Manual of Instruction.

IBM Lubricant No. 9 (SAE 30 oil) should be used in this system. The lubricator should be operated once per week, preferably at the time the machine is started on Monday morning. In cases where the machine is operated more than average it may be necessary to operate the lubricator more than once a week. This should be left to the discretion of the individual serviceman.

This system reaches all oiling points with the exception of the ribbon operating arms, the feed knife assemblies, and the motor and generator.

Dimensions

Length, 34"; Height, 50"; Width, 20".

Weight

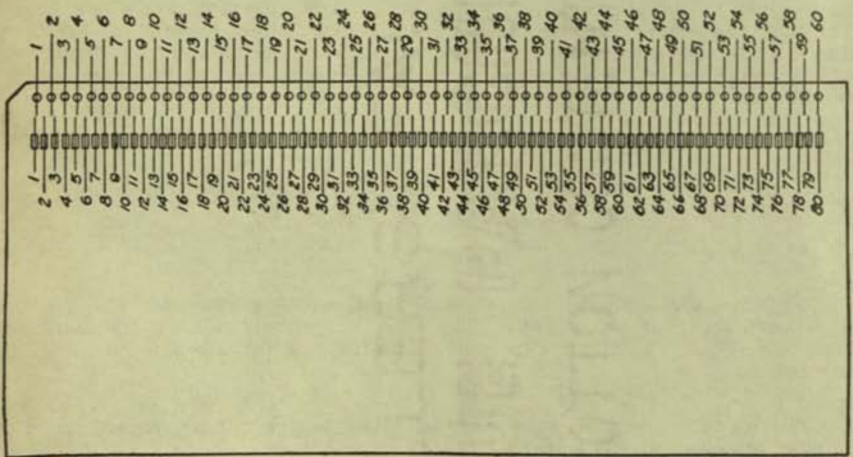
Packed, 1120 Lbs.; Unpacked, 776 Lbs.

FUNCTIONS

The machine is capable of printing on the face of a tabulating card the interpretation of both alphabetic and numerical information punched in the card.

The printing capacity is sixty characters in a row. Figure 1 shows the relative position of type to column. Each printing position is capable of printing either alphabetic (A to Z) or numerical (0 to 9) characters. These characters may be positioned along the top of the card above the 12's position or between the 12's and the 11's positions. The printing position is controlled by means of the printing-

CSD 683



SHOWING RELATIVE POSITION OF TYPE TO COLUMNS 80-COLUMN CARD

Fig. 1

position locating knob, which operates similar to the locating knob on the Numerical Interpreter

If sixty columns of interpreted information are sufficient, the printing can be accomplished in one run. If more than sixty columns of the card are to be interpreted, it is necessary to run the cards through the machine twice. It is obvious that when it is desired to interpret more than sixty columns, the balance will have to be interpreted in the second printing position and the plugboard rewired.

As the machine is not equipped with a mechanical zero printing device, all zeros punched to either the left or to the right of a significant figure will be printed providing those positions are plugged to the type bars. Unpunched card columns will not be interpreted.

If it is desired to interpret a "0" hole as a "10," or to interpret a "11" or a "12" hole, or any special character punching, the type bar assemblies must be equipped with special type.

Switches, Keys and Printing-Position Locating Knob

The main-line switch is located on the front of the machine below the stacker. It is of the circuit-breaker type, and if for any reason this switch becomes overloaded, it will automatically open the line circuit. NOTE: There is a chart on the wiring diagram showing the proper thermal units to be used in this switch.

The stop key is located to the right of the main-line switch, and the start key on the right of the stop key. These keys perform the functions their names imply.

The printing-position locating knob protrudes through the rear cover in line with the feed hopper. It is operated by first pulling it outward in order to unlock it and then turning it to the desired position. When the knob is turned to the right, it positions the card for printing between the "12" and "X" positions. By placing the knob to the left, it positions the cards for printing along the top position above the "12's." A positioning indicator is incorporated on the latest machines to indicate in what printing position the locating knob is in.

X-Eliminator

Each machine is equipped with a device to suppress the sensing of "X" and "12" impulses from fields that contain numerical information. This device is standard equipment, and consists of one twelve-position MCR, of which only ten positions are used.

Class Selectors

The machine can be equipped with one or two class selectors. Class selectors on this machine are not standard equipment.

Numerical information can be field or class selected by the use of class selectors.

Alphabetic information cannot be field selected, but the use of class selectors in conjunction with X-eliminators allows the selection or suppression of printing positions.

PLUGBOARD AND METHOD OF PLUGGING

The plugboard is a single-panel automatic plugboard. The plug-hubs are clearly marked, and by referring to Fig. 2, they can be readily understood.

Interpreting Alphabetic or Numerical Data

Plug from the desired "Reading Brush" hubs to the desired "Type Bar" hubs

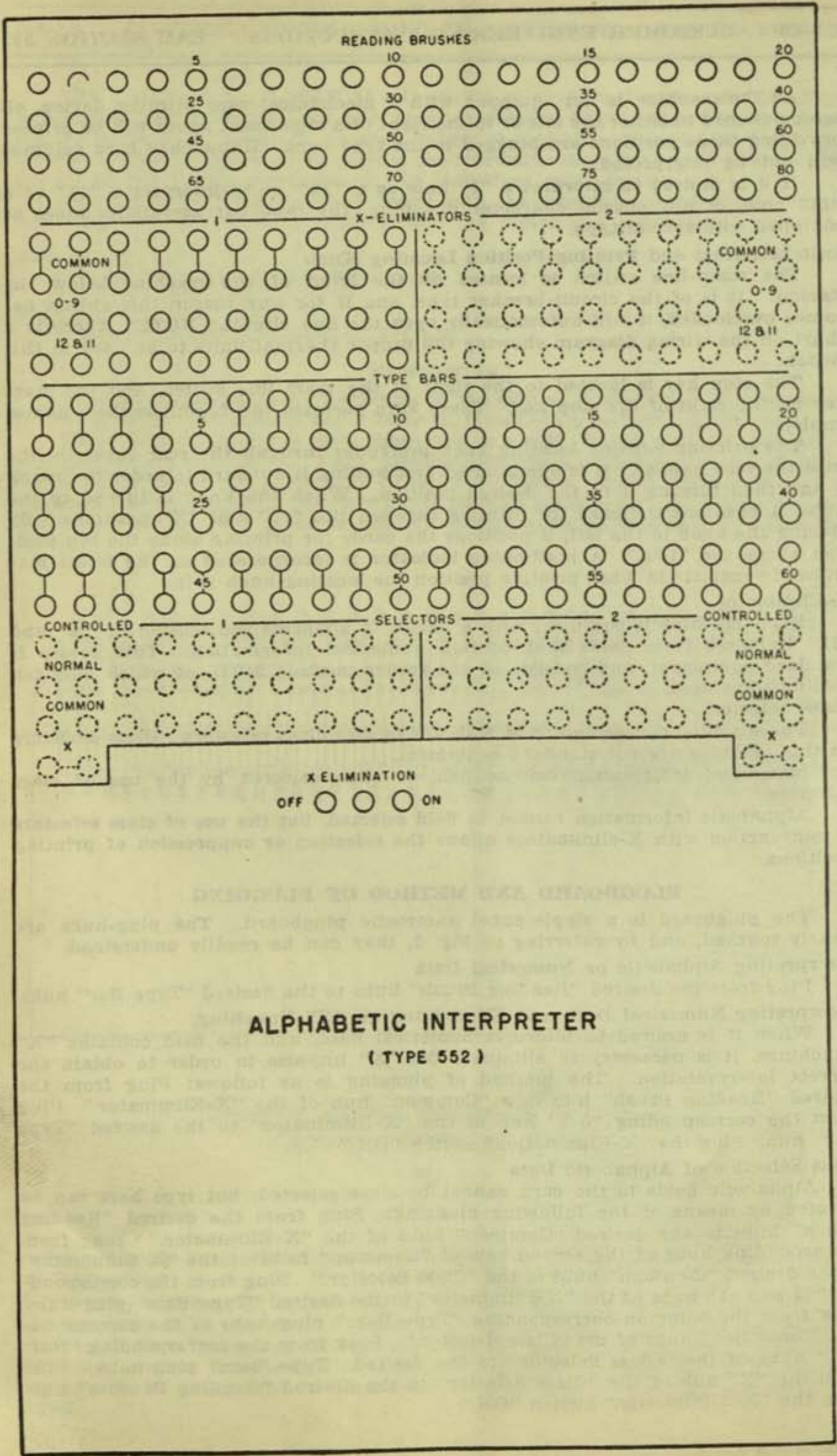
Interpreting Numerical Data and Eliminating on "X" Punching.

When it is desired to interpret numerical data, and the field contains "X" punchings, it is necessary to eliminate the "X" impulse in order to obtain the correct interpretation. The method of plugging is as follows: Plug from the desired "Reading Brush" hub to a "Common" hub of the "X-Eliminator." Plug from the corresponding "0-9" hub of the "X-Eliminator" to the desired "Type Bar" hub. Plug the "X-Elimination" switch "ON."

Class Selection of Alphabetic Data

Alphabetic fields in the card cannot be class selected, but type bars can be selected by means of the following plugging: Plug from the desired "Reading Brush" hubs to any desired "Common" hubs of the "X-Eliminator." Plug from corresponding hubs of the second row of "Common" hubs of the "X-Eliminator" to the desired "Common" hubs of the "Class Selector." Plug from the corresponding "12 and 11" hubs of the "X-Eliminator" to the desired "Type Bars" plug-hubs. Plug from the common corresponding "Type Bars" plug-hubs to the corresponding "Controlled" hubs of the "Class Selector." Plug from the corresponding "Normal" hubs of the "Class Selector" to the desired "Type Bars" plug-hubs. Plug from the "X" hub of the "Class Selector" to the desired "Reading Brushes" hub. Plug the "X-Elimination" switch "ON."

C.S.D. 706



READING BRUSHES
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
1
X-ELIMINATORS
2
COMMON
0-9
12 & 11
TYPE BARS
CONTROLLED
SELECTORS
NORMAL
COMMON
X
X ELIMINATION
OFF
ON
ALPHABETIC INTERPRETER
(TYPE 552)

Fig. 2

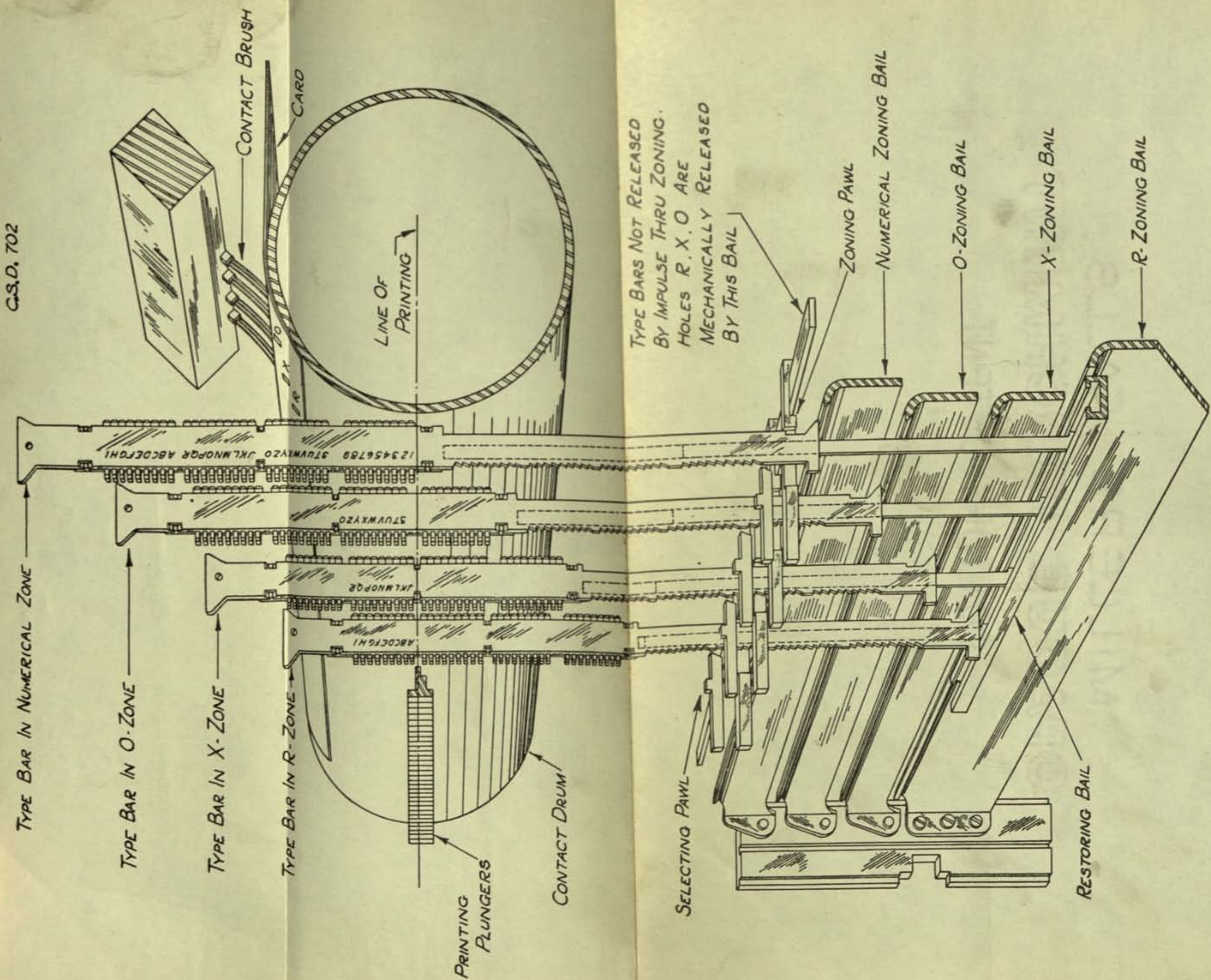

C.S.D. 702
Contact Brush
Card
Line Of Printing
Type Bars Not Released By Impulse Thru Zoning. Holes R, X, O Are Mechanically Released By This Bail
Zoning Pawl
Numerical Zoning Bail
O-Zoning Bail
X-Zoning Bail
R-Zoning Bail
123456789 STUVWXYZO JKLMNOPQR ABCDEFGHI
STUVWXYZO
JKLMNOPQR
ABCDEFGHI
Type Bar In Numerical Zone
Type Bar In O-Zone
Type Bar In X-Zone
Type Bar In R-Zone
Printing Plungers
Contact Drum
Selecting Pawl
Restoring Bail

Fig. 3

OPERATING PROCEDURE

Cards are placed in the feed face up with the "12" edge entering the throat first. After properly wiring the automatic plugboard and inserting it into its receptacle, and setting the printing-position locating knob to the desired position, the machine is ready to be operated. Place the main-line switch in its "ON" position and press the start key. The machine will continue to run unless stopped by one of the following methods: The automatic opening of the main-line circuit by means of the main-line switch, owing to an overload of aforementioned switch; depression of the stop key; feed magazine running out of cards; cards failing to feed; a jam in the machine; or the stacker filling to capacity. If the machine automatically stops, and a card jam exists, do not depress the start key as the jam might result in damage to the machine.

As the card pickers oscillate, they feed the bottom card from the feed through the throat to the first set of feed rolls. The card is carried forward by the first set of feed rolls to the second feed roll and the contact drum at a constant speed. When the card begins to receive its forward motion from the second upper feed roll and the contact drum, the speed of the forward movement decreases. As the card passes between the contact drum and the upper feed roll, it is also passing under the reading brushes. The reading brushes make contact through the zone holes—R, X, or O—and the zoning pawls are actuated by the print magnet unit. After the card reaches the O position, the card feed mechanism, with the exception of the picker knives and the first set of feed rolls, almost comes to a stop long enough for the magnet restoring bail to operate. The above is necessary in order to restore the print magnet armature on top of the drive rod lever after the zoning is completed. For exact movement of card, see the mechanical timing chart.

It should be mentioned at this time that when the card reaches the contact drum it passes under gripper fingers at each end of the drum. As the drum revolves, these gripper fingers hold the card securely to the drum until the card leaves the drum. This insures the card being held in the proper printing position.

After the print magnet unit is restored to normal, the speed of the card feeding increases, and the selecting pawls are set up by the print magnet unit which receives its impulses through the holes (1 to 9) in the cards.

The movement of the type bars and the card is synchronized, and all the type bars will be stopped in the printing position at the same time the card reaches its selected printing position. At this time the type bars and the card will remain in a stationary position until the printing operation is completed. After the printing is accomplished, the card resumes its forward movement and the type bars are restored to their normal position.

The printing is accomplished by means of individual plungers, which are cammed as a unit against the type tails.

At the completion of the printing, the card resumes its forward movement and is fed into the stacker.

Figure 3 is a schematic drawing showing the zoning of the type bars as a card passes through the zoning position.

OPERATION AND ADJUSTMENTS

Index

The index is located on the rear end of the printing cam shaft, and it is dowelled in place. It is divided into 30 points which are subdivided into twelfths. Each of the subdivisional points is equal to one degree, therefore one point is equal to twelve degrees. The index on the latest machines is divided into degrees.

Printing Cam Shaft

If the machine is disassembled for any reason, the first adjustment to be made is to time the printing cam shaft assembly. After this shaft is correctly timed, the remaining shafts may be timed in any desired sequence. The timing of this shaft establishes the correct index timing by which all other timing is set. The following method is employed to obtain the correct timing of the printing cam shaft (See Fig. 4):

Turn the machine over by hand until the printing cam follower on the print unit "A" just starts to ride on the high lobe of the printing cam "B." Insert a

Printed in U. S. A.

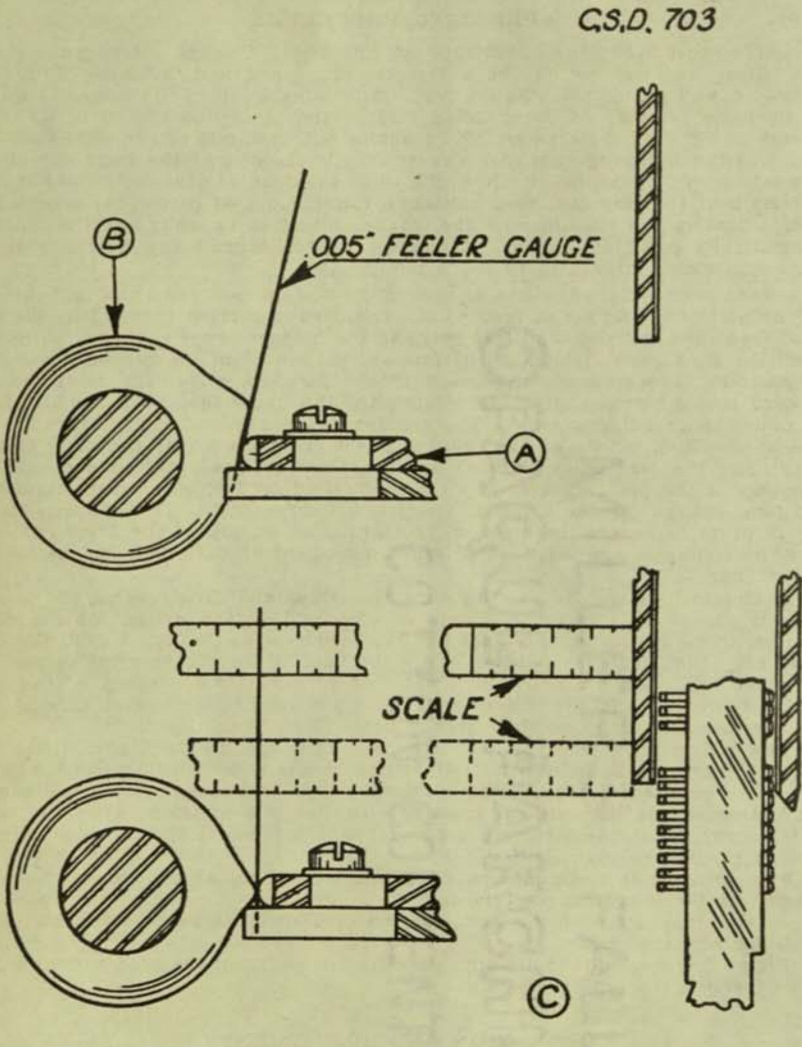


Fig. 4

.005" feeler gauge between te follower and the cam as shown in Fig. 4. Continue turning the machine over by hand until the feeler gauge assumes an absolute vertical position as shown at "C." Check this position by measuring from the feeler gauge to the print unit as illustrated. At this point the index should be at 210°.

Contact Drum Cam—Fig. 5.

With the index set at 60°, the contact drum cam "A" is pinned to the shaft so the scribed line "B" will be against the contact drum cam roller "C" in line with the center line "D" of the operating rack assembly.

Note: Correct timing will cause the card to be advanced ¼ in. every 7½ degrees from 108 degrees to 168 degrees.

An incorrect adjustment of this cam will make it impossible to obtain the specified timing for the brush assembly in relation to the selection circuit breakers.

Cam Shaft Assembly

This shaft is located at the left end of the machine, and receives its motion from a vertical shaft driven by the horizontal drive shaft. The drive gear, on the rear end of the shaft, can be adjusted in relation to the shaft a portion of a tooth by means of the four screws on the gear. If it is necessary to move the shaft more than a portion of a tooth, it will then be necessary to remove the bearing caps and unmesh the drive gear and turn the shaft as required.

Reading from front to rear the cams are as follows:

1 and 10 Restoring Bail Cams. The purpose of these cams is to restore the type bars to their normal position.

2 and 9 Zone Carrier Cams. These cams control the type bar travel during selection time through control of the zoning bail carriage.

3 and 8 Magnet Unit Restoring Cams. These cams and the respective zone carrier cams are one piece. These cams restore the magnet unit to its normal setting after zoning and after selecting.

4 and 7 Restoring Bail Complementary Cams. These cams govern the travel of the print unit restoring bail on the down stroke.

5 Zone Bail Cam. This cam controls the zoning balls for their motion "in" (under the type bars) and "out" (clear of the type bars).

6 Pin Bail Operating Cam. This cam operates the pin bail, placing the drive rods in either the zoning or the selecting position.

The cam shaft is timed at the factory, but in case of removal, it will be necessary to re-time it to the machine as follows: Remove the head of the print unit. With the end type bar deposited on the numerical zone ball and the machine set at 100°, the type bar should have moved downward 3/32" when the machine is turned to 115½°. Fig. 6.

Note: The ball bearing housings of this shaft are similar in appearance, but they differ in construction. One contains a simple ball bearing with no thrust provision, while the other is designed to take care of the thrust of the cam shaft drive.

It is, therefore, important that these bearing housings be correctly replaced on the shaft after they have been removed. The thrust bearing housing is on the front end of the shaft, and the plain ball bearing housing is on the rear end of the shaft. In case these housings do not have identification marks, we advise you to mark them in order to be able to correctly identify them.

Magazine Front Plate

Only the magazine front plate is adjustable, and it is adjusted for .008" to .010" clearance over the length of the card. This adjustment is obtained by means of adjustable bushings.

Card Feed Knife Assemblies Fig. 7

The card feed knives should be adjusted for a .004" to .0045" projection.

The card feed knife holders should be adjusted by means of the adjusting screws "A" so they feed the card in straight. Check to see that on the back stroke, the knives travel 1/32" beyond the edge of the card.

Card Feed Knife Crank Shaft Coupling—Fig. 7

The card feed knife crank shaft is a split shaft connected by means of a coupling "B" directly under the card feed bed. The purpose of this coupling is to properly time the feeding of the card. The timing is as follows: Set the printing locating knob to print in the upper position. Place a card in the feed and turn the machine over by hand until the top (leading) edge of the card is ⅛" below the center line of the contact drum "C." At this time, the machine index should be at 185°. To advance or retard the feeding of the card in order to obtain this correct timing, the coupling is adjusted by means of loosening the set screws "D" and turning the shaft accordingly.

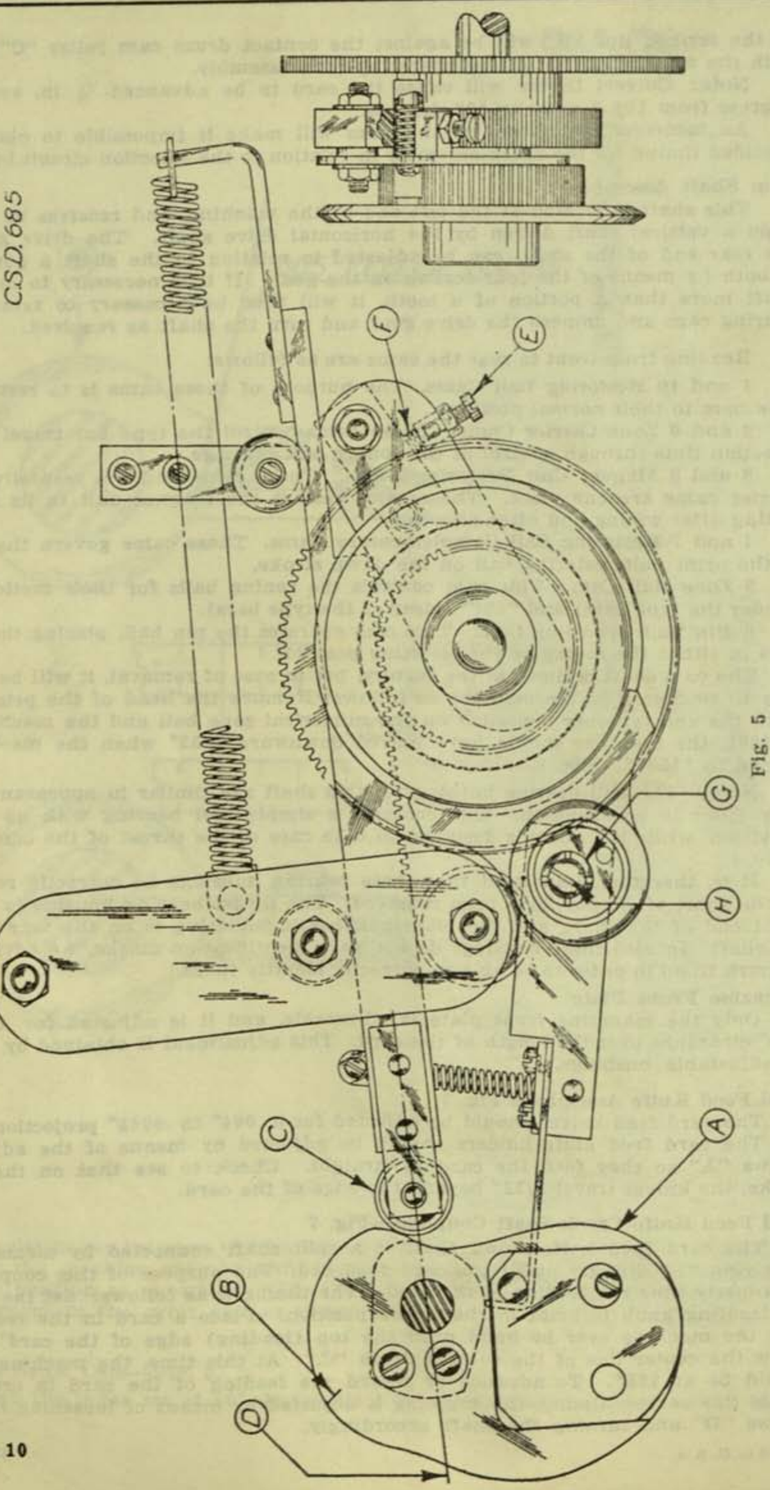


Fig. 5

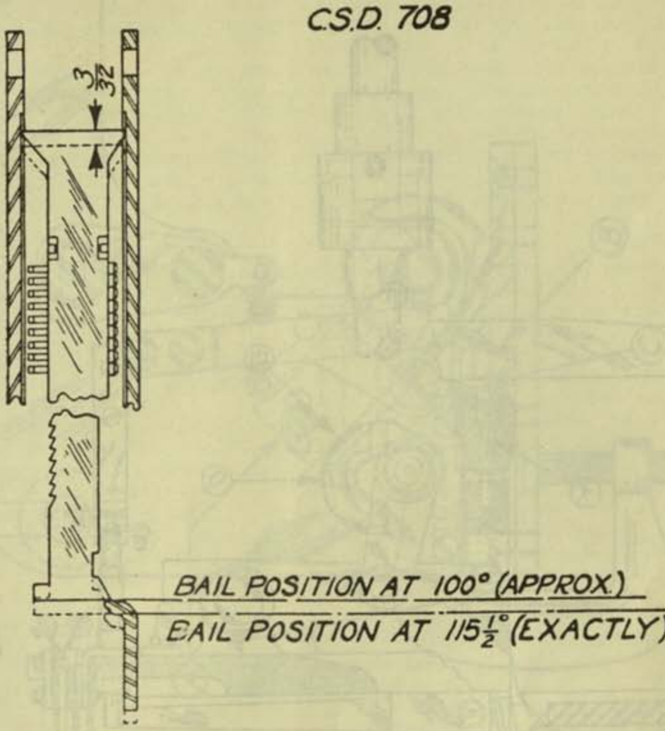


Fig 6

Throat Knife and Throat Block

The throat knife and the throat block adjustments are standard. They should be adjusted so an .008″ and not a .010″ thickness gauge will pass through the opening in the three standard ways.

Card Guide

There are four card guides similar to the two upper card guides on a sorter. They are attached to the magazine back plate and are adjusted by bending. They are adjusted for a clearance of .012″ to .020″ between them and the lower guide plate.

Brush Assembly—Fig. 8

The brush assembly is composed of 80 three-group brushes, and it differs from other brush assemblies in that it is fitted with a grooved dilecto roll which acts as a brush guide and a feed roll.

The brushes are inserted in the holder until the end of the ferrule is flush with the edge of the holder. The holder is moved in the assembly until the clamping screws "A" are centrally located in the slots and then tighten the clamping screws. Install the card brush gauge (Part #178027) on the assembly as shown with the studs "B" firmly against the card plate "C." Pull the brushes back individually until one strand at the heel of each brush drops off the edge of the bar. Tighten the brush clamping screws. This procedure results in the correct brush projection of ⅛″

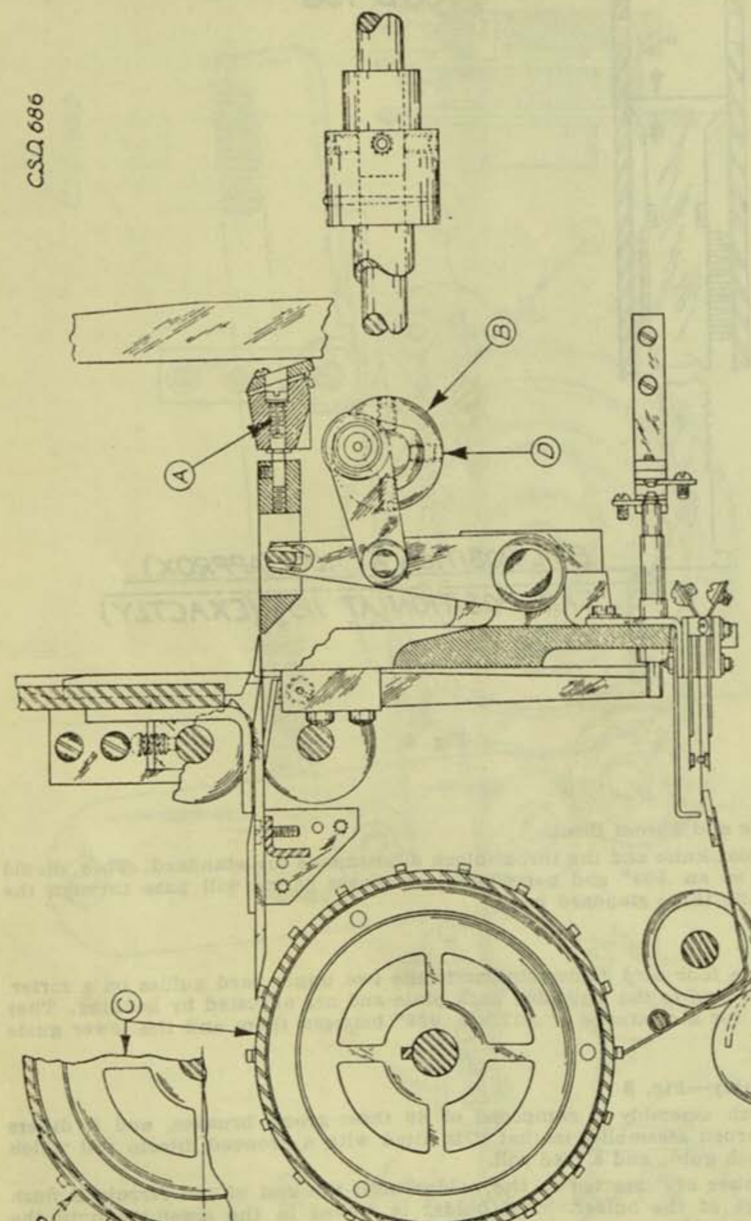


Fig. 7

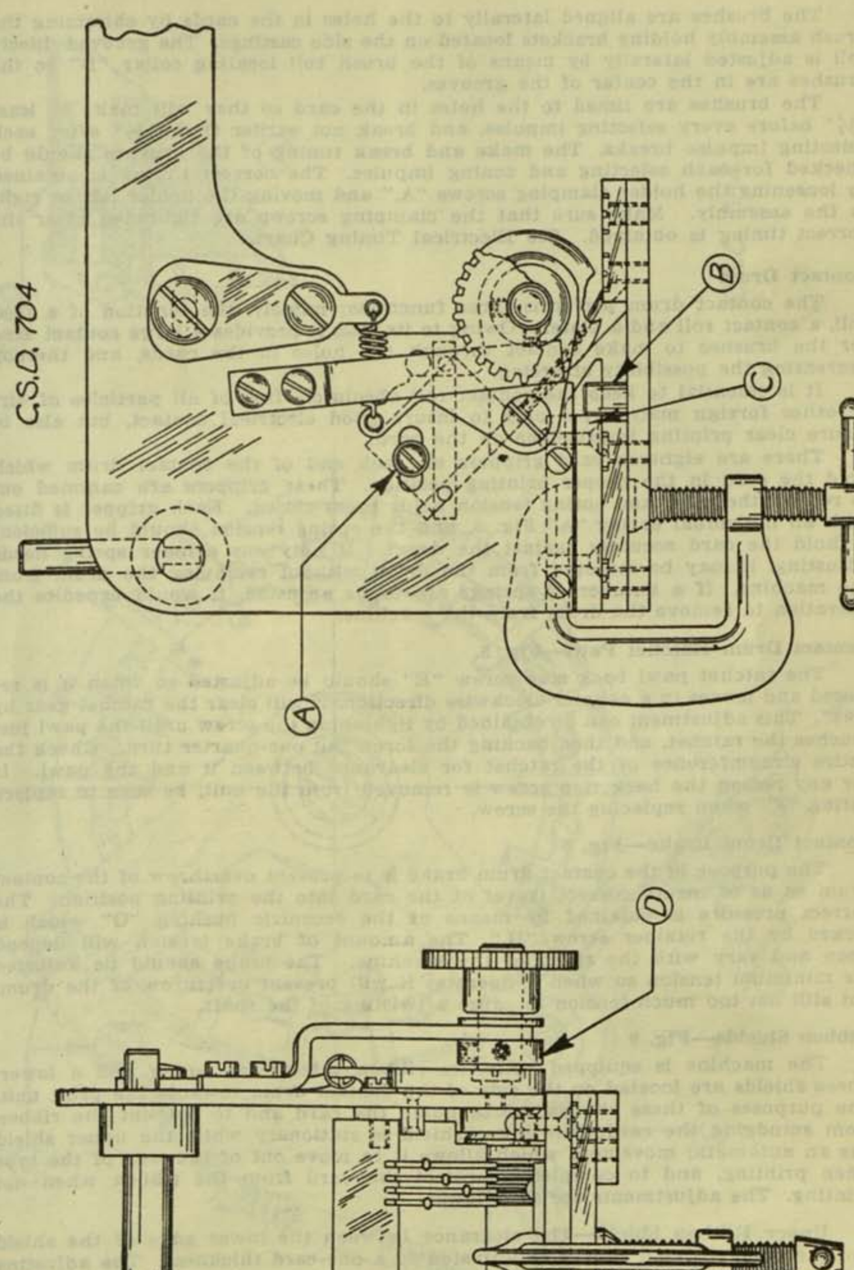


Fig. 8

The brushes are aligned laterally to the holes in the cards by shimming the brush assembly holding brackets located on the side castings. The grooved dilecto roll is adjusted laterally by means of the brush roll locating collar "D" so the brushes are in the center of the grooves.

The brushes are timed to the holes in the card so they will make at least 1½° before every selecting impulse, and break not earlier than 1½° after each selecting impulse breaks. The make and break timing of the brushes should be checked for each selecting and zoning impulse. The correct timing is obtained by loosening the holder clamping screws "A," and moving the holder left or right in the assembly. Make sure that the clamping screws are tightened after the correct timing is obtained. See Electrical Timing Chart.

Contact Drum

The contact drum performs three functions; namely, the function of a feed roll, a contact roll and a platen. Owing to its size, it provides a large contact area for the brushes to make contact through the holes in the cards, and thereby decreasing the possibility of arcing.

It is essential to keep the contact roll absolutely free of all particles of dirt or other foreign matter, not only to insure good electrical contact, but also to insure clear printing impressions on the card.

There are eighteen card grippers on each end of the contact drum which hold the card in the proper printing position. These grippers are cammed out to receive the card, and spring tension holds them closed. Each gripper is fitted with an individual spring "A" Fig. 9, and the spring tension should be sufficient to hold the card securely against the drum. If only one gripper spring needs adjusting, it may be removed from the drum without removing the drum from the machine. If a number of springs are to be adjusted, it would expedite the operation to remove the drum from the machine.

Contact Drum Ratchet Pawl—Fig. 5.

The ratchet pawl back stop screw "E" should be adjusted so when it is released and moves in a counter clockwise direction, it will clear the ratchet gear by .008". This adjustment can be obtained by tightening the screw until the pawl just touches the ratchet, and then backing the screw out one-quarter turn. Check the entire circumference of the ratchet for clearance between it and the pawl. If for any reason the back stop screw is removed from the unit, be sure to replace spring "F" when replacing the screw.

Contact Drum Brake—Fig. 5

The purpose of the contact drum brake is to prevent overthrow of the contact drum so as to insure correct travel of the card into the printing position. The correct pressure is obtained by means of the eccentric bushing "G" which is locked by the retainer screw "H." The amount of brake tension will depend upon and vary with the speed of the machine. The brake should be adjusted for minimum tension so when it operates it will prevent overthrow of the drum, but still not too much tension to cause a twisting of the shaft.

Ribbon Shields—Fig. 9

The machine is equipped with two ribbon shields—an upper and a lower. These shields are located on the side of the contact drum towards the print unit. The purposes of these shields are to guide the card and to prevent the ribbon from smudging the card. The lower shield is stationary while the upper shield has an automatic movement which allows it to move out of the way of the type when printing, and to completely protect the card from the ribbon when not printing. The adjustments are as follows:

Upper Ribbon Shield—The clearance between the lower edge of the shield and the contact drum should be adjusted to a one-card thickness. The adjusting screws "B" are used to obtain this adjustment. Adjust the ribbon shield drive sector "C" by means of its screws "D" so when the shields are closed there will be a minimum clearance between the two shields. Check the opening of the shields at the printing position. This opening should not exceed 7/32" nor be under 3/16". When the shields are in a closed position, the edges should be even in order to prevent the cards from striking the edge of the lower shield.

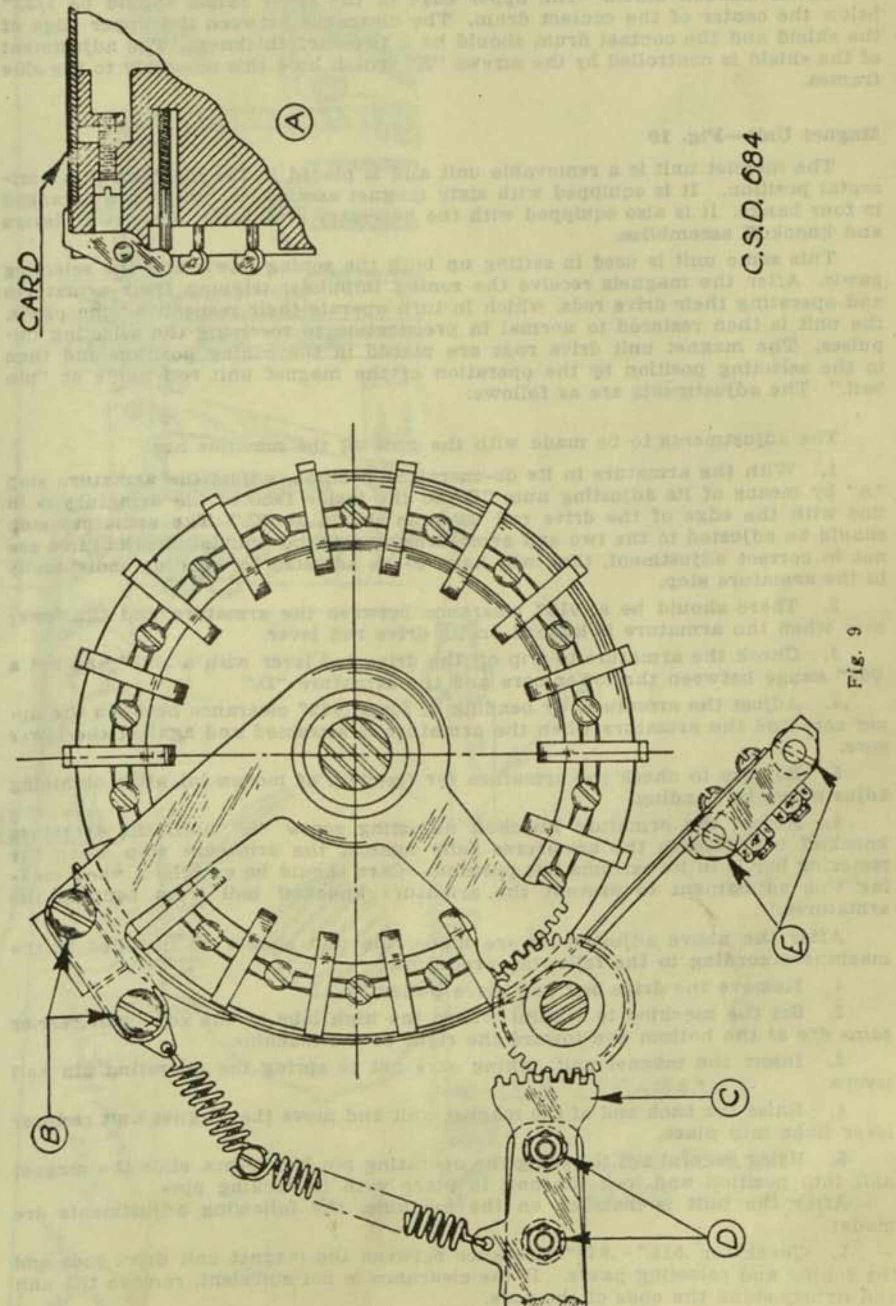


Fig. 9

Lower Ribbon Shield—The upper edge of the lower shield should be 3/32" below the center of the contact drum. The clearance between the upper edge of the shield and the contact drum should be a two-card thickness. The adjustment of the shield is controlled by the screws "E" which hold this assembly to the side frames.

Magnet Unit—Fig. 10

The magnet unit is a removable unit and is placed in the machine in a horizontal position. It is equipped with sixty magnet assemblies, which are arranged in four banks. It is also equipped with the necessary armatures, drive rods, levers and knockoff assemblies.

This same unit is used in setting up both the zoning pawls and the selecting pawls. After the magnets receive the zoning impulses; tripping their armatures and operating their drive rods, which in turn operate their respective zone pawls, the unit is then restored to normal in preparation to receiving the selecting impulses. The magnet unit drive rods are placed in the zoning position and then in the selecting position by the operation of the magnet unit rod guide or "pin bail." The adjustments are as follows:

The adjustments to be made with the unit off the machine are:

1. With the armature in its de-energized position, adjust the armature stop "A" by means of its adjusting nuts "B" so the inside face of the armature is in line with the edge of the drive rod lever as shown at "C." The armature stop should be adjusted to the two end armatures, and if the remaining armatures are not in correct adjustment, they will have to be adjusted by bending individually to the armature stop.

2. There should be a .015" clearance between the armature and the lower core when the armature is latched on its drive rod lever.

3. Check the armature to trip off the drive rod lever with a .003" and not a 005" gauge between the lower core and the armature "D."

4. Adjust the armature, by bending it, for a .002" clearance between the upper core and the armature when the armature is attracted and against the lower core.

5. Be sure to check the armature for freedom of movement after obtaining adjustments by bending.

6. Adjust the armature knockoff adjusting screw "E" until the armature knockoff bail returns the armatures fully against the armature stop when the restoring bar is in its extreme left position. Care should be exercised when making this adjustment to prevent the armature knockoff bail from bending the armatures.

After the above adjustments are made, the unit should be installed in the machine according to the following procedure:

1. Remove the drive belt and drive pulley.

2. Set the machine to a point where the high lobe of the zone bail carrier cams are at the bottom and toward the right of the machine.

3. Insert the magnet unit, taking care not to spring the operating pin bail levers.

4. Raise the back end of the magnet unit and move the magnet unit restorer lever links into place.

5. Being careful not to spring the operating pin bail levers, slide the magnet unit into position and lock the unit in place with its locking pins.

After the unit is installed on the machine, the following adjustments are made:

1. Check for .015" - .030" clearance between the magnet unit drive rods and the zoning and selecting pawls. If the clearance is not sufficient, remove the unit and lightly stone the ends of the rods.

2. Adjust the magnet unit restorer lever link screws "F" so when the levers are in the maximum restoring position, there will be a clearance of 3/64" between the armatures and the drive rod levers.

C.S.D. 687

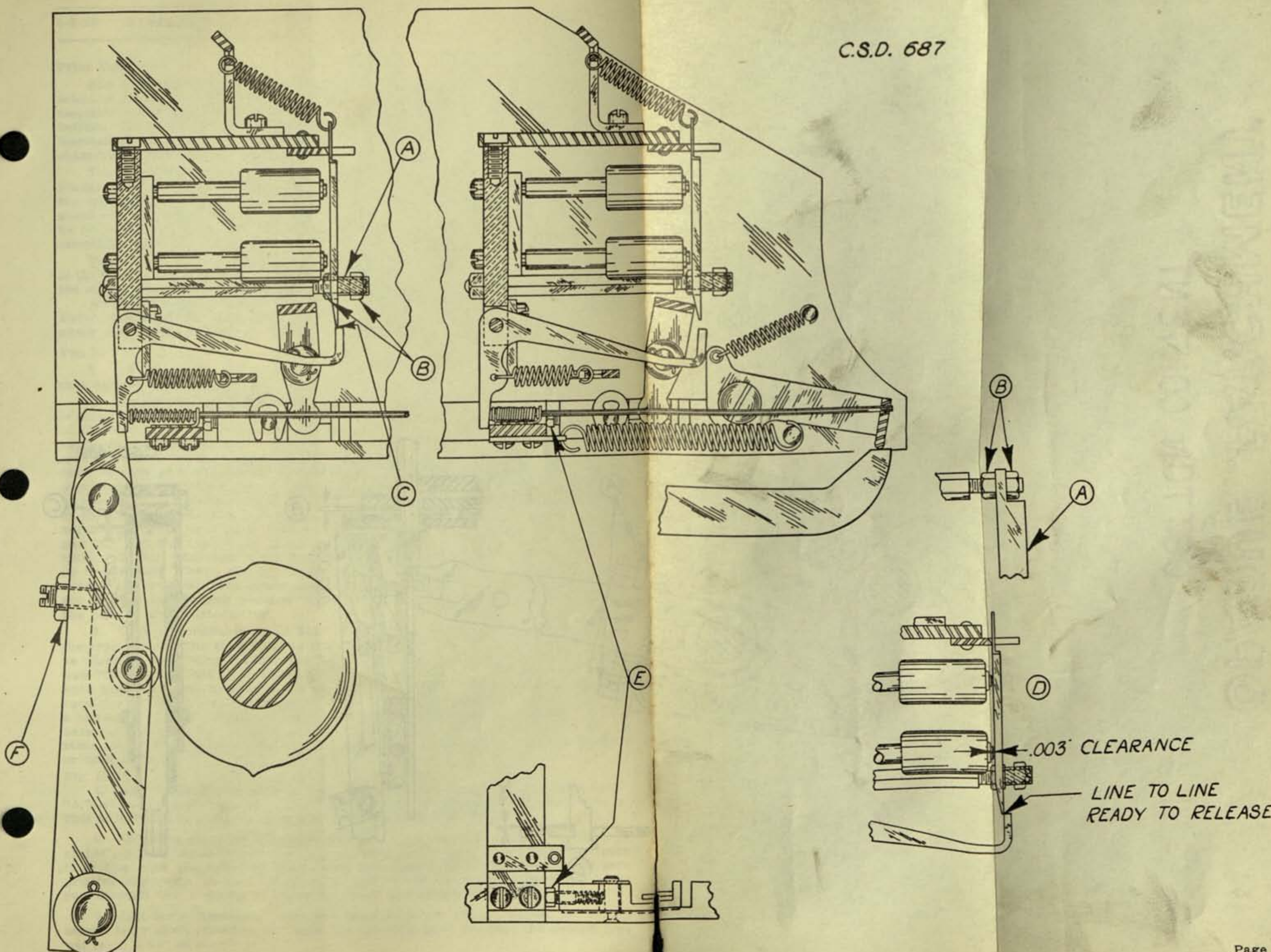


Fig. 10

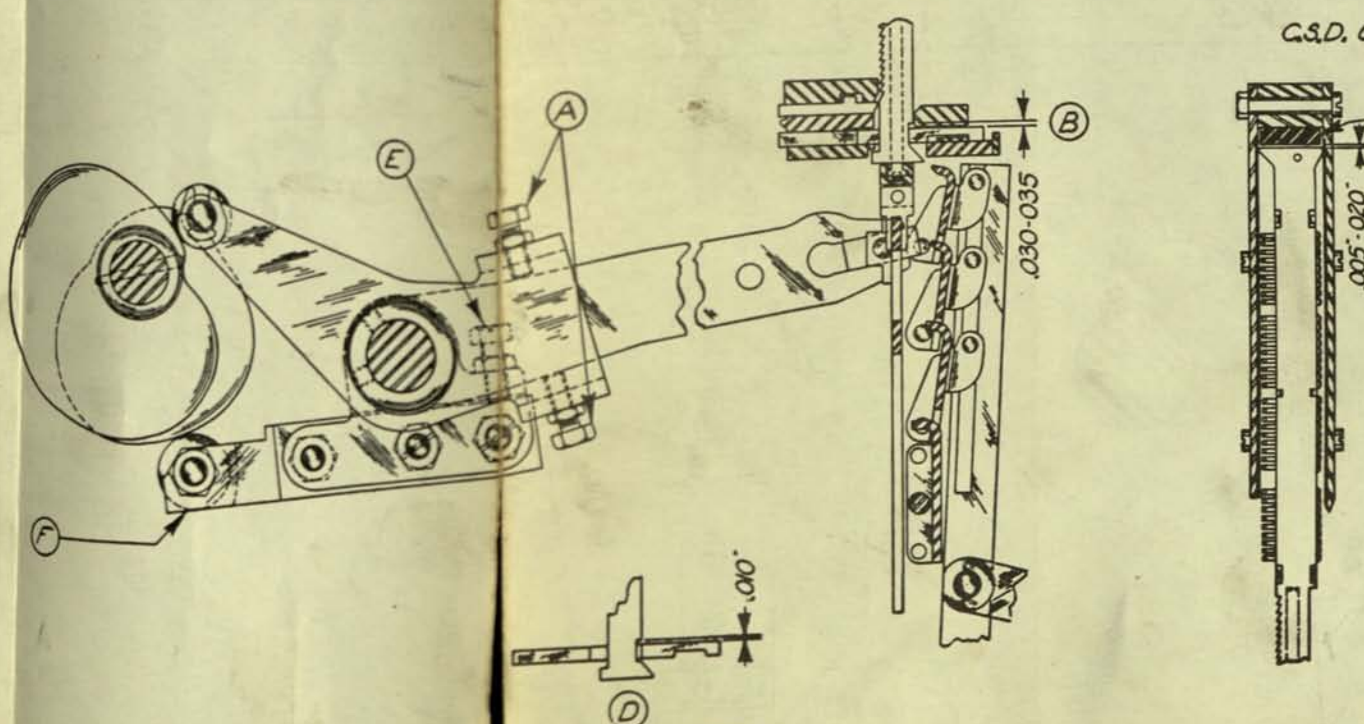


Fig. 11

Print Unit

The print unit consists of sixty type bar assemblies and their zoning and selecting pawls, and the hammer unit, which is termed the printing pressure bar assembly. The type bar is divided into four zones: namely, reading from top to bottom, "R" zone, "X" zone, "O" zone, and numerical zone. Special type may be inserted in the blank positions between the various zones in order to print special characters. This is an optional feature.

The printing pressure bar assembly is composed of a row of sixty individual plungers which operate against the type tails when the unit is cammed in against the type. These plungers are backed-up by a strip of rubber which absorbs the shock and holds the plungers in their extended position. This rubber strip should be held firmly in place, and if there is any clearance between it and the holding assembly, shims should be used to remove the clearance.

There is no provision on this unit to automatically print 0's if no hole appears in the card. Only card columns which contain punched information, and for which the machine is plugged to interpret, will be printed.

All of the adjustments of this unit are made with the unit on the machine. Before installing the unit check the type bars for freedom of movement, and check the friction springs for wear. The adjustments are as follows:

Fig. 11

1. Adjust screw "E" so the cam follower roller "F" will ride against the cam surface without binding.

2. Set the machine at 336° and adjust the restoring bail cam levers by means of screws "A" for a .030" to .035" clearance between the zoning pawl and the top of the cut in the type bar as shown at "B." This clearance can be checked by removing the type bar guide cover plate and turning the machine over until the type bars are at their extreme upward limit of travel. At this time, the type bars must be pressed down against the restoring bail. Continue turning the machine over, and note the distance the type bars travel downward until they are stopped by means of their zoning pawls. A .030" to .035" downward movement will result in the correct clearance between the type bars and their zoning pawls. This adjustment will result in a .005" to .020" clearance between the type bar stop pad "C" and the top of the type bars when they are in their extreme upward travel. If this clearance is not correct, then the above adjustment will have to be re-checked. Check also for a clearance of at least .010" between the upper edge of the type bar latch recess and the upper edge of the zone pawl when they are at their intersecting position "D." This clearance can be observed through the hole in the front casting.

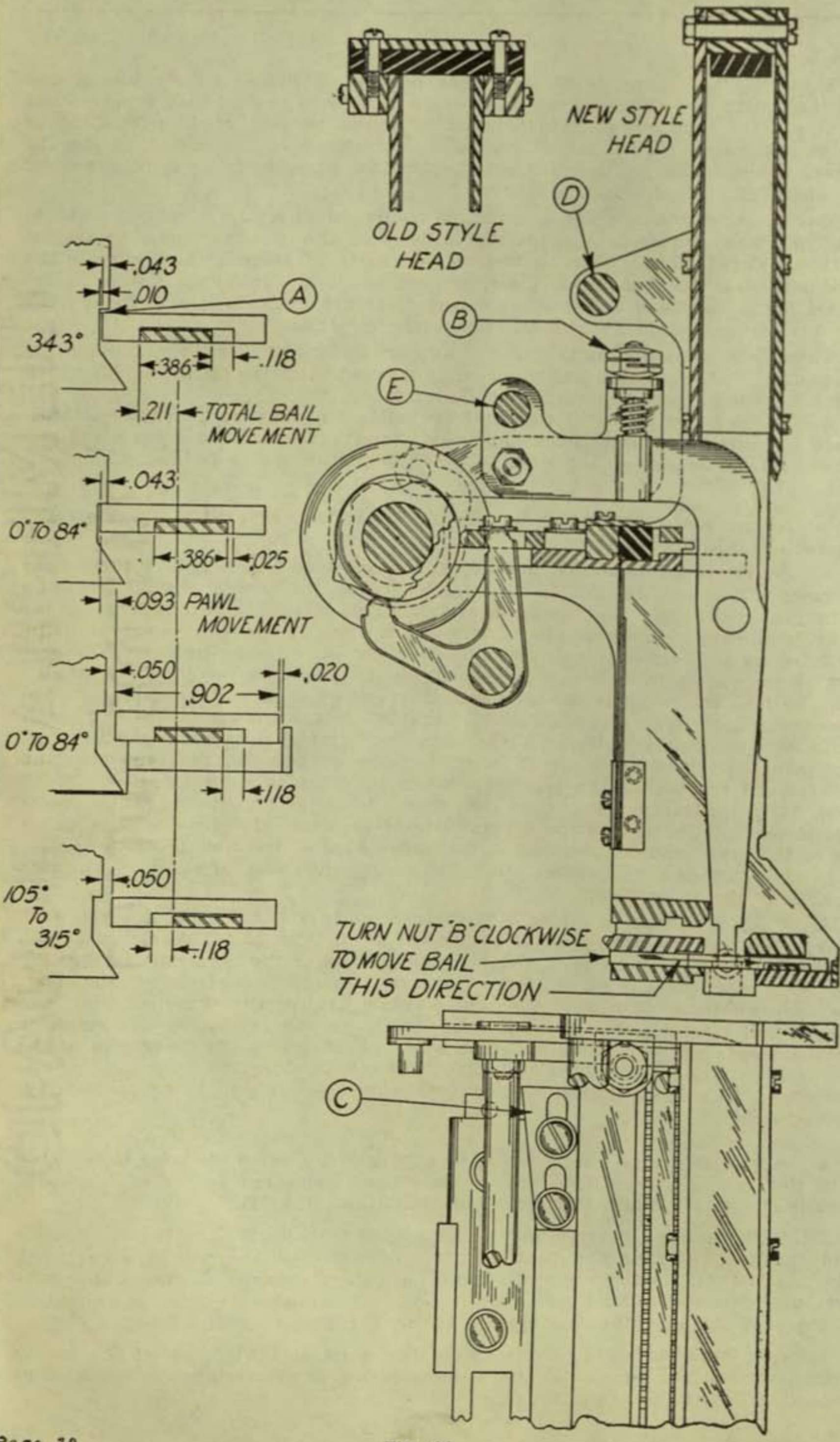
3. With the machine set at 343° there should be a .010" clearance between the type bar and the zone pawl as shown at "A" in Fig. 12. This clearance can be observed by looking through the hole in the side of the type unit. Adjusting nuts "B" are provided to obtain this adjustment. In order to obtain a .010" clearance back off these nuts until the zone pawl is against the type bar, and then turn the nut clockwise one complete revolution, as one revolution will result in a clearance of .010" Continue the cycle by hand, observing the movement of the bars until stopped by the zone bail. All the bars should move downward at the same time. This is an indication that both nuts are adjusted in proper relation to each other.

Fig. 13

4. Adjust the zoning bails so the type bars will overlap the zone bails 1/16", "A," when the type bars have been released and deposited on the zoning bails. This adjustment is obtained by means of zoning bail link "B."

5. With the type bar resting on the zero zone bail "C" and the machine is at 204°, adjust the zone unit locating bar screws "D" so the zero type bar tooth is in line with the selecting pawl. This adjustment results in the proper zero printing alignment. A card punched "0" and "8" in alternate columns should be run through the machine in order to check the proper alignment.

6. List lap adjustment. With the machine set at 115½°, adjust the zoning carrier lever shaft eccentric "E" until the selecting pawl overlaps the second type bar tooth 1/64" as shown at "F."



NEW STYLE HEAD
OLD STYLE HEAD
D
B
E
A
C
.043
.010
343°
.386
.118
.211
TOTAL BAIL MOVEMENT
.043
0° To 84°
.386
.025
.093
PAWL MOVEMENT
.050
.902
.020
0° To 84°
.118
.050
105° To 315°
.118
TURN NUT "B" CLOCKWISE TO MOVE BAIL THIS DIRECTION

Fig. 12

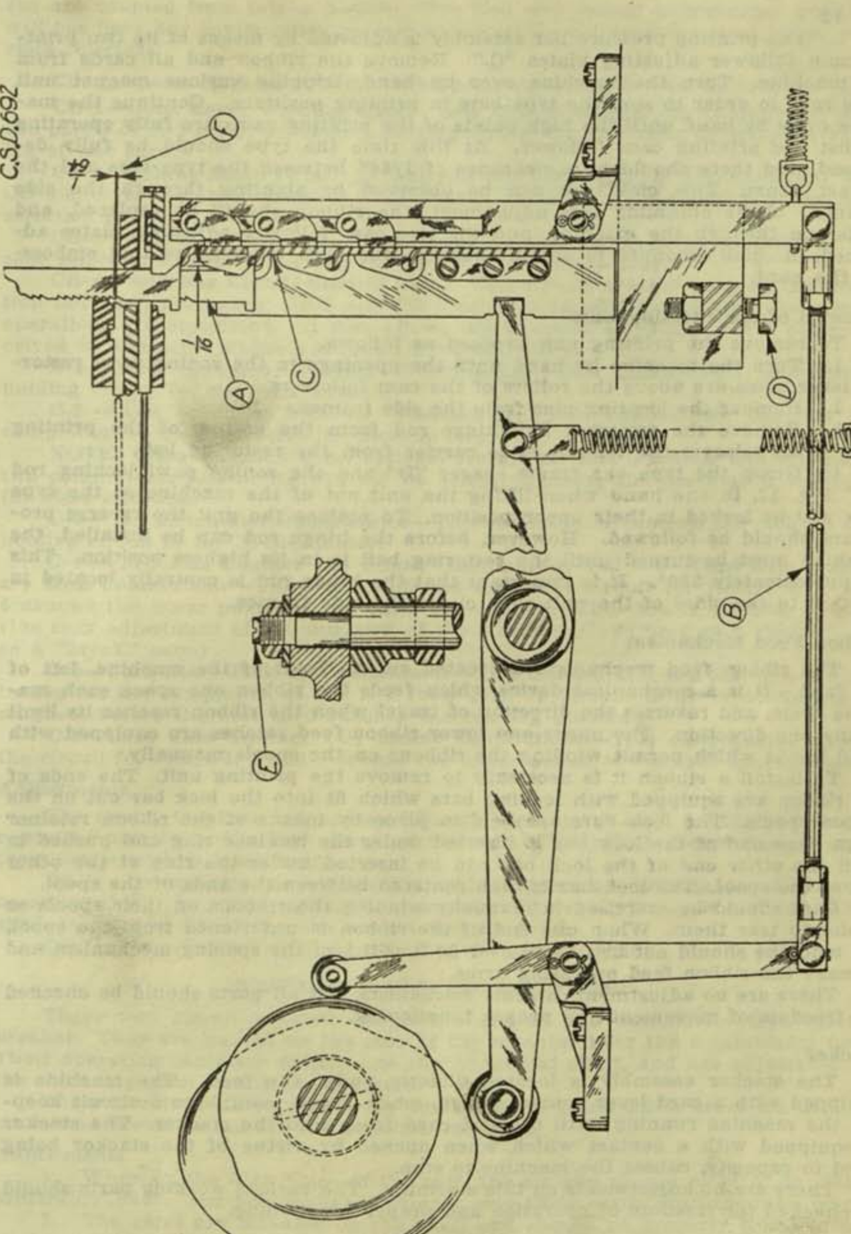


Fig. 13

Fig. 12

7. The printing pressure bar assembly is adjusted by means of its two printing cam follower adjusting plates "C." Remove the ribbon and all cards from the machine. Turn the machine over by hand, tripping various magnet unit drive rods in order to stop the type bars in printing positions. Continue the machine cycle by hand until the high points of the printing cams are fully operating against the printing cam follower. At this time the type should be fully depressed, and there should be a clearance of 1/64" between the type face and the contact drum. This clearance can be observed by sighting through the side castings. After obtaining this adjustment, the ribbon should be replaced, and cards run through the machine, and the two cam follower adjusting plates advanced, in small amounts, to obtain clearness and even pressure without embossing the card.

Removal of the Printing Unit

To remove the printing unit proceed as follows.

1. Turn the machine by hand until the openings in the zoning pawl restoring lever cams are above the rollers of the cam followers.
2. Remove the locating pins from the side frames.
3. Remove the restoring ball hinge rod from the bottom of the printing unit. This releases the friction slide carrier from the restoring ball.
4. Grasp the type bar frame spacer "D" and the zoning pawl locking rod "E," Fig. 12, in one hand when lifting the unit out of the machine so the type bars will be locked in their upper position. To replace the unit the reverse procedure should be followed. However, before the hinge rod can be installed, the machine must be turned until the restoring bail is in its highest position. This is approximately 336°. It is important that the hinge rod is centrally located in relation to the sides of the unit so it clears the side frames.

Ribbon Feed Mechanism

The ribbon feed mechanism is located on the front of the machine, left of the feed. It is a mechanical device which feeds the ribbon one space each machine cycle, and reverses the direction of travel when the ribbon reaches its limit in any one direction. The upper and lower ribbon feed ratches are equipped with hand knobs which permit winding the ribbons on the spools manually.

To install a ribbon it is necessary to remove the printing unit. The ends of the ribbon are equipped with locking bars which fit into the lock bar cut on the ribbon spools. The lock bars are held in place by means of the ribbon retainer rings. One end of the lock bar is inserted under the retainer ring and pushed in until the other end of the lock bar can be inserted under the ring at the other end of the spool. The lock bar is then centered between the ends of the spool.

Care should be exercised in manually winding the ribbons on their spools so as not to tear them. When one end of the ribbon is unfastened from the spool, the machine should not be turned over as it will jam the spacing mechanism and damage the ribbon feed operating arms.

There are no adjustments on this mechanism, but all parts should be checked for freedom of movement and proper functioning.

Stacker

The stacker assembly is located directly under the feed. The machine is equipped with a card lever contact which, when closed, completes a circuit keeping the machine running until the last card feeds into the stacker. The stacker is equipped with a contact which when opened by virtue of the stacker being filled to capacity, causes the machine to stop.

There are no adjustments on this assembly. The various working parts should be checked for freedom of operation and proper functioning.

CIRCUIT BREAKER AND COMMUTATOR UNIT

This unit is located on the left rear end of the machine, and is composed of four circuit breaker assemblies and seven commutator assemblies, all mounted on a vertical shaft. The shaft is driven from the horizontal drive shaft by means of worm gears.

The circuit breakers are located at the top end of the shaft and are numbered from top to bottom. The commutators are lower down on the shaft, and they too are counted from top to bottom. The first and second commutator positions will not have any commutator contact straps unless the machine is equipped with class selectors.

The purposes of these circuit breakers and commutators are as follows:

CB-1—Card Lever Holding Cam. This circuit breaker, in conjunction with the points of R-2 relay, provides a holding circuit for R-2 relay to complete reading of last card.

CB-2—Zoning Make Cam. This circuit breaker, working in conjunction with CB-3 and various other contacts in the circuit, controls the completion of the zone selection circuit.

CB-3—Zoning Break Cam. This circuit breaker controls the duration of the zone selection circuit by opening the circuit at a definite time.

CB-4—Selection Circuit Control Cam. This circuit breaker controls the selection impulses, preventing CB-5 and CB-6 functioning electrically until the zoning operations are completed. It also allows the selection impulses 1 to 9 being received by the print magnets through CB-5 and CB-6.

C-1—Class Selection Holding Commutator. This commutator provides a holding circuit for the class selector.

C-2—Class Selection Pick-up Commutator. This commutator controls the completion of the class selection pick-up circuit.

NOTE: Class Selection is an optional feature on this machine, and the above two commutator assemblies will not be complete unless the machine is equipped for class selecting.

C-3—"X" Eliminator Commutator—This commutator controls the pick-up and holding circuit of the X-Eliminator.

C-4—Card Jam Contact (L) Shunt Commutator, and C-5—Card Jam Auxiliary Cam Commutator—These commutators shunt the circuit for Relays 1, 5, and 6 around the lower points of the card jam contact. They are in parallel to provide easy adjustment of the duration of the circuit. (C5 is used as a "make", C4 as a "break" cam.)

C-6—Card Lever Pick-up Commutator—This commutator establishes a definite timing for the completion of the R-2 relay pick-up circuit, to prevent tripping of magnets before the first card reaches the reading position.

C-7—Card Jam Contact (U) Shunt Commutator—This commutator shunts the circuit for relays 1, 5 and 6 around the upper points of the card jam contact.

Adjustments

The circuit breakers are adjusted for an air gap of .015" to .025" when the operating arm is on the high dwell of the cam. The points should contact over their entire surface when made.

On the commutator assemblies, the contact straps are adjustable, and should be adjusted for the proper duration of contact. The commutator is shifted on the shaft in order to time it for the correct making point.

Consult the electrical timing chart for the proper timing.

SELECTION CIRCUIT BREAKERS

These two circuit breaker assemblies are of the automobile type circuit breaker. They are located on the rear of the machine near the commutator unit. Their operating cams are fastened to the horizontal shaft, and are adjustable on the shaft to permit timing the breakers.

These circuit breakers, which are numbered CB-5 and CB-6, provide a definite make and break timing for the selection impulses.

Adjustments

1. When on the high point of the cam, the air gap should be .015" to .025", preferably .020". The points should contact over their entire surface when made.
2. The cams are movable on the shaft and should be properly timed in accordance with the timing chart. In order to facilitate the timing of these circuit breakers, the section of the timing chart allotted to these breakers is divided into degrees.
3. The spring tension on the operating contact arm should be 15 to 16 ounces. It is imperative that this tension be correct, as it will prevent excessive wear of the fiber cam follower.
4. Check the operating arm for free movement on its pivot.

CARD LEVER, CARD JAM, AND STACKER CONTACTS

The location, purpose, and adjustment of these contacts are as follows:

Card Lever Contact—This contact is located under the feed magazine. It is actuated by a plunger which receives its motion from a card lever, which in turn is operated by the card as it emerges from between the first set of feed rolls.

The purpose of this contact is to control the energizing of Relay No. 2, preventing this relay from being energized when no cards are feeding.

This contact should be adjusted for a 1/16" air gap, when open, and when closed the operating strap should move the right strap 1/32" off its brass support. The card lever assembly should be adjusted by bending, so when it is fully operated by a card, its lower end will not strike the casting. When no cards are operating the lever, the plunger should be against the operating strap.

Card Jam Contact—This contact is located to the left of the card lever contact. It is operated by a card lever which is actuated by the cards as they pass through the lower ejector rolls into the stacker.

The purpose of this contact is to control, in conjunction with its shunt commutators, the circuit to the motor relays, opening this circuit in case of a card jam, and consequently causing the machine to stop.

It is very essential that the contact assembly be adjusted so the contacts make and break in accordance with the timing on the electrical timing chart. The air gap between the points, when the points are open, should be .020" to .025". When the lower contact points are open, the lower strap should have a .015" rise off its brass support. The card jam contact lever stop should be adjusted for a slight clearance between the stop and the insulator on the center strap when the card **jam lever is fully operated by a card.**

Stacker Contact—This contact is located below the stacker, and it is operated by the card stacker when the stacker fills to capacity.

The purpose of this contact is to open the motor relays circuit when the stacker fills to capacity, and thereby stopping the machine.

When the contact is made, there should be sufficient tension on the operating strap to raise the other strap 1/64" off its brass support. The contact should be adjusted to break when the stacker fills to its capacity, which is approximately 900 cards.

RELAYS

Mounted on relay panels in the front and rear cabinets are the necessary operating relays. The heavy duty G.E. motor relays are located in the front cabinet, and the duo and multi-contact relays are located in the rear cabinet. Class selection and additional X-elimination relays are also located in the rear cabinet. The positions of the relays in the rear cabinet are illustrated on the wiring diagram incorporated in the write-up.

The part numbers of the relays and the type of relays are as follows:

Part No.	Type of Points Looking at Armature End A	B	C	Relay No.
				Duo Relays
111288	—	—	M	1
117378	—	—	M	2
26477	M	M	—	3 and 4 Class Selector (Optional)
				G. E. Relays
39720	—	—	—	Motor Relays 5 and 6
				Multi-Contact Relays
123791	—	—	—	X-Eliminator and Class Selector (Optional)

Adjustments

The following adjustments apply to all relays:

1. All relay armatures should be free.
2. Armature and armature retainer clearance should be .002" to .003".
3. All points should be clean and line up.
4. Upper contact spring stop should be adjusted to just touch the upper contact strap with slight tension when the armature is energized.

The following adjustments apply to relays as listed.

Relay 26477

1. Armature and core gap when de-energized .015".
2. There should be a .015" air gap between the contact points.
3. The upper contact strap should have a .010" rise off its support when the armature is attracted.

Relay 111288

1. Armature and core air gap when de-energized .020".
2. Air gap between the contact points should be .020".
3. The upper contact strap should have a .015"—.020" rise off its support when the armature is attracted.

Relay 117378

Same as relay 111288.

MC Relay 123791

1. Armature and core air gap when de-energized .030".
2. Adjust make contact for .020" air gap when de-energized.
3. Break contact to have a .010" lift off its support when de-energized.
4. Make contact to have a .010" to .015" lift off its support when energized.
5. Break contact to have sufficient air gap when energized.

Purpose of Relay Contacts

R-1—These points when normally open prevent energizing the motor relays, with the consequent starting of the machine, by any means other than the depression of the start key.

R-2—These points when normally open prevent the completion of the zoning and selection circuits when no cards are feeding into the machine.

X-Elimination MCR—This relay is used in controlling the impulses to the print magnets when it is desired to eliminate either "12" or "X" impulses. The normally closed points permit the completion of the "12" and "X" circuits to the print magnets, and the normally open points when closed permit the completion of the 0 to 9 circuits to the print magnets.

CIRCUITS

1. Generator Motor Circuit. When the main line switch, which is of the sentinel circuit breaker type, is placed in its "ON" position it completes a circuit to the generator motor. The circuit is as follows: One side of the main line, thermal unit side of the circuit breaker switch, plug contact, generator motor, plug contact to the other side of the circuit breaker and out the other side of the line.

The generator motor is coupled to the generator, and when the generator is operating at its efficient output, the red signal light will glow. The circuit for this light is directly across the line from post 6 to post 1. The start key should not be depressed until the signal light glows.

2. Generator Circuits. The generator circuits will be as follows: 10 amp. fuse, plug contact, terminal line connection "L", series field, armature, armature connection "A," plug terminal to 10 amp. fuse. At the same time, a parallel circuit is completed through the shunt field of the generator: 10 amp. fuse, plug contact terminal line connection "L," shunt field, field connection "F," external variable resistor, contact terminal "A" to 10 amp. fuse.

NOTE: The external variable resistor is used to control the output of the generator.

3. Start Key Circuit. After the generator motor has driven the generator for approximately half a minute, the output of the generator will be sufficient to operate the machine. This will be indicated by a red signal light on the latest machines. When the start key is depressed the following circuit will be completed: Post No. 7, start key, coils of R-1, coils of the motor relays 5 and 6, stop key, stacker stop contact to post No. 2.

4. Drive Motor Circuit. Energizing the motor relays 5 and 6 and the consequent closing of their contact points, will complete a circuit to the drive motor as follows: One side of the main line circuit breaker switch, points of motor relay No. 5, plug contact, drive motor, plug contact, points of motor relay No. 6 to the thermal unit side of the circuit breaker switch. The drive motor will continue to run as long as relays 5 and 6 are energized.

5. **R-1, R-5, and R-6 Holding Circuit.** These relays will be held energized through circuits under control of C-4, C-5, C-7, and the card jam contact. These circuits, however, can be opened at any time through the operation of the stop key or the stacker stop. When first starting the machine after placing cards in the feed magazine, it will be necessary to hold the start key depressed until the third machine cycle in order to permit the first card to reach the card jam contact position. As this machine is not equipped with any means of stopping at a definite point on the index, we will assume for purposes of explanation that it is stopped at "0." The depression of the start key will then cause the machine to go into a machine cycle and the holding circuits for the above relays will be as follows:

(A) After the machine cycle has advanced C-4 and C-7 to their making points, the circuit will be from post No. 8, C-7, C-4, contact points and coil of R-1, coils of R-5 and R-6, stop key, stacker stop to post No. 2.

(B) When C-4 breaks and before the card jam lever operates, the circuit will then be as folows: Post No. 8, C-7, lower points of the card jam contact, contact points and coil of R-1, coils of R-5 and R-6, stop key, stacker stop to post No. 2. A parallel circuit thru C-5 will also be established shunting around the card jam contact lower when C-5 makes.

When cards reach the card jam contact lever station operating the lever and opening the lower contact points and closing the upper points, the holding circuits will be as follows:

(C) When the upper points of the card jam contact makes before C-7 breaks, the following circuit will be established: Post No. 8, upper points of the card jam contact, C-5, contact points and coil of R-1, coils of R-5 and R-6, stop key, stacker stop to post No. 2. After C-5 breaks and before C-7 makes, the circuit will then be held through C-4 and the upper card jam contacts. When C-4 breaks then the circuit will be held through C-7 and the lower points of the card jam contact until C-5 makes. Before C-7 breaks, the upper points of the card jam contact makes and then the circuit is identical to the circuit described above

6. **R-2 Pick-up Circuit.** After the card lever contact is closed by means of the card passing through the first set of feed rolls, C-6 makes completing the pick-up circuit as follows: Post No. 8, C-6, card lever contact, coil of R-2 to post No. 3.

7. **R-2 Holding Circuit.** After C-6 breaks, R-2 will hold up through its own contact points and CB-1 as follows: Post No. 9, CB-1, points and coil of R-2 to Post No. 3. This relay will be continuously held up through circuits 6 and 7 as long as cards are feeding.

8. **Zoning Circuits.** These circuits are under control of CB-2 and CB-3, and are completed only while cards are feeding. The circuit is as follows: Post No. 9, CB-1, points of R-2, CB-3 and CB-2, common brush, contact drum, holes in the card, reading brushes, plughubs, plug wires to the desired print magnet plughubs, coils of print magnets to post No. 4.

9. **Selection Circuits.** These circuits are under control of CB-4, CB-5, and CB-6, and are completed only when cards are feeding. The circuit is as follows: Post No. 9, CB-1, contact points of R-2, CB-4, CB-5 and CB-6, common brush, contact drum, holes in the card, reading brushes, plughubs, plug wires to the desired print magnet plughubs, print magnets to post No. 4.

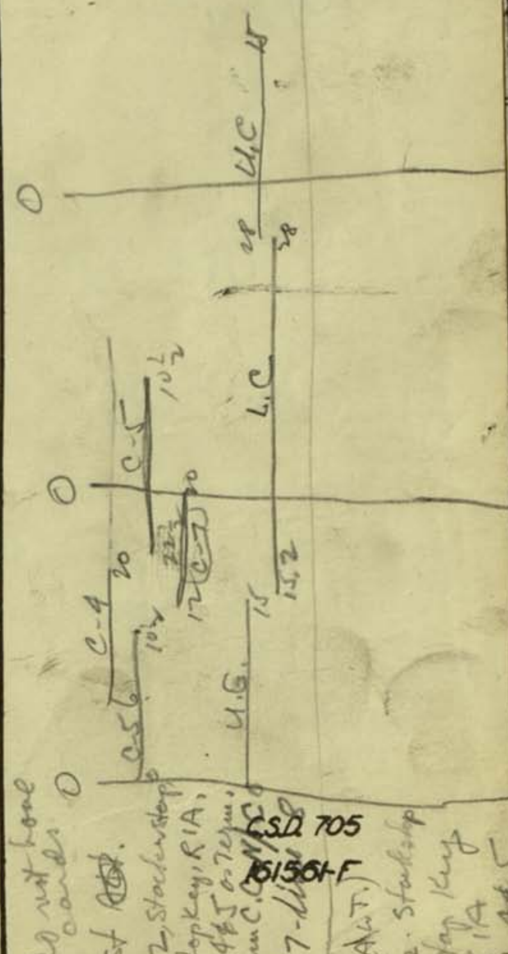
10. **"X"-Eliminator MCR Circuit.** When using this relay in connection with suppressing the sensing of "X" and "12" impulses, and also in connection with the use of class selectors. The circuit is as follows: Post No. 9, CB-1, points of R-2, "X Elimination" hubs plugged "ON," C-3, "X"-eliminator MCR to post No. 3. This relay remains energized as long as C-3 is made.

11. **"X"-Elimination Circuit.** When it is desirous to eliminate "X" and "12" impulses when only 0 to 9 interpretation of certain fields is wanted, the following circuit is completed: Post No. 9, CB-1, points of R-2, CB-4, CB-5, CB-6, common brush, contact drum, hole in card, reading brush, plughub, plug wire to common plughub of X-eliminator, normally open contact points, 0-9 plughub of X-eliminator, plug wire to desired print magnet plughub, print magnet to post No. 4.

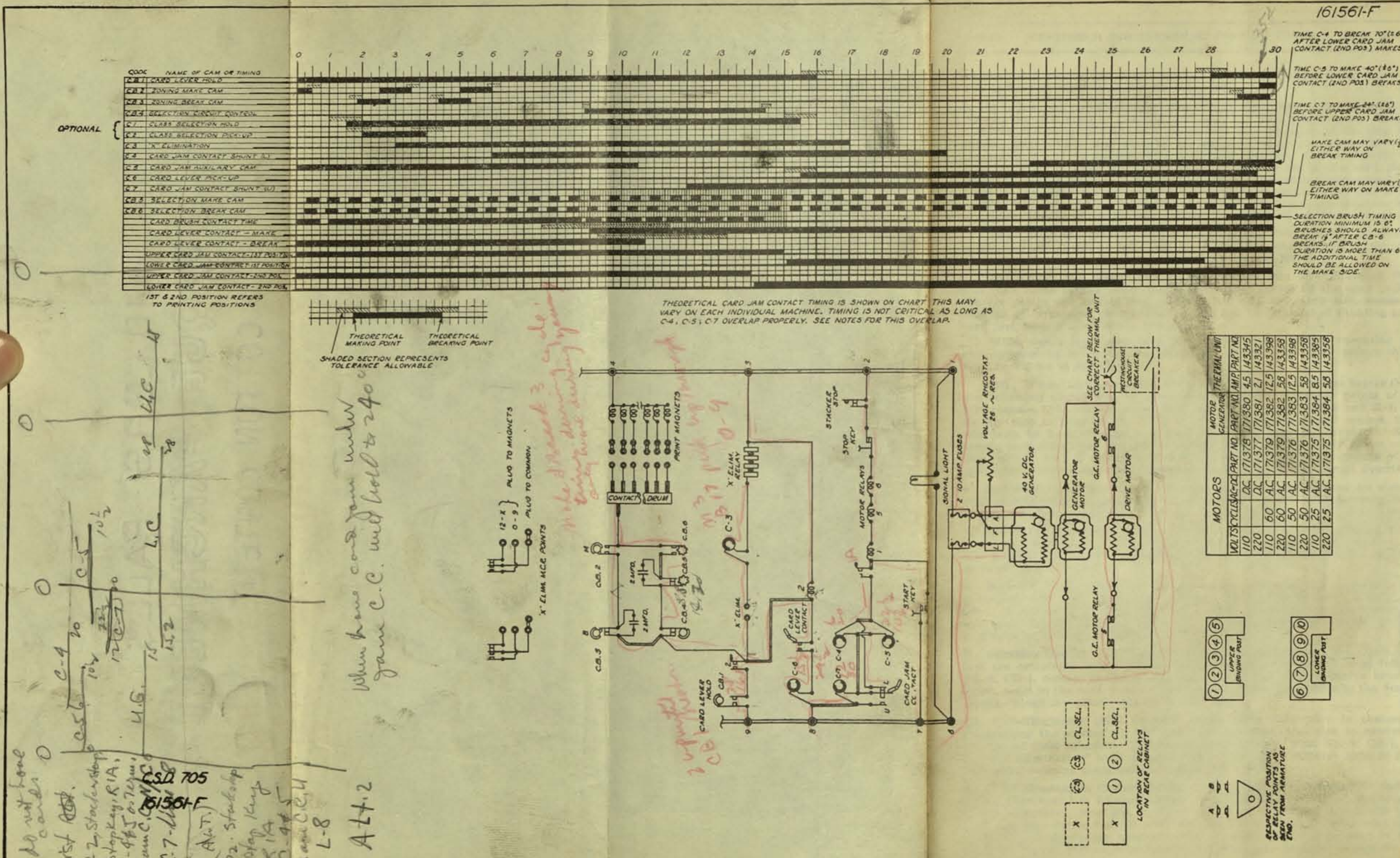
CODE	NAME OF CAM OR TIMING
CB 1	CARD LEVER HOLD
CB 2	ZONING MAKE CAM
CB 3	ZONING BREAK CAM
CB 4	SELECTION CIRCUIT CONTROL
C 1	CLASS SELECTION HOLD
C 2	CLASS SELECTION PICK-UP
C 3	"X" ELIMINATION
C 4	CARD JAM CONTACT SHUNT (L)
C 5	CARD JAM AUXILARY CAM
C 6	CARD LEVER PICK-UP
C 7	CARD JAM CONTACT SHUNT (U)
CB 5	SELECTION MAKE CAM
CB 6	SELECTION BREAK CAM
	CARD BRUSH CONTACT TIME
	CARD LEVER CONTACT — MAKE
	CARD LEVER CONTACT — BREAK
	UPPER CARD JAM CONTACT—1ST POSITION
	LOWER CARD JAM CONTACT 1ST POSITION
	UPPER CARD JAM CONTACT—2ND POS.
	LOWER CARD JAM CONTACT— 2ND POS.

OPTIONAL { C 1, C 2

1ST & 2ND POSITION REFERS TO PRINTING POSITIONS



161561-F



MOTORS				MOTOR GENERATOR	THERMAL UNIT	
VOLTS	CYCLES	AC-DC	PART NO.	PART NO.	AMP.	PART NO.
110		D.C.	171378	171380	4.5	143345
220		D.C.	171377	171381	2.1	143321
110	60	A.C.	171379	171382	12.5	143398
220	60	A.C.	171379	171382	5.8	143358
110	50	A.C.	171376	171383	12.5	143398
220	50	A.C.	171376	171383	5.8	143358
110	25	A.C.	171375	171384	8.5	143385
220	25	A.C.	171375	171384	5.8	143358

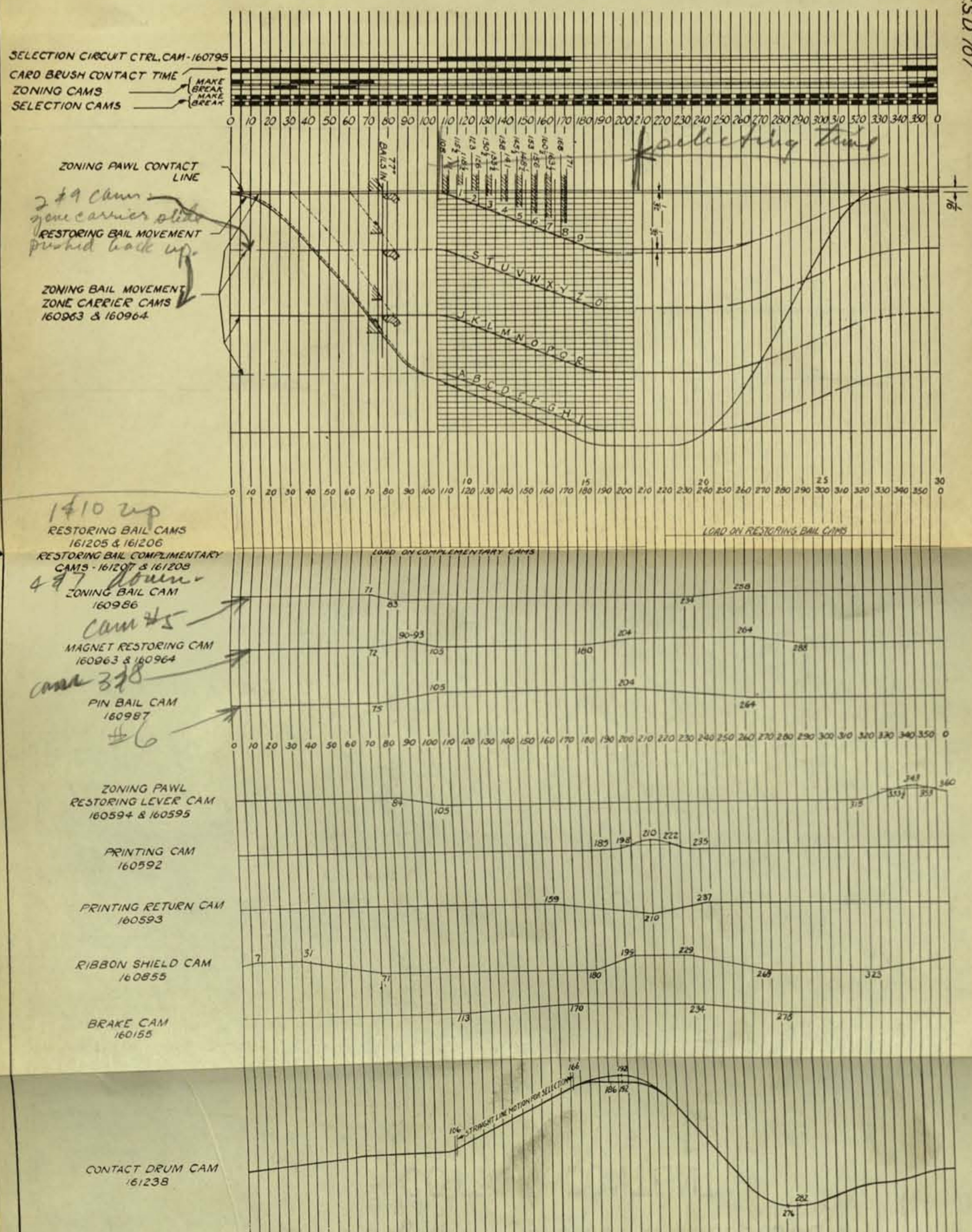
When have card jam under jam C.C. will hold to 240°

C.S.D. 705
161561-F

Alt. 2

Fig. 14

C.S.D. 707



TOLERANCE OF CAM SHAFT SETTINGS

SEE SERVICE INSTRUCTIONS FOR METHOD OF TIMING - E.B.A. SECTION 552

NOTE 1- CAM NUMBERS INDICATE CAM POSITION ON SHAFT - COUNTING FRONT TO REAR

MAIN CAM SHAFT ASSEMBLY :- PLUS OR MINUS $\frac{1}{2}$ DEGREE

CAMS:-
- 1 & 10 - RESTORING BAIL CAM
- 2 & 9 - ZONE CARRIER CAM
- 3 & 8 - MAGNET UNIT RESTORING CAM
- 4 & 7 - RESTORING BAIL COMPLIMENTARY CAM
- 5 - ZONE BAIL CAM
- 6 - PIN BAIL OPERATING CAM

PRINTING CAM SHAFT ASSEMBLY - PLUS OR MINUS $\frac{1}{2}$ DEGREE

CAMS:-
- 1 & 5 - ZONING PAWL RESTORING LEVER CAM
- 2 & 4 - PRINTING CAM
- 3 - PRINTING RETURN CAM
- 6 - RIBBON SHIELD CAM

FEED CAM SHAFT:

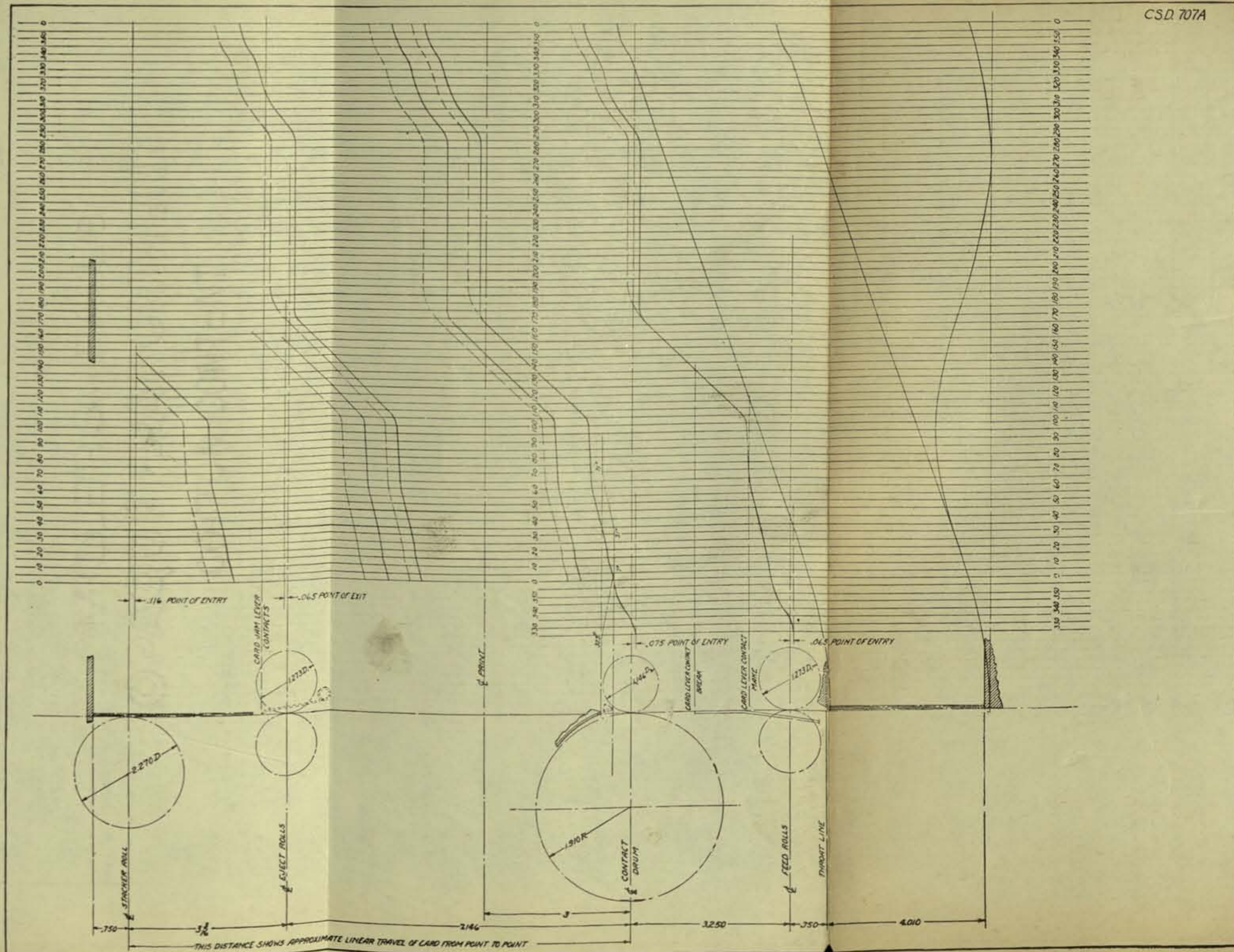
CAMS:-
- 1 - BRAKE CAM
- 2 - CONTACT DRUM CAM

CARDS/MIN.	SECS/DEGREE	DEGREES/SEC.
60	.00278	360

30)360 12

Printed in U. S. A.

CSD 707A



.116 POINT OF ENTRY
.065 POINT OF EXIT
CARD JAM LEVER CONTACTS
1.273 D.
2.270 D.
℄ PRINT
.075 POINT OF ENTRY
1.146 D.
CARD LEVER CONTACT BREAK
CARD LEVER CONTACT MAKE
.065 POINT OF ENTRY
1.273 D.
1.910 R
℄ STACKER ROLL
℄ EJECT ROLLS
℄ CONTACT DRUM
℄ FEED ROLLS
THROAT LINE
.750
3 3/16
2.146
3
3.250
.350
4.010
THIS DISTANCE SHOWS APPROXIMATE LINEAR TRAVEL OF CARD FROM POINT TO POINT

IBM CUSTOMER ENGINEERING REFERENCE MANUAL

PREVENTIVE MAINTENANCE

Alphabetical Interpreter Type 552

CONTENTS

Form 22-5749-2

PREVENTIVE MAINTENANCE

Alphabetical Interpreter, Type 552

General

Machine should be given a general cleaning before the actual inspection is begun. Brush out card dust and wipe up any excess grease and oil from the base and the various parts. Check conditions of ribbon at this time. If ribbon replacement is necessary, remove and wipe ink from ribbon shield and associated parts. A better, more efficient inspection can be performed on a clean machine.

CAM AND DRIVE SHAFTS

I. Cleaning

All dirt and old grease should be cleaned from cams and cam followers.

II. Inspection

1. Cam Followers for loose studs.
2. Cams for loose pins.
3. Contact Drum brake and ratchet assembly for freedom of action.

III. Lubrication

IBM 9

(1) Reverse friction lock, particularly at point where steel shoulder of drive pulley operates against the reverse friction lock arm.

IBM 17

(1) Light film on all linen dilecto gears.
(2) All gears and cam surfaces not lubricated by Bijur System.

IBM 21

(1) Zerk fitting in drive pulley.

FEED UNIT

I. Cleaning

See *General Section* under headings listed below.

II. Inspection

1. Hopper and Feed Rolls (see *General Section—Horizontal Feeds*)
   (a) CLEANING
   (b) FEED KNIFE ADJUSTMENTS
   (c) FEED KNIFE GUIDE SLIDES
   (d) EVEN FEEDING OF CARDS
   (e) HOPPER SIDE PLATES
   (f) ROLLER THROAT
   (g) FEED ROLL TENSION
   (h) CONTACT ROLL CARD GRIPPERS for good spring tension.
   (i) FEED KNIFE TIMING
   (j) HOPPER POSTS

2. Brush Assemblies (see *General Section*)
   (a) CLEANING. It is essential to keep the contact roll absolutely free of all particles of dirt or other foreign matter, not only to insure good electrical contact but also to insure clear printing impressions on the card. Removing the card guide between the contact roll and the hopper will simplify the cleaning.
   (b) BRUSH SEPARATORS. Revolve the rolls and watch for brush movement. Any dirt between the separators will result in brush movement.

(c) BRUSHES
(d) BRUSH ALIGNMENT TO SCRIBED LINE. Use gauge #450388 and line nearest bend in gauge.
(e) BRUSHES EVENLY SPACED BETWEEN SEPARATORS. Special care should be taken that all dirt is cleaned from between the segments of the feed roll separator. The grooved dilecto roll is adjusted horizontally by means of the brush roll locating collar so that the brushes are in the center of the grooves. Use the brush bending tool on individual brushes. Revolve the roll to make sure brushes are free all the way around.
(f) BRUSH TRACKING. Change by shimming the brush assembly holding brackets located on the side castings.
(g) BRUSH TIMING. The brushes are timed to the holes in the card so they will make at least $1\frac{1}{2}°$ before every selecting impulse, and break not earlier than $1\frac{1}{2}°$ after each selecting impulse breaks. The make and break timing of the brushes should be checked for each selecting and zoning impulse. The correct timing is obtained by loosening the holder clamping screws and moving the holder left or right in the assembly. Make sure that the clamping screws are tightened after the correct timing is obtained. The brushes should never have a duration of longer than 2° before and after the make and break of the selection circuit breakers, or a total of 7° duration at selection time. See information on "CB's" under *Base* for this machine.

3. Stacker
   (a) STACKER ROLLS for freedom of operation and wear.
   (b) JAM CONTACT for adjustment and timing.

4. Card Levers (see *General Section*)

III. Lubrication

IBM 6

(1) Roller throat.
(2) Card lever pivot points.

IBM 9

(1) Feed knife guide slides.
(2) Feed knife guide pin.
(3) Brush separator roll bearings.
(4) Card stacker shaft assembly pivots.
(5) Bell crank assembly pivot.

IBM 17

(1) Card levers—very light film between operating lever and phenolic pad on contact strap.
(2) Both ends of bell crank assembly.

PRINT UNIT

I. Cleaning

Type bars should be cleaned of all dirt and old ink. The face on the type tails should be cleaned with a stiff brush taking care to clean out all accumulated material from the center of the letters. An alternate cleaning method would be to use plastic type cleaner, part 450528.

II. Inspection

1. Type Unit. Before removing type unit from machine, operate the machine manually under power without cards and observe the operation of the type bars. They may best be viewed from the left end of the machine under the magnet unit. Check the releasing time and the restoring of the bars. Any bars in which the friction slide spring tension is insufficient will have a tendency to fall down during the restoring part of the cycle. Note the number of any bars not operating correctly and correct when unit is removed.

With unit removed:

(a) TYPE BARS for bent or broken type tails, broken type tail springs and freedom of operation of type bars in their guides.
(b) PRINTING PRESSURE BAR ASSEMBLY for wear.

2. Magnet Unit. Check with unit removed from machine.

(a) DRIVE ROD BAIL for freedom of movement.
(b) ARMATURES for wear at point where drive rod lever contacts it.
(c) TERMINAL WIRES for loose or broken connections.
(d) RIBBON FEED ASSEMBLY for wear and freedom of operation.

III. Lubrication

IBM 6

(1) Print magnet armature pivot point.
(2) Type bar stop pawls.

IBM 9

(1) Ribbon feeding mechanism.

IBM 17

(1) Magnet armatures at point where drive rod levers rest.
(2) Internal cuts in zoning pawl restoring lever cams.
(3) Top of magnet unit restoring levers where they fit into slot in sides of magnet unit.
(4) Zone carrier lever arms at end that fit into type unit.
(5) Type bar friction springs.

IBM 21

(1) Cam rollers for magnet restoring cam.
(2) Cam roller on zoning carrier lever.
(3) Drive shaft end bearing behind linen dilecto gear.

BASE

1. CB Cams and Contacts (see *General Section*)

When the brushes are worn to the extent that the duration of contact through the hole in the card is increased, difficulty may be experienced both with the brushes making too early and too late. Wear of the CB cams, contacts and cam followers resulting in longer impulses, aggravates this condition. A worn brush, making contact early through a hole in the card before CB 5 and 6 have broken the circuit for the previous impulse, may result in tripping the magnets early causing printing under. With a worn brush making contact too long, or if CB 4, 5 and 6 are making early, it is possible for a zero hole to make contact for a one impulse and the type bar will be stopped by the zero-one position which is normally blank. To overcome these conditions, the timing below should be adhered to: CB 5 makes at 108° for a one impulse, CB 6 breaks three degrees later at 111°. As further check, CB 5 should make at 153° and CB 6 should break at 156° for a 7 impulse. CB 4 should not make earlier than 107°.

Occasionally a brush will drop into the zero hole in the card, while the zone make cam CB 2, due to its long duration, is closed for an X and if the brush overlaps the CB by as little as 1° the discharge of the 2MFD condenser may operate the print magnet. Such an impulse will start the type bar moving much sooner than it should, and it may be deposited on the X bail.

To overcome this condition the zone cams CB 2 and 3 are now cut for a shorter duration. These cams, Part #160759, are available for installation and should be ordered on MES Group 11 to eliminate difficulties of this nature.

The theoretical timing of CB 2 and CB 3 with this shorter duration is shown on wiring diagram #161561-K reading as follows:

	Make	Break
CB 2	30°	36°
	60°	66°
	354°	360°
CB 3	28°	34°
	58°	64°
	352°	358°

2. Relays (see *General Section*)
3. Motors and Generators (see *General Section*)
4. Bijur System (see *General Section*)
5. Control Panel (see *General Section*)

TESTS

MOST CUSTOMERS have a 513 control panel wired for 80-80 reproducing. This may be inserted in the 552 and used for the first three tests below, if a test deck blank in columns 21 through 40 is used. Check the printing after running a test deck through once to be sure all positions have printed correctly; then run the same deck through several times and check to see that the printing has been the same every time.

1. Check a test deck punched with numeric information in all positions.
2. Check alphabetical interpretations with the same control panel using cards punched with the alphabetical characters in sequence in all columns of the card.
3. Punch a card with zeros in all columns. Check printing results. For further checking, punch an individual card in all columns for each digit and letter. Check results.
4. Check X elimination device operation.
5. Check zero elimination device (optional feature).
6. Check quality of all printing for clearness and legibility.
7. Check to see that cards are not embossed.
8. Stand by and check the customer's work as it comes off machine to insure against trouble being left which the above tests did not show. Also, it is possible to place trouble on machines when covers are installed.

PREVENTIVE MAINTENANCE

Electric Multiplier Type 601

CONTENTS

New York, New York
Printed in U.S.A.
Form 22-5750-0

PREVENTIVE MAINTENANCE

Electric Multiplier, Type 601

CARD FEED UNIT

I. Cleaning

The card feed unit requires frequent inspection to insure good performance. On every inspection the feed should be carefully cleaned of all dirt, excess oil, card dust, etc. Clean out all dirt and card dust from the feed knife slide guides and from the throat roller.

II. Inspection

1. Clutch for freedom of operation and for all adjustments.
2. Feed (see *General Section—Horizontal Feeds*)
   - (a) CLEANING
   - (b) FEED KNIFE ADJUSTMENTS
   - (c) FEED KNIFE GUIDE SLIDES. It is not necessary to turn the entire machine over by hand to check these for freedom of operation as suggested in the general section. They may be checked by removing a spring clip in the operating linkage.
   - (d) EVEN FEEDING OF CARDS
   - (e) HOPPER SIDE PLATES
   - (f) ROLLER THROAT
   - (g) FEED ROLL TENSION on the first, second and third set of rolls.
   - (h) AUXILIARY FEED ROLLS for even tension and for freedom of operation of the small rollers. To give proper tension, the set screws holding the auxiliary feed roll bracket should be in a vertical position.
   - (i) TIMING OF FEED KNIVES. This in conjunction with setting the brushes. Check with hopper from 1/2 to 3/4 full of cards for best results. Change by cam link adjusting rod.
   - (j) HOPPER POSTS
3. Brush Assembly (see *General Section*)
   - (a) CLEANING
   - (b) BRUSH SEPARATORS
   - (c) BRUSHES
   - (d) 1/8" PROJECTION
   - (e) BRUSH ALIGNMENT TO SCRIBED LINE
   - (f) BRUSHES EVENLY SPACED BETWEEN SEPARATORS
   - (g) BRUSH TRACKING. This can be changed by shifting the brush holder in the slide assembly.
   - (h) CONTACT ROLL for shake and dirt.
   - (i) BRUSH TIMING
4. "X" Brushes and Card Lever (see *General Section*). Punch a card with all the X's normally used by the customer. Check the registration and feed this card into position to check the alignment of the X brushes. As the card is fed in, check for proper timing of the X brushes. Any X brushes that are damaged should be replaced. While the card is being fed past the X brushes, check for proper rise of the X card lever contact.
5. FC Cams (see *General Section—Make and Break Cam Contacts*). Also, wipe an oil cloth across the tension straps to prevent red rust.

III. Lubrication

IBM 6

(1) Roller throat.

IBM 9

(1) Pressure shoe first feed roll.
(2) FC cam shaft bearings.
(3) Feed roll bearings.
(4) Clutch pawl pivot.
(5) Ball closing oil well on ratchet gear.
(6) Pivot in cam link adjusting rod.

(7) Feed knife shaft.
(8) Feed knife guide slides.
(9) Three oil tubes on each side casting.

IBM 17

(1) Internal cam in CF index.
(2) Very light film on CF cam surfaces.

PUNCH UNIT

THE PUNCH NEED not be removed from the machine on every inspection; all adjustments can be checked with the punch mounted on the base. To lubricate and check the mechanisms under the base, the motor drive unit can be removed with the punch mounted on the base.

I. Cleaning

As in the case of all other units, the punch should be carefully cleaned before oiling or adjusting. Carefully clean out all dirt, oil, etc., around the key stems to insure freedom of operation. Do not soak the keys with oil to overcome sluggish action. If the keys have become very sluggish, remove the key unit, completely disassemble, and wipe all parts with an oil-soaked cloth. The rack should also be thoroughly cleaned with a stiff brush and cleaning fluid.

II. Inspection (see *016-031 Section for Detail*)

(1) Linkage from motor plate to punch magnet armature.
(2) Armature pivot shaft.
(3) Bell crank pivot screw.
(4) P.M. contact.
(5) "Slipping By".
(6) Motor plate linkage adjustments.
(7) Punch travel.
(8) Die.
(9) Dog and escapement.
(10) Rack.
(11) Skip lifter.
(12) Governor.
(13) Punching registration.
(14) Emitter fingers should be checked for wear and alignment with the emitter segments. Then wipe a thin film of IBM lubricant 17 over the surface of the emitter.
(15) Duplicating armature levers for freedom of operation. Any binds result in slow punching. Lift each lever slightly and see that it drops to normal because of its own weight.

III. Lubrication

Lubrication is the same as that for punch unit under 016-031 with the two following additions:

Use IBM 6 on duplicating magnet armature pivot points.
Use IBM 17 on the emitter face (only a slight film).

COUNTERS

UNLESS A COUNTER has been giving trouble, it need not be removed from the base when inspected. Whenever a counter has to be removed from the base to replace a part, take advantage of the opportunity to lubricate all cams and followers accessible from the bottom of the counter.

I. Cleaning

Clean all old grease and dirt from the unit. If too much lubrication has been used in the past, oil and dirt sometimes accumulates between the add magnet cores and their armatures. This can be wiped off with a rag soaked in cleaning fluid when add magnets are removed for inspection of add magnet armature residuals.

II. Inspection

1. Lower Counter

(a) ADD WHEEL CLUTCH GEAR for .008"-.012" clearance of teeth. If this is too close, it will indicate either a worn clutch lever or improper latch block adjustment.

(b) ADD MAGNET ARMATURES for .003"-.005" to latch block when attracted. This can be checked by tripping the armature by hand, allowing the clutch lever to pivot and move the high portion of the latch block in front of the armature. Tapping the armature with a light screwdriver should result in a very slight wink of the armature. About once or twice a year the add magnet should be removed to check the armature residuals.

(c) CLUTCH TEETH OVERLAP. Crank the machine to any index line from 9 through 1 and check each counter for $\frac{1}{32}$" overlap of the clutch teeth at this point. Be sure the overthrow locks are seated. Any variations indicate partly sheared pins or twisted shafts.

(d) OVERTHROW LOCK ASSEMBLY for loose overthrow lock screws which may have backed out part-way. Look at the inner right side plate for a broken spring on the adding wheel shaft bushing detent. This detent holds the adding wheels at 0 and prevents rotation of the shaft due to inertia at the end of a reset cycle. Consequently, a broken detent spring may result in overthrow of the adding wheels on reset. Also check both ends for wear on the bail and its operating cams.

(e) CARRY MAGNET for loose rivets in the armature and then check the unlatching clearance. Also, check operation of carry contacts in RHA and LHA counters.

2. Top Counter Moulding

Reset all counters to 5 and seat overthrow locks. Check all top counter gears for proper timing. If any counters have shown signs of improper timing of top counter brushes by occasional failures, remove moulding assembly and check individual brushes for damage and proper projection. Replace needed brushes and wipe a film of IBM lubricant 17 on the inner surface of the mouldings before replacing; to prevent additional damage to brushes, be sure to set the counter to 9 before removing the top counter moulding and to 1 before replacing it.

Reset clutches for unlatching and relatching adjustments and for loose collars. The proper adjustment of the reset clutch may be checked by resetting a counter while cranking the machine by hand. All carry levers should unlatch and move about ⅛" to $\frac{3}{16}$" before being relatched.

III. Lubrication

IBM 6

(1) Adding clutch lever pivots.
(2) Adding clutch gear pivots.
(3) Add wheels.
(4) Top counter shaft pivots.

IBM 9

(1) Clutch disengaging lever bail pivots.
(2) Overthrow lock pivots.
(3) Carry lever bail pivots.
(4) All bearings on both side plates.

IBM 17

(1) Clutch grooves on adding wheel clutch gear.
(2) Overthrow and carry lever bail cams.
(3) All cam surfaces under counter. These should be re-lubricated every time the counter is removed.
(4) Light film on the inside surface of the top counter mouldings any time they are removed.

MULTIPLYING AND COLUMN SHIFT PLATES

ALL THE MULTIPLYING and column shift plates should be removed *at least* once a year for lubrication unless usage requires more frequent inspection. While plates are removed, check for washers, screws, etc. in the plate housing assembly.

Before replacing plates in the unit, lubricate as directed. The adjustment of the individual bail eccentrics and knockoff screws will have to be checked after replacing the plates in the unit.

I. Cleaning

If contacts are dirty, wash with cleaning solution, using a ***clean brush***. The contacts may be cleaned by folding a piece of Trimite Paper and inserting it between all contact points. Then drag the paper out with only the tension of the contacts holding them together. Do not hold the contact points together, as too much cutting action results.

II. Inspection

With plate out of machine:

(1) BAILS, LATCHES AND ARMATURE for freedom of operation.
(2) CONTACT POINTS. After cleaning, check for $\frac{1}{32}$" clearance between points when the bail is latched.

With the plate in the machine:

(3) ARMATURE UNLATCHING CLEARANCE. Turn the machine to $14\frac{1}{2}$ index time. This is the time when CC2 makes to energize the magnet. The armature should be free from pressure at this time. Check all nine plates, then run the machine under power and recheck this adjustment.
(4) ARMATURE RELATCHING CLEARANCE. Turn the machine to the high point of the bail operating cam at 13 index time. Check to see that there is approximately $\frac{1}{32}$" travel of the split latch past the armature latch point.
(5) CONTACT POINTS with the contact bail unlatched all contacts should be positively closed. No rear strap should touch the insulating strip on the bail.

III. Lubrication

IBM 6

(1) Armature pivot.
(2) Split latch pivot.
(3) Bail pivot shaft bearings.

IBM 17

(1) Armature latching mechanism.
(2) Very thin film on edge of linen dilecto bail.
(3) Tip of bail operating lever foot.

BASE

I. Cleaning

The entire frame of the machine should be wiped down with a rag soaked in cleaning fluid. Clean all dirt and old grease from cams and cam followers.

The oil pans over the lower counters and the multiplying plate unit should be kept clean. The lower oil pan under the lower base collects oil leaking from the housing and will have to be cleaned out periodically to prevent soaking cables with oil. Also, an excessive amount of oil in the lower pan will overflow and soil the customer's floor.

II. Inspection

1. **Index.** Use the lower index for timing in all cases. Upper index on side of feed unit should be used only to time the feed unit to the base and to determine whether the feed cycle is in the first or second machine cycle.
2. **Shafts and Cams** for wear and partially sheared pins. Also check that all drive shaft bearings lubricated from oil cups are receiving oil.

3. Lower Drive Housing for wear and proper oil level. Remove the check plug in the lower housing and check for proper oil level. Oil should be within 1" of check plug. Also check oil flow up through the vertical shaft by removing upper housing plug and look for appearance of oil while machine is running. Add IBM 12 lubricant, if necessary.
4. CC Cams (see *General Section—Make and Break Type Cams*)
5. CB Cams (see *General Section—Circuit Breaker Cams*)
6. Emitters. The emitter brushes should be carefully checked for wear and damage. Replace brushes that show a noticeable bevel. Wipe any old grease off the emitter segments and common rings and check for cracked or missing segments. Apply a thin film of IBM lubricant 17. Then carefully check the emitter brush timing.
7. Motor Generators (see *General Section*)
8. Relays (see *General Section—Duo Relays*)
9. Control Panel (see *General Section*)

III. Lubrication

IBM 6

(1) Duo relay armature pivots.
(2) CB cam contact arm pivots.
(3) Drive pulley ratchets.

IBM 9

(1) Oil cups on the upper base casting. These lubricate counter drive shaft bearing on the upper base, emitter shaft bearings, CC cam shaft bearings, and CB cam shaft bearings.
(2) Ball closing oil well in reset shaft gears.
(3) All oil cups on reset shaft.
(4) Oil cup on bearing casting to the right of the feed unit.
(5) Motor and generator bearings (only a slight amount).
(6) Two oil cups just back of lower gear housing.
(7) Oil cup on lower reset shaft.
(8) Oil cup on lower base casting. This lubricates counter drive shaft bearings on lower base.
(9) Control panel pivot frame.

IBM 12

(1) Drive housing. Fill from top plug if oil level is lower than 1" below check plug in lower gear housing.

IBM 17

(1) MCR armature pivot points.
(2) Reset clutch knockoff finger.
(3) Reset clutch pawl disengaging roller.
(4) Contact operating cam.
(5) All reset clutches.
(6) Light film on the following linen dilecto items:
 (a) Emitter surface.
 (b) CC and CB cam surfaces.
 (c) CB cam rollers.
 (d) Generator coupling.
(7) Relatch bar operating stud and guide for multiplying plates.
(8) Internal cut cams operating multiplying and column shift plates.

TESTING

THE TEST DECK should be punched with the reading fields in the same positions that the customer uses, wherever possible. The control panel should be set up to use full capacity of the counters.

The customer engineer should write or interpret the individual and progressive totals on the back of each card. This may readily be done with a Type 551 or 552 Interpreter by feeding the cards with a column 1 at the column 80 end of the hopper, 12 edge first, and wiring the control panel accordingly. As the multiplier is being tested, the figure in the LHC and summary counters may be compared with the interpretations on the backs of the cards as they are stacked. If more time is needed for the visual comparison, it is only necessary to hold the ejector jaws by hand to prevent the card from being completely stacked, thus delaying the reset of the LH counter.

If a discrepancy is noted in these figures, it indicates a failure. The card on which the failure occured may be run through the machine again, or it may be reproduced in quantity and run repeatedly to localize the point of failure. To stop the machine after the first multiplying cycle, it is only necessary to insulate the N/O A points of CS relay 1 with a piece of card. At this time the multiplier and multiplicand counters may be checked visually to determine that they have read the proper factors. If a piece of card is now placed between the N/O A points of CS relay 2 and the piece removed from CS relay 1 A points, the machine will take a second multiplying cycle. This may be continued until all eight multiplying cycles have been checked. If the RH and LH components totals are correct, the total in the LH components counter after the RH to LH transfer cycle will indicate whether the total was properly transferred.

MULTIPLICATION

Wire the control panel for individual multiplication, using fields of 8 columns. Refer to values shown in Figure 1 (Parts 1-3) as shown on the following pages.

CROSS FOOTING

If the machine has tested correctly for multiplication, the only additional items necessary to test for cross footing are the CA1, CA2 and Cross Footing Add-Subtract Relay Points. The CA1 and CA2 have 12 points on each and, therefore, 12 position read fields must be used.

The machine should be checked for A + B = C, and then for A − B = C. Wire as shown in Figure 2. The only difference between A + B = C and A − B = C is in the wiring of "R.H.C. to L.H.C.". Use the values shown in Figure 3 (Parts 1-3).

The dotted line shown in Figure 2 for the punching of the "C" field is to be included on only the A − B = C test, and then only if the machine has additional cross footing. Punching of "C" has no effect on the test of A − B = C, but having this field punched into the card is necessary for a later test of additional cross footing.

ADDITIONAL CROSS FOOTING

If the test for cross footing is correct, the only items to check on additonal cross footing are the 10 position CA3 relay and emitter number 3. This may be checked by using the previous deck with the "C" field punched into it. Wire the control panel as shown in Figure 4. The "Cross Foot to Summary #1" should not be plugged and the "Cross Foot to Summary #2" should be plugged *both* ON and OFF. This will allow the machine to run without resetting the summary counter. Since "C" is the same as A − B, the result of each calculation in the summary counter should be zero, and, therefore, the summary counter should come to zero for each card unless an error develops. In that case the summary counter will not come to zero again until the cards are removed and it is reset by hand. In case of errors the figures in the product counter may be checked against the "A − B in Products Counter" column in Figure 4.

MULTIPLIER TEST

Card No.	Multiplier	Multiplicand	Product Counter (Individual)			Summary Counter (Progressive)	
			B	A		Summary Counter Wired to Left Ten Positions of Product Counter	Summary Counter Wired to Right Ten Positions of Product Counter
1	11111111	11111111	01234567	87654321		1234567787	6787654321
2	11111111	22222222	02469135	75308642		370370362	362962963
3	11111111	33333333	03703703	62962963		740740724	725925926
4	11111111	44444444	04938271	50617284		1234567874	7876543210
5	11111111	55555555	06172839	38271605		1851851812	1814814815
6	11111111	66666666	07407407	25925926		2592592537	2540740741
7	11111111	77777777	08641975	13580247		3456790050	54320988
8	11111111	88888888	09876543	01234568		4444444351	4355555556
9	11111111	99999999	11111110	88888889		5555555439	5444444445
10	22222222	11111111	02469135	75308642		5802469014	9019753087
11	22222222	22222222	04938271	50617284		6296296164	6170370371
12	22222222	33333333	07407407	25925926		7037036889	6896296297
13	22222222	44444444	09876543	01234568		8024691190	1197530865
14	22222222	55555555	12345678	76543210		9259259066	9074074075
15	22222223	66666666	14814814	51851852		740740517	525925927
16	22222222	77777777	17283950	27160494		2469135544	5553086421
17	22222222	88888888	19753086	02469136		4444444146	4155555557
18	22222222	99999999	22222221	77777778		6666666323	6333333335
19	33333333	11111111	03703703	62962963		7037036685	6696296298
20	33333333	22222222	07407407	25925926		7777777410	7422222224
21	33333333	33333333	11111110	88888889		8888888498	8511111113
22	33333333	44444444	14814814	51851852		370369949	9962962965
23	33333333	55555555	18518518	14814815		2222221763	1777777780
24	33333333	66666666	22222221	77777778		4444443940	3955555558
25	33333333	77777777	25925925	40740741		7037036480	6496296299
26	33333333	88888888	29629629	03703704		9999999383	9400000003
27	33333333	99999999	33333332	66666667		3333332649	2666666670

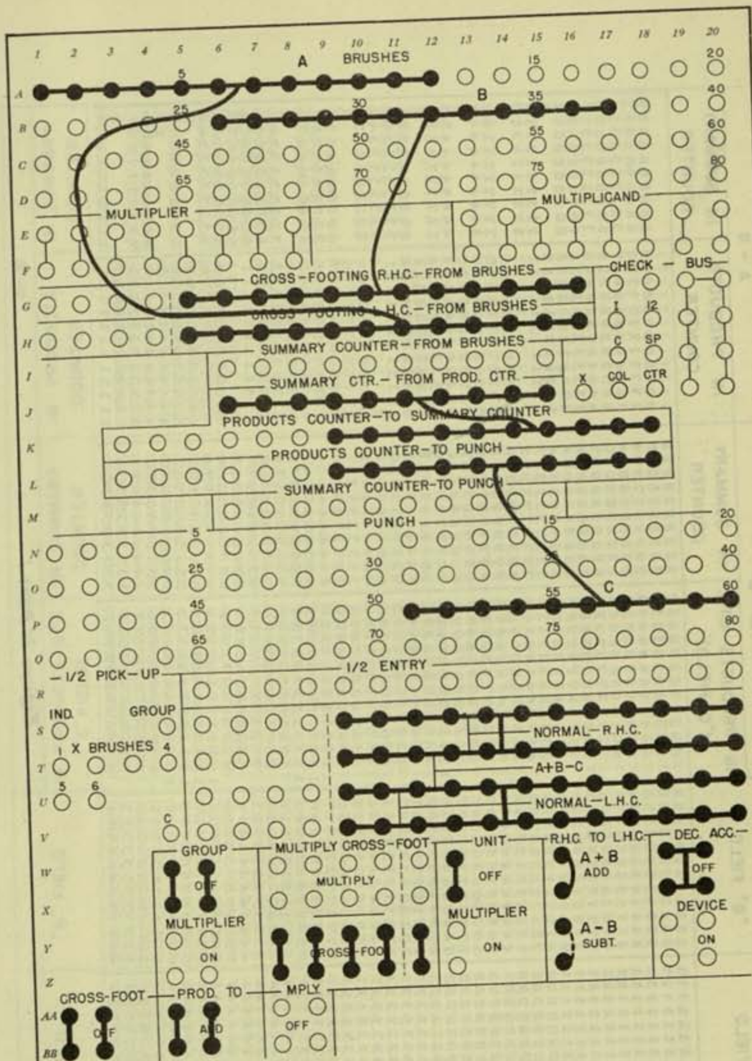
Figure 1. Part 1

28	44444444	11111111	04938271	50617284	3827159799	9817283954
29	44444444	22222222	09876543	01234568	4814814100	4118518522
30	44444444	33333333	14814814	51851852	6296295551	5570370374
31	44444444	44444444	19753086	02469136	8271604153	4172839510
32	44444444	55555555	24691357	53086420	740739906	9925925930
33	44444444	66666666	29629629	03703704	3703702809	2829629634
34	44444444	77777777	34567900	54320988	7160492863	2883950622
35	44444444	88888888	39506172	04938272	1111110067	88888894
36	44444444	99999999	44444443	55555556	5555554422	4444444450
37	55555555	11111111	06172839	38271605	6172838360	8382716055
38	55555555	22222222	12345678	76543210	7407406236	6259259265
39	55555555	33333333	18518518	14814815	9259258050	8074074080
40	55555555	44444444	24691357	53086420	1728393803	3827160500
41	55555555	55555555	30864196	91358025	4814813494	3518518525
42	55555555	66666666	37037036	29629630	8518517123	7148148155
43	55555555	77777777	43209875	67901235	2839504690	4716049390
44	55555555	88888888	49382715	06172840	7777776196	6222222230
45	55555555	99999999	55555554	44444445	3333331640	1666666675
46	66666666	11111111	07407407	25925926	4074072365	2392592601
47	66666666	22222222	14814814	51851852	5555553816	3844444453
48	66666666	33333333	22222221	77777778	7777775993	6022222231
49	66666666	44444444	29629629	03703704	740738896	8925925935
50	66666666	55555555	37037036	29629630	4444442525	2555555565
51	66666666	66666666	44444443	55555556	8888886880	6911111121
52	66666666	77777777	51851850	81481482	4074071961	1992592603
53	66666666	88888888	59259258	07407408	9999997768	7800000011
54	66666666	99999999	66666665	33333334	6666664301	4333333345
55	77777777	11111111	08641975	13580247	7530861814	1846913592
56	77777777	22222222	17283950	27160494	9259256841	6874074086
57	77777777	33333333	25925925	40740741	1851849381	9414814827
58	77777777	44444444	34567900	54320988	5308639435	9469135815
59	77777777	55555555	43209875	67901235	9629627002	7037037050
60	77777777	66666666	51851850	81481482	4814812083	2118518532
61	77777777	77777777	60493825	95061729	864194678	4713580261
62	77777777	88888888	69135801	08641976	7777774786	4822222237
63	77777777	99999999	77777776	22222223	5555552408	2444444460
64	88888888	11111111	09876543	01234568	6543206709	6745679028
65	88888888	22222222	19753086	02469136	8518515311	5348148164
66	88888888	33333333	29629629	03703704	1481478214	8251851868
67	88888888	44444444	39506172	04938272	5432095418	5456790140
68	88888888	55555555	49382715	06172840	370366924	6962962980
69	88888888	66666666	59259258	07407408	6296292731	2770370388
70	88888888	77777777	69135801	08641976	3209872839	2879012364
71	88888888	88888888	79012344	09876544	1111107248	7288888908
72	88888888	99999999	88888887	11111112	9999995959	6000000020

Figure 1. Part 2

73	99999999	11111111	11111110	88888889	1111107047	7088888909
74	99999999	22222222	22222221	77777778	3333329224	9266666687
75	99999999	33333333	33333332	66666667	6666662490	2533333354
76	99999999	44444444	44444443	55555556	1111106845	6888888910
77	99999999	55555555	55555554	44444445	6666662289	2333333355
78	99999999	66666666	66666665	33333334	3333328822	8866666689
79	99999999	77777777	77777776	22222223	1111106444	6488888912
80	99999999	88888888	88888887	11111112	9999995155	5200000024
81	99999999	99999999	99999998	00000001	9999994955	5000000025
82	12345678	12345678	01524157	65279684	152410720	765279709
83	23456789	23456789	05502209	50190521	702631670	1715470230
84	34567891	34567891	11949390	88187881	1897570758	803658111
85	45678912	45678912	20865630	01503744	3984133759	3805161855
86	56789123	56789123	32250044	91109129	7209138250	8296270984
87	67891234	67891234	46092196	54042756	1818357904	7950313740
88	78912345	78912345	62271581	93399085	8045516097	6143712765
89	89123456	89123456	79429904	09383936	5988506506	6553096701
90	91234567	91234567	83237462	15677489	4312252721	2768774190
91	01010101	01010101	00010203	04030201	4313273025	3072804391
92	02020202	02020202	00040812	16120804	4317354241	4288925195
93	03030303	03030303	00091827	36271809	4326536977	7025197004
94	04040404	04040404	00163248	64483216	4342861841	1889680220
95	05050505	05050505	00255076	00755025	4368369441	9490435245
96	06060606	06060606	00367309	45087236	4405100386	435522481
97	07070707	07070707	00499948	97479849	4455095283	5333002330
98	08080808	08080808	00652994	57932864	4520394740	4790935194
99	09090909	09090909	00826446	26446281	4603039366	9417381475
100	10101010	10101010	01020304	03020100	4705069769	9820401575
101	20202020	20202020	04081216	12080400	5113191381	1432481975
102	30303030	30303030	09182736	27180900	6031465006	5059662875
103	40404040	40404040	16324864	48321600	7663951456	1507984475
104	50505050	50505050	25507600	75502500	214711531	1583486975
105	60606060	60606060	36730945	08723600	3887806039	6092210575
106	70707070	70707070	49994897	47984900	8887295786	5840195475
107	80808080	80808080	65299457	93286400	5417241579	1633481875
108	90909090	90909090	82644626	44628100	3681704223	4278109975

Figure 1. Part 3



CROSS FOOTING

A+B AND A-B

PUNCH C FIELD FOR ADDITIONAL C.F.

Figure 2

CARD NO.	"A" FIELD	"B" FIELD	A + B: IN PRODUCTS CTR. ("C" FIELD)	A + B: IN SUMMARY COUNTER	A − B: IN PRODUCTS COUNTER	A − B: IN SUMMARY COUNTER
1	111111111111	111111111111	222222222222	2222222222		
2	111111111111	222222222222	333333333333	5555555555	888888888889	8888888889
3	111111111111	333333333333	444444444444	9999999999	777777777778	6666666667
4	111111111111	444444444444	555555555555	5555555554	666666666667	3333333334
5	111111111111	555555555555	666666666666	2222222220	555555555556	8888888890
6	111111111111	666666666666	777777777777	9999999997	444444444445	3333333335
7	111111111111	777777777777	888888888888	8888888885	333333333334	6666666669
8	111111111111	888888888888	999999999999	8888888884	222222222223	8888888892
9	111111111111	999999999999	1111111111110	9999999994	111111111112	4
10	222222222222	111111111111	333333333333	3333333327	111111111111	1111111115
11	222222222222	222222222222	444444444444	7777777771		1111111115
12	222222222222	333333333333	555555555555	3333333326	888888888889	4
13	222222222222	444444444444	666666666666	9999999992	777777777778	7777777782
14	222222222222	555555555555	777777777777	7777777769	666666666667	4444444449
15	222222222222	666666666666	888888888888	6666666657	555555555556	5
16	222222222222	777777777777	999999999999	6666666656	444444444445	4444444450
17	222222222222	888888888888	1111111111110	7777777766	333333333334	7777777704
18	222222222222	999999999999	1222222222221	9999999987	222222222223	7
19	333333333333	111111111111	444444444444	4444444431	222222222222	2222222229
20	333333333333	222222222222	555555555555	9999999986	111111111111	3333333340
21	333333333333	333333333333	666666666666	6666666652		3333333340
22	333333333333	444444444444	777777777777	4444444429	888888888889	2222222229
23	333333333333	555555555555	888888888888	3333333317	777777777778	7
24	333333333333	666666666666	999999999999	3333333316	666666666667	6666666674
25	333333333333	777777777777	1111111111110	4444444426	555555555556	2222222230
26	333333333333	888888888888	1222222222221	6666666647	444444444445	6666666675
27	333333333333	999999999999	1333333333332	9999999979	333333333334	9
28	444444444444	111111111111	555555555555	5555555534	333333333333	3333333342
29	444444444444	222222222222	666666666666	2222222200	222222222222	5555555564
30	444444444444	333333333333	777777777777	9999999977	111111111111	6666666675
31	444444444444	444444444444	888888888888	8888888865		6666666675
32	444444444444	555555555555	999999999999	8888888864	888888888889	5555555564
33	444444444444	666666666666	1111111111110	9999999974	777777777778	3333333342
34	444444444444	777777777777	1222222222221	2222222195	666666666667	9
35	444444444444	888888888888	1333333333332	5555555527	555555555556	5555555565
36	444444444444	999999999999	1444444444443	9999999970	444444444445	10
37	555555555555	111111111111	666666666666	6666666636	444444444444	4444444454
38	555555555555	222222222222	777777777777	4444444413	333333333333	7777777787
39	555555555555	333333333333	888888888888	3333333301	222222222222	9
40	555555555555	444444444444	999999999999	3333333300	111111111111	1111111120

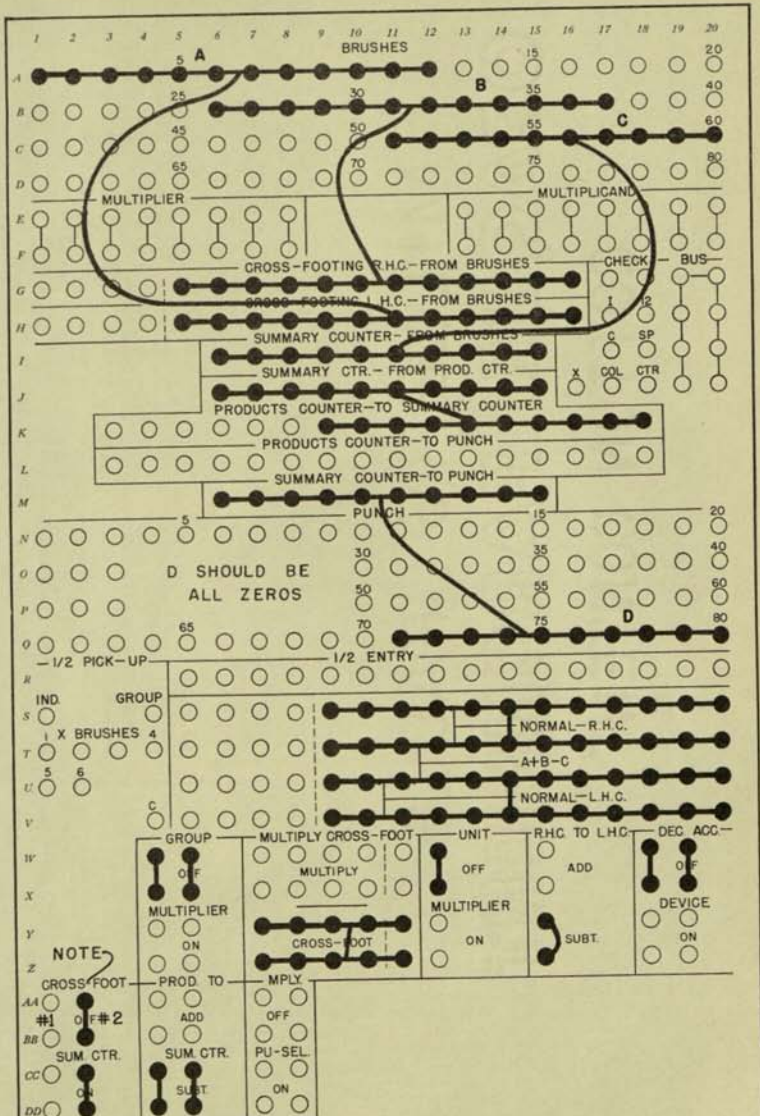
Figure 3. Part 1

CARD NO.	"A" FIELD	"B" FIELD	A + B IN PRODUCTS CTR. ("C" FIELD)	A + B IN SUMMARY COUNTER	A– B IN PRODUCTS COUNTER	A– B IN SUMMARY COUNTER
41	555555555555	555555555555	1111111111110	4444444410		1111111120
42	555555555555	666666666666	1222222222221	6666666631	888888888889	9
43	555555555555	777777777777	1333333333332	9999999963	777777777778	7777777787
44	555555555555	888888888888	1444444444443	4444444406	666666666667	4444444454
45	555555555555	999999999999	1555555555554	9999999960	555555555556	10
46	666666666666	111111111111	777777777777	7777777737	555555555555	5555555565
47	666666666666	222222222222	888888888888	6666666625	444444444444	9
48	666666666666	333333333333	999999999999	6666666624	333333333333	3333333342
49	666666666666	444444444444	1111111111110	7777777734	222222222222	5555555564
50	666666666666	555555555555	1222222222221	9999999955	111111111111	6666666675
51	666666666666	666666666666	1333333333332	3333333287		6666666675
52	666666666666	777777777777	1444444444443	7777777730	888888888889	5555555564
53	666666666666	888888888888	1555555555554	3333333284	777777777778	3333333342
54	666666666666	999999999999	1666666666665	9999999949	666666666667	9
55	777777777777	111111111111	888888888888	8888888837	666666666666	6666666675
56	777777777777	222222222222	999999999999	8888888836	555555555555	2222222230
57	777777777777	333333333333	1111111111110	9999999946	444444444444	6666666674
58	777777777777	444444444444	1222222222221	2222222167	333333333333	7
59	777777777777	555555555555	1333333333332	5555555499	222222222222	2222222229
60	777777777777	666666666666	1444444444443	9999999942	111111111111	3333333340
61	777777777777	777777777777	1555555555554	5555555496		3333333340
62	777777777777	888888888888	1666666666665	2222222161	888888888889	2222222229
63	777777777777	999999999999	1777777777776	9999999937	777777777778	7
64	888888888888	111111111111	999999999999	9999999936	777777777777	7777777784
65	888888888888	222222222222	1111111111110	1111111046	666666666666	4444444450
66	888888888888	333333333333	1222222222221	3333333267	555555555555	5
67	888888888888	444444444444	1333333333332	6666666599	444444444444	4444444449
68	888888888888	555555555555	1444444444443	1111111042	333333333333	7777777782
69	888888888888	666666666666	1555555555554	6666666596	222222222222	4
70	888888888888	777777777777	1666666666665	3333333261	111111111111	1111111115
71	888888888888	888888888888	1777777777776	1111111037		1111111115
72	888888888888	999999999999	1888888888887	9999999924	888888888889	4
73	999999999999	111111111111	1111111111110	1111111034	888888888888	8888888892
74	999999999999	222222222222	1222222222221	3333333255	777777777777	6666666669
75	999999999999	333333333333	1333333333332	6666666587	666666666666	3333333335
76	999999999999	444444444444	1444444444443	1111111030	555555555555	8888888890
77	999999999999	555555555555	1555555555554	6666666584	444444444444	3333333334
78	999999999999	666666666666	1666666666665	3333333249	333333333333	6666666667
79	999999999999	777777777777	1777777777776	1111111025	222222222222	8888888889
80	999999999999	888888888888	1888888888887	9999999912	111111111111	

Figure 3. Part 2

CARD NO.	"A" FIELD	"B" FIELD	A + B		A − B	
			IN PRODUCTS CTR. ("C" FIELD)	IN SUMMARY COUNTER	IN PRODUCTS COUNTER	IN SUMMARY COUNTER
81	99999999999	99999999999	199999999998	9999999910		
82	12345678123	12345678123	24691357246	6913578156		
83	23456789134	23456789134	46913578246	6049360624		
84	34567891245	34567891245	69135782469	7407185314		
85	45678912356	45678912356	91357824691	985432226		
86	56789123467	56789123467	113578246913	6767901360		
87	67891234578	67891234578	135782469135	4592592716		
88	78912345689	78912345689	157824691357	2839506294		
89	89123456791	89123456791	178246913578	5308642076		
90	91234567812	91234567812	182469135782	9999999900		
91	10101010101	10101010101	20202020202	202020102		
92	20202020202	20202020202	40404040404	606060506		
93	30303030303	30303030303	60606060606	1212121112		
94	40404040404	40404040404	80808080808	2020201920		
95	50505050505	50505050505	101010101010	3030302930		
96	60606060606	60606060606	121212121212	4242424142		
97	70707070707	70707070707	141414141414	5656565556		
98	80808080808	80808080808	161616161616	7272727172		
99	90909090909	90909090909	181818181818	9090908990		
100	101010101010	101010101010	202020202020	1111111010		
101	202020202020	202020202020	404040404040	5151515050		
102	303030303030	303030303030	606060606060	1212121110		
103	404040404040	404040404040	808080808080	9292929190		
104	505050505050	505050505050	1010101010100	9393939290		
105	606060606060	606060606060	1212121212120	1515151410		
106	707070707070	707070707070	1414141414140	5656565550		
107	808080808080	808080808080	1616161616160	1818181710		
108	909090909090	909090909090	1818181818180	9999999890		

Figure 3. Part 3



ADDITIONAL CROSSFOOTING

Sum Ctr. Should Restore To Zero
'D' Field Should Punch All Zeros
Sight Check For 'D' Field Zeros

Figure 4

Form 22-5750-0

Use of 602 Multiplication - Division Test Deck

This test deck may be used for either multiplication or division. When testing division the product (dividend) is divided by the multiplier (divisor) to arrive at the quotient. Therefore, a deck with an accurately punched product must be available before a division test can be attempted.

The card columns are used as follows:

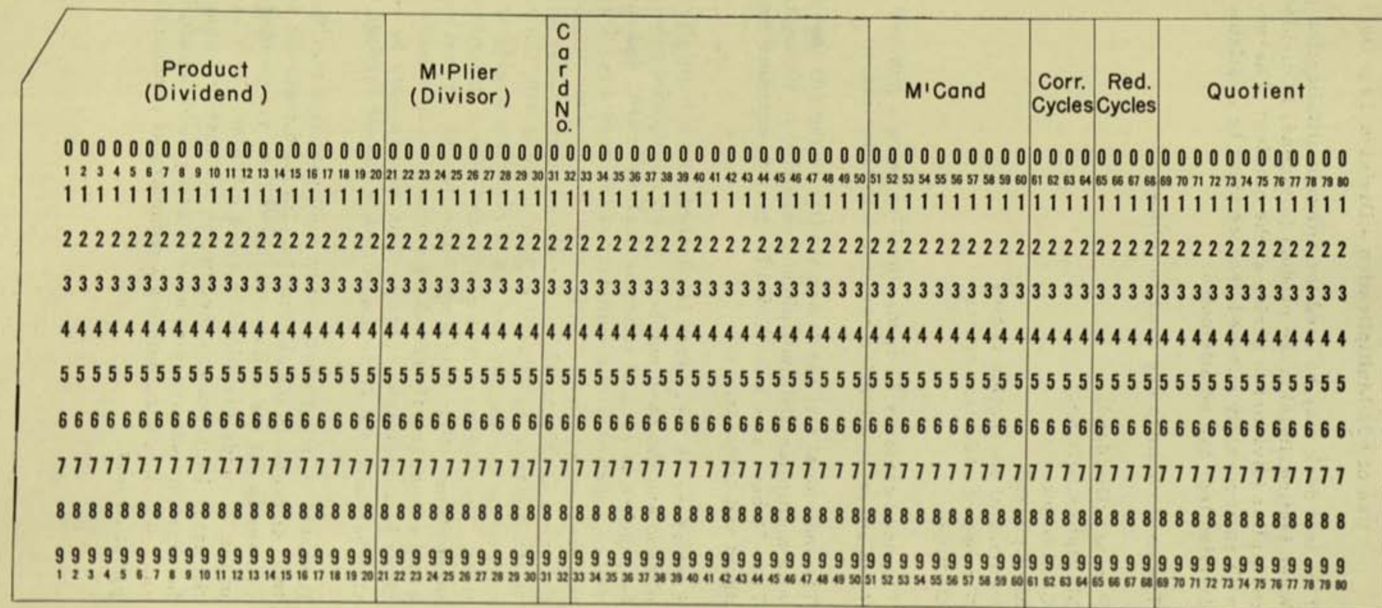
Product (Dividend)	1-20
Multiplier (Divisor)	21-30
Card Number	31-32
Multiplicand	51-60
Number of correction cycles	61-64
Number of reduction cycles	65-68
Quotient	69-80

The deck contains 77 cards, the 77th being x punched in column 74 to serve as a trailer card for summary totals.

The individual test cards are similar to the 601 test cards but with multiplier and multiplicand expanded to 10 positions. Cards 73 to 76 have also been added for testing extreme limit shifts of drum and contacts.

Each of the 76 test cards is punched with a multiplier, a multiplicand and the card number. When multiplying, the product will be punched in each of the individual test cards and the 77th card will be punched with a summary of the products. During division the product, columns 1 to 20, will serve as the dividend and the columns, 21-30, previously used as the multiplier will be used as the divisor. Each card will be punched with the number of correction cycles, the number of reduction cycles and the quotient. The 77th card will be punched with a summary of these three items. Punching may be confined to the trailer card to avoid unnecessarily remaking cards when it is believed the machine is operating correctly. This may be done by removing the skip bar until the 76 no x cards have passed through the machine.

It should be noted when testing multiplication that the summary total of products punched in the 77th card from the summary counter is not the same total that will be received if the products of the 76 cards are added in a 405 machine. This is because of the carry back system used on the 602 machine coupled with the fact that the summary counter is being used beyond its normal capacity when accumulating a summary of products on this multiplication test.

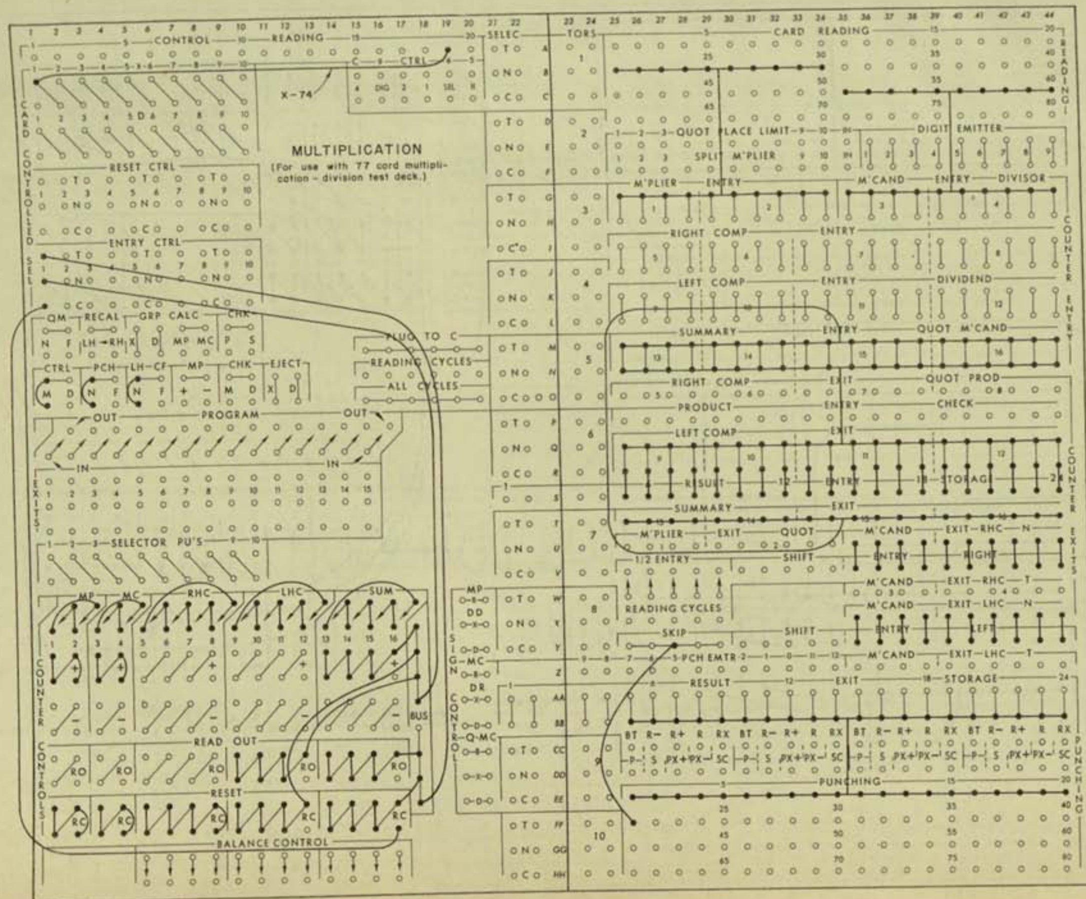

Product (Dividend)
M'Plier (Divisor)
Card No.
M'Cand
Corr. Cycles
Red. Cycles
Quotient

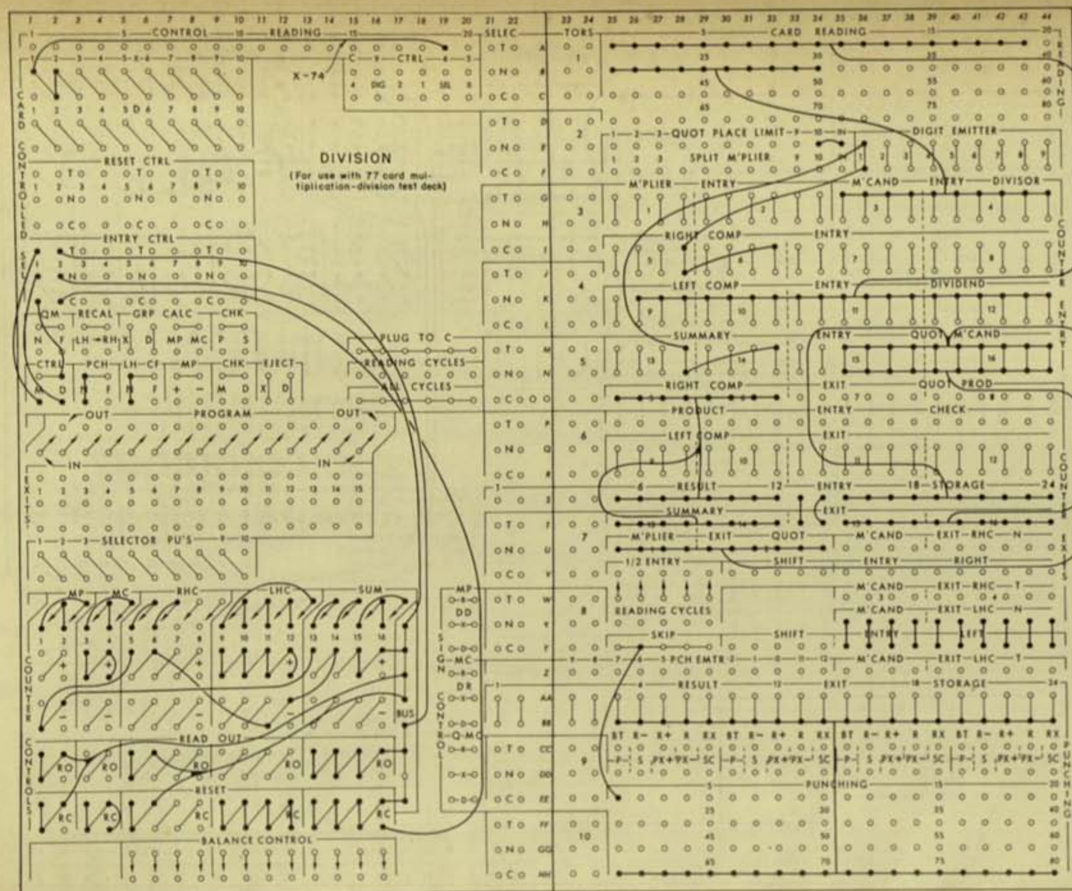
CARD NO.	MULTIPLIER (DIVISOR)	MULTIPLICAND		RH AND LH COMPONENTS PRODUCT (DIVIDEND)	PROGRESSIVE PRODUCT	CORR. CY.	RED. CY.	QUOTIENT	PROGRESSIVE CORR. CY.	PROGRESSIVE RED. CY.	PROGRESSIVE QUOTIENT
1	1111111111	1111111111	RH	1234567900987654321							
			LH								
			PR	1234567900987654321	1234567900987654321		9	111111111		9	111111111
2	1111111111	2222222222	RH	2469135801975308642							
			LH								
			PR	2469135801975308642	3703703702962962963		18	222222222		27	333333333
3	1111111111	3333333333	RH	3703703702962962963							
			LH								
			PR	3703703702962962963	7407407405925925926		18	333333333		45	666666666
4	1111111111	4444444444	RH	4938271603950617284							
			LH								
			PR	4938271603950617284	12345679009876543210		18	444444444		63	1111111110
5	1111111111	5555555555	RH	6172839504938271605							
			LH								
			PR	6172839504938271605	18518518514814814815	2	19	555555555	2	82	1666666665
6	1111111111	6666666666	RH	7407407405925925926							
			LH								
			PR	7407407405925925926	25925925920740740741	1	20	666666667	3	102	2333333332
7	1111111111	7777777777	RH	8641975306913580247							
			LH								
			PR	8641975306913580247	34567901227654320988		18	777777778	3	120	3111111110
8	1111111111	8888888888	RH	9876543207901234568							
			LH								
			PR	9876543207901234568	44444444435555555556		18	888888889	3	138	3999999999
9	1111111111	9999999998	RH	11111111107777777778							
			LH								
			PR	11111111107777777778	55555555543333333334		19	1000000000	3	157	4999999999
10	2222222222	2222222222	RH	4938271603950617284							
			LH								
			PR	4938271603950617284	60493827147283950618		18	222222222	3	175	5222222221
11	2222222222	3333333333	RH	7407407405925925926							
			LH								
			PR	7407407405925925926	67901234553209876544		18	333333333	3	193	5555555554
12	2222222222	4444444444	RH	9876543207901234568							
			LH								
			PR	9876543207901234568	77777777761111111112	1	19	444444444	4	212	5999999998
13	2222222222	5555555555	RH								
			LH	12345679009876543210							
			PR	12345679009876543210	90123456770987654322		18	555555556	4	230	6555555554

CARD NO.	MULTIPLIER (DIVISOR)	MULTIPLICAND	RH AND LH COMPONENTS PRODUCT (DIVIDEND)	PROGRESSIVE PRODUCT	CORR. CY.	RED. CY.	QUOTIENT	PROGRESSIVE CORR. CY.	PROGRESSIVE RED. CY.	PROGRESSIVE QUOTIENT
40	7777777777	7777777777	RH 1111111110888888889 LH 4938271603950617284 0 PR 6049382714839506172 9							
41	7777777777	8888888888	RH 740740740592592592 6 LH 6172839504938271605 0 PR 6913580245530864197 6	1111111088555555557 8	8	18	777777778	79	732	2688888888 9
42	7777777777	9999999998	RH 370370370629629629 6 LH 7407407404814814815 0 PR 7777777775444444444 6	8024691334086419755 4	8	18	888888889	87	750	2777777777 8
43	8888888888	8888888888	RH 493827160395061728 4 LH 7407407405925925926 0 PR 7901234566320987654 4	5802469109530864200 1		19	1000000000	87	769	2877777777 8
44	8888888888	9999999998	RH 246913580419753086 4 LH 8641975305802469136 0 PR 8888888886222222222 4	3703703675851851854 6	8	18	888888889	95	787	2966666666 7
45	9999999998	9999999998	RH 123456790320987654 4 LH 9876543205679012346 0 RR 9999999996000000000 4	2592592562074074077 1		17	1000000000	95	804	3066666666 7
46	1234567891	1234567891	RH 152369849606623988 1 LH 45938142194800 0 PR 152415787748818788 1	2592592558074074077 6		1	1	95	805	3066666666 8
47	2345678912	2345678912	RH 545627141598448174 4 LH 45938142217022000 PR 550220955820150374 4	2745008345822892865 7	1	17	123456789	96	822	3079012345 7
48	3456789123	3456789123	RH 957777681696446912 9 LH 237161422392664000 0 PR 1194939104089110912 9	3295229301643043240 1		17	234567891	96	839	3102469134 8
49	4567891234	4567891234	RH 614820790854344254 6 LH 1471742241711060021 0 PR 2086563032565404275 6	4490168405732154153 0	3	17	345678912	99	856	3137037026 0
50	5678912345	5678912345	RH 516782566444535560 5 LH 2708221975774804342 0 PR 3225004542219339902 5	6576731438297558428 6	3	18	456789123	102	874	3182715938 3
51	6789123456	6789123456	RH 667246545710481730 6 LH 3941973184370456663 0 PR 4609219730080938393 6	9801735980516898331 1	4	18	567891234	106	892	3239505061 7
52	7891234567	7891234567	RH 1032086452975656764 9 LH 5195071846165910984 0 PR 6227158299141567748 9	4410955710597836724 8	3	19	678912346	109	911	3307396296 3
				6381140097394044738	2	17	789123457	111	928	3386308642 0

53	8912345678	8912345678	RH	4602747184229606624							
			LH	74827158299935673060							
			PR	79429905484165279684	85811045581559324422	3	17	891234568	114	945	34754320988
54	9123456789	9123456789	RH	2990545626935971041							
			LH	80246918153814219480							
			PR	83237463780750190521	69048509362309514944		17	912345679	114	962	35666666667
55	101010101	101010101	RH	10203040504030201							
			LH								
			PR	10203040504030201	69058712402813545145		12	10101010	114	974	35676767677
56	202020202	202020202	RH	40812162016120804							
			LH								
			PR	40812162016120804	69099524564829665949		8	20202020	114	982	35696969697
57	303030303	303030303	RH	91827364536271809							
			LH								
			PR	91827364536271809	69191351929365937758		8	30303030	114	990	35727272727
58	404040404	404040404	RH	61218243024181206							
			LH	102030405040302010							
			PR	163248648064483216	69354600577430420974	1	19	40404040	115	1009	35767676767
59	505050505	505050505	RH	51015202520151005							
			LH	204060810080604020							
			PR	255076012600755025	69609676590031175999	1	13	50505050	116	1022	35818181817
60	606060606	606060606	RH	61218243024181206							
			LH	306091215120906030							
			PR	367309458145087236	69976986048176263235	1	20	60606061	117	1042	35878787878
61	707070707	707070707	RH	91827364536271809							
			LH	408121620161208040							
			PR	499948984697479849	70476935032873743084		9	70707071	117	1051	35949494949
62	808080808	808080808	RH	40812162016120804							
			LH	612182430241812060							
			PR	652994592257932864	71129929625131675948		9	80808081	117	1060	36030303030
63	909090909	909090909	RH	10203040504030201							
			LH	816243240322416080							
			PR	826446280826446281	71956375905958122229		9	90909091	117	1069	36121212121
64	1010101010	1010101010	RH	1020304050403020100							
			LH								
			PR	1020304050403020100	72976679956361142329		13	101010101	117	1082	36222222222
65	2020202020	2020202020	RH	4081216201612080400							
			LH								
			PR	4081216201612080400	77057896157973222729		10	202020202	117	1092	36424242424

CARD NO.	MULTIPLIER (DIVISOR)	MULTIPLICAND	RH AND LH COMPONENTS PRODUCT (DIVIDEND)	PROGRESSIVE PRODUCT	CORR. CY.	RED. CY.	QUOTIENT	PROGRESSIVE CORR. CY.	PROGRESSIVE RED. CY.	PROGRESSIVE QUOTIENT
66	3030303030	3030303030	RH 9182736453627180900 LH PR 9182736453627180900	86240632611600403629		10	303030303	117	1102	36727272727
67	4040404040	4040404040	RH 6121824302418120600 LH10203040504030201000 PR16324864806448321600	2565497418048725230		22	404040404	117	1124	37131313131
68	5050505050	5050505050	RH 5101520252015100500 LH20406081008060402000 PR25507601260075502500	28073098678124227730		14	505050505	117	1138	37636363636
69	6060606060	6060606060	RH 6121824302418120600 LH30609121512090603000 PR36730945814508723600	64804044492632951330		22	606060606	117	1160	38242424242
70	7070707070	7070707070	RH 9182736453627180900 LH40812162016120804000 PR49994898469747984900	14798942962380936231	1	10	707070707	118	1170	38949494949
71	8080808080	8080808080	RH 4081216201612080400 LH61218243024181206000 PR65299459225793286400	80098402188174222631	1	10	808080808	119	1180	39757575757
72	9090909090	9090909090	RH 1020304050403020100 LH81624324032241608000 PR82644628082644628100	62743030270818850732		10	909090909	119	1190	40666666666
73	3737373737	1111111111	RH 4152637485140291807 LH PR 4152637485140291807	66895667755959142539		9	111111111	119	1199	40777777777
74	2828282828	1111111111	RH 3142536475241301908 LH PR 3142536475241301908	70038204231200444447		9	111111111	119	1208	40888888888
75	4646464646	1111111111	RH 5162738495039281706 LH PR 5162738495039281706	75200942726239726153		9	111111111	119	1217	40999999999
76	1919191919	1111111111	RH 2132435465342312009 LH PR 2132435465342312009	77333378191582038162		9	111111111	119	1226	41111111110
77			RH66509989809636093865 LH10823388381945944297 77333378191582038162							


MULTIPLICATION
(For use with 77 card multiplication - division test deck.)
X-74
CONTROL
READING
CARD READING
SELECTORS
COUNTER ENTRY
COUNTER EXITS
PUNCHING
RESET CTRL
ENTRY CTRL
PROGRAM
SELECTOR PU'S
READ OUT
RESET
BALANCE CONTROL
PLUG TO C
READING CYCLES
ALL CYCLES
DIGIT EMITTER
QUOT PLACE LIMIT
SPLIT M'PLIER
M'PLIER ENTRY
M'CAND ENTRY DIVISOR
RIGHT COMP ENTRY
LEFT COMP ENTRY DIVIDEND
SUMMARY ENTRY QUOT M'CAND
RIGHT COMP EXIT QUOT PROD
PRODUCT ENTRY CHECK
LEFT COMP EXIT
RESULT ENTRY STORAGE
SUMMARY EXIT
M'PLIER EXIT QUOT
1/2 ENTRY
SHIFT
SKIP
RESULT EXIT STORAGE



DIVISION
(For use with 77 card multiplication-division test deck)
X-74
CONTROL
READING
SELECTORS
CARD READING
CARD CONTROLLED
RESET CTRL
ENTRY CTRL
QUOT PLACE LIMIT
SPLIT M'PLIER
DIGIT EMITTER
M'PLIER
ENTRY
M'CAND
DIVISOR
RIGHT COMP
LEFT COMP
DIVIDEND
SUMMARY
QUOT
PROD
PRODUCT
CHECK
EXIT
RESULT
STORAGE
SHIFT
RIGHT
1/2 ENTRY
READING CYCLES
SKIP
PCH EMTR
PUNCHING
PLUG TO C
ALL CYCLES
PROGRAM
OUT
IN
EXITS
SELECTOR PU'S
MP
MC
RHC
LHC
SUM
COUNTER
READ OUT
RESET
BALANCE CONTROL
BUS
SIGN CONTROL
COUNTER ENTRY
COUNTER EXITS

THE PROOF MACHINE FOR BANKS

TYPE 801

GENERAL DESCRIPTION

The Proof Machine for Banks sorts, lists, and proves checks in one operation There are 24 individual receptacles into which the checks are sorted, 24 selector keys which are used to select the proper pocket and 24 separate adding machines which accumulate check amount totals by pocket.

There is also a group adding machine and a grand adding machine. The group total adding unit is used for checking the total on each deposit slip. The grand total adding unit is used for checking the total of an entire block of checks.

Signal devices are provided to notify the operator when a pocket is filled to capacity, if the check failed to feed, if the check feeds at too great an angle, if the check does not enter the pocket properly and if the tapes are low. In addition there are certain other electrical and mechanical interlocks which cause the machine to be inoperative if certain units should fail to function properly.

The number of the pocket which the check has been deposited into is printed on the left side of the control tape.

KEYBOARD AND TOP PANEL

Amount Keyboard

The amount keyboard is of the ten key type which is particularly suitable for touch operation. The 4, 5, and 6 keys are the guiding keys, having a deeper recess for the fingers.

Release Bar

Located to the lower right of the amount keyboard is a large flat key. This is the release bar, or motor key, the depression of which causes the machine to go thru its cycle.

Selector Keyboard

The selector keys are located just to the left of the ten key unit. There are 24 keys and these are used to select the proper receptacle into which the check should be sorted.

Signal Reset Key and Green Jewel

The key is located above the selector keyboard and is projected upward when a pocket is filled to capacity. When this occurs, a green jewel mounted just above the ten key setup becomes illuminated and the release bar is locked up. Then the signal reset key is depressed, which extinguishes the signal light, unlocks the release bar, then the door is opened, the checks are removed, and the door closed. The machine is then operative again.

Red Jewel

Beside the green jewel mentioned above is a red jewel. When anyone of the 24 individual tapes is nearing depletion, this jewel becomes illuminated and it is necessary to go to the back of the machine where the individual adding machines are located and replace the depleted roll.

Glass Windows

To the right and slightly toward the front of these jewels are two windows. In the small window may be read the number of the compartment that is in position for the reception of a check. In the large window may be seen the amount of the check as setup on the keyboard giving a visible reading which may be read before depositing the check in its proper receptacle.

Error Lever

Just above the two windows is the error lever. If an incorrect amount is setup it may be corrected by pulling this lever forward. The correction is then made without the necessity of putting the machine through its listing cycle.

Control Keys

There are six control keys located in a group near the right hand end of the machine. These are the control keys as follows:

The lower row of keys are the total keys and reading from left to right they are the grand total key which is depressed at the end of a run of a block of checks, the group total key which takes a sub-total at any desired time, usually after the items on a deposit ticket have been listed, and the compartment total key which prints the total of each individual tape on that tape together with the number of the receptacle. When the compartment total key is depressed the operator starts from the number one selector key and depresses each of the 24 selector keys, striking the release bar after each key is depressed.

The grand and group total keys print on the control tape only.

The upper row of keys, reading from left to right, are the non-add key, which may be depressed when an item is entered in the machine which is to be listed but not added into any of the adding machines, the adding key, which stays down after being depressed until raised by the key release or the grand or group total keys and causes the machine to function as an ordinary adding machine, adding into the group and grand total adding units. The amounts, however, will not be added into the 24 individual adding machines. The last key is the key release, which restores any one of the total keys before the release bar is depressed, except the group total key. The reason for this exception is that the group total key is used so frequently that the machine was designed so that the depression of this key automatically trips the release bar causing the machine to go thru its cycle.

Check Sensing Control Key.

Should the operator depress the release bar before placing the check into the chute, or place it in late or the check does not feed properly the release bar will automatically be locked up. This lock is released by depressing the small check sensing control key which is located just to the rear of the check chute.

This lock is disabled automatically when any control key is depressed.

When the machine is to be used for distribution purposes, and there are no checks being deposited in the chute, this lock can be permanently disabled by depressing this lever and pulling it slightly forward.

Opalescent

The opalescent indicates merely that the switch has been turned on and that the motor is running.

Veeder Counters

Located just below the signal reset key are two veeder counters and corresponding counter reset wheels. Each check as it passes thru the machine is automatically counted, registering in these two counters, one of which may be reset by the operator at the end of each group of checks, while the other is locked and may be reset only by the head of the department or supervisor. This, of course, gives a complete control of all checks handled thru the machine.

When sorting checks, a buzzer warns the operator if a check is fed at too great an angle, or if the check goes behind the bail. The operator must open the door at the side of the machine, depress the reset contact button, place the check in the pocket properly and close the door to make the machine operative again.

Current

The starting and running amperes are as follows:

			110 Volts		220 Volts	
	Cycles	Phase	Starting Amps	Running Amps	Starting Amps	Running Amps
DC			14.5	1.6	7.0	.8
AC	60	1	23.6	4.5	12.0	2.8
AC	50	1	23.0	4.5	12.0	2.8
AC	25	1	20.0	4.3	10.0	2.2

Weight

Packed: 1120 pounds
Unpacked: 850 pounds

OPERATION OF MACHINE

The operator sits at the machine with his left forearm resting on a conveniently placed arm rest which may be adjusted to suit any operator. With the fingers of his left hand, he makes a selection of the proper receptacle as read from the top check on the check chute. He then picks up the check with his left hand, reads the amount and while depositing it in the chute, sets up the amount by the touch system with his right hand, then he strikes the release bar with the heel or side of his right hand and the machine goes thru its listing cycle.

It is advisable to note that the depression of a selector key immediately causes the reel to be brought around to its proper position, this occurring while the amount is being set up. This sequence of positioning the reel and then operating the machine thru its listing cycle means that there will be no wait between operations.

Should the operator forget to close the compartment reel door, the release bar and reel are automatically locked and will not operate until the door is closed.

ADDING AND PRINTING UNITS

Fig. 1

Adding Cycle

When the operator depresses one of the keys in the ten key unit, a plunger is pushed up and the escapement is tripped, releasing the set-up slide and thru spring tension the set-up slide moves forward, until it is stopped by the plunger which has been pushed up. After the amount has been set up, the operator depresses the release bar, which starts the machine thru its cycle.

At the beginning of a cycle, the restoring bail, controlled thru the forked arm and cam action, is raised, carrying with it any loose slides which were tripped by the wide tooth on the counter wheel striking the transfer arm during the preceding cycle. At the same time, the link controlled by the other end of the forked arm moves down, carrying with it the bails which in turn pushes down on the tails of the hooks, which release the transfer arms, allowing them to swing under the loose slides and holding them in position as the restoring bail moves down.

The control slides, which are held up by a cam, drop over the set-up slides. The bail which holds the control slides in their home position is released thru cam action. The control slides, thru spring tension move forward, until they are stopped by the stud on the side of the set-up slides.

As the control slides move forward, the type bars, thru bell crank connections with the control slides are raised. As the type bars raise, thru connecting beams, the 24 rear printer sectors are set up. All control slides which have no set up drop over a bar fastened to the 10 key set-up unit. This bar holds the type bars out of printing position.

The aligner then functions, and the amount set up is printed. The adding bar thru cam actions moves upward and thru link connection the cam slotted arm moves with it, which in turn takes the counter wheels from their stationary aligner into mesh with the loose slide rack. At the same time the adding bar moves upward, the check pawls are released and mesh with the rack on type bars, holding them in position while the control slides are raised clear of the set-up slides, and thru the bail brought back to their home position. At the same time, the type bars and rear printer sectors are restored and the amount which had been set up is added into the counter wheels. The adding bar moves back to its normal position, placing the counter wheels over their stationary aligners and disengaging the check pawls from type bar racks. The set-up slides and ten-key unit are also restored to their home position.

Carry Over

The counter wheels have ten teeth each, in order to accumulate the figures from 0 to 9. Those corresponding with the numbers 1 to 9 inclusive are narrower than the one corresponding with 0, which is the full width of the counter wheel. Let us assume that figure 9 is the last accumulated in a certain counter wheel. Let us also assume one more is to be added into this counter wheel. The downward movement of the type bar would cause the wide tooth to strike the transfer arm, pivoting the arm on its shaft and swinging the lower end of the transfer arm out from under the path of the loose slide, which causes the spring to pull the loose slide down one tooth. At the same time, a hook latches over the other end of the transfer arm and holds it in its tripped position until the restoring bail functions. It must be understood that the wide tooth strikes the transfer arm and releases the slide in the next position to the left. In this way, the counter wheel in that particular digit is turned one more tooth and thus the carrying is accomplished.

Total Cycle

When a total key is depressed, a hook latches up the control slides. At the same time the stud which controls the counter engaging of the total key which is depressed, moves from the adding bar into the total bar. The other two studs move into the neutral bar.

The group total key when fully depressed automatically sends the machine thru a cycle. If the grand or compartment total key is depressed, it is necessary to also depress the release bar to start the machine thru a cycle. As the machine starts thru its cycle, the counter wheels, by means of their controlling stud in the total bar, are brought in mesh with the type bars. The control slides are then released and the type bars raise until the wide tooth on the counter wheels comes in contact with the end of the transfer arm, stopping the type bar at that point. The aligners then function and the total is printed. The counter wheels disengage and the type bars and control slides are returned to their home position.

When taking a group or grand total, the rear printer is disabled, and the amount is only printed on the control printer tape with its symbol.

When taking compartment totals, the control printer is disabled, the number of the pocket which the machine is set at, together with an asterisk and the total is printed on the rear printer tape. Between 40 degrees and 60 degrees of the cycle, the total bar thru cam action moves upward, and between 190 degrees and 210 degrees the total bar is returned to its home position. The neutral bar is held stationary.

AUXILIARY ADDING UNIT AND ZERO ELIMINATION MECHANISM

Fig. 2

Operation

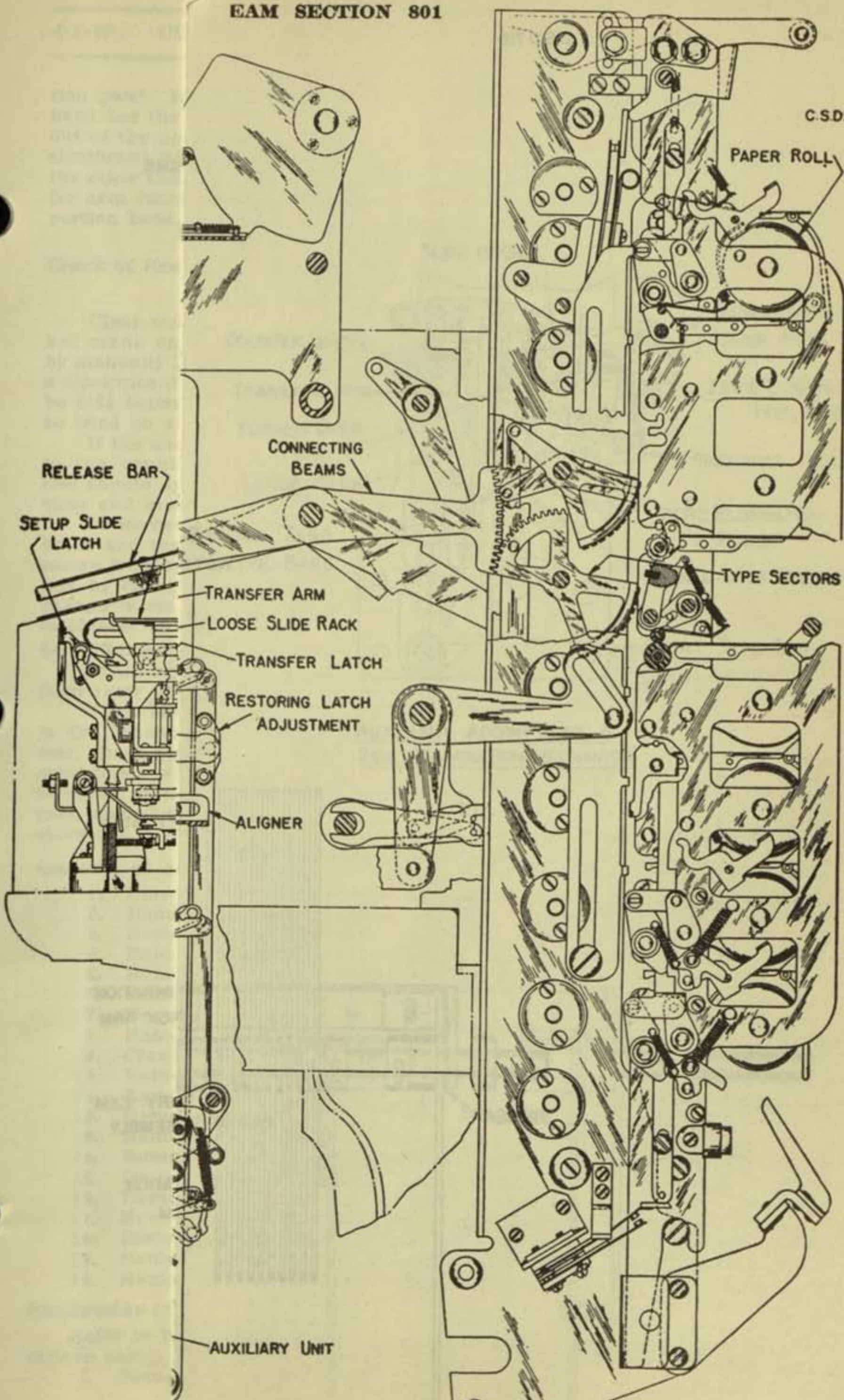
This is the controlling unit for the compartment counter wheels. It pivots on a shaft in the lower part of the adding unit.

The difference between the adding unit and the zero elimination mechanism, also known as the auxiliary adding unit, is that in the adding unit the counter wheels are cammed in to mesh with the loose slide racks, while the loose slide racks in the zero elimination mechanism, thru its cam slotted arms, is cammed in to mesh with the compartment counter wheels. Due to this reverse movement, the stationary aligners, as shown in the adding unit, must be movable in the compartment counter wheels. Therefore as the zero elimination mechanism is cammed in to mesh with the counter wheels, thru its associated mechanism, the aligner is pushed clear of the counter wheels, permitting them to revolve freely. The transfer arms, in the zero elimination mechanism are in two parts. This difference is necessary in taking totals as explained at this time.

It is necessary to call attention to the different methods of printing in the control and compartment printing mechanism. In the first, there are individual hammers and while the zeros to the left of the last significant figure are in printing position, they will not print because their respective hammers are not tripped. In the compartment printer, the single rubber printing platen runs the full length of the ten figures and when tripped, will print everything that is set up, whether significant figures or zeros, when taking compartment totals.

With the compartment total key depressed, as the machine starts thru a cycle, the slide hooks, thru cam action, are raised. As the slide hooks are raised, the slidable part of the transfer arm, thru spring tension, moves forward, until the turned over toe on the slidable part is over the zero elimination pawl. The zero elimination mechanism then operates, engaging the loose slide on the short type bar, with the compartment counter wheels. Where the wide tooth is at the zero position, the tooth will push the slidable portion of the transfer arm back, so that when the zero elimination pawls, which now function, are released, they can swing in front of the turned over toe. The other end moves into the notch in the short type bar, holding the type bars in the blank position, thereby eliminating the printing of zero to the left of the last significant figure. The zero elimination pawl of the last significant figure comes to rest against the turned over toe on the slidable portion of the transfer arm, thereby preventing the other end of the zero elimination pawl from dropping into the notch of the short type bar.

When the type bars begin to travel upward, the wide teeth on the wheels having significant figures will at varying times push back the toes but by that time, the notch will have gone past the point where it may be locked by the zero elimina-


C.S.D. 714
PAPER ROLL
CONNECTING BEAMS
RELEASE BAR
SETUP SLIDE LATCH
TRANSFER ARM
LOOSE SLIDE RACK
TRANSFER LATCH
TYPE SECTORS
RESTORING LATCH ADJUSTMENT
ALIGNER
AUXILIARY UNIT

depressed, moves from the adding bar into the total bar. The other two studs move into the neutral bar.

The group total key when fully depressed automatically sends the machine thru a cycle. If the grand or compartment total key is depressed, it is necessary to also depress the release bar to start the machine thru a cycle. As the machine starts thru its cycle, the counter wheels, by means of their controlling stud in the total bar, are brought in mesh with the type bars. The control slides are then released and the type bars raise until the wide tooth on the counter wheels comes in contact with the end of the transfer arm, stopping the type bar at that point. The aligners then function and the total is printed. The counter wheels disengage and the type bars and control slides are returned to their home position.

When taking a group or grand total, the rear printer is disabled, and the amount is only printed on the control printer tape with its symbol.

When taking compartment totals, the control printer is disabled, the number of the pocket which the machine is set at, together with an asterisk and the total is printed on the rear printer tape. Between 40 degrees and 60 degrees of the cycle, the total bar thru cam action moves upward, and between 190 degrees and 210 degrees the total bar is returned to its home position. The neutral bar is held stationary.

AUXILIARY ADDING UNIT
AND
ZERO ELIMINATION MECHANISM

Fig. 2

Operation

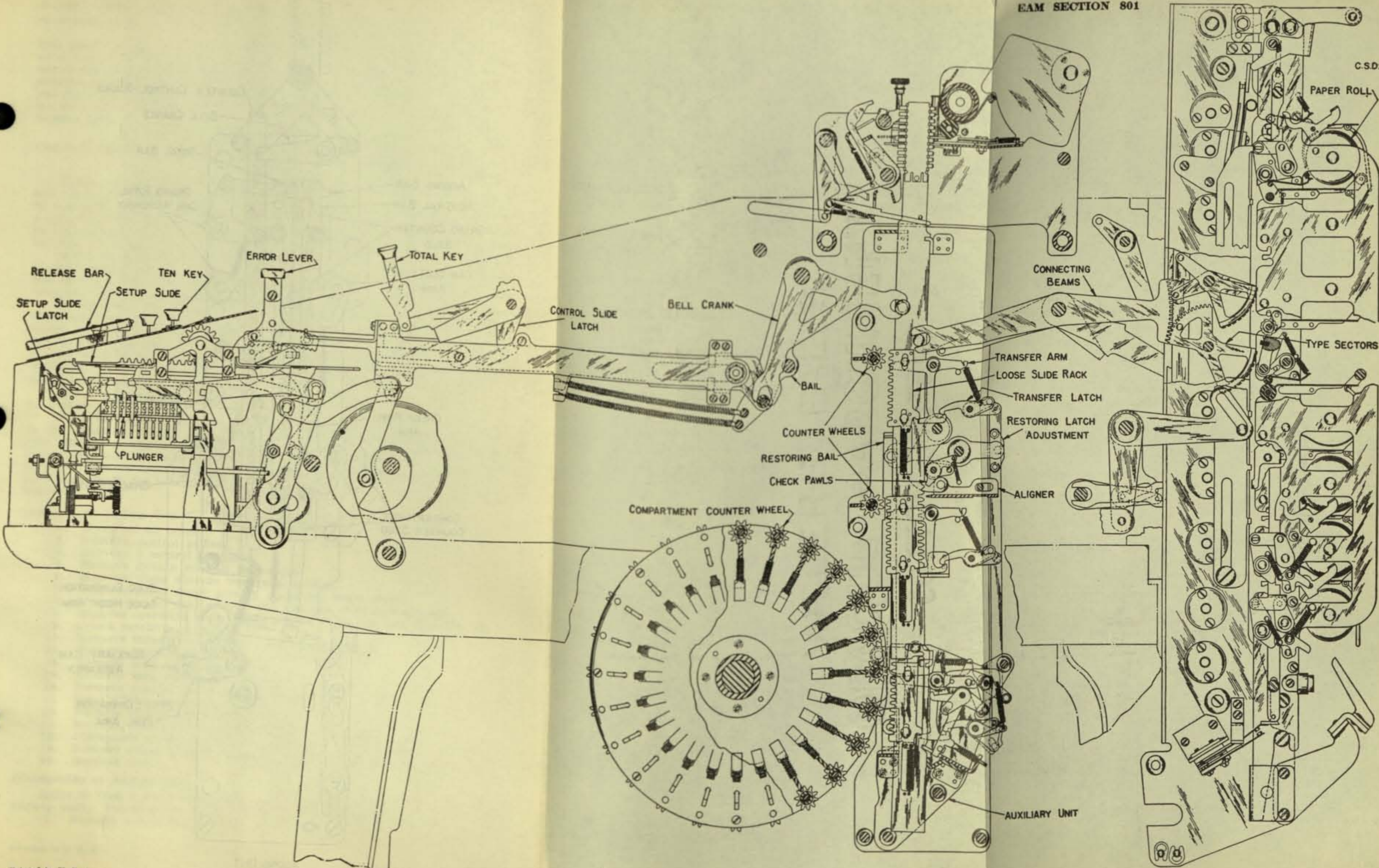
This is the controlling unit for the compartment counter wheels. It pivots on a shaft in the lower part of the adding unit.

The difference between the adding unit and the zero elimination mechanism, also known as the auxiliary adding unit, is that in the adding unit the counter wheels are cammed in to mesh with the loose slide racks, while the loose slide racks in the zero elimination mechanism, thru its cam slotted arms, is cammed in to mesh with the compartment counter wheels. Due to this reverse movement, the stationary aligners, as shown in the adding unit, must be movable in the compartment counter wheels. Therefore as the zero elimination mechanism is cammed in to mesh with the counter wheels, thru its associated mechanism, the aligner is pushed clear of the counter wheels, permitting them to revolve freely. The transfer arms, in the zero elimination mechanism are in two parts. This difference is necessary in taking totals as explained at this time.

It is necessary to call attention to the different methods of printing in the control and compartment printing mechanism. In the first, there are individual hammers and while the zeros to the left of the last significant figure are in printing position, they will not print because their respective hammers are not tripped. In the compartment printer, the single rubber printing platen runs the full length of the ten figures and when tripped, will print everything that is set up, whether significant figures or zeros, when taking compartment totals.

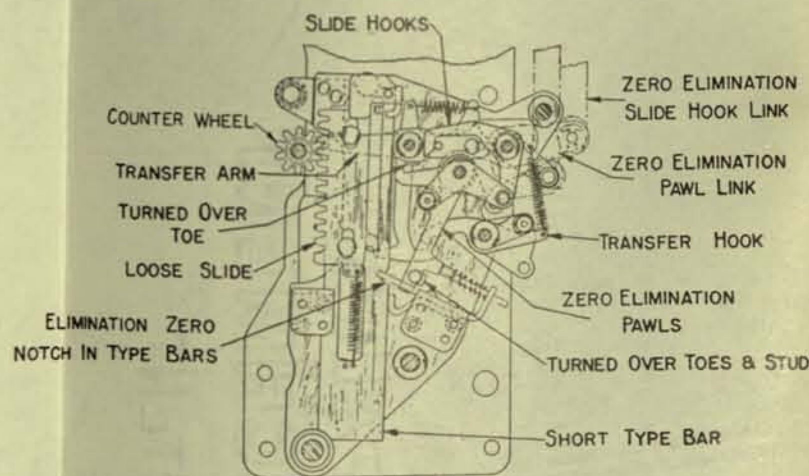
With the compartment total key depressed, as the machine starts thru a cycle, the slide hooks, thru cam action, are raised. As the slide hooks are raised, the slidable part of the transfer arm, thru spring tension, moves forward, until the turned over toe on the slidable part is over the zero elimination pawl. The zero elimination mechanism then operates, engaging the loose slide on the short type bar, with the compartment counter wheels. Where the wide tooth is at the zero position, the tooth will push the slidable portion of the transfer arm back, so that when the zero elimination pawls, which now function, are released, they can swing in front of the turned over toe. The other end moves into the notch in the short type bar, holding the type bars in the blank position, thereby eliminating the printing of zero to the left of the last significant figure. The zero elimination pawl of the last significant figure comes to rest against the turned over toe on the slidable portion of the transfer arm, thereby preventing the other end of the zero elimination pawl from dropping into the notch of the short type bar.

When the type bars begin to travel upward, the wide teeth on the wheels having significant figures will at varying times push back the toes but by that time, the notch will have gone past the point where it may be locked by the zero elimina-



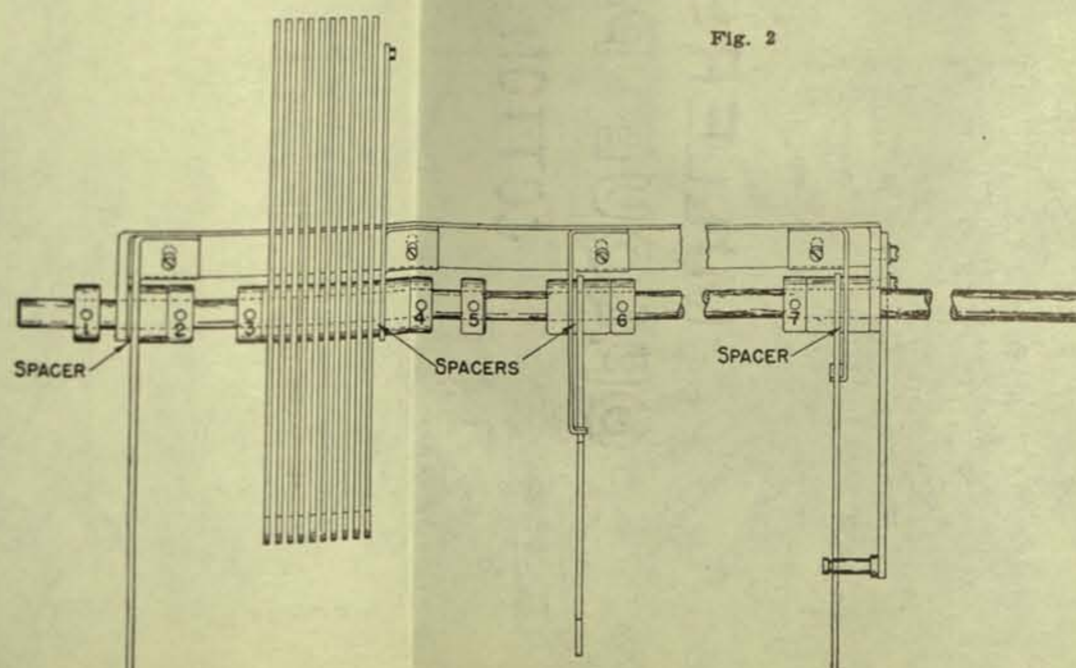
ADDING & PRINTING MECHANISM

Fig. 1



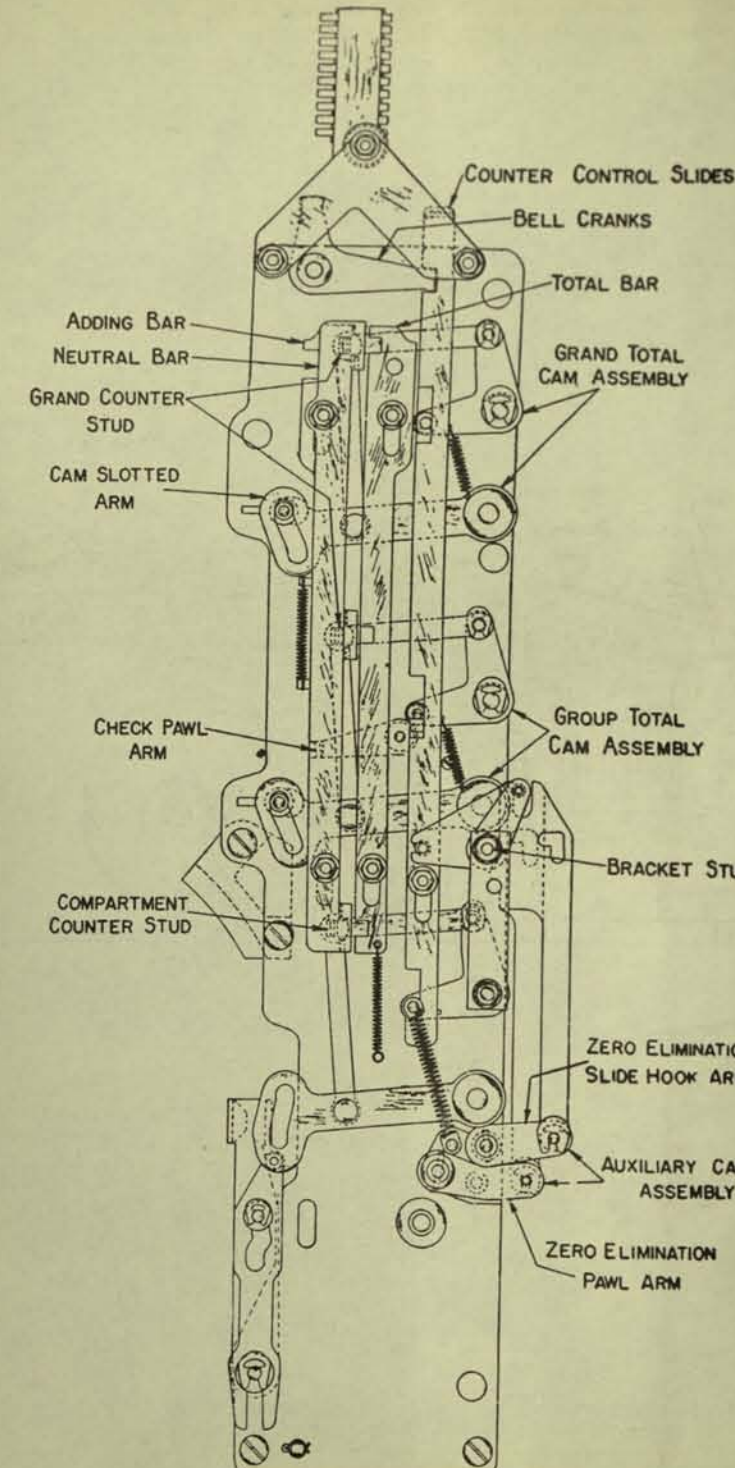
AUXILIARY ADDING UNIT & ZERO ELIMINATION MECHANISM

Fig. 2



SQUEEZE BAR OPERATING LEVER SHAFT

Fig. 3



ADDING UNIT

Fig. 4

tion pawl. It may be noted at this time that the stud in the zero elimination pawl has the function of holding all the pawls to the right of a significant figure out of the notch in the short type bars, so that the zeros to the right of the last significant figure may be printed. When the slide hooks are raised, the tail on the other end swings over a stud in the transfer arm. This is to prevent the transfer arm from being cammed down while the wide tooth is pushing the slidable portion back.

Check of Reel Lock Arm to Show the Relation of Counter Wheels to Adding Unit

Fig. 5

Clear out all compartment counters. Disconnect the adding link from the bell crank end. Press down solenoid to latch stop arms. Engage counter wheels by manually lifting up on camming arms. Disengage the reel lock and turn reel in a clockwise direction. The slot in the lug on the reel should move so there would be 1/32 between the top of the lug and the top of the reel lock. This test should be tried on all 24 lugs.

If the check shows an excessive tolerance, then the unit must be moved closer to the counter wheels. If the dimension should be to a degree where the reel should spring in a counter clockwise direction when checked, then it is too close and must be moved away from the counters.

To move the unit, disconnect the locating arms and loosen the rear locating brace and then move the unit either in or out (In either case, just sufficient to secure freedom of movement between the loose slides and counters. This is realized by checking the type bars in a total cycle with all 9s set up). In case a change is made, it will be necessary to peen the locating arms on the present machines. In the future, an eccentric bushing will facilitate any adjustment.

Zero-Elimination Pawl Arm. Refer to Fig. 4.

Adjust arm so that plungers protrude at least **¼"** and not more than **⅜"** out from their guide.

When adding trouble is experienced with the machine, first check the unit in the machine. Check the adding and total bar, check restoring front and rear, check zero elimination links; check for sticky type bars, by taking compartment totals with all 9's in counters. Check over sectors and links in rear printer. Secondly, remove the adding unit and check transfer arms; loose slides in type bars, and check for broken springs, loose taper pins, broken parts and sluggish operation.

Removal of Adding Unit

1. Crank up all nines.
2. Remove control printer.
3. Remove 5 control key links.
4. Remove double spacing link shaft.
5. Remove three squeeze bar yoke springs.
6. Remove seven taper pins in operating beam shaft.
7. Remove upper rear adding unit support shaft and spacers.
8. Remove operating beam shaft, pulling it out left side (See Fig. 3).
9. Crank machine to home.
10. Remove three screws from lower locating brace.
11. Remove locating brace bolt and remove brace.
12. Remove zero elimination links.
13. Remove zero elimination link stud.
14. Remove symbol bar operating lever.
15. Drop adding unit locating arms (2).
16. Remove aligner link from machine.
17. Remove adding slide restoring link from machine.
18. Disconnect short aligner link from adding unit end.
19. Remove upper front adding unit shaft and spacers.
20. Remove unit.

Disassembly of Adding Unit

Refer to Figs. 1 and 4 for views of this assembly, showing the location of the various parts. Procedure to remove the parts is as follows:

1. Remove neutral and adding bars.

2. Remove the total bar.
3. Remove compartment total lug spring.
4. Remove zero slide and hook disengaging bracket.
5. Remove bracket stud.
6. Remove bail cranks and counter control slides.
7. Remove counter engaging arm assembly of auxiliary unit by driving out 2 pins. Reassemble when removed.
8. Remove check pawl operating arm by driving out pin.
9. Remove group total cam assembly (reassemble when out).
10. Remove clips and grand total assembly.
11. Remove grand total cam assembly.
12. Remove side plate (right facing unit—13 screws). Watch for spacers.
13. Remove transfer arm detents.
14. Repeat for group total.
15. Remove screw on other side plate and take out check pawl.
16. Remove transfer arm by driving out pin from lower hub.
17. Repeat for group total.
18. Remove counter wheels.
19. Remove upper two combs.
20. Remove type bars.

Removing Auxiliary Unit

1. Remove camming screws.
2. Remove one cotter key and pull out auxiliary unit pivot shaft.
3. Drive out 2 taper pins in the zero elimination operating arms.
4. Remove these shafts.
5. Lift auxiliary unit out.

Disassembly of Auxiliary Unit

1. Disconnect loose slide spring.
2. Disconnect transfer arm spring.
3. Remove right side plate.
4. Remove guide.
5. Remove 10 slides.
6. Remove transfer pawl.
7. Remove zero elimination pawl.
8. Disassemble.

Installing Adding Unit in Machine

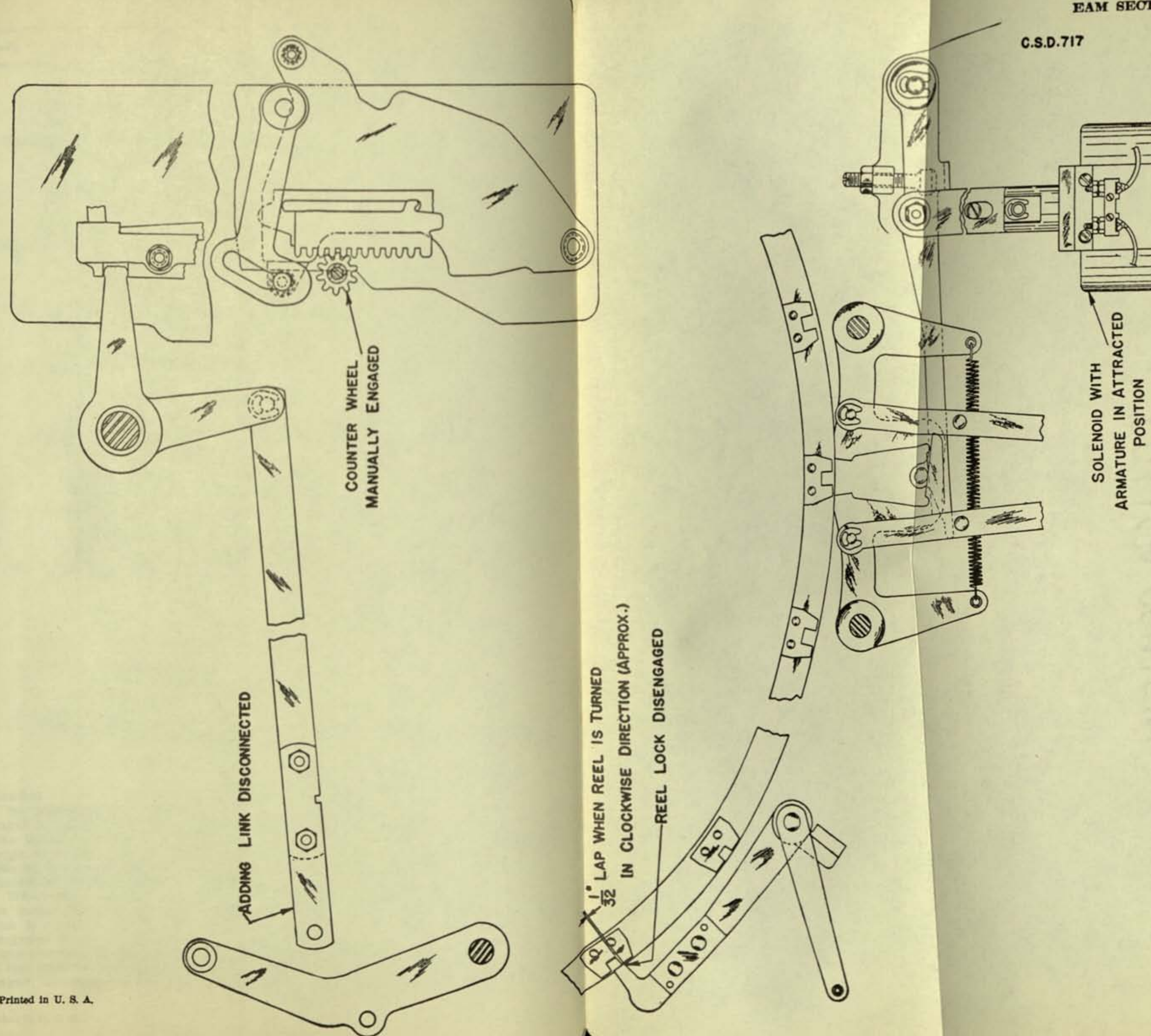
1. Machine must be in home position.
2. Unit must be set in making sure aligner arms on auxiliary unit are over aligner arm on counter wheel disc. Also that the total and adding bell cranks are in respective bars. The bell cranks must mesh in racks. Secure unit in place by rear adding unit shaft, disregarding spacers. Then insert front adding unit shaft with spacers.
3. Position positive locating arms on studs at bottom.
4. Install stud and zero elimination slide links clips and all.
5. Assemble all links with clip and operating beam shaft. Fig. 3. Check link adjustments.
6. See that symbol bar gear is in proper mesh with other link. Install symbol operating gear first.
7. When installing operating beams, be sure gauge is in place on rear printer to insure proper alignment of beams with sectors. All nines must be set up.
8. Install control printer and test.

ADJUSTMENTS

Cam Shaft Links

(Numbered reading from intermediate frame to right frame)

1. Rear printer link (no adjustment).
2. Aligner link (adjust at front).
3. Transfer restoring bail (adjust front).
4. Control slide restoring link (adjust front).
5. Adding link (adjust front).
6. Total link (adjust rear).



CHECK OF REEL LOCK ARM TO SHOW THE RELATION
OF COUNTER WHEELS TO ADDING UNIT

Fig. 5

7. Control printer link (adjust rear).
8. Zero elimination pawl link (adjust front).
9. Zero elimination slide hook (adjust rear).

To Remove the Cam Lever Shaft

1. Remove holding screw in right base opposite shaft.
2. Remove middle bushing on shaft.
3. Screw in to end of shaft a long 10/32 member.
4. Pull shaft out by screw.
5. Do not turn shaft as other end is forked.
6. Keep oil groove up when replacing.

Adjustment of Links

1. Zero elimination slide hook—Machine at home position. Pull slide hook operating arm downward so that top of slot rests on locating stud; then adjust operating link to allow .005 clearance above locating stud. Fig. 2.
2. Zero elimination pawl—Machine at home. Same as slide hook adjustment. Zero elimination pawl operating arm should have .030 movement above adjusting point to allow freedom of movement on compartment totals. Fig. 2.
3. Adding bar—Machine at home. Adjust link so that grand total, group and compartment adding engaging cams carry high enough to insure full engagement of adding wheel with type bars and still have grand, group and compartment counter studs move freely through stationary bar. Fig. 4.
4. Total bar—Machine at home. Same as adding bar adjustment. Fig. 4.
5. Control slide link. Turn machine through cycle. Slides should drop over stop bar and clear by .015. Also it must pull rack down far enough to allow zero elimination pawls to enter notch on short type bar. Fig. 4.
6. Aligner link—Turn machine through cycle until aligner is fully engaged. Loosen adjusting nuts on aligner link. Check aligner for full engagement and then set adjusting link so aligner has .030 clearance from bottom of aligner teeth on back of type bars.
7. Restoring bail (front). Fig. 1.
   A. Turn machine through cycle until bail reaches its maximum travel. At this position, loose slides should have at least .030 play above bail.
   B. Clear out all totals. Set up all nines and add 1 to trip all transfer arms. At home position, slides must have about .005—.010 clearance over restoring bail.
8. Restoring bail rear—With transfer tripped, the bail shaft should set about .030 above transfer latching pawls. There is a separate adjustment for the rear.
9. Rear printer link. No adjustment.
10. Control printer link. Loosen adjusting nuts with machine at home. Push link up to meet latched-up hammer and tighten adjusting nuts.

TEN KEY SET-UP MECHANISM

Fig. 6

Operation

By depressing any one of the ten keys thru its key lever, the corresponding plunger is raised. Only one key may be depressed at one time, this interlocking action being governed by nine discs in the casting riding side by side with only enough clearance between them to admit the thickness of one key lever. The stroke of the key is limited by the key lever striking the stop block. They key is returned by spring tension.

When one of the ten keys is depressed, the key bail, which is common to all keys, raises the escapement so that the stationary pawl engages with the rack, which is attached to the pin carriage, and holds it. The movable pawl, being disengaged from the rack, moves over ready to catch the next tooth in the rack. On the upstroke of the ten key, the escapement is returned to its normal position, and the stationary pawl is disengaged from the rack, while the movable pawl is engaged, allowing the pin carriage to move over one tooth.

As the carriage moves over one space, the slide latch passes the latch trip, releasing the set-up slide and thru spring tension moves forward until it is stopped by the selected plunger. The selected number is denoted on the reading wheel, which is in mesh with the set-up slide. When an error is made, the error lever is pulled forward manually, restoring the plungers and carriage to normal position.

Adjustments—Fig. 6.

1. To secure proper adjustment and timing between the plunger and escapement, adjust the key ball escapement adjustment screw so that the escapement trips immediately after the plunger has gone beyond the center of the detent stud. Fig. 6-A.
2. As there are no number nine plungers used, the restoring bail adjustable stop is used to assure proper alignment for the nine set-up. Fig. 6-B.
3. The escapement bracket adjusting screw is used to permit the control slides to drop over the set-up slides without interference. Fig. 6-C.
4. The escapement pawl adjustable stop is to prevent the escapement pawl from being thrown back too far. The pawl should clear the high point of the rack by approximately 1/32". Fig. 6-D.
5. The escapement adjustable stop is to prevent the escapement from being thrown too high. When one of the ten keys is fully depressed, the movable pawl should clear the top of the rack by approximately 1/32". Fig. 6-E.
6. The pin carriage adjustable stop is to allow the control slides to properly drop over the set-up slides when a complete set-up is made. Fig. 6-F.
7. The key lever adjustable stop is to control the down movement of the ten keys. When one of the ten keys is depressed, as soon as the plunger is in its up position, the key lever should strike the stop. Fig. 6-G.
8. Adjust set-up slide latch release so when ratchet trips off there should be 1/32" clearance between set-up slides and latch pawls.
9. Adjust carriage return arm so there will be 1/16" clearance beyond last tooth of rack.
10. When cam returns bail, there should be a few thousandths clearance between carriage stop and carriage when spring stop is depressed. Fig. 6.
11. The key bail adjustment is to place the escapement movable pawl flush with top of rack teeth. Fig. 6-L.
12. Adjust restoring bail return arm so set-up slides overthrow 1/32" beyond latch when slides are being restored.

Disassembly of Ten Key Unit

To remove pin carriage:

1. Remove 4 screws on side frame as well as two nuts.
2. Remove control key spring.
3. Remove carriage return spring.
4. Remove 3 large and 2 small clips on zero elimination mechanism and remove links.
5. Remove 8 dowel screws.
6. Remove side frame.
7. Remove operating springs.
8. Remove right bracket (2 screws).
9. Remove right bail stop.
10. Remove operating bail right.
11. Remove restoring bar (mark upper side).
12. Move cam operating arm to remove carriage.

To disassemble unit:

1. Remove error lever spring and guide.
2. Disconnect error lever pawl spring.
3. Remove 4 screws and 2 dowels to remove pin carriage casting.
4. Top dowel pins flush with bar.
5. Remove carriage casting.
6. Remove release bar lock.
7. Remove total key interlock link.
8. Remove ten key operating lever.
9. Remove total key lock guide.
10. Remove ten key springs.

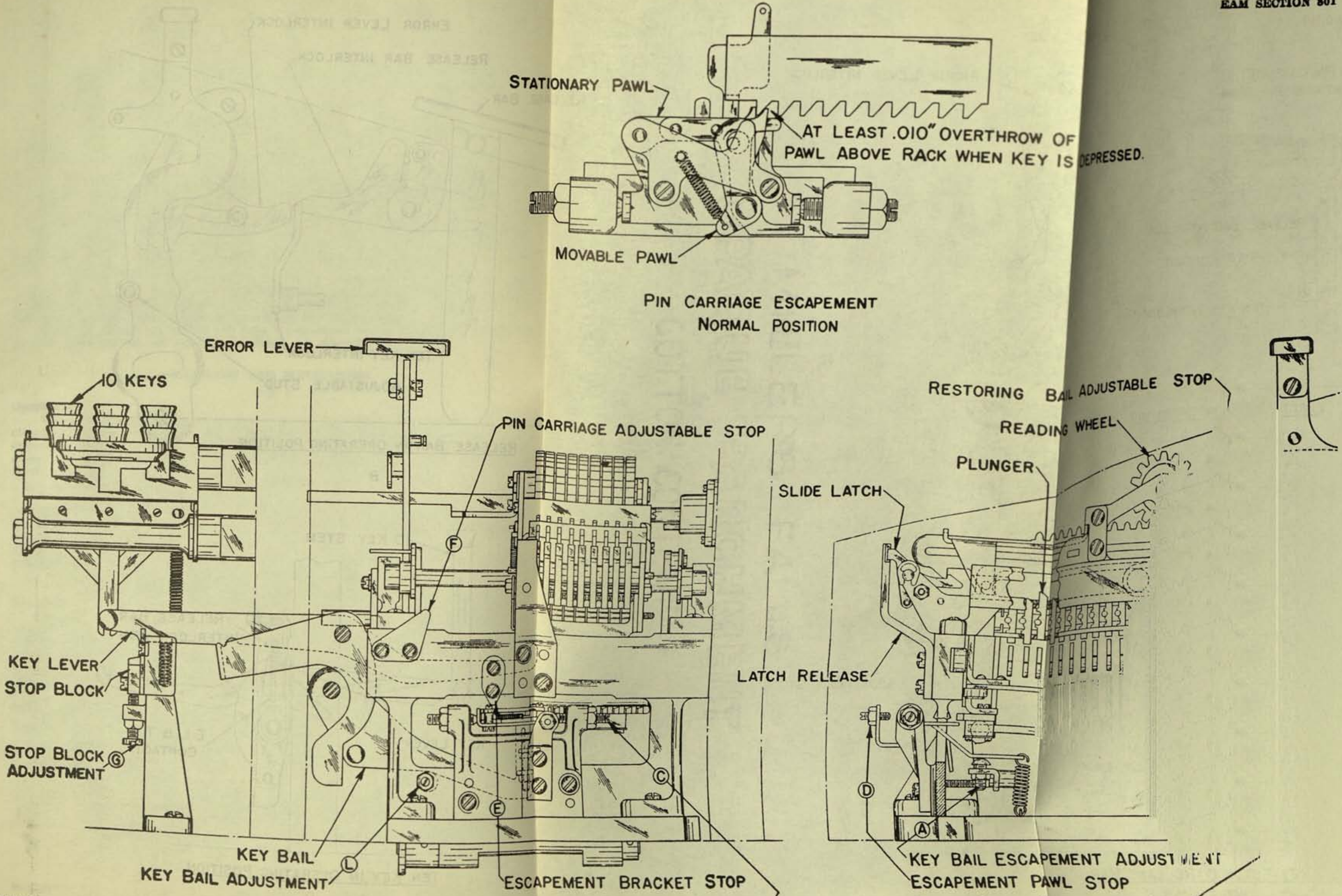
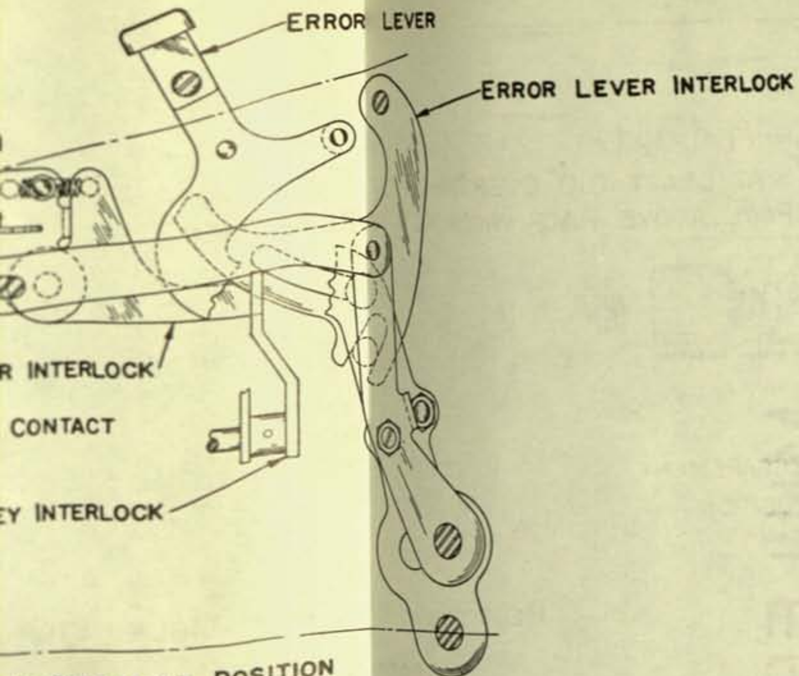
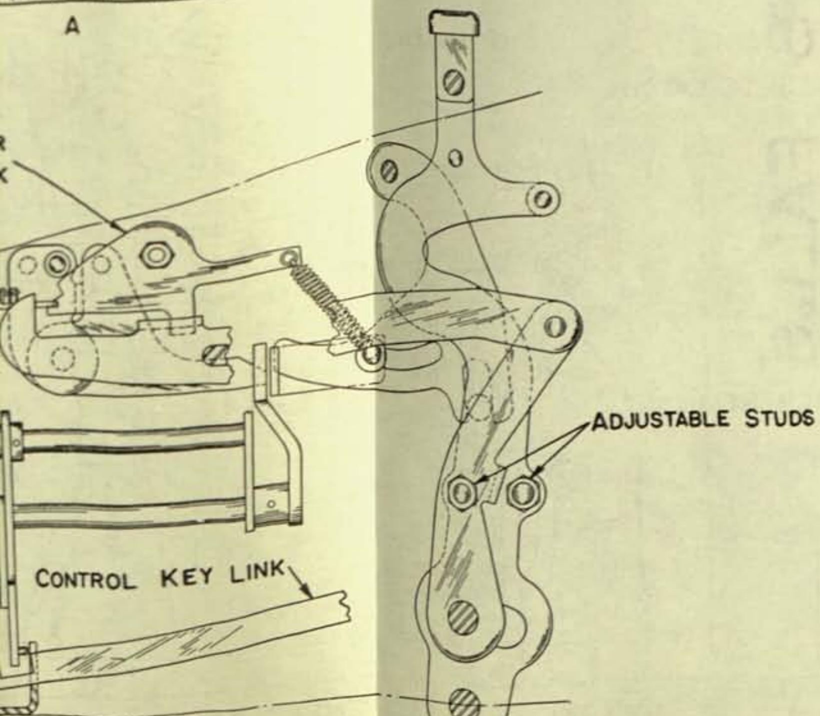

STATIONARY PAWL
AT LEAST .010" OVERTHROW OF PAWL ABOVE RACK WHEN KEY IS DEPRESSED.
MOVABLE PAWL
PIN CARRIAGE ESCAPEMENT
NORMAL POSITION
ERROR LEVER
10 KEYS
PIN CARRIAGE ADJUSTABLE STOP
RESTORING BAIL ADJUSTABLE STOP
READING WHEEL
PLUNGER
SLIDE LATCH
LATCH RELEASE
KEY LEVER
STOP BLOCK
STOP BLOCK ADJUSTMENT
KEY BAIL
KEY BAIL ADJUSTMENT
ESCAPEMENT BRACKET STOP
ESCAPEMENT BRACKET ADJUSTMENT
KEY BAIL ESCAPEMENT ADJUSTMENT
ESCAPEMENT PAWL STOP
SETUP SLIDE RESTORING ARM

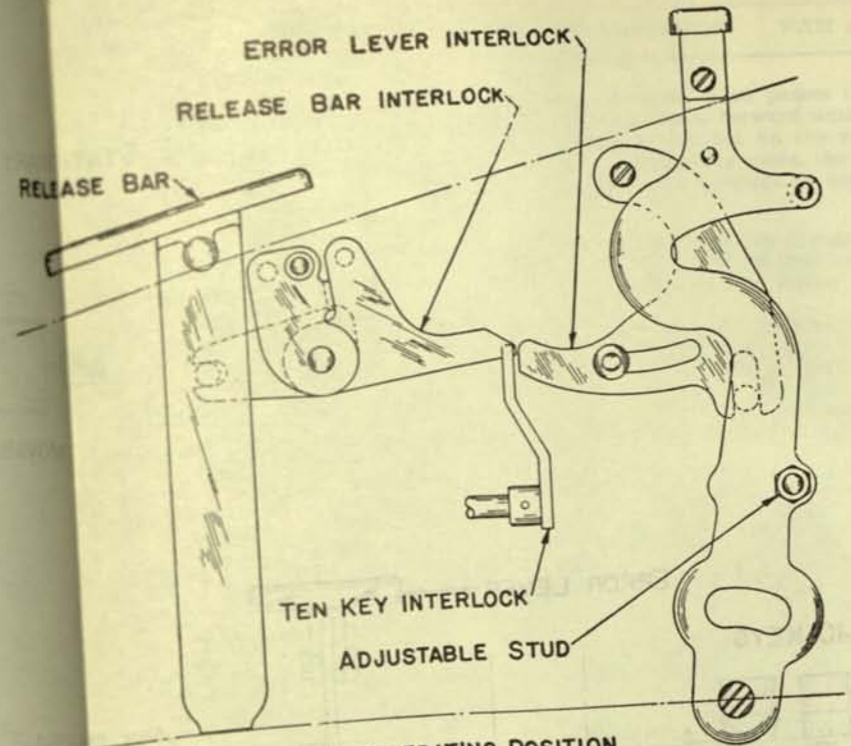
Fig. 6



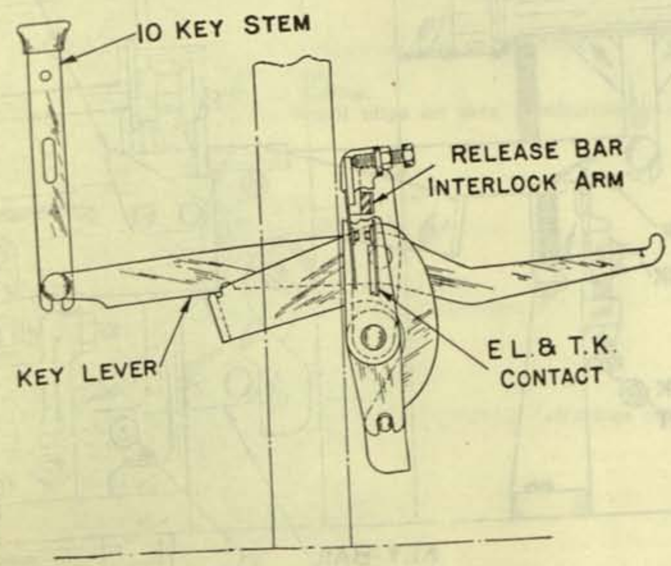
IN OPERATING POSITION
A



SETUP & RELEASE BAR INTERLOCKS
C



RELEASE BAR IN OPERATING POSITION
B



TEN KEY IN OPERATING POSITION
D

Fig. 7

11. Remove ten key assembly (2 nuts).
12. Remove key lever guide.
13. Remove bail spring.
14. Remove bail asembly.

TEN KEY SET-UP AND RELEASE BAR INTERLOCKS

Fig. 7

Operation

Fig. 7-C. Showing the interlocks in their operative position.

The link shown at the bottom is an interlock between the total keys and the ten keys. When one of the total keys is depressed, the link moves to the left, locking out the movement of the ten keys by preventing the bail from operating.

Fig. 7-A. When the error lever is pulled forward, the error lever interlock swings into the path of the release bar interlock. At the same time, the E. L. and T. K. contact is opened, breaking the circuit to the release bar magnet. The movement of the ten keys is blocked by the ten key interlock striking on the side of the error lever interlock.

Fig. 7-B. When the release bar is depressed, the release bar interlock swings into the path of the error lever interlock preventing the error lever from being pulled forward. The movement of the ten keys at this time is blocked by the ten key interlock striking the side of the release bar interlock.

Fig. 7-D. When one of the ten keys is depressed, the E. L. & T. K. contact is opened, breaking the circuit to the release bar magnet.

RELEASE BAR MECHANISM

Fig. 8

Operation

When the release bar is depressed, it opens the release bar contact No. 1 and closes the release bar contact No. 2. The closing of the lower contact completes a circuit to the release bar magnets. When the armature is attracted to the magnet cores, it releases the clutch pawl. Thru a tension spring the pawl is drawn into mesh with the ratchet which is continually running, starting the machine thru a cycle. At the same time, the armature closes the R. B. M. holding contact.

When the release bar magnet is deenergized near the end of the cycle, the release bar is still held down by a mechanical interlock which operates when the pin carriage restoring bail starts its function, and this same bail is the means of releasing the release bar at the very end of the cycle when it restores to its home position.

Release Bar Circuits Detailed—Circuits No. 8 through No. 10.

CONTROL KEY UNIT

Operation

The control key unit is used to control the various operations of the adding unit and place the other various parts of the machine in a position to carry out that particular operation. The unit consists of six keys with the classification printed on each. The unit is so designed that only one key can be depressed in each bank of three keys at one time. Also an interlock plate prevents the depressing of keys in one bank when keys are down in the other. It is not necessary to describe all of the functions of the various keys. However, the two major keys are described below with diagram of each.

Removal of Control Key Unit

1. Remove control printer.
2. Remove machine at home.
3. Remove key tops and key plate.
4. Remove control key links:
   - #5 operates compartment total.
   - #4 operates adding machine.
   - #3 group total.
   - #2 non-add.
   - #1 grand total.
5. Remove control printer disabling stud.

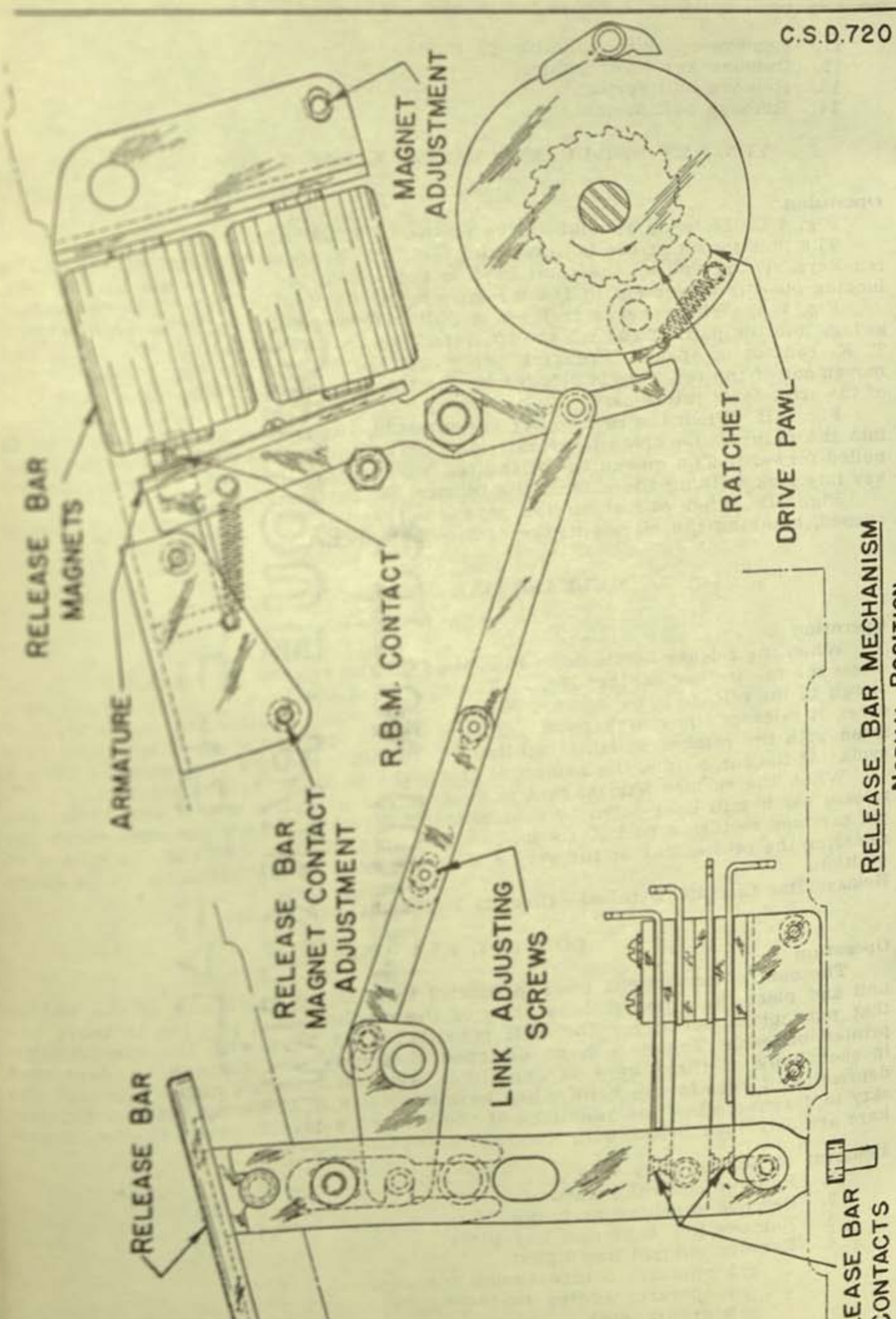
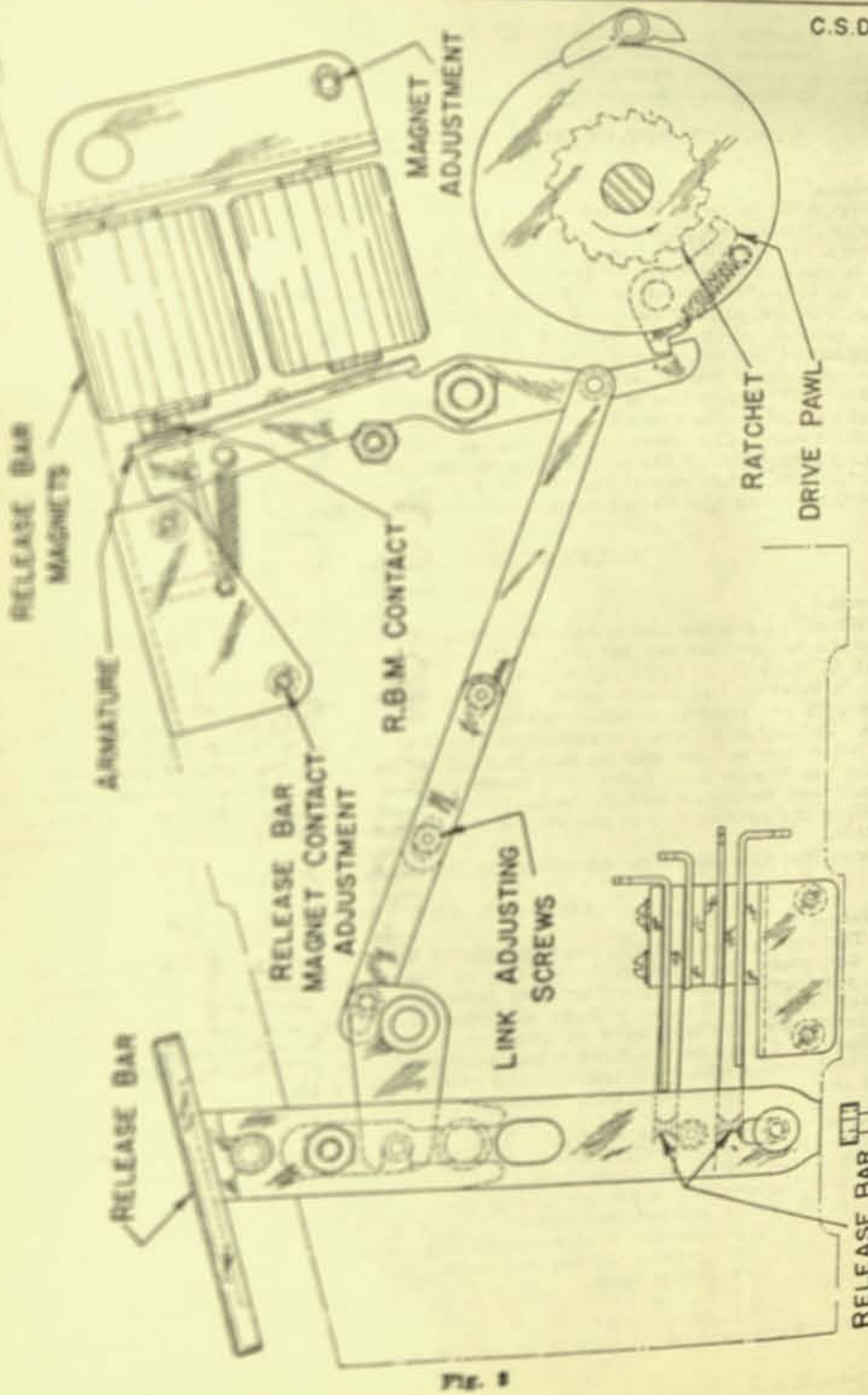

C.S.D.720
MAGNET ADJUSTMENT
RELEASE BAR MAGNETS
ARMATURE
R.B.M. CONTACT
RATCHET
DRIVE PAWL
RELEASE BAR MAGNET CONTACT ADJUSTMENT
LINK ADJUSTING SCREWS
RELEASE BAR
RELEASE BAR CONTACTS
RELEASE BAR MECHANISM
NORMAL POSITION

Fig. 8

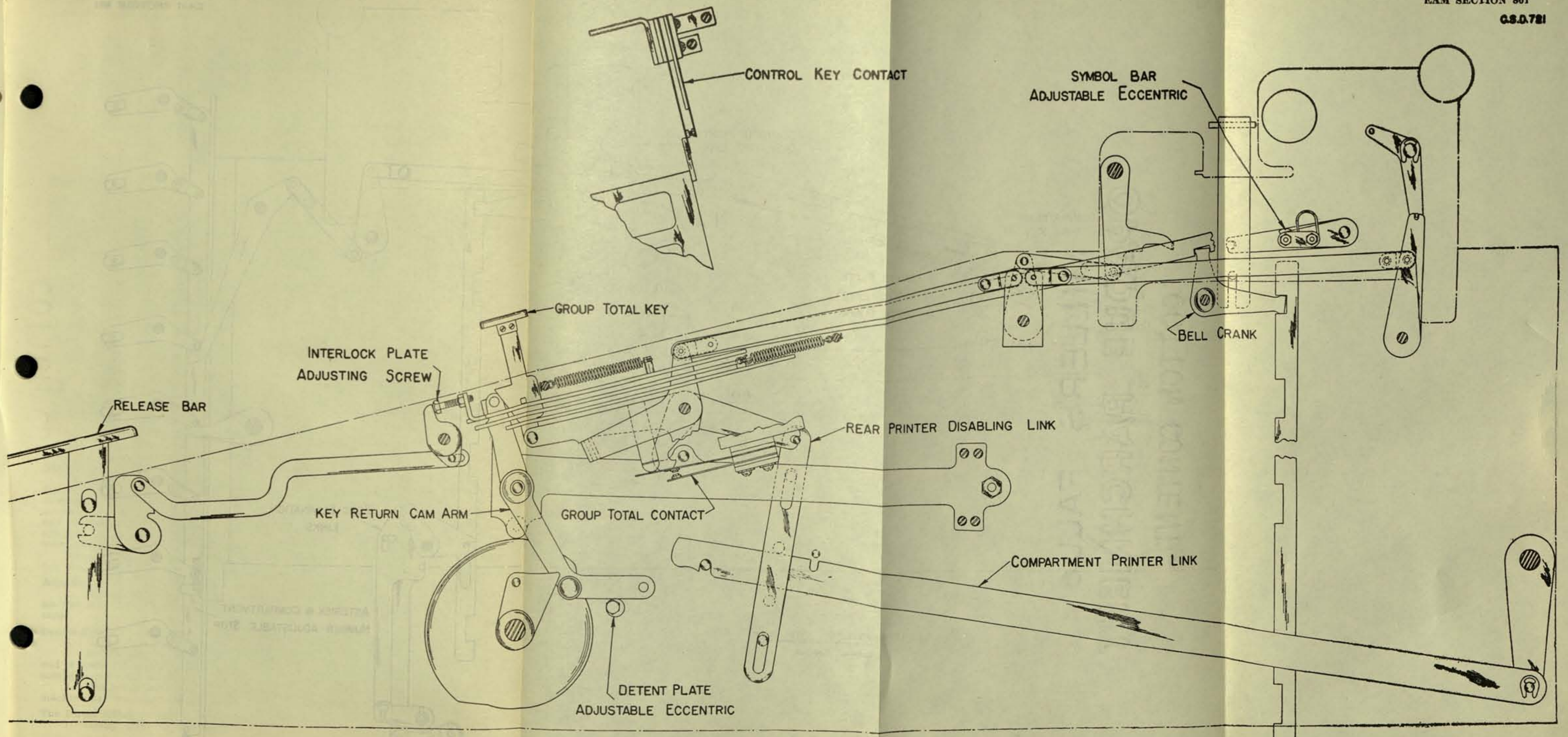
C.S.D.720



RELEASE BAR MECHANISM
NORMAL POSITION

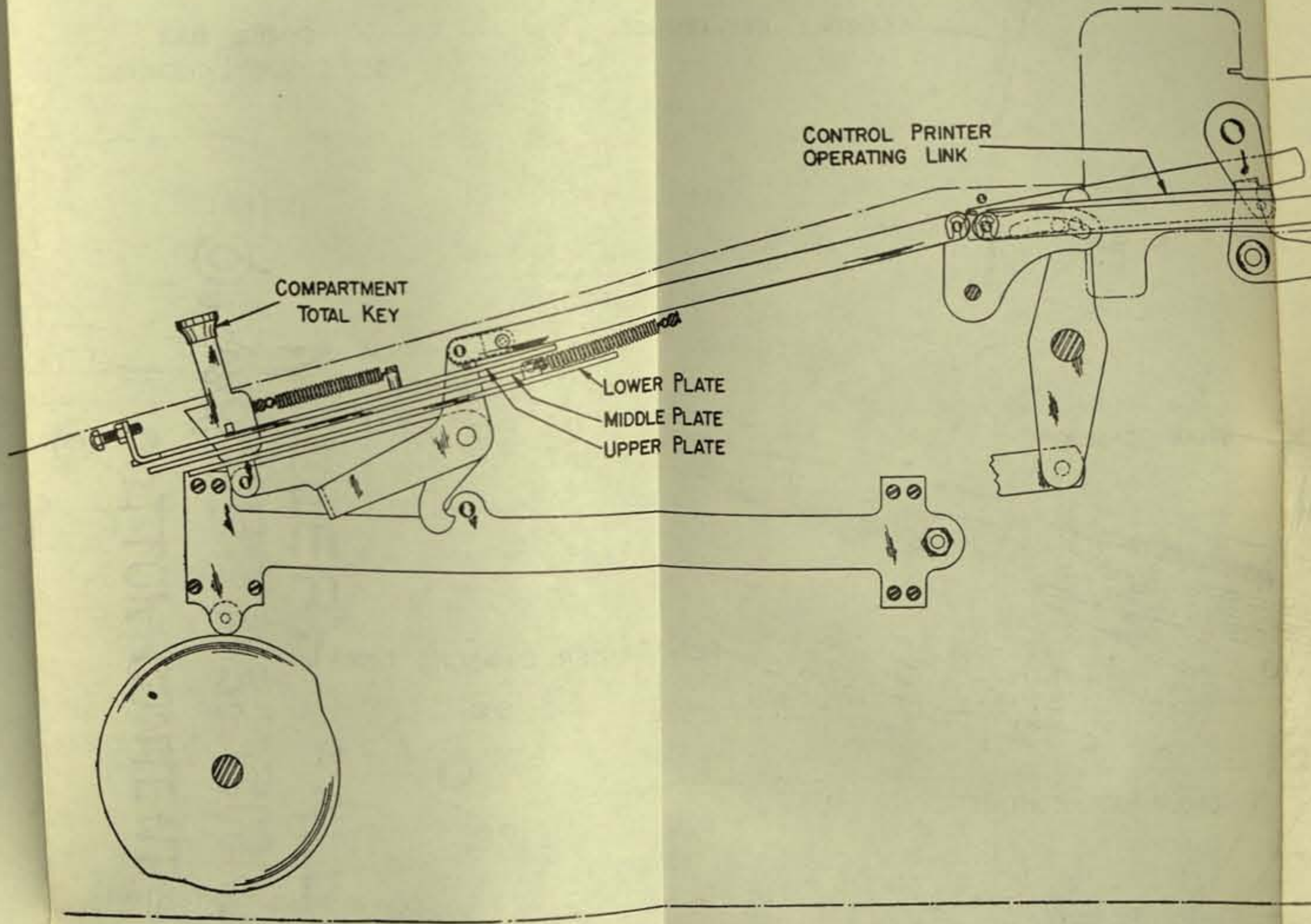
Fig. 8

C.S.D.721



GROUP TOTAL KEY
NORMAL POSITION

Fig. 9



COMPARTMENT TOTAL KEY

NORMAL POSITION

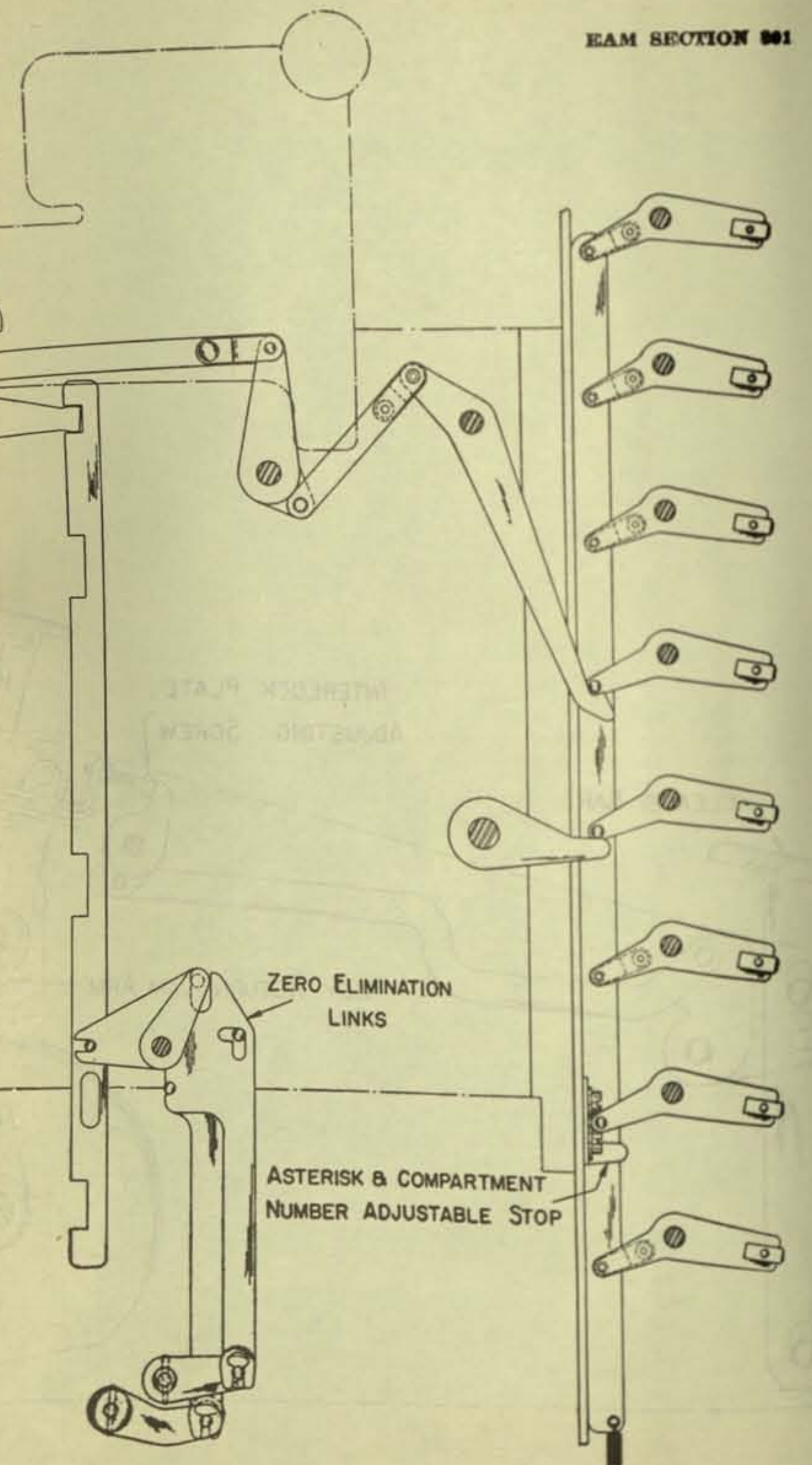


Fig. 10

6. Remove error lever spring.
7. Disconnect control key interlock link (1 spring—1 clip).
8. Disconnect wires from terminal block and control key contacts.
9. Remove cam arm key return.
10. Remove zero elimination cam link (outside).
11. Remove 4 control key casting screws.
12. Remove the unit.
13. Re-installing.
    A. Careful of long interlock link.
    B. Be sure rear printer disabling arm is over stud in disabling link.

GROUP TOTAL KEY

Fig. 9 and Fig. 3.

Operation

When the group total key is depressed thru links and bell cranks, the symbol bar is raised until the group total symbol type is in printing position. This symbol is printed to the right of the total, at the same time the compartment printer link is raised to a non-operating position. The C. K. contact shown at the top opens, as soon as any one of the control keys are depressed, breaking the circuit to the release bar magnet. When the key is fully depressed and latched down, this contact closes again.

When the group total key is fully depressed, the G. T. contact on the bottom closes, completing a circuit to the release bar magnet which starts the machine thru a cycle. The group total, grand total and non-add keys are automatically restored at the completion of a cycle.

The grand total key functions the same as the group total key only it is necessary to depress the release bar to start the machine thru a cycle.

Adjustments

1. The interlock plate adjusting screw is used to prevent depression of another control key while the machine is going thru a cycle.
2. The detent plate adjustable eccentric is to prevent the latched down key from being restored too soon. The control keys should not be released until 345 degrees of the cycle.
3. The symbol bar adjustable eccentric is used to align the symbol type with the amount printed on the control tape.

COMPARTMENT TOTAL KEY

Fig. 10

Operation

When the compartment total key is depressed, thru bell cranks and links, the control printer operating link, is disengaged, causing the control printer to be inoperative. At the same time, the zero elimination links are moved from their inoperative position to their operative position. The hooks holding the asterisk and compartment numbers are also drawn clear of the studs, permitting the asterisk and compartment numbers to go into printing position, while taking a compartment total.

The compartment total key is restored to its normal position only by depressing the key release.

Adjustments

1. Asterisk and compartment number adjustable stop is to properly align the asterisk and the compartment number with the total printed on the rear printer tapes.

Detent Plates

1. Upper plate prevents depressing of key while the cam shaft is in motion.
2. Middle plate is used to latch the keys down. The action of this plate at end of cycle will release the group, grand and non-add key. The add machine and compartment total keys are released only by release key.
3. The lower plate is used to prevent the depressing of the non-add and add machine key when any of the three keys in the lower bank are depressed.

The Direct Effect of Depressing Keys on Adding Unit

1. Group total key moves group counter engaging stud from add bar to

total bar. Also the grand and compartment counter lugs are moved into neutral bar.

2. Grand total key moves grand counter engaging stud from add bar to total and group and compartment to neutral.

3. Compartment key moves compartment counter stud into total bar and grand and group into neutral bar. Also, zero elimination links are put into operating position.

4. Adding machine key puts compartment counter stud into neutral bar and leaves grand and group in add bar.

5. Non-add key puts all counter studs in neutral bar.

CONTROL PRINTER MECHANISM

Figs. 14 and 15

Operation

The releasing of the hammers in the control printer is controlled by the type bars in the adding unit. When the type bars are in their home position, the latch arms are drawn clear of the ball movement, by studs riveted into the side of the type bars. As the machine goes thru a cycle, the upper portion of the ball moves clear of the hammers, while the lower portion moves toward the hammer latch. If no significant figure is set up, no hammers will be released. When a type bar is raised to a significant figure printing position, the latch arm thru spring tension moves with it until it comes to rest at the bottom of the ball. The operating arm, which is controlled thru cam action, causes the ball which is pinned to the operating arm shaft to push against the step on the latch arm, until the tail on the hammer is clear of its latching point on the hammer latch. The hammer thru spring tension flies forward until it strikes the type, printing the amount set up. The bent portion of the hammer latch overlaps the hammer to the right, thereby printing the zeros to the right of a significant figure.

The paper feed arm, which is also pinned to the operating arm shaft, moves to the right as the machine goes thru a cycle; as it clears the paper feed ratchet, its upward movement is stopped by a stud riveted into the side of the feed control lever. In an adding cycle, this stop permits the paper feed arm to move the paper feed ratchet one tooth. In a total cycle, the stop allows the paper feed arm to raise higher, permitting the paper feed ratchet to feed two teeth. The ratchet detent holds the paper feed ratchet in position, while the paper feed arm moves back for another feed.

The ribbon feed arm is controlled by a tail on the paper feed arm. This in turn through a lever actuates the feed arms, which have a cammed member near their pivot point. This cam portion of the feed arms is held in one position by a stud on a small slidable arm, which is under spring tension. This in turn holds the feed arms in one position. This arm, which is held by spring tension, remains in one position and holds the feed arms so as to feed the ribbon on one spool until it is completely depleted on the other spool. At that time, the feed arm is unable to turn the ribbon feed ratchet, as the ribbon is pulling at its fixed point on the other spool. This will prevent the feed arm from moving a full stroke and will pivot, pushing its cammed member against the stud on the slidable arm, moving it over the high cam point and into the recessed portion on the other side and thus reversing the feed arms so the other arm will feed on to the other spool. The check pawl holds the ribbon feed ratchet while the ribbon feed arm moves back for another feed.

Adjustment

The bail adjustment is to assure the unlatching of the hammers. Fig. 11.

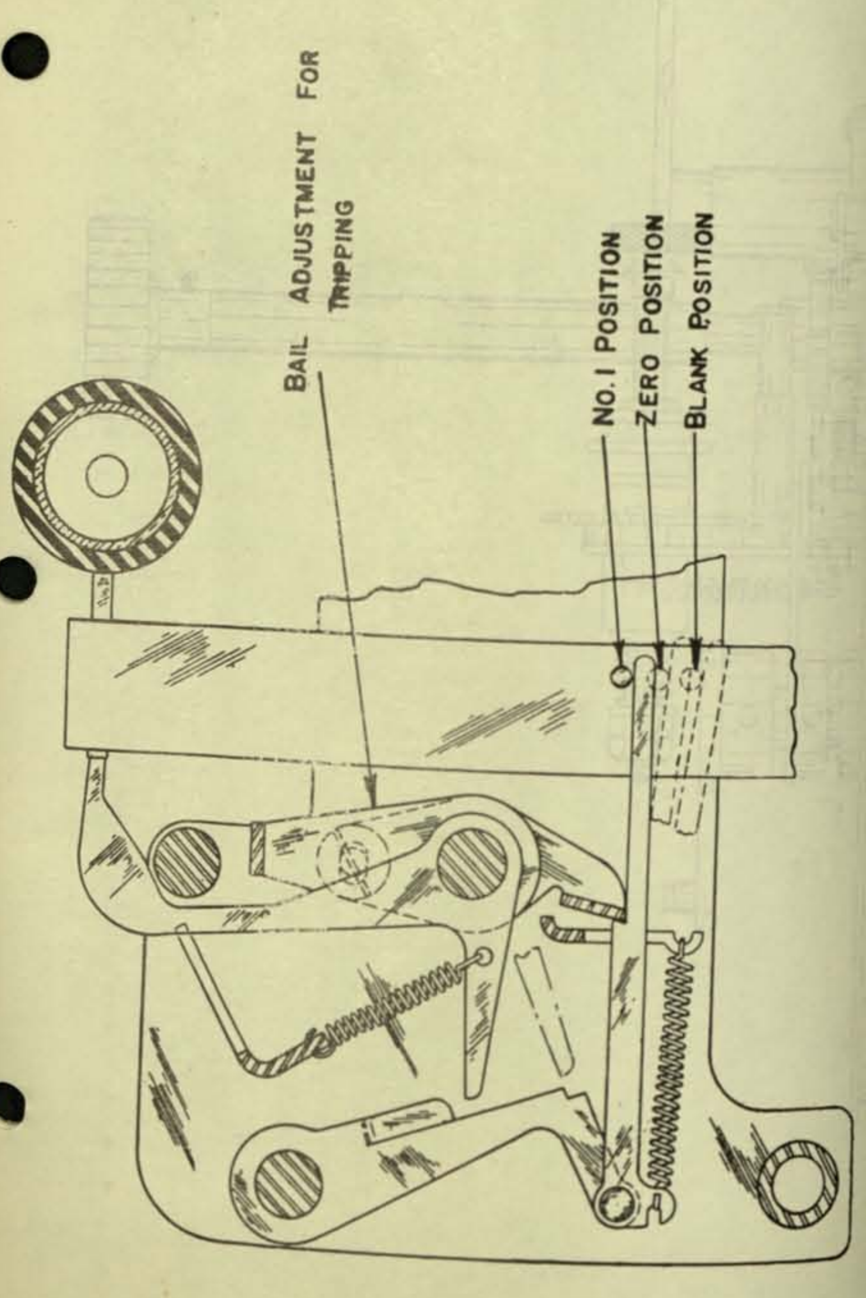
When the machine is in its home position, the tail of the hammer should be held approximately 1/32" past the latching point. Fig. 12.

The paper feed arm adjustment is to assure proper spacing of amounts on control paper. Fig. 13.

The symbol bar adjustable eccentric is to align symbol with amounts on control paper.

Removal of Control Printer.

1. Crank in all nines.
2. Remove two links along side of unit marked "Front."

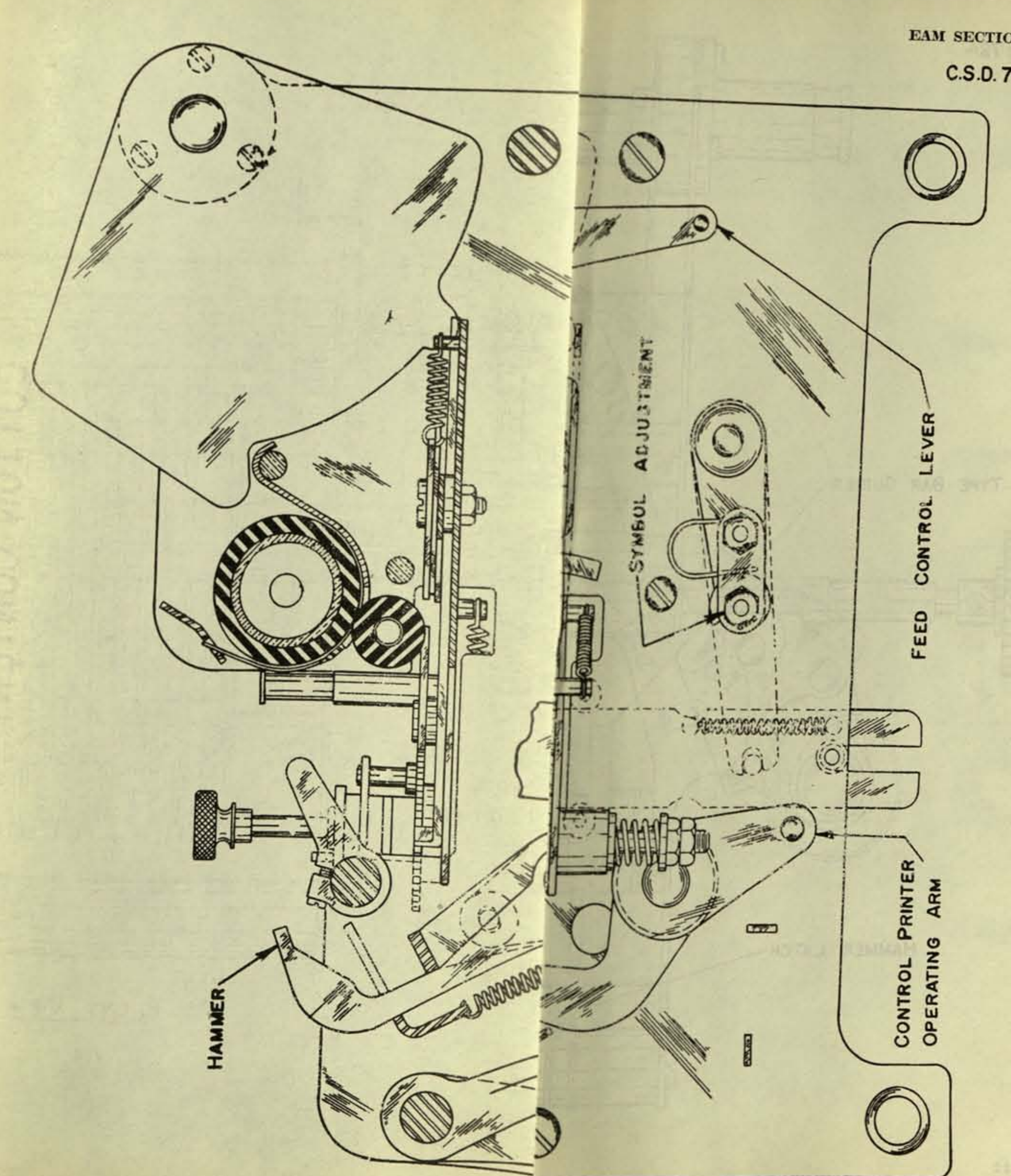


HAMMER OPERATION

Fig. 11

Printed in U. S. A.

C.S.D. 723



PAPER FEED MECHANISM

Fig. 13

er lugs are moved into neutral

ngaging stud from add bar to

ounter stud into total bar and
nation links are put into opera-

unter stud into neutral bar and

utral bar.

CHANISM

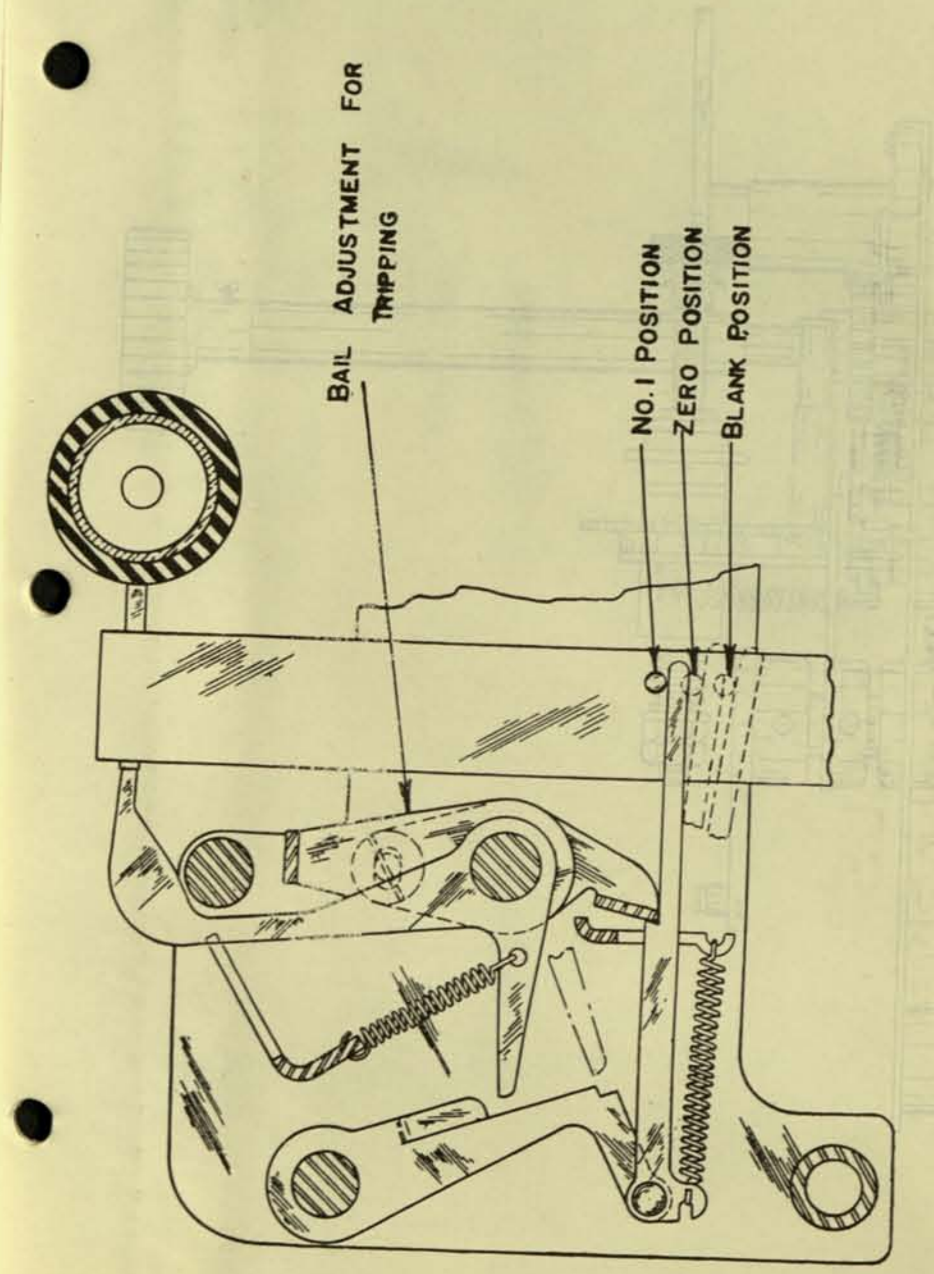
printer is controlled by the type
in their home position, the latch
studs riveted into the side of the
upper portion of the bail moves
moves toward the hammer latch.
ill be released. When a type bar
the latch arm thru spring tension
n of the bail. The operating arm,
bail which is pinned to the oper-
e latch arm, until the tail on the
ammer latch. The hammer thru
type, printing the amount set up.
the hammer to the right, thereby
gure.
to the operating arm shaft, moves
as it clears the paper feed ratchet,
ed into the side of the feed control
paper feed arm to move the paper
stop allows the paper feed arm to
et to feed two teeth. The ratchet
, while the paper feed arm moves

all on the paper feed arm. This in
which have a cammed member near
ed arms is held in one position by
r spring tension. This in turn holds
h is held by spring tension, remains
to feed the ribbon on one spool until
At that time, the feed arm is unable
is pulling at its fixed point on the
from moving a full stroke and will
he stud on the slidable arm, moving
essed portion on the other side and
will feed on to the other spool. The
ile the ribbon feed arm moves back

atching of the hammers. Fig. 11.
n, the tail of the hammer should be
int. Fig. 12.
proper spacing of amounts on

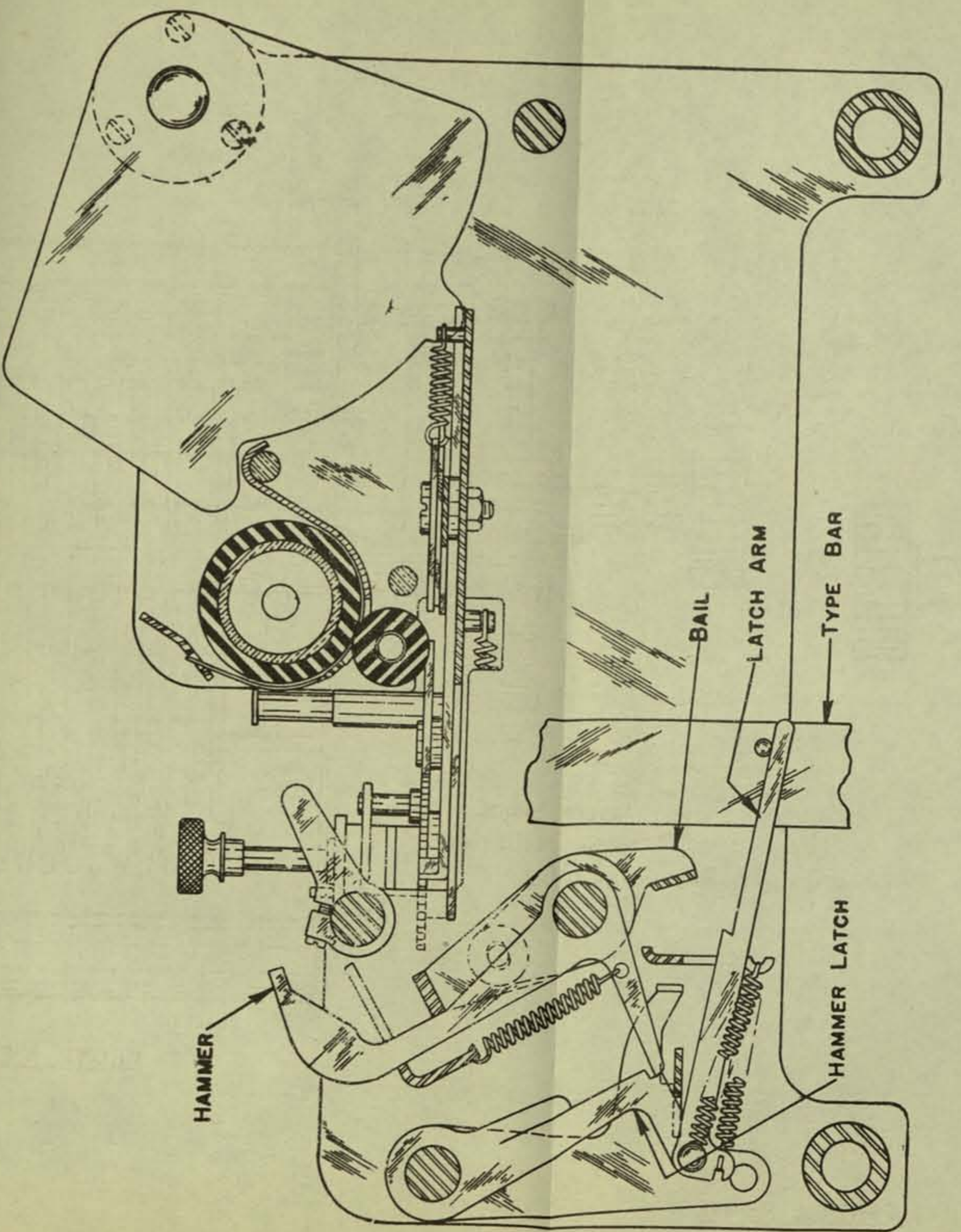
ign symbol with amounts on

d "Front."



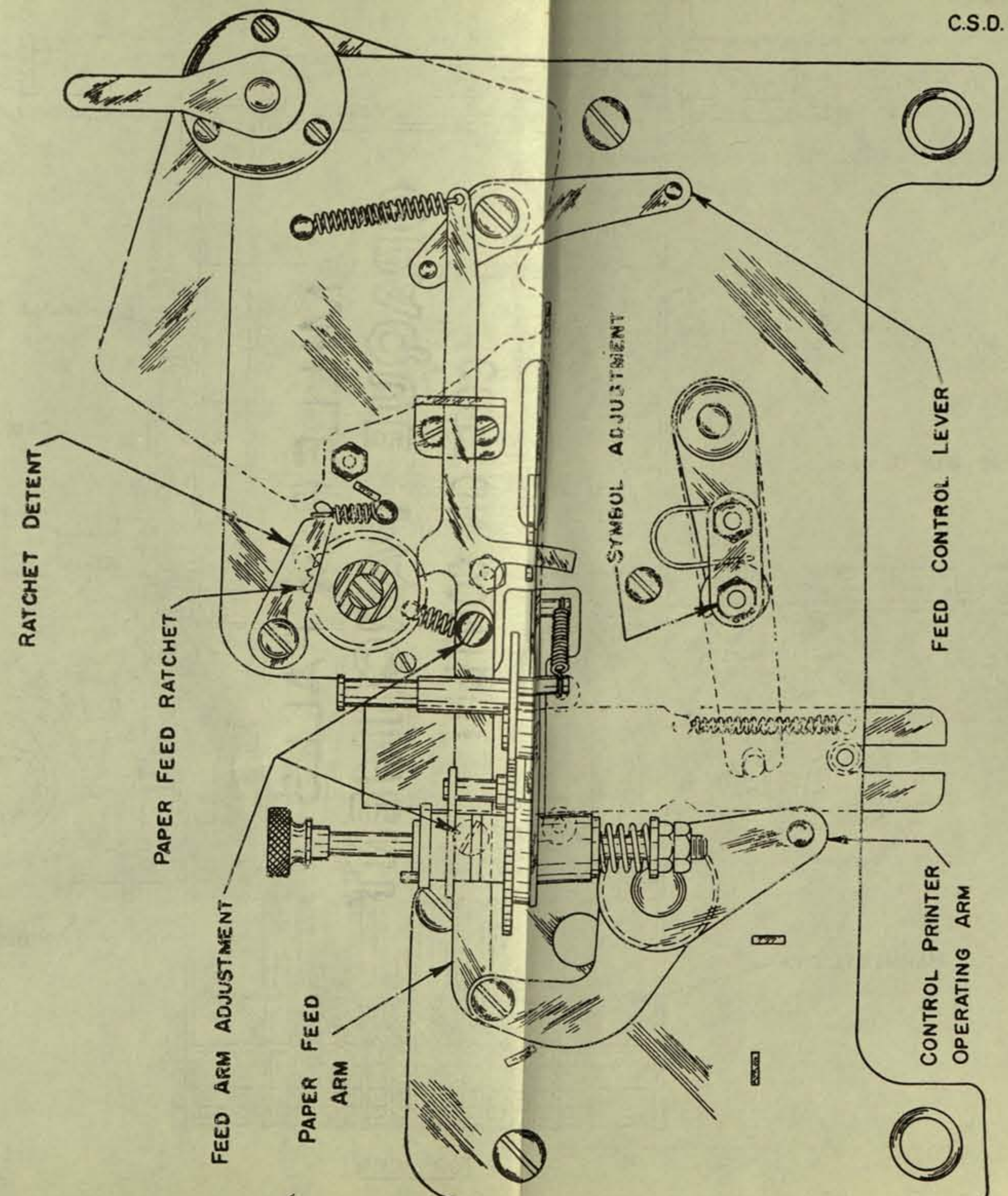
HAMMER OPERATION

Fig. 11



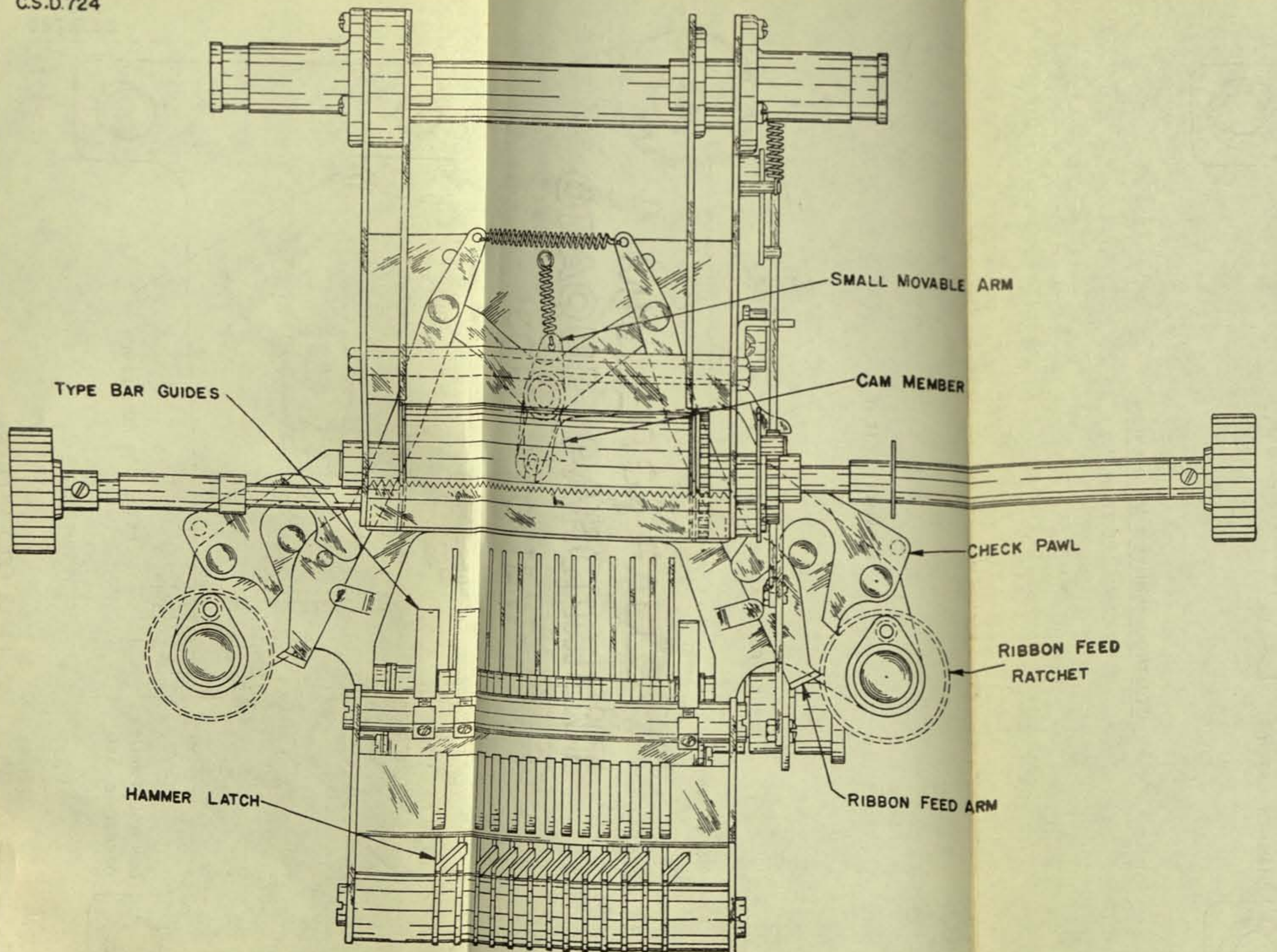
CONTROL PRINTER MECHANISM
NORMAL POSITION

Fig. 12



PAPER FEED MECHANISM

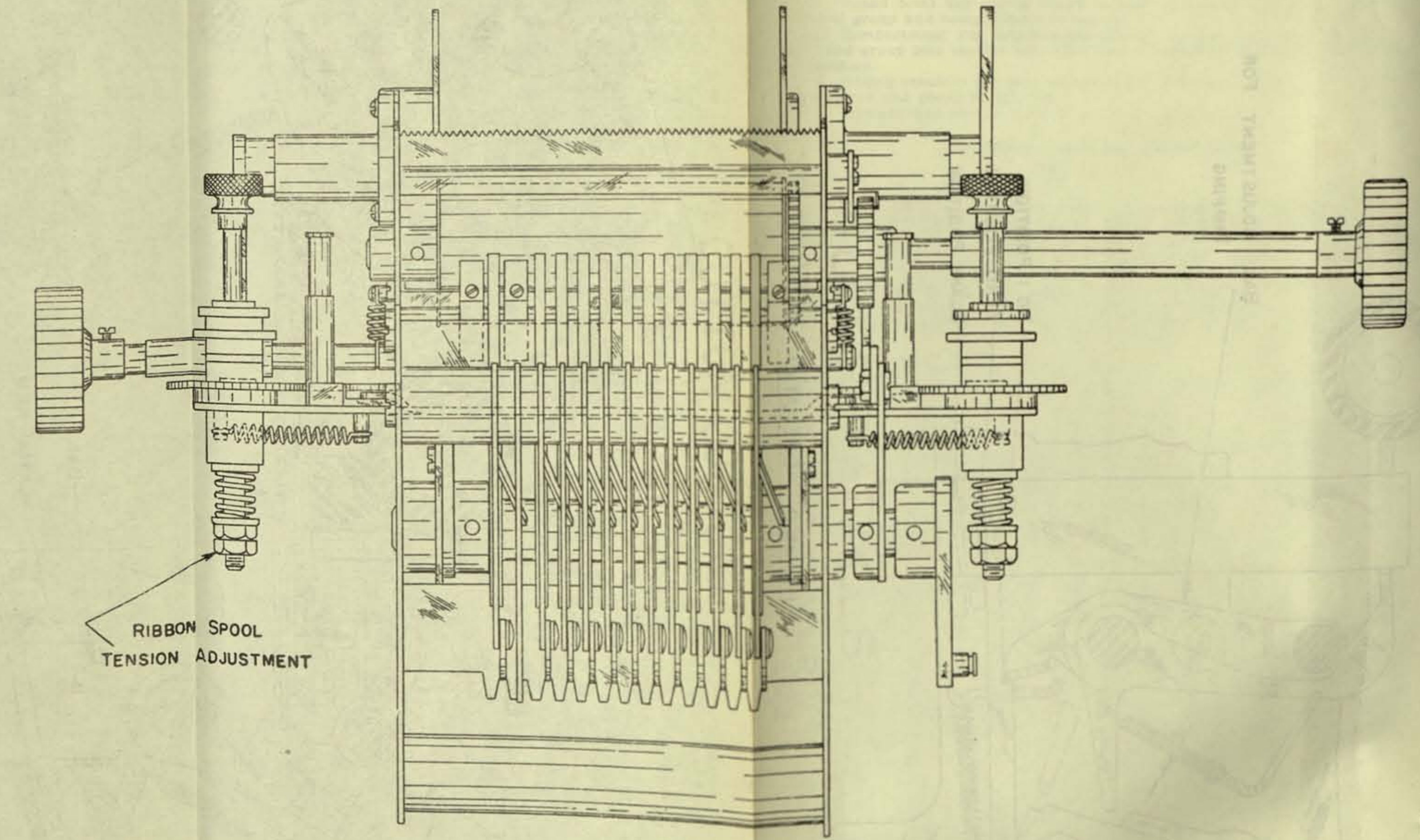
Fig. 13



TOP VIEW

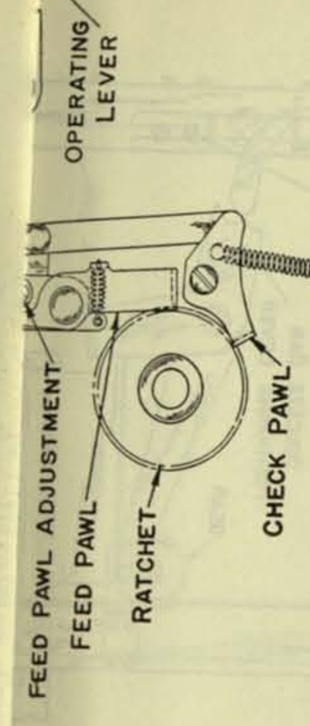
Fig. 14

CONTROL PRINTER



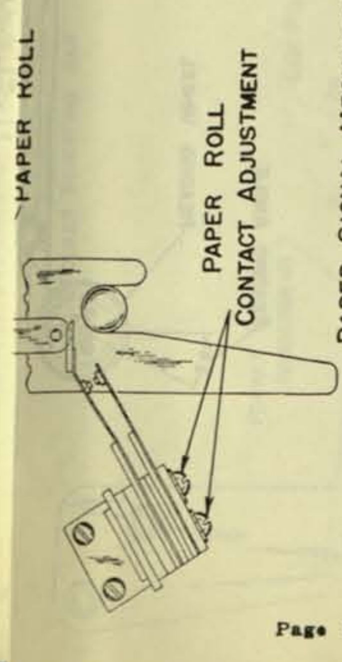
FRONT VIEW

Fig. 15



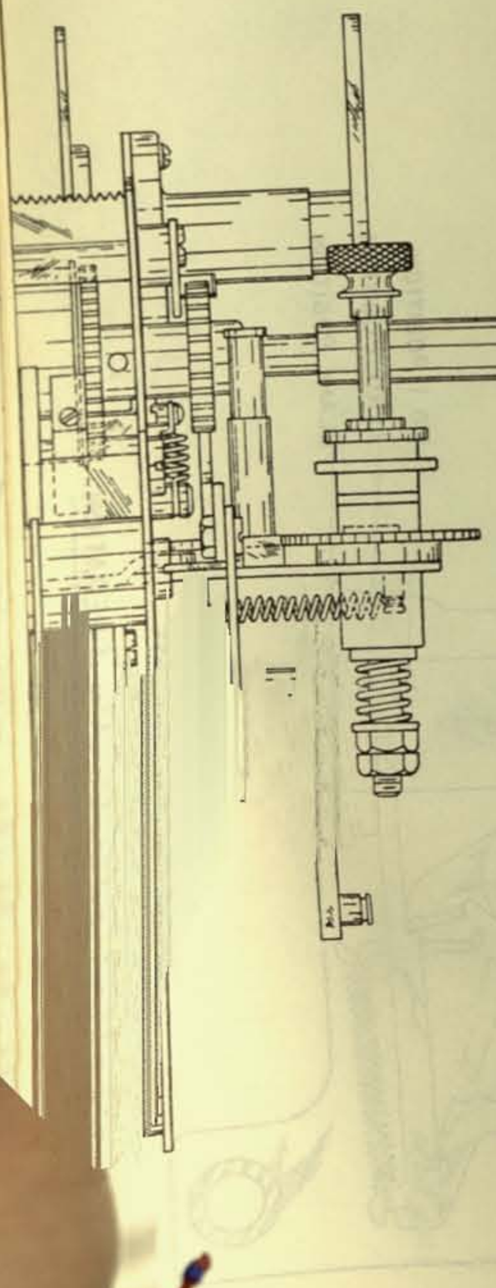
RIBBON FEED MECHANISM

Fig. 22



PAPER SIGNAL MECHANISM

Fig. 21



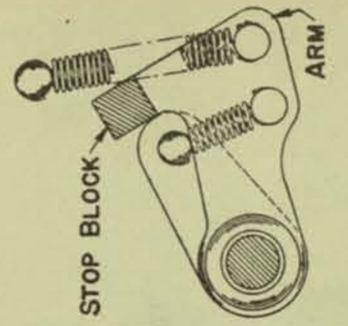


Fig. 20

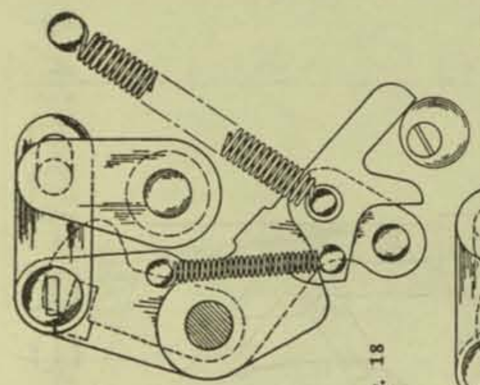


Fig. 18

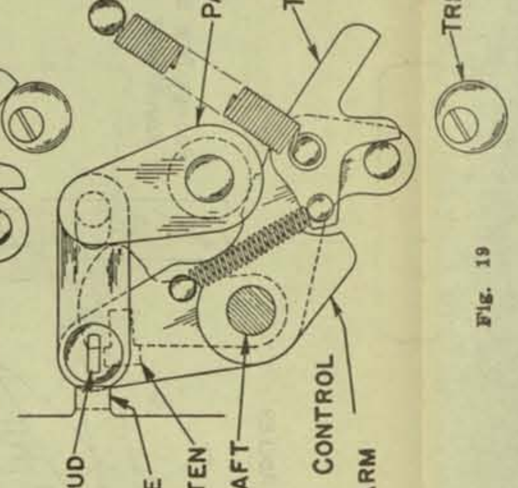


Fig. 19

PLATEN OPERATING MECHANISM

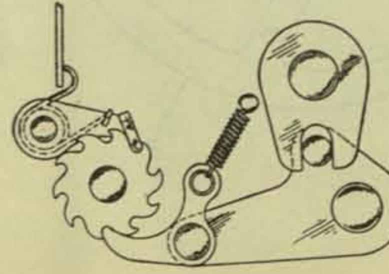


Fig. 16

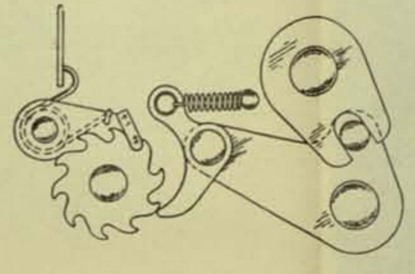
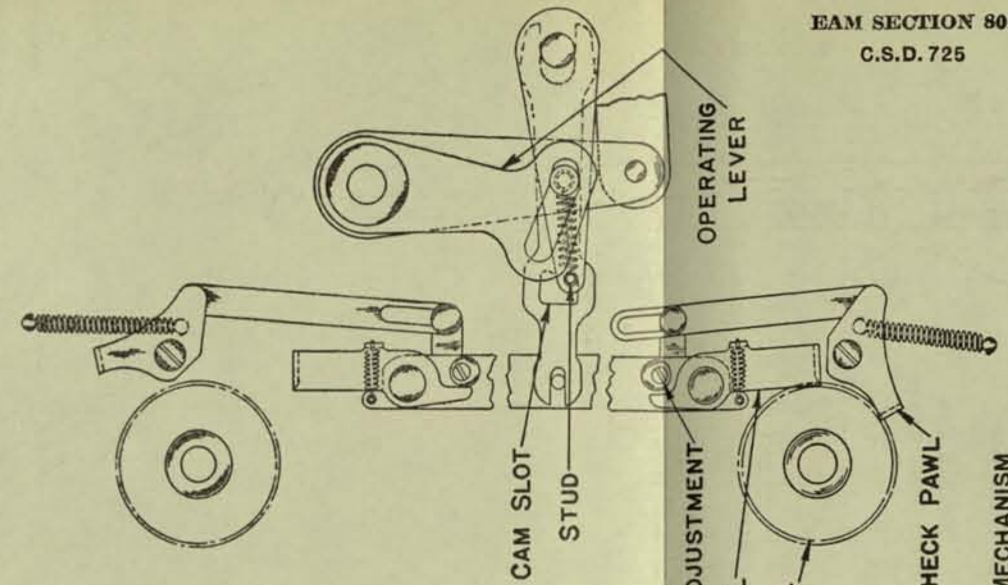
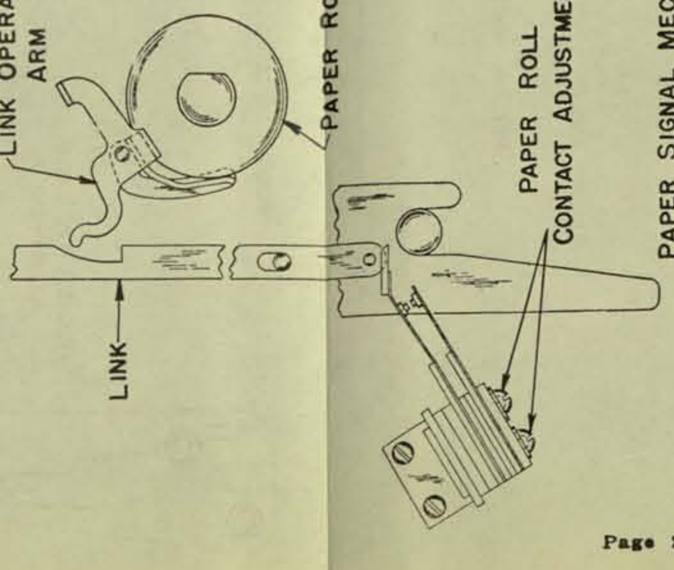


Fig. 17

PAPER FEED MECHANISM



RIBBON FEED MECHANISM
Fig. 22



PAPER SIGNAL MECHANISM
Fig. 21

3. Disconnect symbol hammer lock link.
4. Disconnect operating arm link.
5. Remove two cotter pins.
6. Remove shafts.
7. Tip front of unit up in air at an angle and remove unit.
8. When re-installing operating arm link, press compartment total key and insert link.

REAR PRINTER PAPER UNIT

Paper Feed Mechanism—Figure 17 shows the feed pawl when the machine is in its home position. Fig. 16 shows the feed pawl in its operating position. The paper feed mechanism is pinned to the same shaft as the paper feed arm shown in Fig. 19 in the platen operating mechanism.

Platen Operating Mechanism—Fig. 19 shows this mechanism in its normal position. As the machine goes thru a cycle, the toe on the squeeze bar comes in contact with the stud. The blank which the stud is riveted into pivots on its shaft, causing the trigger which pivots on a stud on the other end of the blank to push against the platen control arm. As the platen control arm moves forward, the platen which is pinned to the same shaft moves back until the trigger comes to rest against the trigger adjustment. The trigger then pivots on its stud until it clears the end of the platen control arm. The platen thru spring tension flies forward until the arm shown in Fig. 18 strikes the stop block. As the stud moves back thru a link connection, the paper feed arm moves with it, causing the paper to feed one space.

Fig. 18 shows the platen operating mechanism just before the platen control arm is released.

Paper Signal Mechanism—Fig. 21. When a paper roll is nearly depleted, the link operating arm, thru spring tension, presses on the step in the link, causing the link to move downward until the paper roll contact is closed.

Ribbon Feed Mechanism—The operating lever, which is controlled thru cam action, moves forward and backward. This movement thru a roller in the cam slot of the operating lever causes the ribbon feed mechanism to move up and down. The check pawl holds the ratchet in position, while the feed pawl moves away for another feed. When the ribbon reaches the end, the stud in the cam slot is rocked to the other side, permitting the ribbon to be fed in the opposite direction. Fig. 22.

Adjustment—The trigger adjustment (shown in Fig. 19 of the platen operating mechanism) should be set so that the trigger releases the platen control arm at approximately 200 degrees of the cycle.

The paper roll contact is adjusted by moving contact up or down to light signal lamp when 18 inches of paper is on any paper roll. Adjust each of the three banks separately. Fig. 21.

REAR PRINTER TYPE UNIT

To Remove:

1. Turn reel to pocket thirteen.
2. Crank up all nines in adding unit.
3. Remove the three paper racks.
4. Remove two nuts and spring from each squeeze bar and remove bar. Keep screw stud in same slot.
5. Remove small clip and washer in each squeeze bar operating arm.
6. Remove screw from lower three operating arms and remove arms. (Mark each one.)
7. Remove wires from terminal block and left-hand contact.
8. Remove BX cable clamp on inside.
9. Remove two bearing screws.
10. Remove three springs from operating levers.
11. Remove twelve dowel screws and remove entire casting.

Re-installing Notes:

1. Use block to hold sectors.
2. Mesh sectors in racks properly.

3. Re-position ribbon operating arms.
4. Use care in replacing wires.
5. Test each squeeze bar for binds.

POCKET INDICATING BAR SET-UP AND REAR PRINTER SELECTION MECHANISM—Fig. 23.

Operation

As the reel is revolved to the desired pocket, the heart-shaped cam, which is attached to it, also rotates. The cam roller, which rides on the cam, is raised or lowered so that the pocket type bar comes to rest in a position in which the type corresponding to the number of the pocket selected is on the printing line.

In mesh with a rack on the pocket type bar is a gear, which is also in mesh with a rack on the right-hand end of the pocket indicating bar, the rack on the left-hand end of the pocket indicating bar is in mesh with a gear on the reading wheel. As the pocket type bar is raised and lowered, the gear revolves, sliding the pocket indicating bar forward or backward. This sliding motion revolves the reading wheel to a position which allows the number corresponding to the pocket selected to be read thru a window in the top panel.

As the pocket type bar is raised and lowered, the squeeze bar positioning lever, which pivots on a shaft, moves with it, allowing the squeeze bars to assume positions which will align one of the toes with the proper operating stud. The squeeze bar toes are spaced so that only one toe and one operating stud will line up for each pocket selected.

Adjustments—Fig. 23.

1. The squeeze bar positioning lever rides under a turned-over blank, which is fastened to the squeeze bar. This blank can be adjusted to properly align the toes with the operating stud.

2. The operating lever adjustment is to properly align the symbol type with hammers.

3. The adjustment on inside of reading wheel is to position the pocket number in the window.

4. The adjustment on the heart-shaped cam is to move cam on its hub. This adjustment is made only when it is impossible to adjust the operating lever so as to position type opposite hammers. This will raise or lower half of the type, namely, 1-12 or 24-11.

CHECK FEED MECHANISM

Fig. 24

Operation

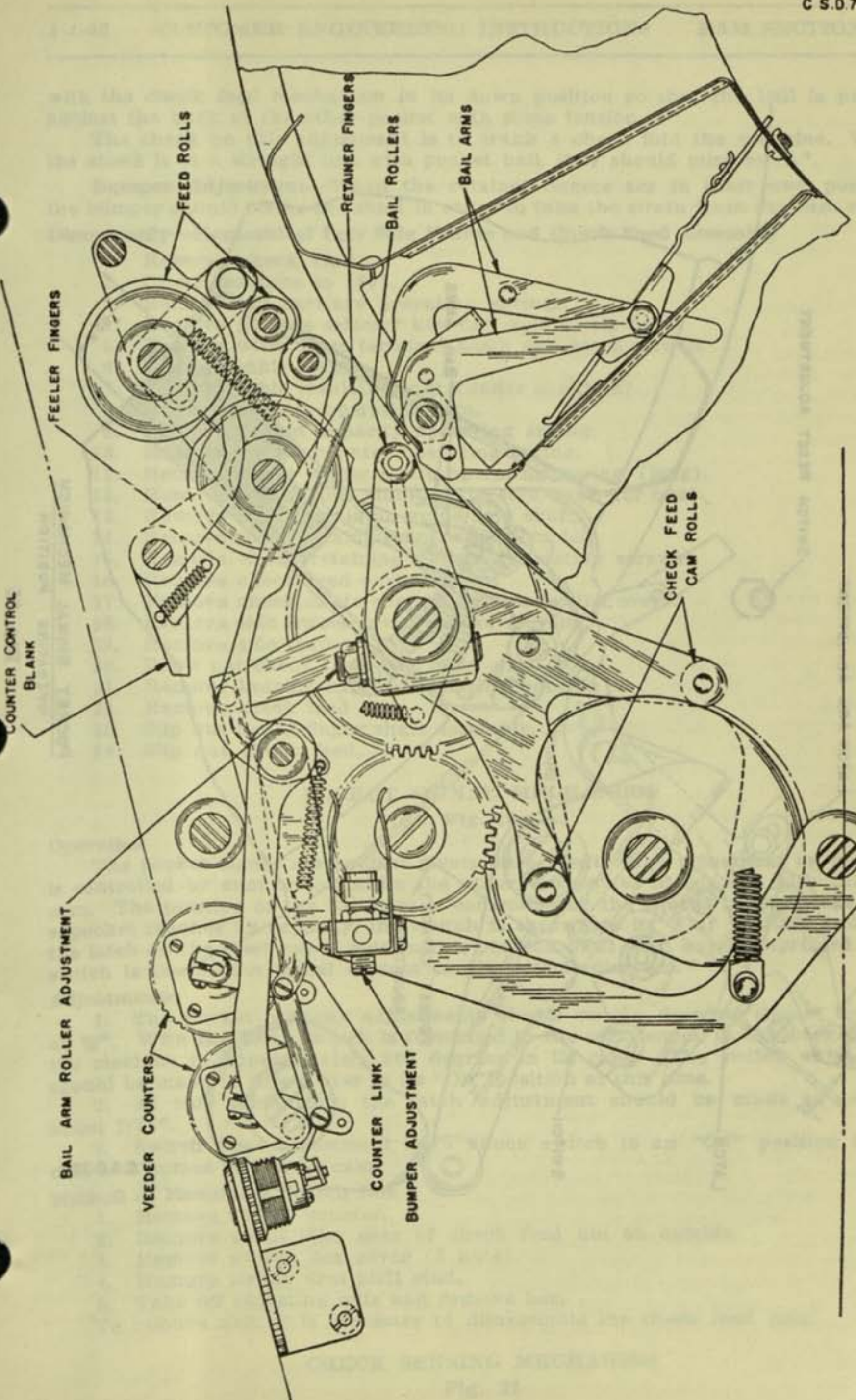
The check is placed manually in the cut-out portion in the upper feed rolls. When the machine starts thru a cycle, the feed rolls begin to revolve, feeding the check into the small rolls. At five degrees of the cycle, the check feed mechanism begins to drop, enabling the small rolls to enter the pocket, insuring the entry of the check into the pocket. At the same time, the retainer fingers are lowered into the pocket. The bail arm rollers come in contact with the bail arms and the bail is carried to the back of the pocket. The space between the bail and the retainer fingers is for the incoming check. This insures a clear passage and also stacks the checks in sequence as they are deposited into the pocket. As the machine completes its cycle, the check feed mechanism is raised, the retainer fingers are withdrawn and the bail comes to rest against the checks in the pocket.

The counting of the checks is accomplished in the following manner: If a check is feeding into the pocket, the feeler fingers come to rest against it and hold the counter control blank clear of the counter link, permitting this link to make its full movement. This movement adds one into the veeder counters.

If the check does not feed into the pocket, the feeler fingers pass thru the chute and the counter control blank drops into the path of the counter link, preventing the veeder counters from operating.

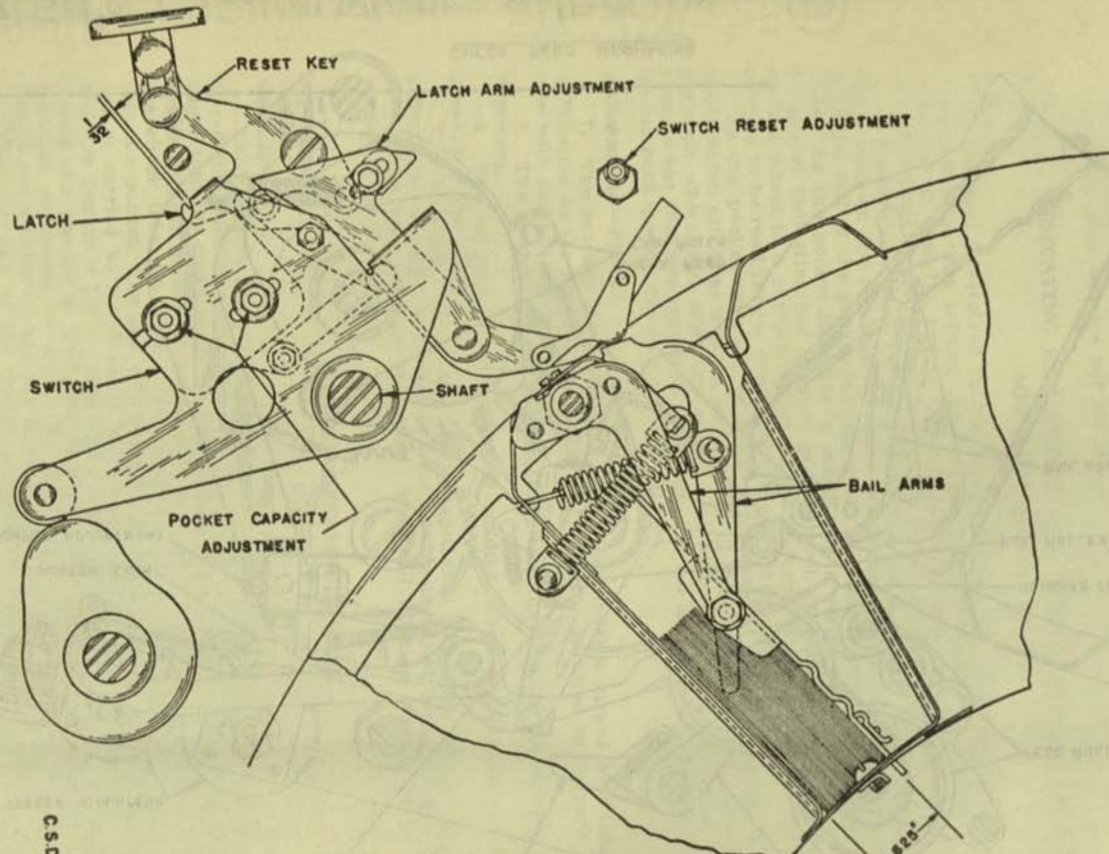
Adjustments

Ball Arm Roller—The purpose of this adjustment is to move the bail against the back of the pocket to prevent checks feeding behind it. It should be adjusted



CHECK FEED MECHANISM

Fig. 24



POCKET SIGNAL MECHANISM
OPERATING POSITION

Fig. 25

with the check feed mechanism in its down position so that the bail is pushed against the back of the other pocket with some tension.

The check on this adjustment is to crank a check into the machine. When the check is in a straight line with pocket bail, they should miss by ¾".

Bumper Adjustment—When the retainer fingers are in their own position, the bumper should strike the shaft in order to take the strain from the cam roller.

Disassembly—Removal of Left Side Frame and Check Feed Assembly

1. Remove check chute.
2. Crank machine to 180°.
3. Remove pin carriage operating springs.
4. Remove pockets selector key unit clamp; tip back.
5. Remove wires from terminal block and block screws.
6. Remove cable clamp.
7. Remove cable insulating nut (under counters).
8. Remove counter operating arm.
9. Remove pocket capacity operating spring.
10. Remove veeder counter operating spring.
11. Remove feeler finger shaft operating spring (long).
12. Remove 2 BX cable clamps (tip side down for one).
13. Remove check retaining guide arm shaft.
14. Remove check retaining finger bumper bar.
15. Remove check retaining fingers (2 casting screws).
16. Remove check feed cover screws.
17. Remove check chute support screws (swing over).
18. Remove side frame dowel screws (seven).
19. Remove side frame.
20. Drive out check feed cam taper pin.
21. Remove bearing caps and bearing housing.
22. Remove check feed cam.
23. Slip out feeler finger shaft assembly.
24. Slip out check feed.

POCKET SIGNAL MECHANISM

Fig. 25

Operation

The pocket signal mechanism pivots on a shaft. The movement on one end is controlled by cam action while the other end comes in contact with the bail arm. The position of the bail arm is controlled by the checks in the pocket. As a pocket reaches its capacity, the switch is thrown to its "On" position and thru the latch on the reset key is held in this position until reset key is depressed. The switch is the pocket signal contact on the circuit diagram.

Adjustments

1. The pocket capacity adjustments shown on the drawing should be held at ⅝". With the block, which is furnished to the servicemen, in the pocket, turn the machine to approximately 300 degrees in its cycle. The switch adjustment should be made to throw over to its "On" position at this time.

2. At this same time, the latch adjustment should be made to overlap about 1/32".

3. Switch reset adjustment is to knock switch to an "Off" position before cam arm comes to rest on cam.

Method of Removing Switch Box

1. Remove veeder counter.
2. Remove small idler gear of check feed nut on outside.
3. Remove switch box cover (2 nuts).
4. Remove switch arm pivit stud.
5. Take off adjusting nuts and remove box.

To remove unit, it is necessary to disassemble the check feed unit.

CHECK SENSING MECHANISM

Fig. 26

Operation

The check sensing mechanism is described in the electrical circuits Nos. 11

thru 13. When one of the control keys is depressed, the circuit to the check sensing magnet is broken thru the disabling contact. When the check sensing control key is in its up position and the check sensing magnet is energized by depressing the key, the machine again becomes operative.

By depressing the check sensing control key and pulling it slightly forward, the check sensing magnet contact is held closed, permitting the machine to be operated without the feeding of checks. Normally the check sensing contacts are closed but should be opened by the check as it passes the tip of the contact strap.

Adjustments

1. The adjustment block is used to obtain the proper making and breaking condition on the check sensing contacts.

2. The adjustment screw is used to obtain the proper making and breaking condition on the diasbling contact when one of the control keys are depressed. This contact is normally closed and should open when one of the control keys is depressed.

REEL DRIVE AND STOP MECHANISM

Figs. 27 and 28

Operation

When a new selector key is depressed, the reel stop solenoid is energized, pulling down the stop arms, through a medium of links and studs, clear of the stop block on the reel. When the stop arms are pulled down, the latch moves over the lugs on the stop arm latch link, holding down the stop arms and permitting the stop latch magnet contact to transfer its points.

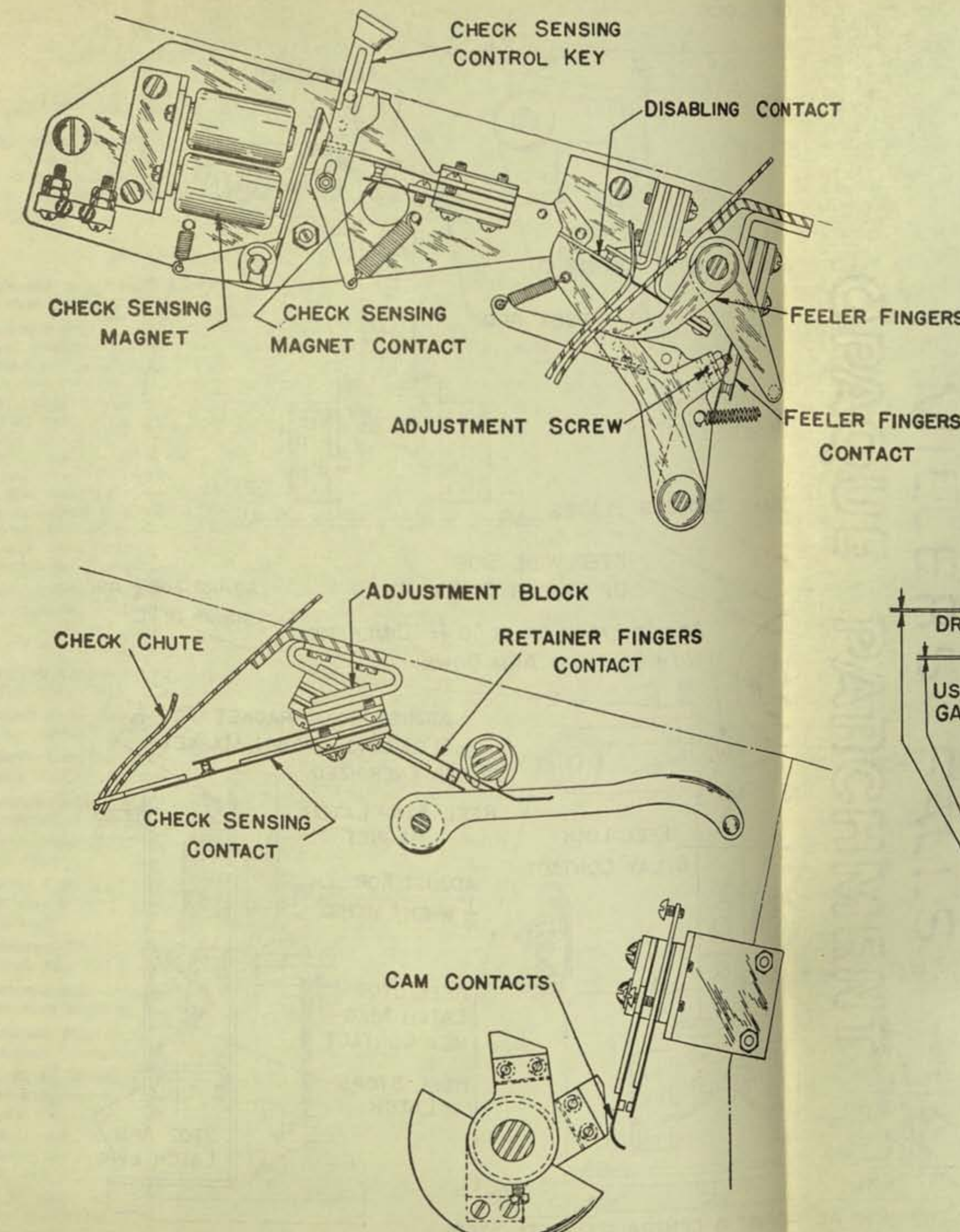
While the stop arms are being pulled down by the solenoid and before they are clear of the reel stop blocks, the reel lock delay contacts are made, which in turn energize the reel lock magnet, which positions the reel lock free of the reel. This in turn breaks the reel lock contact upper, which is in the release bar circuit, and makes the reel lock lower contact, completing the circuit to the drive clutch magnets.

When the clutch magnets are energized, they attract an armature, which pivots a yoke and in turn engages a clutch disc with a driven disc, which is continuously running from a direct drive on the motor generator unit. The friction set up by the engagement of the clutch is sufficient to rotate the reel without slipping, if the clutches are properly adjusted. The ideal adjustment for the clutches is to have .012 between each clutch lining and driven disc with the armature centralized between the cores of the reverse and normal clutch magnet. The central position of the armature is approximately .062 between the cores of the magnets and each side of the armature.

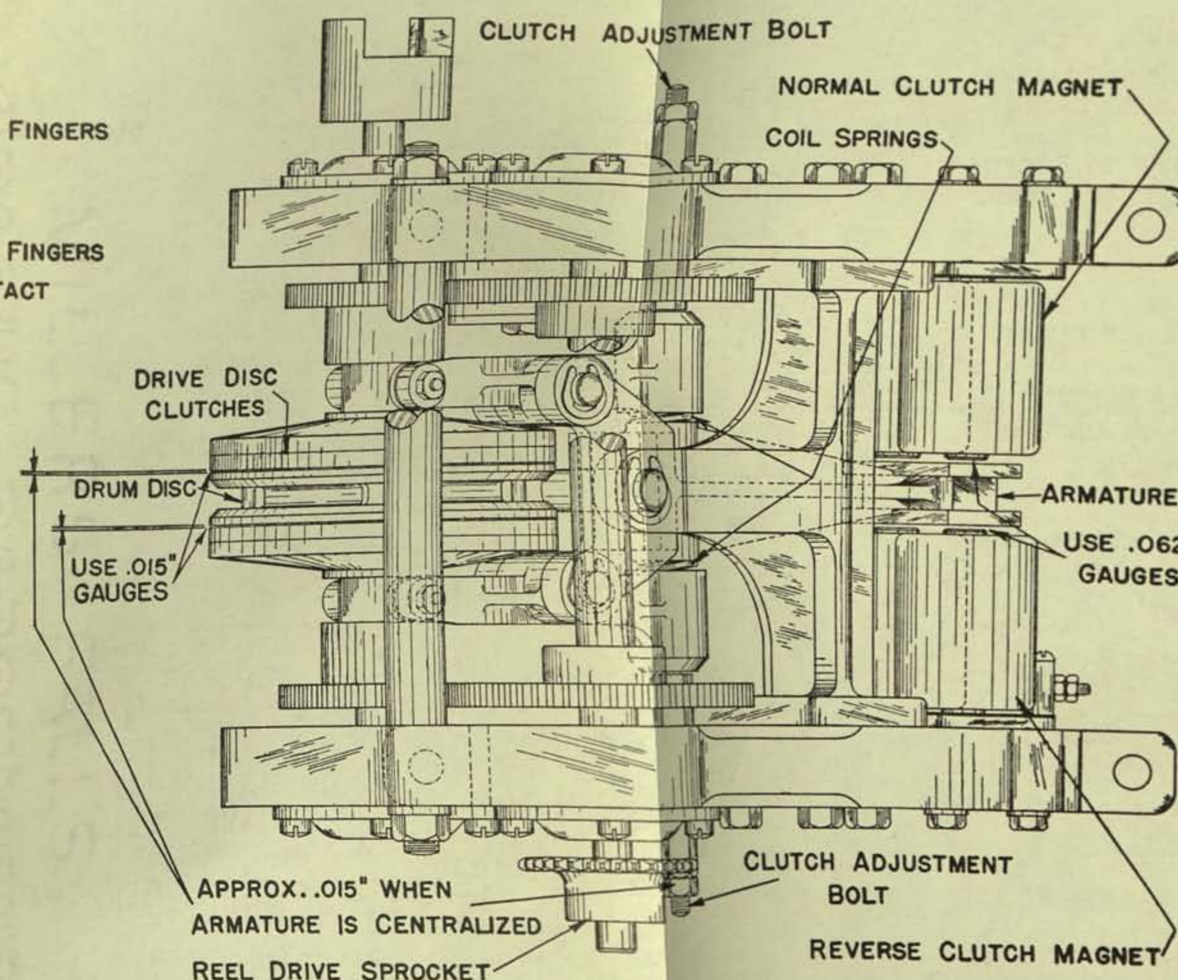
The direction of driving the reel is obtained by energizing one of the two magnets. This in turn engages one of the two clutches, which are geared to another shaft on which the reel drive sprocket is mounted. The one drive disc clutch is geared direct to this sprocket shaft, thus obtaining a reverse direction for the reel while the other drive disc clutch is geared through an idler, thus giving the two shafts the same movement, thus turning the reel in a clockwise or normal direction. The reel rotates until it is 7½ degrees from its newly selected position. At that time, the reel stop latch magnet is energized, overcoming the spring tension on the latch and moving it free of the stop latch links and permitting the stop arms to move up into the path of the stop blocks on the reel.

At the same time the latch magnet is energized, the latch magnet contact is again transferred, closing the top straps and opening the lower straps. However, the reel does not stop because of the latch contact transferring but continues being held by a parallel circuit through R-6 and R-6B until the stop block has driven up to the stop arm, moving it back and pivoting the stop rocker arm, in turn breaking the reel stop timing contacts, which operate off the bottom of the stop rocker arm.

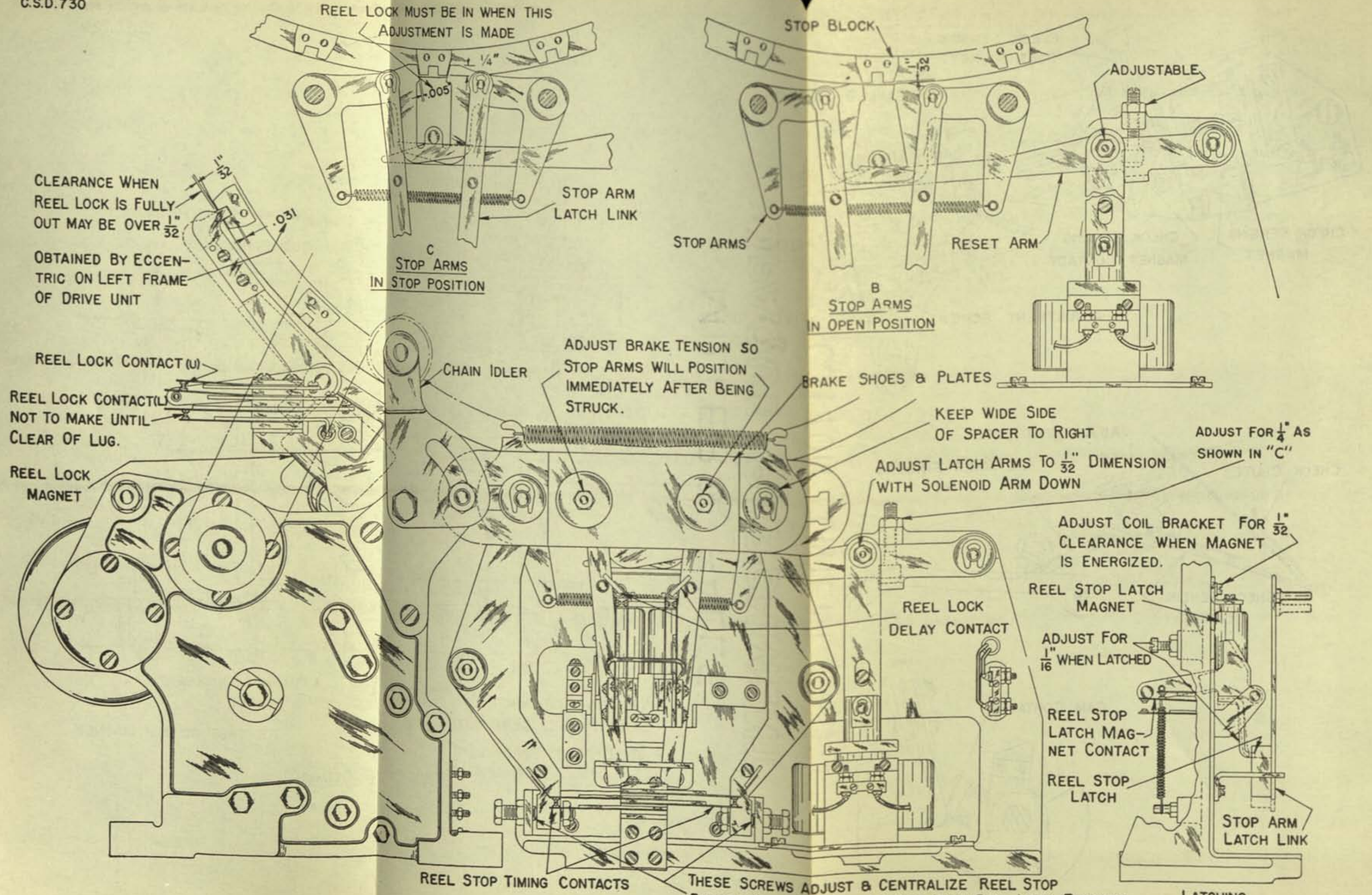
When the inertia of the reel has been overcome by the brake friction plates and springs, the stop arms will be up, allowing the reel lock delay contacts to be broken and in turn permit the reel lock to go back in the lug or stop block of the reel and return all contacts to normal.



CHECK SENSING MECHANISM
Fig. 26



REEL DRIVE CLUTCH
Fig. 27



REEL DRIVE & STOP MECHANISM

Fig. 28

Circuits No. 1 thru No. 7 explain how the drive clutch magnets are energized so that the reel is driven the shortest distance to the newly selected pocket.

Slip Clutch on Motor Drive

The slip clutch is to prevent the breakage or straining of parts, if the machine does not function properly. The adjustment should be made so the machine will just complete its cycle with a margin of safety when every part is functioning properly.

PURPOSE OF CONTACTS AND SIGNAL DEVICES

Selector Key Contact—This contact completes a circuit which causes the desired pocket position to be selected.

Selector Disc—The selector disc consists of two plates, one stationary plate and one rotating plate. The stationary plate contains twenty-six wiper contacts. Twenty-four of these wiper contacts represent the twenty-four pocket positions of the reel and are connected to their corresponding selector key contact. The other two wiper cantacts are used to make contact with the common rings on the rotating disc. The rotating disc consists of two complete contact rings on different radii and a third radius consisting of three segments. The small segment is connected to the intermediate ring and one of the large segments is connected to the inner ring. The other large segment is inserted merely to minimize the wear as it is not used for any electrical circuits. The small segment is for the purpose of determining when the drum arrives at the selected position, and the large section, which is connected with the inner ring, is used to determine when the drum is to rotate in a reverse direction. The rotating disc is pinned to the reel shaft and rotates in synchronism with the reel.

Pocket Signal Contact—This contact indicates when the pocket has been filled to its capacity number of checks. When the mechanism functions, closing the contact, it causes the reel operating and release bar cricuits to be inoperative and completes a circuit to the pocket signal light.

Pocket Signal Lamp—This lamp gives a visible indication, by means of a green light, that the pocket at which the reel is positioned is filled to capacity.

Paper Roll Contacts—These contacts complete a circuit to the paper roll signal lamp when any one of the compartment tapes get within two feet of depletion.

Paper Roll Signal Lamp—This lamp gives a visible indication by means of a red light that the tapes are getting low on the compartment printers.

Compartment Printer Contacts—These contacts cause the release bar circuit to be inoperative when the compartment printer racks are not latched in place.

Door Contact—This contact causes the reel and release bar to be inoperative when the operator has the door open.

Reset Contact—This contact causes the buzzer sensing circuit to be restored to normal after a check has fed into the machine at too great an angle or behind the bail.

Buzzer—The buzzer gives an audible signal to the operator indicating that the check has not been fed into the machine properly.

Release Bar Contact No. 1—This contact causes the reel to be inoperative while the cam shaft is going thru its cycle.

Release Bar Contact No. 2—This contact completes a circuit to the release bar magnet whenever the release bar is depressed.

R. B. M. Holding Contact—This contact completes a holding circuit to the release bar magnet, keeping it energized until R-4B points are opened, if any of the contacts that it shunts around should be opened during the cam shaft cycle.

EL & TK Contacts—This contact causes the release bar cricuit to be inoperative unless the "error" lever is in its normal position and unless all of the keys in the ten key set-up are in their "up" position.

C. K. Contact—This contact causes the release bar circuit to be inoperative unless the control keys are all in their "up" position or the control key that is being operated is in the "down" position and latched down.

G. T. Contact—This contact completes a circuit to the release bar magnet whenever the group total key is depressed.

F. F. Contact—This contact senses the angle at which the check is fed into the machine by means of the feeler fingers and the feeler finger shaft.

Check Retainer Contact—This contact senses that there is a check behind the bail, by means of the check retainer.

Check Sensing Contacts—These contacts sense whether or not the check was fed into the machine.

Check Sensing Magnet Contact—This contact causes the reel and release bar to be inoperative if a check is not fed into the machine. It also causes the selector keys to be locked out so that they cannot be depressed.

Disabling Contact—This contact renders the check sensing inoperative when using the control keys.

CC No. 1-A—This contact completes a set-up circuit for R-4 relay causing the release bar magnet to deenergize after the release bar is latched down by mechanical means.

CC No. 1-B—This contact causes the reel to be inoperative should the release bar contact No. 1 close before the cam shaft completes its cycle.

CC No. 2—This contact operates the circuit that senses if the check is behind the bail in the pocket in series with check retainer contact.

CC No. 3—This contact actuates the circuit that senses if the check is fed into the machine straight or at an angle in series with F. F. contact.

CC No. 4—This contact actuates the circuit that senses whether or not the check is fed into the machine in series with the sensing contact.

Reel Stop Latch Magnet Contact—This contact breaks the circuit to the reel stop solenoid and closes the contact in the clutch circuit after the stop arms are pulled down clear of the drum and latched down.

Reel Stop Timing Contacts—These contacts keep the clutch magnets energized until the reel is positioned.

Reel Lock Delay Contacts—These contacts control the reel lock magnet circuit so that the reel lock is held clear of the reel until the reel has been brought to rest by the reel stop mechanism.

R. L. C. (U) Contact—When the reel lock has been positioned, this contact is closed and completes a circuit to the release bar magnet, making it operative when the release bar is depressed or the G. T. key is depressed.

R. L. C. (L) Contact—This contact completes a circuit to the clutch after the reel lock has been moved clear of the drum.

PURPOSE OF MAGNETS

Selector Key Lock Magnet—This magnet causes the selector keys to be locked if the pocket signal contact operates or if the check is not fed into the machine.

Release Bar Magnet—This magnet operates the clutch mechanism of the cam shaft.

Check Sensing Magnet—This magnet operates the check sensing magnet contact when the check fails to feed into the machine.

Reel Lock Magnet—This magnet operates the reel lock mechanism.

Normal and Reverse Clutch Magnets — These magnets operate the clutch mechanism in its proper direction.

Reel Stop Latch Magnet—This magnet releases the stop arms just before the drum arrives at the desired position, so that the stop arms will get in the path of the stop block in time to stop the reel at the desired position.

Reel Stop Solenoid—This solenoid pulls the stop arms clear of the drum so that the reel can be rotated.

PURPOSE OF RELAY CONTACTS

R-1A—This contact causes the release bar circuit to be inoperative when the reel is in motion and if the reel should stop at a pocket other than that selected.

R-1B—This contact completes the circuit thru the reel stop solenoid when selecting a new pocket position and holds the reel stop solenoid circuit open upon arriving at the selected pocket position.

R-2A—This contact completes a circuit to the proper clutch magnet as determined by the selector disc.

R2-B—This contact breaks a circuit from the selector disc half segment to R-3 relay after R-3 relay has operated, thus preventing the circuit from being broken on the selector disc.

R-3A—This contact completes a holding circuit for R-3 relay after R-3 has been operated thru the selector disc.

R-3B—This contact completes a circuit thru the R-2 relay for a reverse clutch magnet operation.

R-4A—This contact completes a holding circuit for R-4 relay until the release bar contact No. 2 or G. T. contact has been opened.

R-4B—This contact opens the release bar circuit after the release bar has been clutched down mechanically, so that the cam shaft will take only one cycle.

R-5B—This contact breaks the circuit to the reel and release bar operating circuit, after the pocket signal operates indicating that the pocket has been filled to capacity.

R-6B—This contact times the opening of the clutch magnet circuit.

R-7A—This contact completes a holding circuit for R-7 relay until the reset contact is opened, and also completes a circuit to the buzzer.

R-7B—This contact opens the reel stop solenoid circuit when the check sensing for a misfed check has operated, thus making the reel inoperative.

The part numbers of the relays and the type of relays are as follows:

Part No.	Type of Points Looking At Armature End — A	B	Relay No.
111373	T	B	2,
111374	M	M	3, 6
111376	M	B	1, 4, 5
150482	DM	B	7

CIRCUITS

All contacts on the complete circuit diagram are shown in their normal position when the main line switch is "Off."

Nos. 1 thru 7—Reel Control Circuits—Before closing the line switch, it is best to make sure that the selector key, corresponding to the position shown on the indication wheel is depressed. If the selector key is not depressed, the selector drum will start to turn because the circuit is not completed to the selector key and selector disc.

No. 1. As soon as the voltage has built up in the generator a circuit will be completed to the reel stop latch magnet and R-1 coil, due to the fact that a key has been depressed. This causes the R-1 relay to operate closing the R-1A points and opening the R-1B points. The closing of the R-1A points makes it possible to **complete the release bar circuit so the release bar** magnet will be operative when the release bar is depressed. The opening of R-1B contact breaks the circuit to the reel stop solenoid.

No. 2. The selection of another pocket position is accomplished in the following manner: The key for the desired pocket position is depressed. Upon depressing the newly selected key, the key that was formerly depressed is automatically released, allowing the selector key contact for that key to open. This breaks the circuit to the reel stop latch magnet and R-1 coil. The opening of R-1A contact breaks the release bar magnet circuit making it inoperative if the release bar is depressed while the reel is rotating. The closing of R-1B contact completes a circuit to the reel stop solenoid.

No. 3. The completion of the cicuit to the reel stop solenoid causes the solenoid to operate, and pull down the reel stop arms through its associated mechanism. As the stop arms are being pulled down, the reel lock delay contacts are closed, causing the reel lock magnet to become energized, moving the reel lock clear of the drum.

No. 4. When the reel stop arms are pulled all of the way down, they are latched down by the latch magnet mechanism. This mechanism also transfers the reel stop latch magnet contact, opening the reel stop solenoid circuit and closing the circuit to the clutch magnet. After the reel lock is completely clear of the drum RLD (L) is closed, completing a circuit to the clutch magnet, and R-6 coil.

No. 5. At the same time, a circuit is completed to R-6 coil.

The closing of the R-6B points completes a holding circuit for the R-6 relay and also completes a parallel circuit to the clutch magnets, keeping the magnets energized until the stop timing contacts are broken, when the reel stop blocks, strike against the stop arms.

No. 6. The proper clutch magnet is selected by means of the selector disc, R-2 and R-3 relays. If, upon depressing the selector key a circuit is completed to the half sector commutator, R-3 relay will be energized.

No. 7. The energizing of R-3 relay causes the R-3A and R-3B contacts to close. The closing of R-3A sets up a holding circuit for R-3 relay. The closing of R-3B contact completes a circuit to the coil of R-2 relay.

The opening of R-2B points breaks the circuit from the selector disc, thus preventing this circuit from being broken on the disc itself. The reversing of the R-2A points causes a circuit to be completed through the reverse clutch magnet when RLC (L) and the reel stop latch magnet contact are closed. If the circuit is not completed through R-3 relay, R-2 relay will not be energized and R-2A points will be as shown in the large diagram, thus completing a circuit through the normal clutch magnet when RLC (L) and the reel stop latch magnet contacts are closed.

As the reel revolves, the rotor of the selector disc revolves with it. When the small segment on the rotor selector disc comes in contact with the point corresponding to the selected position on the stationary disc, a circuit is completed through the reel stop latch magnet and R-1 coil. This is then a repetition of No. 1 circuit with the mechanical function of the reel stop unit completing the positioning of the reel.

Nos. 8 through 10—Release Bar Circuit—Assuming that R-4B, R-1A, RLC (U), compartment printer contact, EL & TK contact and CK contact are closed, when the release bar contact No. 2 is closed by depressing the release bar or the G. T. contact is closed by depressing the group total key, a circuit is completed through the release bar magnet.

No. 8. When the release bar magnet armature operates, it closes the RBM holding contact. The RBM holding contact holds the release bar magnet energized in case one of the contacts, which it shunts around, should be open while the cam shaft is going through its cycle. This is to make sure that the release bar will be held down until the completion of the cam shaft cycle.

At about 250 degrees in the cycle, or after the pin carriage restoring bail has started forward, CC-1A closes a circuit to R-4 relay.

No. 9. The closing of the R-4A points completes a holding circuit for R-4 relay so that if the release bar or the group total key should be held down, the machine will only go through one cycle.

No. 10. The opening of R-4B contacts breaks the circuit to the release bar magnet so that the cam shaft will latch up at the completion of its cycle.

When the release bar magnet armature is restored to its normal position, the RBM holding contact is opened. When both the release bar contact and the G. T. contact are opened, the circuit through R-4 coil is broken, allowing this relay to return to normal. The circuit is then set up ready for another operation.

Nos. 11 through 13—Check Sensing Circuits—The purpose of the check sensing mechanism is as follows: (A) To determine whether or not the check is fed into the machine, (B) To determine if the check is fed into the machine crooked or straight and (C) To determine if the check is fed in front or behind the check retaining bail.

(A) To determine whether or not a check is fed into the machine is accomplished by means of CC No. 4 and the check sensing contact. The check sensing contacts are operated by the check and are located approximately 1" down in the check feed chute. CC No. 4 is timed to close after 1½" travel of the check. If a check is fed into the machine, it operates the check sensing contacts, causing them to open. Then when CC No. 4 makes, the circuit is inoperative.

If the check fails to feed into the machine, the check sensing contact will be closed completing a circuit to the check sensing magnet when CC No. 4 makes. This causes the check sensing magnet to operate and open the check sensing magnet contact.

The opening of the check sensing magnet contact breaks the operating circuits for the reel and opens the circuit to the selector key lock magnet. When this selector key lock magnet is de-energized, it is impossible to depress a selector key or energize the release bar magnet, as R-1A has opened in the Release Bar circuit. When the machine is in normal operation, a circuit is always completed through the selector key lock.

No. 12 (B) To determine whether or not a check has been fed in crooked or straight is accomplished by means of a feeler finger contact (F. F.) and CC No. 31. The feeler finger contact is operated by the feeler finger shaft. As the check is fed into the machine, the feeler fingers are held back by the check keeping the feeler finger contact closed. As the check passes through the check chute and the back edge of the check releases the feeler fingers, they pass through the check chute and open the feeler finger contact. CC No. 3 is timed to make at approximately 130 degrees, or the equivalent to a 5" check and breaks at 300 degrees.

If a check goes through normally and is not more than 4⅞" wide, the feeler finger contact will be opened before CC No. 3 closes. If the check is fed through at too great an angle, the feeler finger contact will not be opened before CC No. 3 makes and a circuit will be completed to R-7. The operation of R-7 makes the reel inoperative and sets the buzzer sounding, but the release bar is not locked.

(C) To determine if a check is behind the pocket bail is accomplished by means of CC No. 2 and the check retainer contact. CC No. 2 makes at approximately 140 degrees and breaks at 150 degrees. The check retainer contact is operated by a stud on the cam arm of the check retainer fingers. If there is no check behind the bail, the check retainer fingers enter into the pocket before the bail is brought back. When the fingers reach the end of their travel, the check retainer contact is opened. As the bail is brought back, the check retainer fingers pass through slots in the bail, then CC No. 2 closes and opens. No circuit is completed, because the check retainer contact is open.

If there is a check behind the bail, the check retainer fingers will be forced out of their true position due to the slots in the bail being obstructed by the check, and cause the check retainer contact to close. Then CC No. 2 closes, completing a circuit through CC No. 2, check retainer contact, and R-7 relay. This causes the same indication as for a check that has been fed into the machine crooked, or at too great an angle.

This sensing of a check behind the bail does not sense the check as it goes behind the bail, but senses when feeding the next check that is to be fed into that pocket.

No. 13. Buzzer Holding Circuit.

The buzzer holding circuit is maintained by the closing of the points of R-7A. This at the same time completes a circuit to the buzzer and is held until the operator presses the reset contact which is located by the door contact. This drops R-7 and returns the circuits to normal.

No. 14. If the paper on one of the rolls in the compartment printer is nearly exhausted, it allows one of the paper roll contacts to close, completing a circuit to the paper roll signal lamp which indicates to the operator that this condition exists.

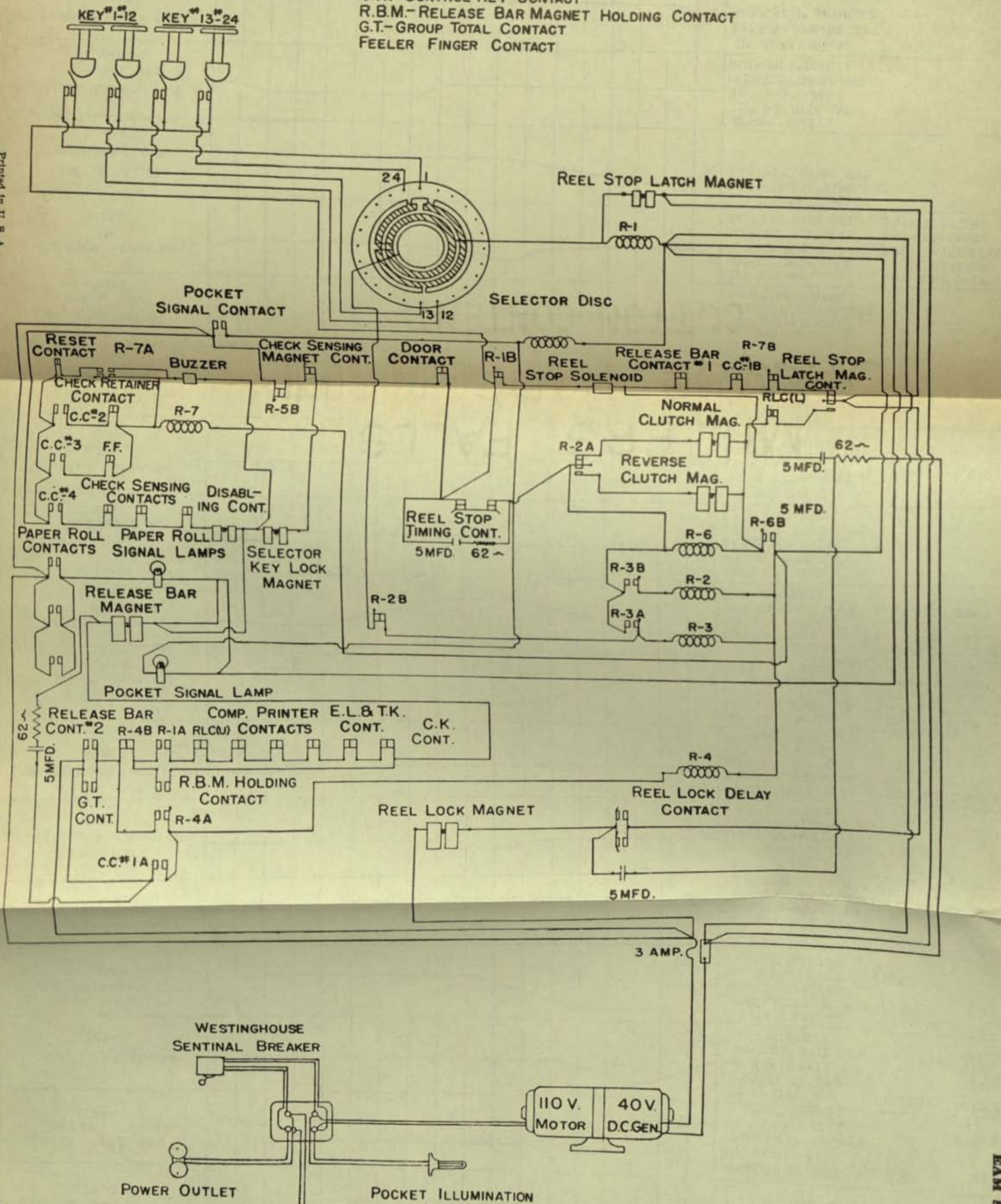
No. 15. If one of the pockets of the reel should become filled to capacity, the pocket signal contacts will be closed, completing a circuit to R-5 coil and to the pockets signal lamp which will indicate to the operator that the pocket should be emptied. The energizing of R-5 causes the R-5B points to open so that the circuits cannot be set up to operate the reel, also locking out the release bar by opening R-1A.

Coding Of Diagram

R-Relay
1 Relay As Numbered In Machines — Relay #1
A-Contact Group On Left Of Relay
B-Contact Group On Right Of Relay — R-1A Relay Cont. Group On Lt. Of Relay

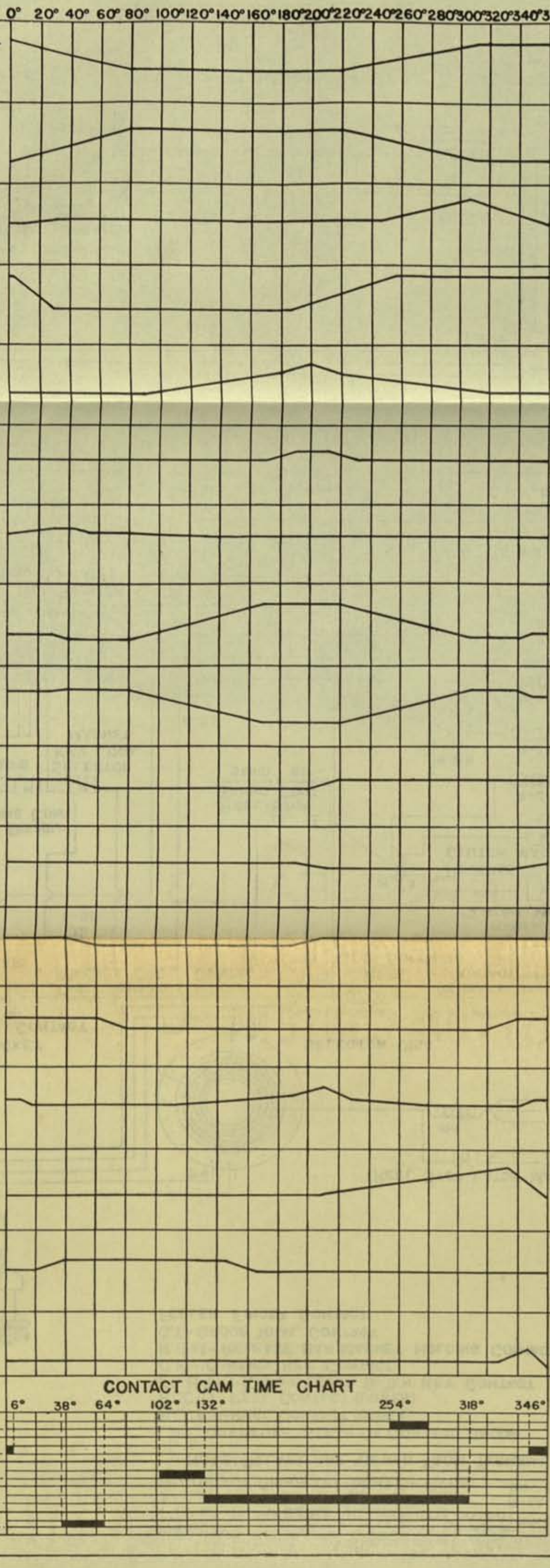
Note: Relays Are Viewed From Terminal End Or Rear Of Relay

Operative Strap Of Contact Group
RLC(U)-Reel Contact (Upper)
RLC(L)-Reel Contact (Lower)
EL.& TK.-Error Lever & Ten Key Contact
C.K.-Control Key Contact
R.B.M.-Release Bar Magnet Holding Contact
G.T.-Group Total Contact
Feeler Finger Contact



Bank Proof Circuit Diagram

CAM MOVEMENT TIME CHART



CHECK FEED ARM RESTORING CAM 130903	0°-80° DROP .843 80°-220° DWELL 220°-310° RISE .843 310°-360° DWELL	
CHECK FEED ARM OPERATING CAM 130902	0°-80° RISE .843 80°-220° DWELL 220°-310° DROP .843 310°-360° DWELL	
POCKET SIGNAL CAM 130968	0°-10° DWELL 10°-30° RISE .062 30°-245° DWELL 245°-305° RISE .625 305°-308° DWELL	308°-360° DROP .687
CHECK RETAINING CAM 150520	0°-1°43' DWELL 1°43'-31°43 DROP .807 31°43'-186°43' DWELL 186°43'-256°43' RISE .807 256°43'-360° DWELL	
REAR PRINTER CAM 131634	0°-90° DWELL 90°-180° RISE .494 180°-200° RISE .169 200°-220° DROP .169 220°-320° DROP .494	320°-360° DWELL
ADDING RACK ALIGNER CAM 131633	0°-170° DWELL 170°-190° RISE .193 190°-210° DWELL 210°-230° DROP .193 230°-360° DWELL	
TRANSFER RESTORING CAM 131633	0°-30° RISE .128 30°-42° DWELL 42°-55° DROP .028 55°-80° DWELL 80°-130° DROP .100	130°-360° DWELL
ADDING RACK DRIVING CAM 150738	0°-30° DWELL 30°-40° DROP .013 40°-80° DWELL 80°-170° RISE .966 170°220 DWELL	220°-310° DROP .966 310°-340° DWELL 340°-350° RISE .013 350°-360° DWELL
ADDING RACK RETURN CAM 150740	0°-30° DWELL 30°-40° RISE .013 40°-80° DWELL 80°-170° DROP .966 170°-220° DWELL	220°-310° RISE .966 310°-340 DWELL 340°-350° DROP .013 350°-360° DWELL
CONTROL SLIDE ENGAGING CAM 131628	0°-40° DWELL 40°-60° DROP .312 60°-200° DWELL 200°-220° RISE .312 220°-360° DWELL	
COUNTER ENGAGING ADDING CAM 131627	0°-190° DWELL 190°-210° DROP .187 210°-340° DWELL 340°-360° RISE .187	
COUNTER ENGAGING TOTALING CAM 131627	0°-40° DWELL 40°-60° DROP .187 60°-190° DWELL 190°-210° RISE .187 210°-360 DWELL	
ZERO ELIMINATION PAWL CAM 131626	0°-60° DWELL 60°-80° DROP .235 80°-320° DWELL 320°-340° RISE .235 340°-360° DWELL	
CONTROL PRINTER CAM 131626	0°-9° DWELL 9°-19° DROP .042 19°-110° DWELL 110°-190° RISE .245 190°-210° RISE .060	210°-230° DROP .160 230°-280° DROP .145 280°-341° DWELL 341°-351° RISE .042 351°-360° DWELL
SETUP SLIDE RESTORING CAM 131625	0°-209°47' DWELL 209°47'-335° RISE .965 335°-365° DROP .965	
ZERO ELIMINATION SLIDE CAM 131624	0°-20° DWELL 20°-40° RISE .198 40°-145° DWELL 145°-165° DROP .198 165°-360° DWELL	
CONTROL KEY CAM 150736	0°-327° DWELL 327°-345° RISE .322 345°-360° DROP .322	

C.S.D. 716

ELECTRIC TEST SCORING MACHINE

Type 805

CONTENTS

(Continued on next page.)

Printed in U. S. A.
Form 27-8048-0

(Continued from cover page.)

CURRENT REQUIREMENTS AND WEIGHT

Current Weight and Dimensions

The operating current for the Test Scoring Machine without and with the item counters is as follows:

Voltage	Amps.	Item Ctr. Amps.	Total Amps.
115 DC	3.0	1	3
230 DC	2.0	.5	2.0
115 AC 60 cycles single ph.	3.6	1	3.6
230 AC 60 cycles single ph.	2.0	.5	2.0

NOTE: Total amperes do not equal the sum of two units because the duty periods do not occur at the same time.

DIMENSIONS: Length 38" Height $29\frac{1}{2}$" Width $29\frac{1}{2}$"

WEIGHT: Packed 580 lbs. With 807 640 lbs.
Unpacked 425 lbs. With 807 485 lbs.

HEAT DISSIPATED in BTU's PER HOUR: AC - 1030
DC - 1170

SPEED -- All items in a test or part of a test are scored simultaneously so that the speed of the machine in practice is limited only by the speed with which the operator can insert the answer sheets and read the scores on the meter. Averages range from 400 to 1,000 scores per hour, depending on individual conditions.

ADJUSTMENTS

The following adjustments apply to the Type 805 Test Scoring Machine:

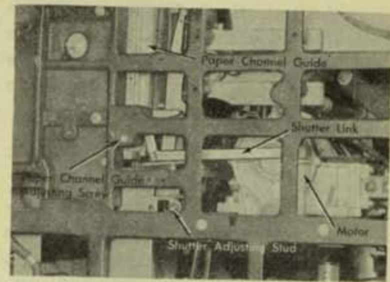


Figure 1

Paper Channel - Figure 1

Adjust the paper channel guides by the screw protruding through the side covers so that the answer sheet response positions line up horizontally with the sensing contacts. The answer sheet should have approximately 1/32" freedom of movement over the ends to facilitate ejection of the answer sheet.

The paper channel screws identified by a spring under the heads are located above and to the front of the shutter adjusting worm shaft stud.

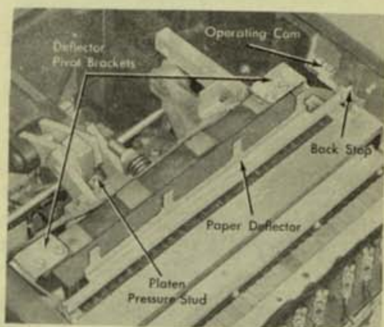


Figure 2

Paper Shutter - Figure 1

Adjust the paper shutter studs that protrude through the inner and right side cover so that the answer sheet lines up vertically with the sensing contacts.

The paper channel guide and paper shutter adjustments may be checked by placing a piece of soft carbon paper in the channel with an answer sheet so that the carbon is next to the answer sheet. Depress the motor key twice and remove the answer sheet and carbon paper. The position of the carbon deposits in relation to the response blocks on the answer sheet will indicate the paper alignment to the sensing unit.

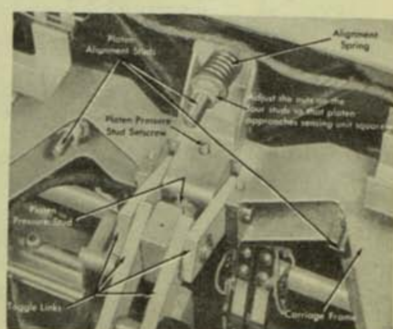


Figure 3

Paper Deflector - Figure 2

Adjust the paper deflector pivot brackets so that the deflector is free and its fingers lay flat against the throat when the platen is in scoring position.

Adjust the deflector operating cam so that with the platen retracted the deflector fingers are in a vertical position. The cam should not interfere with the deflector when holding the paper down against the throat.

Adjust the deflector backstop so that the deflector cannot be pulled any further forward than the vertical position when the platen is retracted.

Platen Alignment Tension Springs-Figure 3

Adjust the four platen alignment stud nuts so that the springs are compressed approximately ½". Then adjust the stud nuts individually so that the platen approaches the sensing unit squarely. The lower alignment stud is not visible in the illustration (Page 3).

NOTE: This adjustment should be made with the throat and paper deflector on the machine.

Platen Pressure Stud - Figure 3

Adjust the platen pressure stud so that the motor will stall with four sheets in the paper channel and not on three. Loosen the platen pressure stud setscrew before moving the pressure stud.

Check at this time to see that the platen pressure is even all over the sensing unit. This test is made by using a piece of carbon paper facing an answer sheet and by operating the platen. The impressions of carbon should be nearly uniform in all areas. A very light impression indicates light pressure due to a low area in platen or a low sensing contact. It may be necessary to sand down the high areas of the platen to the low areas to even up the pressure for proper scoring.

Motor Drive Unit

1. Adjust the end play of the motor armature shaft to .005" by adjusting the thrust bearing plug (Figure 4). Check to see that the commutator lines up properly with the brush holders.

2. The motor start contact should have 1/32" rise from its brass support when the dog stop is latched by the dog latch. The driving dog should be released just before the contact makes.

3. The motor start and the run contacts should have good tension when made; the points should break with 1/32" air gap with the motor drive unit latched up.

4. With the dog stop against the

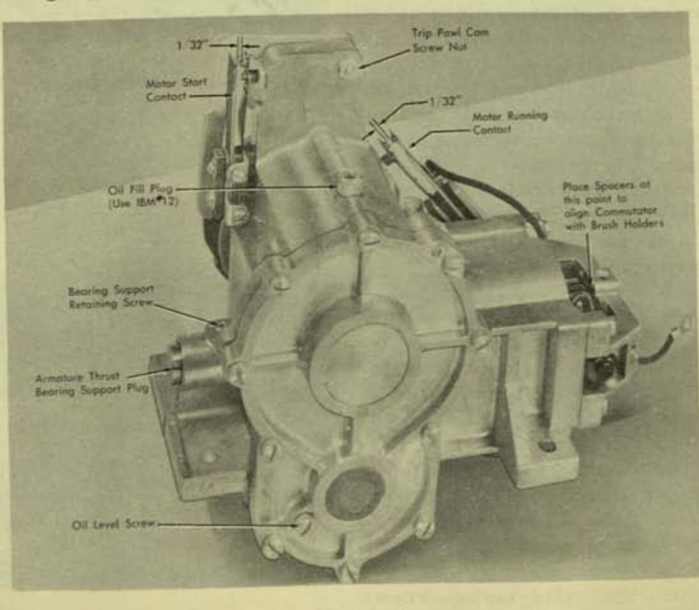


Figure 4

dog there should be .045" clearance between the end of the detent and the detent notch when the clutch disc is pushed ahead as far as it will go (Figure 5).

5. The dog stop should overlap the dogs approximately 1/32" with the dog stop in the normal position.

6. With the clutch latched and the detent seated, the driving dog should have 1/64" between it and the ratchet to prevent "dragging" of the dog (Figure 6). Check when latched on either dog. Lengthen or shorten the dog connecting link by peening to obtain the same on both.

7. The dog stop, when latched on its latch, should have approximately 1/32" unlatching clearance to both dogs (Figure 7).

8. Position the motor key shaft in the hub of the operating arm on the left end of the motor key shaft so that the dog trip latch is under the dog stop by approximately 1/64" with the clutch latched up (Figure 8, page 6).

9. Adjust the trip pawl cam so that the dog stop is driven 1/32" to 1/16" past the latching point on the dog stop latch before the tripping pawl is cammed off the dog stop (Figure 9, page 6).

10. The length of the toggle connecting link should be adjusted so that the toggle links are carried 1/32" past dead center when the links are straightened out (Figure 10). This adjustment assures that the dog seats in the one tooth ratchet before the toggle is collapsed when releasing a test sheet.

Paper Shutter Trip Mechanism

1. With the motor key in the normal position the shutter trip operating arms should be positioned so that the shutter trip levers hold the latch levers approximately 3/32" above the latch block (Figure 11). This adjustment should be the same on both sides so that the shutter will trip evenly.

2. The latch block on the plat-

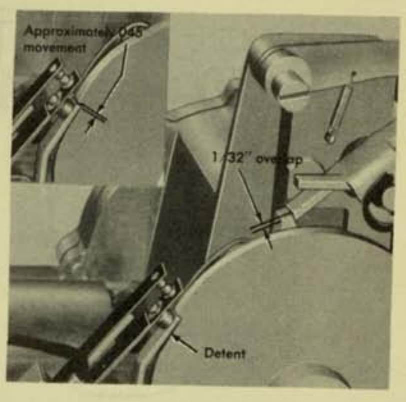


Figure 5

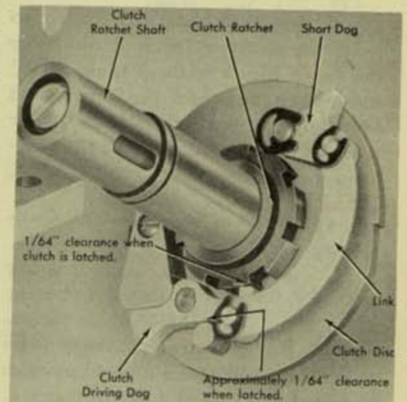


Figure 6

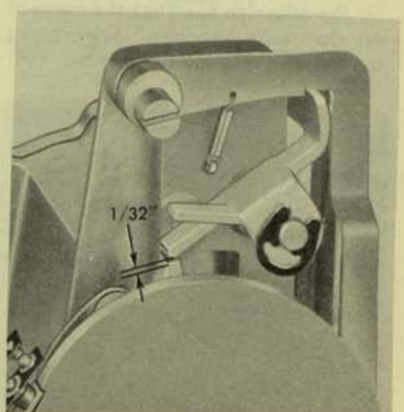


Figure 7

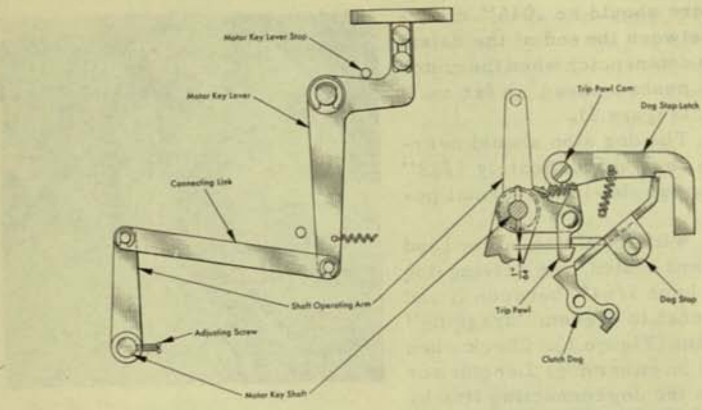


Figure 8

en casting should be positioned so that the shutter latch drops over the latch block with at least .010" clearance between the block and latch surface of the latch lever when the platen is against the sensing unit (Figure 12).

Paper Shutter Signal Light Contacts

1. Adjust the contacts to make with light tension when the shutter slide is against the shutter stops.

2. Readjust the contacts to be open with an answer sheet between the shutter slide and shutter stops.

3. Check with an answer sheet caught between the shutter slide and shutter stop only on one side or the other to see that the contact on that side is open, preventing the shutter signal light to be ON.

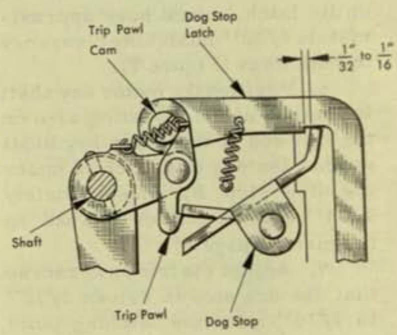


Figure 9

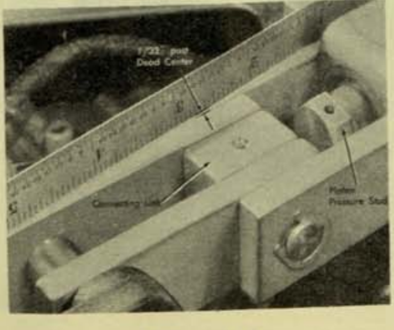


Figure 10

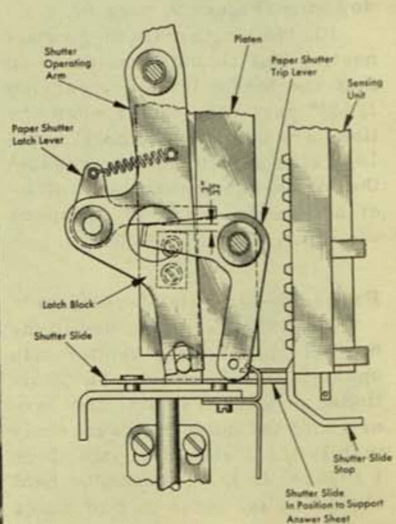


Figure 11

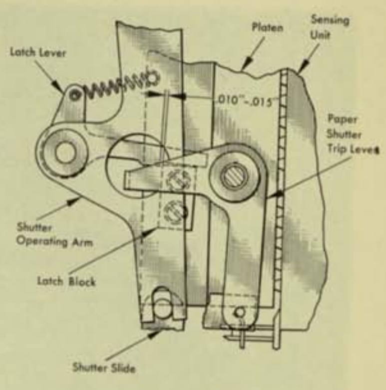


Figure 12

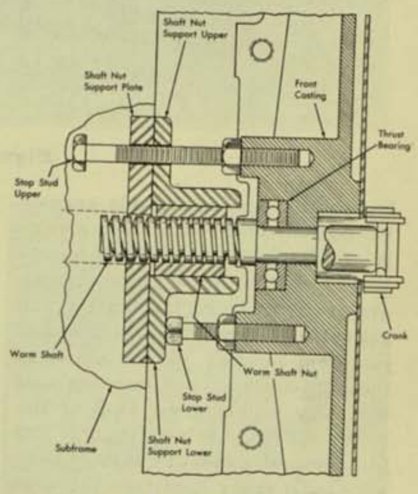


Figure 13

Subframe Stop Studs - Figure 13

1. Adjust the stop stud lower so that the crank stops in a horizontal position when the subframe is all the way to the front of the machine.

2. Adjust stop stud upper so that when the subframe is all the way in for scoring that the crank is stopped in a horizontal position so that the crank handle may be folded in. The crank should make four complete turns, moving the subframe from one extreme limit of travel to the other.

Master Control Switch - Figure 14

1. The contacts should be adjusted to have sufficient rise off the supports when closed to make a good contact.

2. The switch rear contacts should have very little tension when they are opened and are against the cams. With the contacts adjusted to have good tension when made, the operated strap should be adjusted with the contact mounting block off the switch frame so that the contacts open with 3/32" air gap.

3. The detent spring should have heavy tension against the detent and the cam.

Check to see that there are NEVER more than one group of contacts made at a time when operating the switch.

Answer Key Frame

1. Adjust the two answer key frame support screws so that the pins in the pin set unit line up centrally in the holes of the key frame vertically.

2. Adjust the screws in the sides of the frame so that the pins in the pin set unit line up laterally with the holes in the key frame. The key frame should fit snug between the side plots of the subframe.

Check the bottom of the key frame as well as the top.

Subframe and Pin Set Unit

When the subframe is all the way in the scoring position, there should be at least the thickness of three answer sheets clearance between the ends of the item pins and the backing plate.

If this clearance cannot be obtained or held by the stop stud upper, the subframe will have to be moved forward in relation to the shaft nut plate. Place shims between the shaft nut support plate and the shaft nut support upper and lower until the proper adjustment is obtained (Figure 15).

Resistor Unit

The resistor unit rests at the

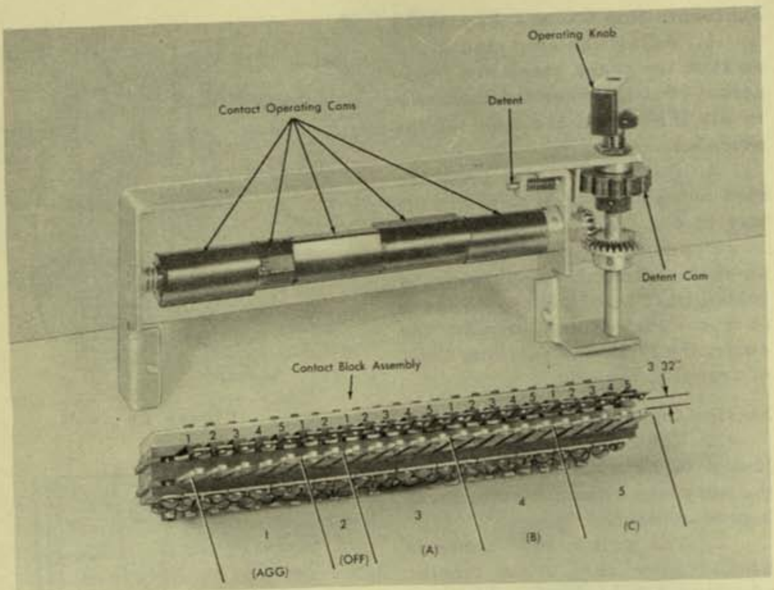


Figure 14

bottom on two adjustable screws to align the unit properly in a vertical position. They should be adjusted so that the tips of the resistors center with the sensing and pin set unit contact caps. The adjustment screws on the sides in the side frames position the unit laterally to align the tips of the resistors with the sensing unit and pin set unit contact caps. These screws merely position the unit and do NOT hold the unit. The unit should be free to shift.

Meter

The meter needle should be

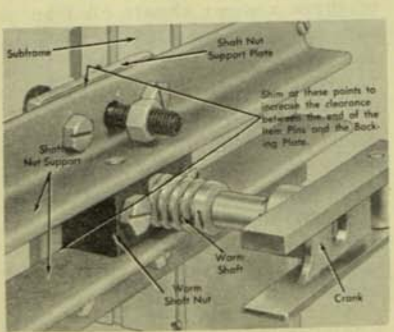


Figure 15

set to read 1/2 by adjusting the zero adjustment screw. The original scoring settings should also be set to read the number of answers recorded plus 1/2. A score of 75 should read $75\frac{1}{2}$.

If a meter appears to be inaccurate, the meter calibration test should be run after the power supply has been thoroughly checked for proper voltage regulation. If the meter is not linear in its readings from 0 to 100 and the error is progressive in nature, the compensating plate on the face of the poles of the movement (Figure 16) may be moved slightly to adjust for proper readings. If the meter reads low, move the plate slightly to the right.

Do NOT make any other adjustments to the meter movement. Be very careful when adjusting and checking the meter as it is a DELICATE and a PRECISION instrument.

Electronic Power Pack Voltage Adjustments - Figure 17

The power pack has three ad-

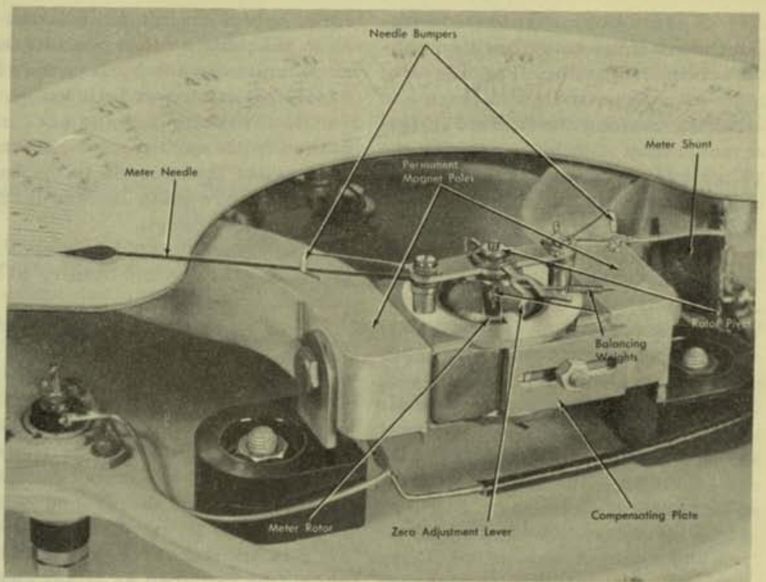


Figure 16

justable potentiometers marked 90, 225, and 135 protruding through the chassis. The voltages are regulated by the potentiometers and should be adjusted in the following manner:

1. Adjust the 225 potentiometer for 225 volts from the plus terminal to the 225 volt terminal.
2. Adjust the 135 volt potentiometer for 135 volts from the plus terminal to the 135 volt terminal.
3. Adjust the 90 volt potentiometer for 90 volts from the plus terminal to the 90 volt terminal.

Recheck all settings and reset if necessary. The transformer has three taps on the primary side labelled 0, 105 and 115. Normally, the 0 and the 105 voltage tap are used. If the outside power supply voltage is normally above 115 volts, the wire on the 105 voltage tap should be moved to the 115 voltage tap.

CIRCUIT ANALYSIS

Circuit Testing

It is important that a Test

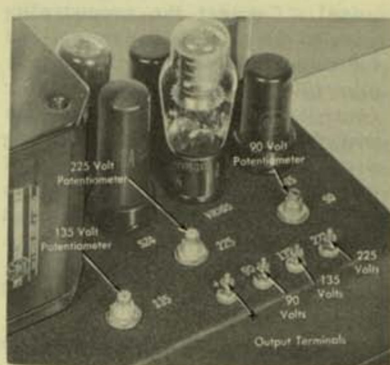


Figure 17

Light should NEVER be used to trace circuits in the Test Scoring Machine for the following reasons:

1. It endangers and possibly damages the meter.
2. It breaks down or carbonizes an existing high resistance current leakage between circuits.
3. A test light will not indicate high resistance current leakages which are causing errors in scores.

A circuit is incorporated within the machine to be used in conjunction with the meter and two of the 45 volt batteries to trace and test the various circuits. The test circuit may also be used with the 90 volt tap on the power pack providing there are no difficulties with the power pack.

It is suggested that a voltohmeter, preferably of 20,000 ohms per volt sensitivity, be used in analyzing the machine circuits, particularly on machines equipped with power pack.

There are two test terminals located on the right end of the rear control panel. Use the test circuit shown on the wiring diagram as follows:

Disconnect two 45 volt batteries and connect one of the three plug wires, supplied with each machine, to the negative side of one battery and to the minus test terminal. Connect the second plug wire to the plus test terminal and the third plug wire to the battery plus (90 volts). Turn the master control switch to OFF. To be sure that the test circuit is operating properly, touch the free ends of the second and third plug wires together. The meter should read approximately 90. When testing a circuit in which there are no resistors, the meter should still read approximately 90.

To test for high resistance shorts and high resistance leakages to ground, the ohmic resistance between the two points in question may be computed from the meter reading using the equation

$$R_x = \frac{9,000,000}{\text{meter reading}} = 100,000$$

The 90 volt terminal on the power pack may be used in the same manner as two 45 volt batteries.

Batteries Tests

As the 45 volt batteries age, the internal resistance increases to the point where it becomes a source of scoring error. Therefore, a test circuit is included in each machine so that the internal resistance of each battery may be easily measured as follows:

1. Three test leads are furnished with each machine. Connect two of these leads to the battery test terminals located on the rear control panel.

2. Connect the other ends of the test wires to the battery to be tested.

3. Turn the master control switch to the OFF position and record the meter reading.

4. Depress the battery load push button switch which is located between the test terminals and record the new meter reading.

5. Subtract the second reading from the first. If this difference is more than 3, the battery should be replaced as it has an internal resistance in excess of 50 ohms.

The predicted life of the 45 volt batteries is 1 year, but they should be tested every 3 months. The predicted life of the 1.5 volt batteries is considerably longer, as they need only be replaced when they fail to give satisfactory operation of the over 100 circuit.

NOTE: The 1.5 volt batteries cannot be tested with the machine test circuit.

Electronic Power Pack Test

The power pack may be tested by placing a voltmeter, preferably 20,000 ohms per volt sensitivity, across the terminals and checking the drop in voltage by placing a 200 mark load across it by inserting an answer sheet with 200 marks on it and machine set to score. The voltage drop read on the voltmeter should not be more than 3 volts. For a 100 mark load the voltage drop should not be more than .2 or .3 of a volt.

The battery test circuit should NEVER be used on the power pack. The circuit loads the power pack too heavily.

The power pack will normally

regulate a constant voltage output with an input of 95 to 120 volts with the 105 volt primary transformer tap being used. If the 115 volt tap is used, the input voltage may vary from 105 to 130 volts.

Meter Calibration Test

A meter calibration test is very simple in determining if a meter is reading linear. The procedure recommended is as follows: Prepare answer sheets to check meter in graduations of five on the meter scale. Use twenty sheets or one sheet. If twenty sheets are used, you will have a sheet with five marks; one with ten marks, fifteen marks, etc. If you use one sheet, put five marks on sheet then check to see if meter reads five, then add five and check for reading of ten, add five more and check for reading of fifteen, etc. It should be understood that the machine has been set up to read one for each mark or to read seventy-five for seventy-five marks.

It is essential that the DC power supply used in the scoring circuits be well regulated for proper scoring results. For tests refer to Electronic Power Pack Voltage Adjustments and Tests.

PERFORMANCE TESTS

1. With the master control switch turned to OFF, the meter needle should rest halfway between 0 and 1. Adjust the meter, if necessary, by turning the zero adjusting screw directly below the center of the meter.

2. Insert the empty scoring key frame into the channel at the right top of the machine, with the hinged side of the scoring key frame at the bottom and the front of the frame toward the back of the machine. Clamp the key frame into position by turning the key-clamp lever through four full turns in a clockwise direction.

3. Prepare 10 check sheets by marking all spaces in field 1 for checking field 1; mark sheet 2 with all spaces marked in field 2, etc. This gives 75 marks for each field.

With the empty key frame clamped into place, insert a field sheet and adjust the plus potentiometers so that the meter reads $75\frac{1}{2}$ on each of parts A, B, C, or the part that will be used in the scoring setup. The formula switch for the part being set must be set at Rights, since the pins in the key set unit are in the rights position. If the formula switch is set to R-W or R+W, the meter should read the same, $75\frac{1}{2}$, since there are no wrongs. NOTE: It will be necessary to turn the formula switches for sections not in use at the time of checking to a position off the marked dial or to a blank position of the switch. Example: When setting and checking A, turn B and C formula switch to the next position below R-W. When setting and checking B, turn A and C to the next position below R - W; check each of the ten fields in the above manner. Each should read $75\frac{1}{2}$.

The wrongs are automatically set when the rights are set.

4. In order to be sure that the wrongs will pick up, it is well to take a scoring key and punch out only the field selection pin holes for all parts and fields and insert in the top level of key frame and go through the same checking operation as mentioned above for the rights, except set formula switch to W. W will read $75\frac{1}{2}$.

Any variation of more than one point low will indicate generally a position or positions, according to the variations, not picking up due to various reasons. If all fields but one or two read high, it may indicate that the original setting of $75\frac{1}{2}$ was made on a field only picking up 74 or 73 marks.

Check at this point, if such difficulties do exist, to see that the meter needle drops back to $\frac{1}{2}$ without an answer sheet in the machine; a sensing contact may be shorted with a graphite coated paper fiber if it does not return to $\frac{1}{2}$.

5. After step 4 is complete, it is very easy to calibrate over 100 circuit. With the setup for step 5 or 6, mark an answer sheet with 100 marks and check to see if meter reads $100\frac{1}{2}$. It is suggested that an answer sheet then be marked for 150 marks and inserted. The needle will swing off the scale beyond 100. Pull the over 100 key forward and adjust the aggregate potentiometer to read $150\frac{1}{2}$. Then mark an answer sheet for 105 marks and check to see that meter reads $105\frac{1}{2}$. Do NOT adjust plus potentiometer for correction of over 100 reading. If the plus potentiometer is readjusted for under 100 then the over 100 will have to be readjusted for correct reading. It may be necessary to adjust the under 100 readings a little high or a little low to be able to get a reading that can be read when using over 100.

6. The next step in checking and setting up the machine for test if R-W is going to be used, is to set for the subtracting reading. In order to make this check and set up, prepare an answer key and answer sheet to go with it so that the answer sheet will contain a certain number of known rights and wrongs answers. It is suggested that a test be set up to use all three parts of the machine -- A, B, and C. Arrange the first four fields for part A; five, six, seven and eight fields in part B; nine and ten fields in part C.

In each field, mark the answer sheet and punch the answer key so that each field contains ten right responses and five wrong responses. Insert the answer key and the answer sheet into the machine, and, without disturbing the setup described in steps 3, 4, and 5, the scores should read on the meter as follows, using the table for switch settings:

A. R - 40	B. R - 40	C. R - 20
W - 20	W - 20	W - 10
R-W - 20	R-W - 20	R-W - 10
R+W - 60	R+W - 60	R+W - 30

Rights A + B = 80, A + B + C = 100, A+C = 60

Wrongs A + B = 40, A + B + C = 50 A+C = 30

R-W A+B = 40 A+B+C = 50 A+C = 30

R+W A + B = 120 A + B + C = 150 A+C = 90

If the above readings do not check after steps 3, 4 and 5 have checked out close, it might be well to run the meter linear test. Scoring cannot be accurate unless the meter is accurate in scale readings.

GRAPHIC ITEM COUNTER ADJUSTMENTS

The following adjustments apply to the Type 807 Graphic Item Counter and are made in the order of their listing.

Platen Support Arm Cams

Position the left hand platen support arm operating cam on the reset shaft so that when it is resting against its stop stud on the bearing bracket (Figure 18) with

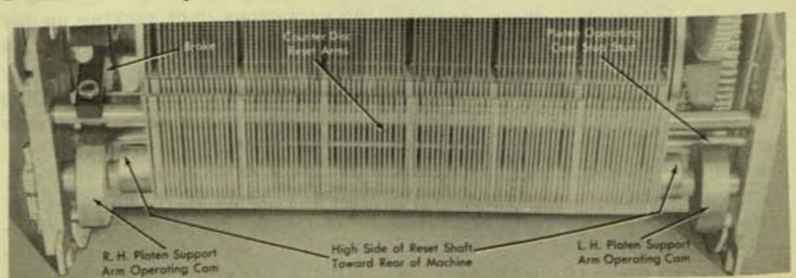


Figure 18

the high side of the shaft toward the rear of the counter, the handle is stopped in the up and vertical position, parallel with the front edge of the left side frame. Position the right hand cam on the shaft in the same relative position as the left hand cam.

Reset Shaft Bearing Brackets - Figure 19

Adjust the reset shaft bearing brackets so that the first tooth on the counter disc measures 2 3/4" from the bottom of the frame with the counter disc stop stud against the reset arm.

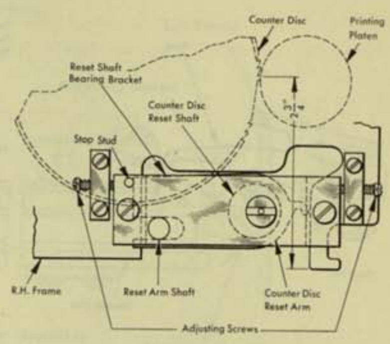


Figure 19

Brake - Figure 20

Adjust the brake so that no gear back lash is apparent at the end of resetting. It must be tight enough so that the counter disc shaft will not rotate as the counter discs are stepped ahead when recording responses, or when counter discs are reset to 0 with the reset arms. It is tightened by tightening the clamping screw on the top of the brake arm. The setscrew on the bottom end of the brake arm is adjusted so that no movement appears between the lower end of the arm and the reset arm shaft. The clamp collar next to the brake is positioned so the shaft has a minimum of end movement between the bearings when the brake is loose on the shaft.

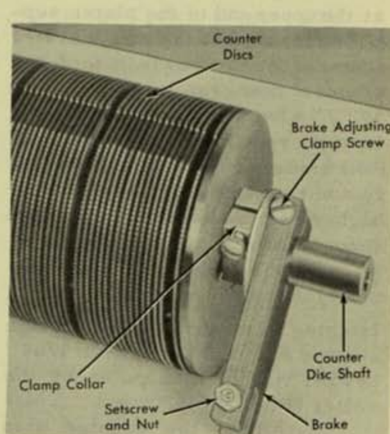


Figure 20

Pawl Carrier Frames

1. Adjust the pawl carrier frame combs laterally so that the pawls line up with the counter discs. The frames should be free on the pivots with a minimum of end shake. The pawl carrier frame and brackets are adjustable for overall length.

2. Adjust the pawl carrier frame eccentric pivot studs on both sides so that the pawls have 1/64" between the toe of the pawls and the face of the counter discs tooth (Figure 21) with the counter discs

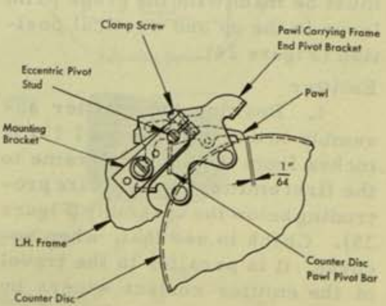


Figure 21

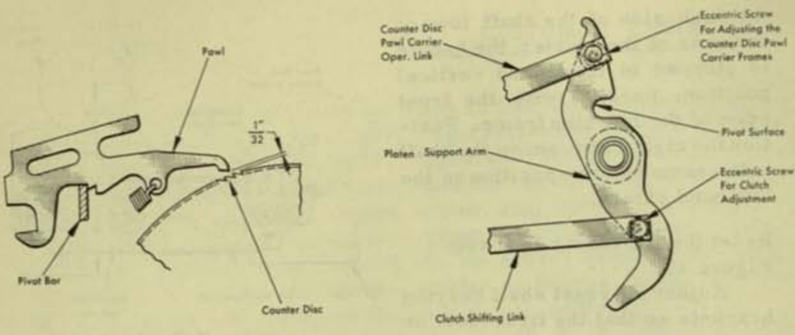


Figure 22

in the reset or 0 position. The pawls should be in their latched position.

3. Adjust the eccentric screws at the upper end of the platen support arm so that the pawl carrier frames lift the pawls out of the counter disc ratchet wheels by 1/32" when the graph print lever is in the reset or printing position. Both sides should be adjusted evenly and the studs should have their high sides in the same direction (Figure 22).

Carriage

1. Adjust the counter disc latching roller arm on the carriage so that the pawl is driven 1/64" beyond its latching point by the roller (Figure 23).

2. Adjust the counter disc magnets on the carriage so that they are .040" above the counter disc pawl when they are in their latched position. Check on both sides of the unit. This adjustment must be made with the graph print lever in the up and vertical position (Figure 24).

Emitter

1. Position the emitter assembly so that it measures 1 17/32 inches from the left side frame to the first emitter contact wire protruding below the assembly (Figure 25). Check to see that, when secured, it is parallel to the travel of the emitter contact wipers by observing that the rise of the wiper off its support is the same at both

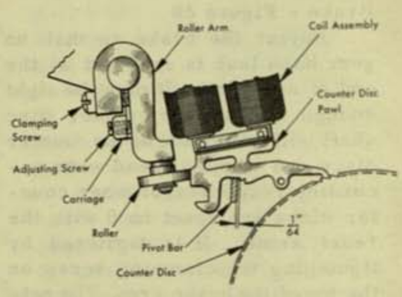


Figure 23

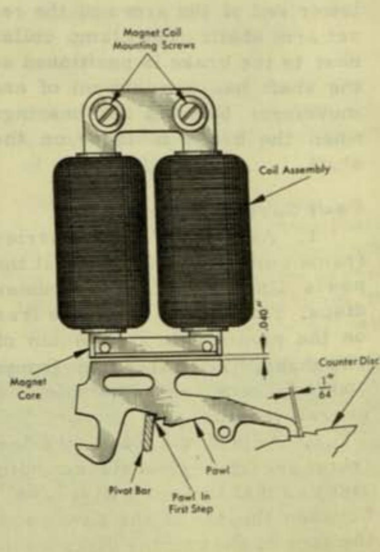


Figure 24

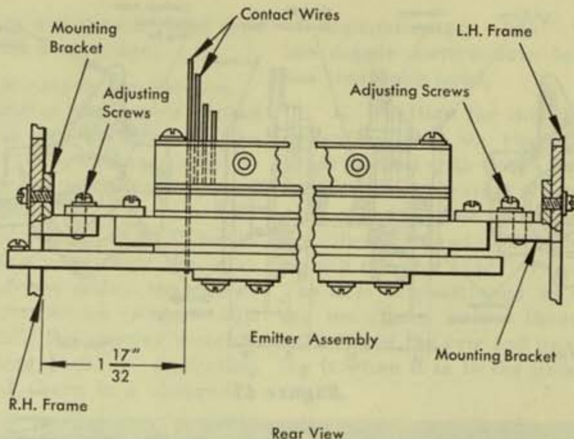


Figure 25

extremes of its travel.

2. Adjust the carriage emitter contact wipers so that when the counter magnet core is centered directly over the counter disc pawl, the contact pin is centered on the emitter contact pin wiper (Figure 26).

3. Adjust the contact support so that the wiping contact strap has .010" rise off the tip of the support. This adjustment should be checked very carefully. Adjust the rail wiper to have good contact tension against the rail.

Carriage Clutch-(Figure 27)

Adjust the left side reverse arm on the end of the carriage feed screw shaft so that when the carriage reaches a position 5/16" from the left side frame, the reverse arm engages the reversing pin in the carriage feed screw nut. Adjust the reverse arm on the right side so that it will engage the reversing pin when the carriage is 9/16" from the right side frame.

At the point of engaging there should be 1/32" between the re-

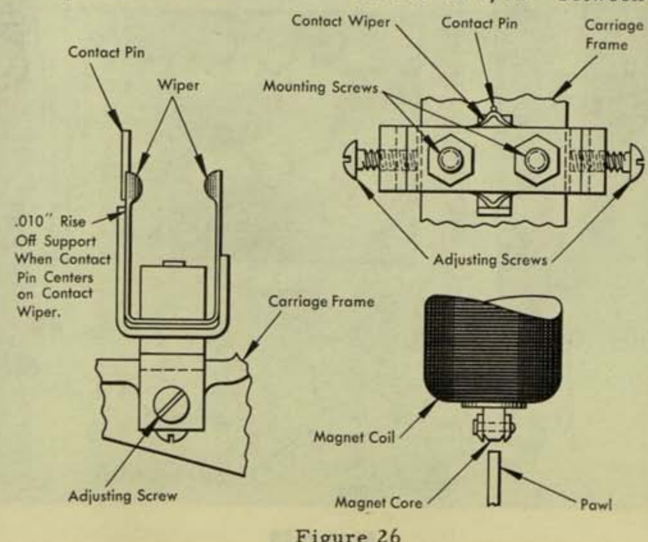


Figure 26

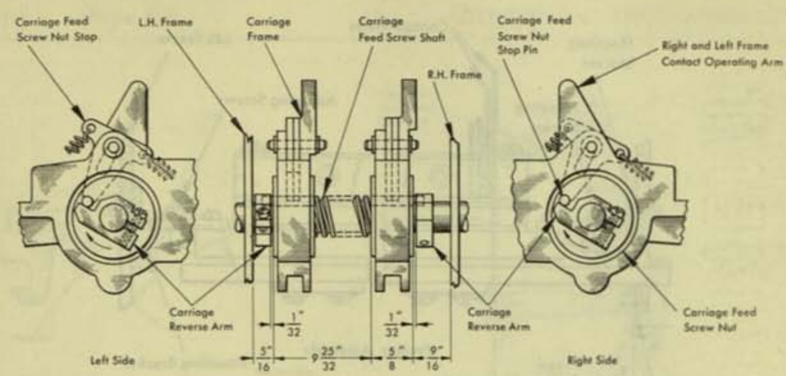


Figure 27

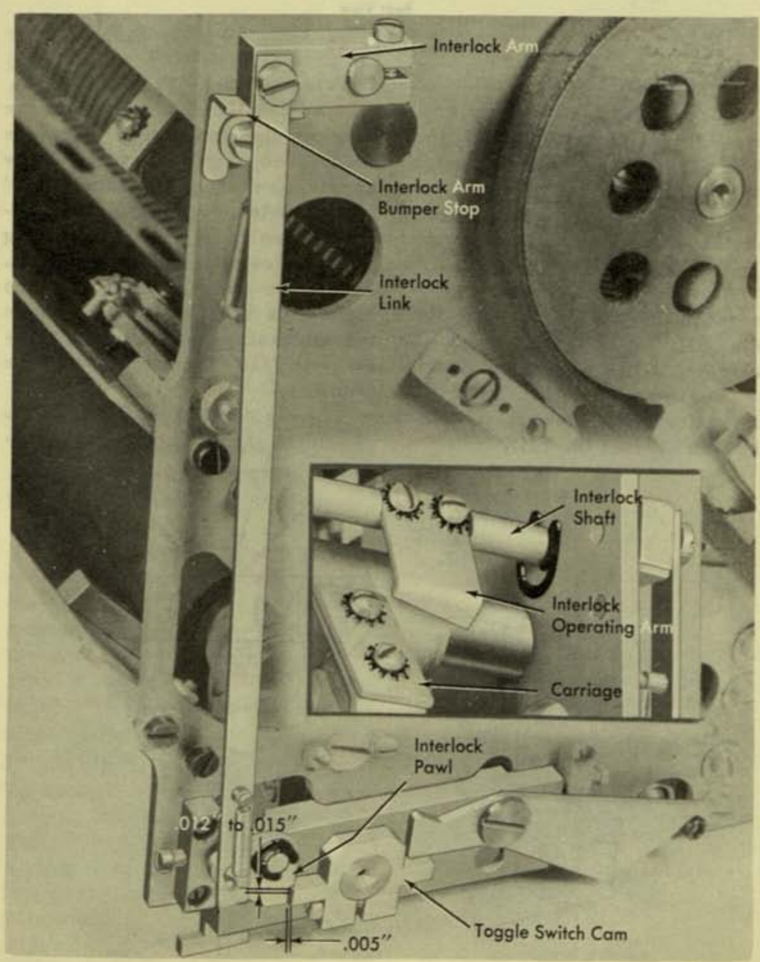


Figure 28

versing arm and the carriage feed screw nut on both sides.

Carriage Interlock Mechanism

1. Position the toggle switch cam on the reset shaft with the graph print lever in the upward position for operation of the counter, so that the toggle switch cam rear ledge travels .012" to .015" below the interlock pawl with the carriage out from under the interlock operating arms (Figure 28).

2. Adjust the bumper bracket under the interlock link operating arm so that there is a clearance of approximately .005" between the toggle switch cam ledge and the interlock pawl.

3. Position the interlock link operating arm on the operating shaft so that with the carriage either to the extreme right or left side operating the interlock pawl, the interlock pawl clears the toggle switch cam by 3/32" (Figure 29). The arm is positioned by loosening the clamp screw through the split end of the arm and by tightening it when it is in the proper position.

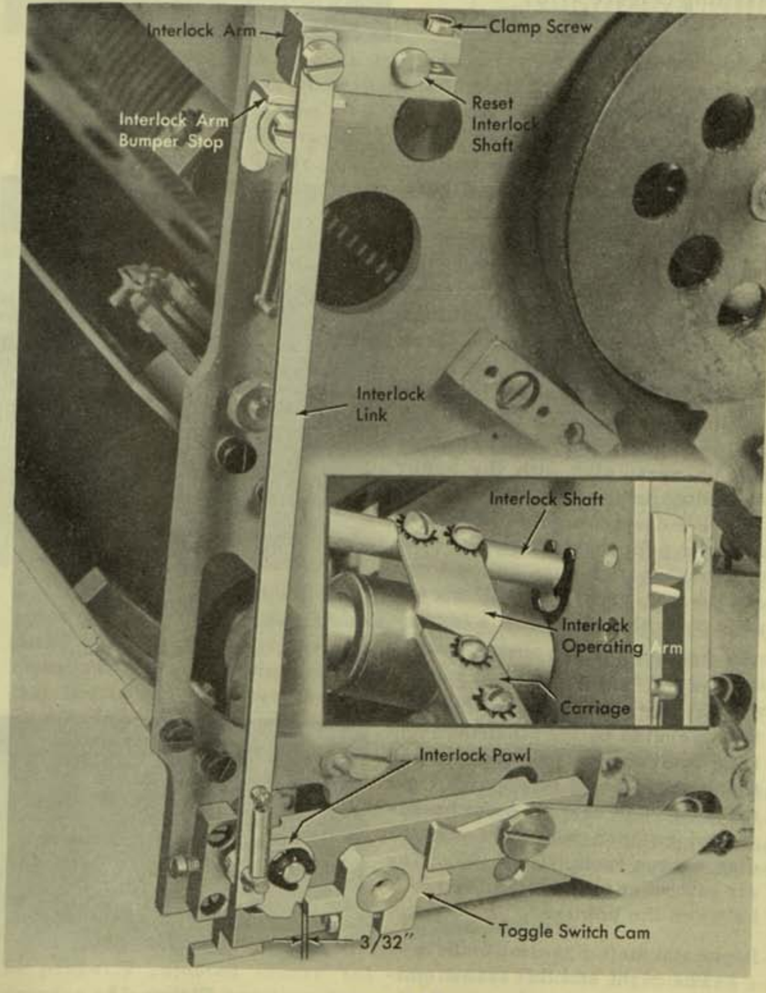


Figure 29

GIC Clutch

1. Position the clutch block on the clutch shaft so that when the floating clutch gear is pushed against the clutch pinion in a position that it will not engage, there should be 3/32" between the clutch block and the floating clutch gear (Figure 30).

2. Adjust the clutch link eccentric screw so that the floating clutch gear engages the same amount into the clutch block for item counting and into the clutch pinion gear for graph printing and resetting (Figure 31).

Paper Stops and Form Guides

1. Adjust the paper stop shaft eccentric studs on each side of the unit (Figure 32) so that the first marks printed on the graph form appears .015" above the bottom guide line across the form (Figure 33).

2. The upper paper guide is positioned laterally through the elongated mounting screw holes so that the upper end of the paper stops are centrally located in the blank counter disc positions.

3. The front lower form guide should be adjusted laterally so that the lower portion of the paper stops line up vertically with the paper stop slots in the top guide.

4. Adjust the guide blocks so that the printing is directly over the counter markings on the form and so that there is .010" clearance over the width of the form.

100 Count Contact

Adjust the 100 count contact so that the lower strap of the contact operated by the pin in the right hand total count disc, rests against the upper contact strap with light tension. The contact must be adjusted to open when the counter disc moves from 99 to 100. The air gap, when open, should be 1/64" between the points.

Right and Left Frame Contacts

The right and left frame contacts, operated by the carriage,

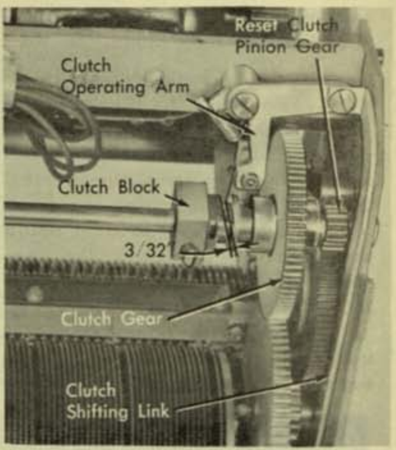


Figure 30

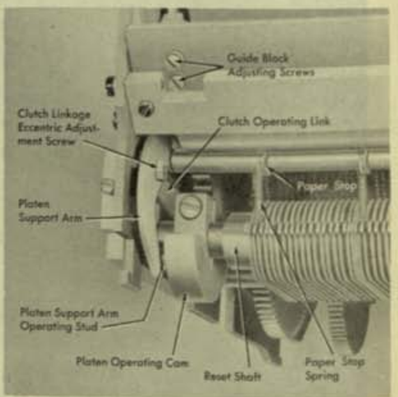


Figure 31

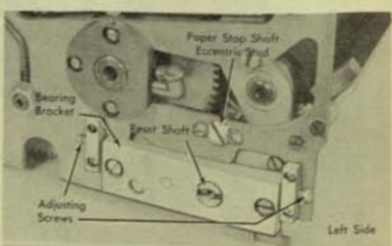


Figure 32

should be adjusted so that the N/O contacts, and the stationary strap should have 1/32" rise off its support with the carriage against the side frame. At the same time the N/C points should have 1/32" air gap. With the carriage away from the contacts the N/O contacts should have approximately 1/64" air gap between the points. The stationary strap of the N/C contacts should have approximately 1/64" rise off its support.

Toggle Switch Brackets - Figure 34

Adjust the toggle switch mounting brackets so that when the toggle switch cam lever has reached its limit of travel in either direction, the corresponding operated switch handle will have 1/32" travel beyond the toggle cam lever.

Motor Governor

The motor governor speed adjustment screw should be adjusted so that the carriage traverses the counter from 3 to 5 seconds. The factory setting is 4 seconds to complete a scanning operation.

Control Panel

1. Adjust the control panel support screws so that the control panel jacks plugs center on the ends of the pins of the pin set unit vertically when the control panel is in place.

2. Adjust the control panel guide strips on the sides of the panel so that the control panel is centered laterally on the pins and that it fits snug between the side plates of the subframe. Check the alignment of pins on the bottom of the panel as well as on the top.

GIC Unit

Position the GIC unit by the retaining lugs so that the emitter control panel contact wires line up with the counter hubs on the control panel. The control panel should be properly adjusted before the counter as a unit is positioned.

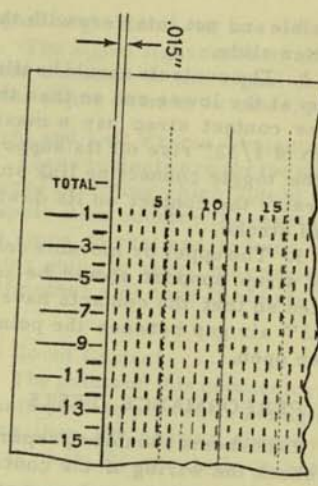


Figure 33

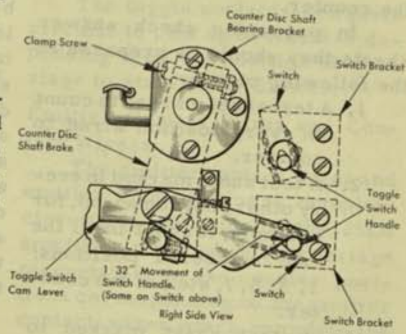


Figure 34

Adjust the individual control panel connecting wires on the top of the emitter so that all the connecting wires contact the control panel counter jacks on the bottom of the control panel at the time the subframe is moved in by $3\frac{1}{2}$ turns of the key clamp crank.

Printing Platen

The printing platen should be free in its bearing. The platen support arms tension springs should have heavy tension and equal on both sides.

Toggle Contacts

1. The toggle contact mounting bracket should be mounted as far to the front of the machine as

possible and not interfere with the shutter slide.

2. The contacts should be tilted up at the lower end so that the lower contact strap has a maximum of 1/32" rise off its support as the toggle connecting link stud operates the contact on its downward stroke.

3. The upper or movable contact strap support should be adjusted so that the contacts have a 1/32" air gap between the points when open.

PERFORMANCE TESTS

Test sheets should be prepared to check the wiring of the control panel after making each new setup and to check the operation of the counter.

In preparing check answer sheets they should be prepared in the following manner:

1. A test sheet marked to count in every position wired to counter.
2. A test sheet marked in every other position wired, for example, to count in all the odd numbered positions: 1, 3, 5, 7, etc., of the counter.
3. A test sheet marked to count in every even numbered counter positions: 2, 4, 6, 8, etc.
4. A test sheet marked to count in every third position of the counter: 1, 4, 7, 10, etc.
5. A test sheet marked to count in every third position: 2, 5, 8, 11, etc.

The above check answer sheets will test the wiring of the control panel and performance of Graphic Item Counter when they are run through for scanning and will test the counter operation with nearly every possible combination of impulses that may affect perfect counter recordings.

The customers should be instructed to use at least the first three types of check answer sheets after each new setup is made.

The check sheets may be run a certain number of times singly and accumulated in the counter to produce a pattern on the graph form. After completing the run of check sheets, print a graph and clear the counter. If the pattern is disrupted on the graph, it will indicate either counter error or wiring error on the control panel.

The pattern produced by running each of the check sheets 1, 2, and 3 five times will be a solid block of printing. Each counter position will record 10 marks. The total count on the right side will show that 15 sheets have been run through the machine. Any under or over counting will be detected by the column being too high or too low on the graph. It is advisable to make a test by running the sheets singly several times and to produce a graph for that type of test sheet. Next, run all the check sheets a definite number of times and produce a graph of their recordings. The pattern will vary according to the number of times that a check sheet is put through the machine

LUBRICATION

Due to the inherent characteristics of the test scoring machine great care should be employed when lubricating the machine. There are only a few moving parts and excessive lubrication must be avoided.

Below is listed the lubricants and where they should be used on the test scoring machine and the graphic item counter.

IBM 12 -- Motor drive unit housing.

IBM 9 -- All linkage, pivots, graphic item counter bearings and carriage slides; motor bearings of 805.

IBM 6 -- Counter disc pawls and combs. It is recommended that the pawls and combs be sprayed lightly.

IBM 17 -- Paper deflector, cam, graphic item counter gears and all camming surfaces and Yaxley formula switch contacts.

The Yaxley formula switches should be washed out with carbon tetrachloride before each new application of lubricant.

PURPOSES OF CONDENSERS, CONTACTS, FUSES, RELAYS, RESISTANCES, SWITCHES, AND TUBES

CONDENSERS

.5MFD Condenser

The purpose of the .5MFD condenser with an internal 10 ohm resistor, placed across the motor run contact points reduces the arc of the points when the motor running circuit is broken.

.1MFD Condenser

The purpose of the condenser in conjunction with the 130 ohm resistor across it, reduces the arc on the GIC motor governor contacts.

100 MFD Condenser

The 100 MFD condenser filters the rectified DC from the 25Z6 tube.

C-1 Condenser

The C-1 condenser in the time delay unit builds up a potential difference of approximately 80 volts between the cathode and starting anode of the OA4G tube to cause the tube to conduct current to pick up the time delay relay.

CONTACTS

Start Contact

This contact completes a circuit to the drive motor when the motor key is depressed.

Motor Run Contact

The motor run contact shunts the start contact and keeps the motor drive operating until either the answer sheet is fully pressed against the sensing unit for scoring or answer sheet is released.

Signal Light Contacts

The signal light contacts complete a circuit to the signal lamp if the paper channel is clear.

Right and Left Frame Contacts

These contacts are for the purpose of detecting which side of the graphic item counter the carriage has come to rest and to keep the motor going to carry the carriage to the other side once it has started.

100 Count Contact

The points of this contact form an interlock to prevent running of more than 100 answer sheets or warns that 100 sheets have been run.

Toggle Contacts

The toggle contacts complete circuits to pick up R-1 or R-2 depending upon the position of carriage to start the GIC motor.

Emitter Contact Wires and Contact Wipers

The emitter contact wires and emitter contact wipers complete circuits to the grids of the 25L6 amplifier tubes when the carriage magnets are in the counter positions corresponding to the emitter contact wires which complete the circuits through the control panel to the response positions. The emitter contact wipers actually TIME the impulses to the individual counter positions.

Carriage Contact Wiping Fingers

These contact wiping fingers complete the circuits to the counter magnets as they move across the unit from one side to the other.

Motor Governor Contact

The contact on the governor regulates the speed of the GIC motor by cutting in and out the resistance in the motor running circuit.

FUSES

Main Line Fuses

These fuses provide protection to all of the machine circuits.

Battery Fuses

The battery fuses protect the scoring circuit and power pack output.

Heater Fuse

The heater fuse protects the sensing unit heater circuit and the GIC circuits.

Motor Fuse

The motor fuse protects the test scoring machine motor and GIC start circuits.

GIC Fuse

The GIC fuse protects the -B circuits of the 25L6 tubes.

Meter Fuse

The meter fuse protects the meter against any current of values great enough to damage the meter.

Power Pack Fuses

These fuses protect the input of the power pack in case of shorts or difficulties with transformer and output side of power pack.

RELAYS

R-1 and R-2

R-1 and R-2 completes the circuits through the GIC motor and its fields, when picked up singly to cause it to operate and give it direction of motion.

Time Delay Relay

The time delay relay completes the GIC operating circuits when it picks up after the tubes have reached an operating temperature.

Time Delay Relay R-A and R-B Points

The R-A N/C provides a circuit to charge condenser C-1 to fire the OA4G tube. R-A N/O points provide a hold circuit for the relay, once it has been picked up, until power to it has been interrupted.

The R-B N/O points provide an interlock in the test scoring machine motor circuit when using the graphic item counter to prevent an answer sheet from being inserted before the tubes are at an operating temperature and the time delay unit is operated.

R-1BL, R-1AL, R-2BL and R-2AL-Points

These points are used for the purpose of reversing the field in relation to the armature and completing the motor circuits when either R-1 or R-2 is picked up.

R-1AU and R-2AU N/O

These points provide holding circuits for their respective relay while the GIC carriage is in motion.

R-1BU and R-2BU N/C

R-1BU and R-2BU serve as an interlock to prevent releasing of an answer sheet while the GIC carriage is in motion.

RESISTANCES

2 Megohm Resistors

The purpose of the 2 megohm resistors is to limit to a uniform amount the current flowing through each pencil mark.

100 Ohm Resistor in the Over 100 Circuit

This resistor in series with the 90 ohm potentiometer, allows a practical range for aggregate scoring. It also makes it possible to use a standard resistance value in all of the potentiometer strips.

The purpose of this resistor in conjunction with the 100 ohm resistor and the AGG potentiometer is to balance out the ohmic value for adjusting the over 100 circuit.

AGG 90 Ohm Potentiometer

This potentiometer is used to adjust for proper readings when using the aggregate scoring unit or when scoring the values of over 100.

A+, B+, C+ Potentiometers

The + potentiometers are used

to adjust for the proper readings of the rights and wrongs.

A-, B-, C- Potentiometers

The minus potentiometers are used to adjust for the proper readings of R-W.

5.25 Ohm Resistor

The purpose of the 5.25 ohm resistor is to provide a voltage drop in the meter circuit to cause a subtracted reading of 100 units when using the over 100 circuit.

50,000 Ohm Resistors, Battery Test Circuit

These resistors allow the meter to be used as a test instrument in conjunction with the batteries or the electronic power pack.

1000 Ohm Resistor, Battery Test Circuit

The 1000 ohm resistor provides a load for the testing of the batteries for their internal resistance.

250 Ohm Heater Resistance

This resistance in the sensing unit heater coil circuit limits the amount of current that it will pass. It also provides an easy means of adapting the heater for a higher voltage.

130 Ohm Governor Resistor

This resistor serves as a bleeding resistor to discharge the governor condenser and to help prevent arcing at the governor contacts.

R1 Resistance, Time Delay Unit

This resistance governs the rate of charging of the C-1 condenser, thus delaying the pickup of the time delay relay. R1 has a value of 35 megohms.

R2 Resistance, Time Delay Unit

R2 resistance limits the current for the holding circuit of the time delay relay. It also allows a standard relay coil to be used in the time delay relay. R2 has a value of 1500 ohms.

1.35 Megohm Resistor, Total Count

This resistor limits the total count grid circuit current to a value for satisfactory operation of the counter magnets through the 25L6 tubes whenever the total count circuit is encountered as the carriage traverses the counter unit when graphic item counting.

1.35 Megohm Resistors, Multiple Response Circuit

These resistors when placed in parallel with 2.75 megohm resistors causes the negative grid bias voltage to be of a higher negative value thus decreasing the sensitivity of the mark sensing circuit, making it necessary to increase the current in the mark sensing circuit by placing two marks in parallel in order to drive the grid positive enough to allow the 25L6 tubes to conduct enough current to energize the counter magnets.

2.75 Megohm Resistor, 25L6 Grid Circuit

The 2.75 megohm resistors in the 25L6 grid circuit governs the -C potential to the grid of the tube and the sensitivity of the mark sensing circuit in conjunction with the 2 megohm resistors.

10,000 Ohm Resistor, 25L6 Grid Circuit

The 10,000 ohm resistor in the mark sensing grid circuit limits the positive grid current to the tube. It also has an effect upon the sensitivity of the circuit in conjunction with the 2.75 megohm resistors in the negative grid circuit.

130 Ohm Resistor, Tube Heater Circuit

This resistor in the tube heater circuit provides a voltage drop of the value so that the 25Z6 tube, and the two 25L6 tube heaters when wired in series will receive 25 volts on each heater when placed across a 115 volt line. The voltage drop in the resistor will be approximately 40 volts.

1000 Ohm Resistor, Screen Circuit
This resistor limits the current in the screen circuit to a value that the screen element in the tube will not be damaged when the tube is conducting.

25 Ohm Resistor, 25Z6 Anode Circuit
The 25 ohm resistor limits the plate current of the tube to a value that the tube elements will not be damaged by the instantaneous high current demands of the 100 mfd condenser in the filter circuit. The resistor also performs a filtering effect in the rectifying circuit.

SWITCHES

Main Line Switch
The main line switch provides means of disconnecting the machine circuits from the outside power supply without removing the power cord.

NOTE: With the main line switch OFF, the sensing heater is still ON due to its being connected across the main line fuses which are on the power side of the main line switch.

Over 100 Switch
When the over 100 key is pulled forward when scoring items running over 100, it causes 100 units to be subtracted from the meter reading so that the scores may be read directly.

Negative Score Switch
The negative score switch reverses the terminals of the meter so that scores of a negative value may be read directly.

Master Control Switch Contacts
The master control switch contacts completes circuits for scoring and isolates other circuits to prevent interference with the function being performed.

Formula Switches
These switches set up the scoring circuits to perform predetermined functions on a test to arrive automatically at a calculated score.

Battery Test Switch
The purpose of this switch is to place a load across the batteries when testing them for deterioration.

Graphic Item Switch
The graphic item switch provides a means of connecting the graphic item counter circuits to the test scoring machine.

Multiple Response Switch
The multiple switch sets up the grid circuits so that the counter will record only when two pencil marks of two response positions are wired to one counter position.

GIC Runout Switch
The GIC runout switch provides means of returning the GIC carriage to the left side frame of counter if the power should be interrupted during a scanning operation and stopping carriage in between the side frames.

Heater Switch
The purpose of the heater switch is to turn the dryer bulb off and on as needed.

Voltage Switches
These switches provide circuit to the individual sections so that a pencil mark may be weighted over a wide range. The switch, when set on high, multiplies the low voltage by $2\frac{1}{2}$ times.

Over 100 Count Switch
The over 100 count switch serves two purposes. The switch permits item counting of more than 100 sheets. It also provides for

counting of 1 to 100 sheets in the right hand total column of graph form and counting of all over 100 in the left hand total column.

Cover Interlock Switch

This switch breaks the circuit from the electronic power pack to the sensing unit when the hinged cover over the GIC control panel is raised to prevent 1.35 volt potential existing between the base and of the item pins when the GIC switch is ON if the machine is grounded.

Interlock Switch Upper

This switch prevents the toggle contacts from picking up R-1 or R-2 from a test scoring machine operation if the graph print lever is in some other position than up a vertical position.

Interlock Switch Lower

This switch prevents the operation of the test scoring machine motor any time that the graph print lever is not in the normal position which is up, with the graphic item switch ON.

Motor Switch

The motor switch completes a circuit to pick R-1 which causes the GIC motor to operate, printing a graph and resetting the counter, when the graph print lever is in printing position.

TUBES

25Z6 Tube

The 25Z6 is used as a conventional half wave rectifier with a 100 mfd condenser as a filter.

25L6 Tube

The two 25L6 tubes are used as amplifiers to amplify the amount of current going through a pencil mark to the value that it will energize a magnet.

5Z4 Tube -- Power Pack

This tube is the rectifier tube of the power pack.

6J5 Tube -- Power Pack

This tube is actually the voltage regulator receiving the changing voltage caused by the outside line fluctuation. Its grid is controlled by the amplification of change of output by the 6V6 tube.

6V6 Tube -- Power Pack

This tube is used as a voltage amplifier to increase the sensitivity of the regulating circuit.

OC3/VR105 -- Power Pack

This tube provides a standard voltage of 105 volts to the cathode of 6J5 tube and anode of 6V6.

The 6V6, 6J5, OC3 tubes form the voltage regulating network.

INTERNATIONAL AUTOMATIC BILL FEED
Type 920

GENERAL DESCRIPTION

The Automatic Bill Feed is a special carriage, so designed that it may be installed on the print head of the 3-B, 3-E, 3-G, 3-S and 4-S Electric Accounting Machines and the Alphabetic Accounting Machines. This installation may be made on a new machine at the factory, before the machine is shipped, or it may be installed in the field on a machine which is already in service. In some cases, when installing the bill feed device in the field, templates will be needed to locate the various mounting holes. These templates may be secured from the factory.

The bill feed device cannot be adjusted laterally in relation to the type bars. It may be mounted in either one of two positions on the 3-S machines, either offset to the left or offset to the right. This location is determined at the time of installation and cannot be changed by the customer. The bill feed on 4-S machines can be mounted in only one position. This position corresponds to the offset left position on Type 3-S machines. On the Alphabetic Printer, it is always in a central position in relation to the type bars, and this is the only location on this machine.

It will perform the various functions of a standard carriage with the exception that it cannot be adjusted laterally in relation to the print banks. In addition it will feed individual bill forms, continuous forms, tabulating cards, envelopes, insurance policies, and small pamphlets. The recording of information on the forms while at the printing position may be either a tabulated or a listed operation. The paper feeding other than line spacing is termed as an ejection.

The detail construction of the Automatic Bill Feed will vary, depending upon the particular type of work being performed, but the general principle of construction and operation will remain practically the same. It is the purpose of this manual to impart a practical knowledge of the bill feed device to the Customer Serviceman so that it may be applied to whatever type of bill feed that he may be called upon to service.

The bill feed is designed to feed forms in the same manner that the horizontal Sorter feeds cards, and the feed hopper is of the same general design, except that the magazine side plates are movable to accommodate the various blanks or bills.

The feed has four knife spaces and may be equipped with two or more knives which catch the edge of the bill and draw it toward the throat. Between the knife spaces are three spaces in which the throat may be mounted. The actual throat is only one-half the width of the throat space, and therefore, either the right or the left half of any throat space may be used, the one being used that provides the best feeding condition. The magazine side plates of the bill feed magazine may be adjusted for any width of bill within the minimum and maximum limit, but should not be set within the space occupied by the feed knife. When the position or width of the bill has to be changed in the field it may be necessary to have a new bill weight to correspond to the new form, and if previously used knives are exposed, special knife covers should be ordered for them.

SIZE OF FORM

The form may vary in width from 5⅜″ to 18″, width in this case meaning the dimensions from left to right of the form. Within these limits the exact final dimension to be chosen is affected by the relation of the print banks to the various features of the bill feed, and cannot be determined until this relationship has been taken into full consideration.

There is a space of 18¼″ available between the side frames, but ⅛″ must be left at each end to allow for lateral alignment of the bill to the type bars.

The standard length of the bill, measuring from top to bottom is one of the following dimensions: 3¼″, 3½″, 3¾″. 4″, 4½″ or 5″. This dimension must be accurate within a limit of 1/64″, and the edges should be clean cut both top and bottom.

BILL STOCK

A good grade of paper should be used with the minimum thickness of .004″. Tabulating card stock will give good results. When it is desired to

Printed in U.S.A.
Form 22-8228-0

use paper which is thicker than tabulating card stock, a sample should be submitted to the Engineering Department for approval.

FUNCTIONS

The various functions of the Automatic Bill Feed may be understood by explaining the principal types of work that it will accomplish.

Line Spacing — The maximum distance which can be provided between lines of printing is 9/16″. Although it is possible to obtain this spacing of 9/16″, most bill feeds are used on spacing from 3 to 8 lines to the inch. For more than 6 lines to the inch, smaller type than standard must be used, in order to avoid the overprinting of adjacent lines. The use of narrow spacing with the bill feed is very advantageous when it is desired to increase the effective capacity of a form.

Single Item Ejection — The listing of single items on individual forms may be accomplished without reset cycles, each form ejecting after each listed item. This application is of special use for listing on ledger accounts.

NOTE — See paragraphs on head space and line space adjustments.

Total Ejection — Information can be recorded on individual forms, either by tabulating or by listing. If the information is tabulated, it is group indicated and total printed on the minor reset cycle in the normal manner, and the form is ejected on the same reset. If it is desired to record several minor totals on the form, it may be ejected at the intermediate or major change. The bill feed circuit may be designed to eject on a particular reset, or it may be variable, so that the operator can select the reset on which the form is to be ejected.

When the information is listed only, or listed and total printed, the form can be ejected on the minor reset. In cases where forms are printed, some with single items and others with multiple items, the single card total suppression device may be installed to prevent printing of a total after a single listed item.

Predetermined Lines — The first heading line of printing can be set at a predetermined distance from the top of the form. Succeeding lines directly followed by a total can then be printed, or the total may be placed on a predetermined line at a fixed distance from the bottom of the form, even though the number of listed items may vary.

Head Space — Head space is the name given to the space between the top of the bill and the center of the first printed line. There is no maximum or minimum distance from the top of the form at which the first line or printing may occur, as it may be printed in any position on the bill. Once set for a certain dimension, it may be necessary to call a Customer Serviceman to change the head space on a bill.

Predetermined Total — The predetermined total line is normally any distance up to 2⅞″ (center to center) below the first line of printing, while not being more than 1-9/16″ from the bottom of the form. If a distance greater than 2⅞″ is desired, the Engineering Department should be consulted. The location of the predetermined total line can be changed, but it may be necessary to call the Customer Serviceman to make this change.

All items which are listed on the form must be printed in the space between the two predetermined lines, the first line and the total line. The entire capacity of the form below the first line may be used for listing, if the predetermined total line is not used. In this event, totals will be printed on the next succeeding line after the listed item.

Roll Paper and Single Sheet Feeding — A paper rod is supplied, when ordered, to hold the roll paper, which may be fed through the bill feed. Single sheets may be manually fed through the bill feed when it is desired. Any size sheet up to 17½″ wide can be used regardless of the size of the bills being fed through the bill feed.

The bill feed is equipped with a pressure release, therefore, right or left hand adjustment of the sheet can be made after inserting the paper. A special chute assembly is being shipped with the bill feed if it is called for on the order to provide for the manual feeding of forms. The chute can be adjusted by the operator for any desired width of form up to 17½″.

Continuous Form Paper — Continuous form paper may be fed through the bill feed. A pressure release is provided so that the lower set of pressure rolls on the platen may be released. The paper is then drawn through by the upper set of feed rolls only. A special paper guide release is provided, when ordered, to give more space between the platen and the paper guide when using multiple copies or stapled forms.

Envelope Feeding — Envelopes may be fed by the Automatic Bill Feed only when they are especially designed for the purpose. The same points, which apply to size of forms, also apply to size of envelopes and they must also be designed so that no pasted edges pass through the throat. Samples should be submitted to the Engineering Department for approval.

Small Pamphlet Feeding — Pamphlets, insurance policies, or small magazines may be fed through the bill feed when desired. A sample of the form or pamphlet should be sent to the Engineering Department for approval, as a special design of the feed is necessary in some cases.

SPEED

Data may be listed to the individual forms at the rated listing speed of the tabulator to which the bill feed is attached. This is true when one or more items are listed, and the form ejected at the reset. The feeding and ejection of forms occur simultaneously with the reset of the tabulator. The time required for handling individual forms in a bill feed application is thus the same as that required for listing and total printing in the regular way on roll paper.

When single item ejection is being used, (that is, the form is ejected during each list cycle without a reset) the speed of printing is 75 forms per minute on the 3-S regardless of the rated listing speed of the tabulator. This speed will be 80 forms per minute on the Alphabetic Printer.

OPERATING CONTROLS

Knurled Knobs — Fig 2. Located on each end of the platen roll shaft is a knurled knob (G), which may be used to space the platen either forward or backward. When it is desired to space the platen in a reverse direction, the feed drive clutch and the platen clutch must be released.

Feed Drive Clutch Release Lever — Fig. 2. This lever (F) should be pushed all the way down to release the feed drive clutch, so that the platen can be turned backward. It is not necessary to hold this lever down, as a latched lever holds the clutch in this position until the machine is started again. During the upstroke of the drive clutch arm, the end of the latched lever hits against the stud, thus throwing in the clutch.

NOTE — The platen clutch must also be released before the platen can be turned in a reverse direction.

Platen Clutch Thumb Release — Fig. 3. The clutch (C), at the left side of the machine, is thrown out by turning the knurled washer (B) upward. The washer (B) must be held up while the platen is being turned backward. The clutch (C) is automatically thrown in as soon as the washer (B) is released.

NOTE — Also see Fig. 4.

Pressure Release Shifter Lever Handle — There are two styles of pressure release levers used on the bill feed device for releasing the pressure of the feed rolls above and below the platen.

The one style shown in AA, Fig. 2, has two positions for the pressure release lever. When in the rear position, the pressure is applied to the feed rolls. When the lever is moved to its forward position, the pressure is released which makes it possible to shift the paper.

The other style is shown in Fig. 5. Here the release lever has three positions so that the pressure can be released on the feed roll below the platen while the pressure is maintained on the feed roll above the platen, thus giving a good feeding condition for folded forms. When the pressure release lever handle is in the rear position (C), the normal operating pressure is applied to the feed roll above and below the platen. This condition is proper for feeding individual sheets or bills.

When the lever is moved to the central position (B), all pressure is released on the feed roll below the platen, but normal pressure is maintained on the feed roll above the platen. This arrangement is used for feeding continuous forms or roll paper.

If it is desired to release the pressure on both the upper and lower feed rolls, the lever is moved to the forward position (A). This condition is provided to permit the straightening and adjusting of forms.

Platen Guide — Fig. 5. A special adjustable platen guide is furnished on bill feeds ordered for feeding continuous forms that are thick or stapled and that would ordinarily bind between the guide and the platen. For adjusting, the platen guide assembly has a link (G) attached on either end. Each link (G) has two holes, one of which lines up with the hole in the side frame for either position of the guide.

For feeding individual sheets (bills), the guide must be in its upper position (D) and secured by inserting screw (F) through holes that are aligned to link (G) and side frame (H). Be sure to fasten the guide in this method on both sides.

For feeding thick or stapled continuous forms, the screws (F) should be removed and the guide lowered until the other hole in the link (G) lines up with the hole in the side frame (H). When the guide is in the lower position (E), it should be secured with screw (F) to the link (G) and into the side frame (H).

Upper Ribbon Bar Release Knob — Fig. 3. In the event that a bill or form should become jammed under the upper ribbon bar or guide, the bar may be removed by pulling out on the knob (D).

Front Bill Guide — Fig. 6. The bill guide may be removed by sliding it slightly to the right.

Stacker Plate Release Knob — Fig. 3. The stacker plate may be removed from the machine by pulling out on the release knob (E). It may be necessary to remove this stacker plate when taking out a jammed bill.

Magazine Side Plates — Fig. 2. The magazine side plates (A) may be shifted laterally if necessary to line up the bill with the type bars and also to accommodate the proper width of bill.

MOUNTING — Fig. 2

The unit is hinged to brackets (B) mounted on the back of the base, so that it may be tilted back when necessary for inspection and adjustment. The bill feed rests on two adjustable bolts (E) at the front.

Before raising the bill feed, make sure that the stop plates (D) at the end of both grooves in the side frames are in the proper location to prevent the stacker pressure plate assembly from falling out when the unit is up. To return the unit to normal, raise the stop link (located inside side frame), and see that the mark on the gear is opposite the mark on the timing pointer on the older type of unit. Time the new style according to the timing chart which will accompany it.

GENERAL OPERATION — Fig. 1

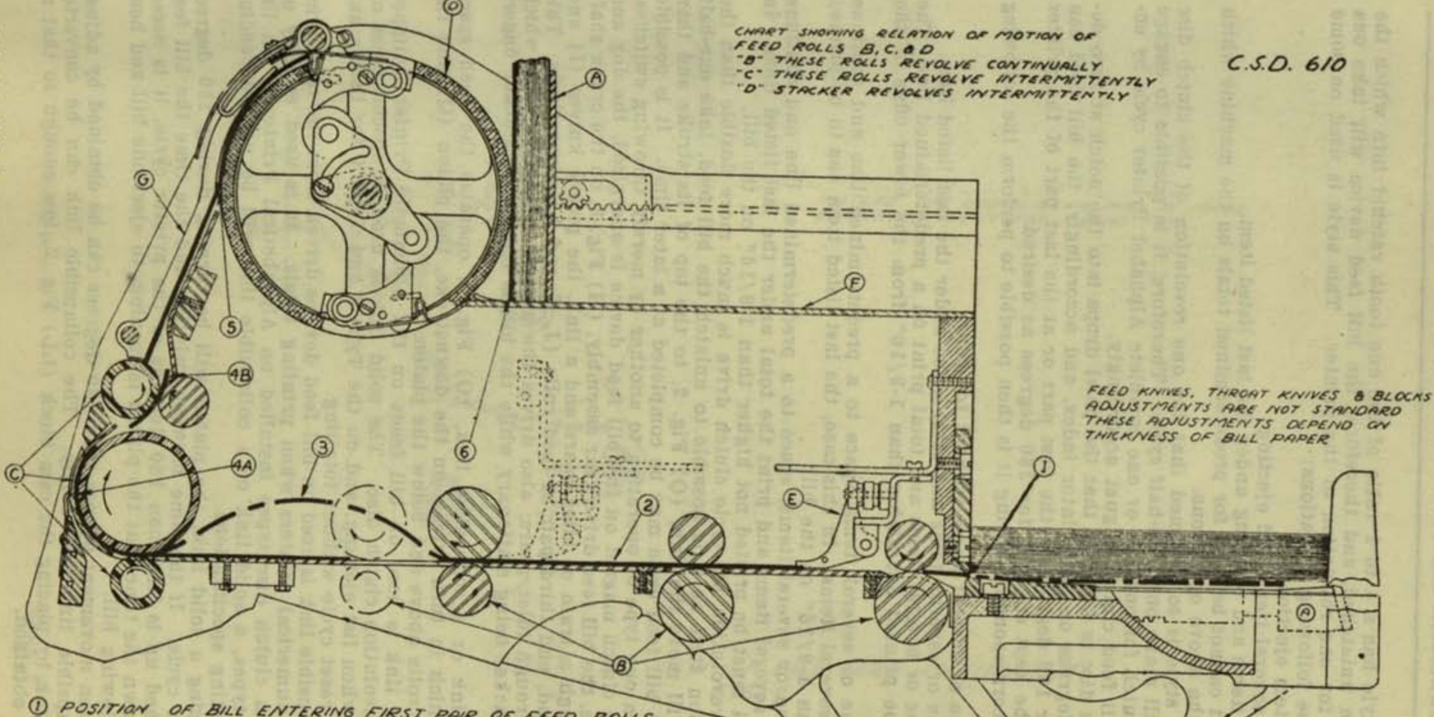
Forms are placed in the bill feed hopper face down with the top edge of the form toward the throat. The feed knives then push the bottom form through the throat and it is carried from there to the printing position of the type bars. If the bill feed is not equipped for automatic feeding of the first bill into the printing position, it is necessary to operate the bill feed manually by depressing the proper key two or three times as required. After printing, the form advances to a scanning position where it is visible to the operator in the event that sight checking is required. From this position it passes into the eject stacker. Should the supply of forms in the feed hopper become exhausted or if for any reason a form fails to feed, the accounting machine automatically stops.

EJECTION OPERATION — Fig. 2

On all bill feed devices a clutch and latch, which are controlled by a magnet, are provided to enable the ejecting mechanism of the device to be mechanically disconnected from the printer.

The knife type bill feed can be driven from the total print shaft or from the list shaft for an eject cycle on the 3-S and 4-S numerical printers. On machines where it is desired to eject on a reset cycle the bill feed is driven from the total print shaft through a train of spur gears. On bill feeds designed to list one item on each bill and then eject, the bill feed mechanism is driven from the list shaft.

On the Alphabetic Printer the bill feed is driven from a gear on the index shaft through a train of spur gears. There are two styles of drives on this printer which are similar in construction and different only in gear ratio of the clutch mechanism.



① POSITION OF BILL ENTERING FIRST PAIR OF FEED ROLLS
② BILL IN INTERMEDIATE POSITION
③ POSITION OF BILL BUCKLING BEHIND PLATEN
④ BILL IN PRINTING POSITION - A-SMALL HEAD SPACE - B-LARGE HEAD SPACE (TOP OVERLAPS PREVIOUS BILL)
⑤ BILL IN SCANNING POSITION
⑥ POSITION OF BILL STACKED

BILL BUCKLING
FIG. 1

The one style has a 1 to 1 ratio of the one tooth ratchet into which the dog drops when unlatched, and therefore, the bill feed device will take one complete cycle for one revolution of the printer. This style is used on some machines for the following operations:

1. Single item ejection.
2. Listing several items and ejecting.
3. Listing items and totalling under the last listed item.

NOTE — It cannot be used for predetermined totals on the machine which is performing the above operations.

The other style is so designed that for one revolution of the clutch disc the bill feed will make only one-half cycle. Therefore, it is possible to engage the bill feed clutch for one-half or one complete Alphabet Printer cycle by energizing the bill feed clutch magnet accordingly.

The clutch disc is timed so that the pawl drops into the notch at zero degrees or 180 degrees on the printer index, and accordingly, the bill feed can be operated for 180 degrees on the first part or at the last part of the printer cycle, or may be kept engaged for 360 degrees as desired.

With the corresponding wiring it is then possible to perform the following operations:

1. List one or several items without totalling.
2. List one or several items and total print under the last listed item.
3. List one or several items and total print on a predetermined line. The latter has to be printed not higher than 1-9/16" from the lower edge of the bill.
4. List one or several items, space to a predetermined line and continue listing one or several items. In this case, the last listed item has to be printed not higher than 1-9/16" on the bill.
5. List one or several items, space to a predetermined line and continue listing one or several items and print the total under the last listed item. In this case, total must be printed not higher than 1-9/16" on the bill.

The two revolution per cycle clutch drive is much more flexible than the single revolution style as it is possible to unlatch the bill feed, take one-half cycle which will move the link, (O) Fig. 2, to the top of its stroke and then latch up. The bill feed cycle may be completed at a later time. It is possible to change from one type of operation to another by merely throwing switches.

When the clutch magnet on the bill feed device is energized, the dog and ratchet engage, the bill feed drive gear assembly, (H) Fig. 2, on the crank shaft operates through a train of idler gears and a link, the picker knives (I) and the first, second, and third pair of feed rolls (J, K, and L) respectively. This same gear, through idler gears, also drives the geneva movement (N), which insures the stacker being stationary while the bill is fed to the stacker fingers (I) Fig. 7.

A solid link or a collapsible link, (O) Fig. 2, operates the head space clutch (P) which in turn drives, on the downstroke, the platen (Q) and the adjacent feed rolls above and below the platen.

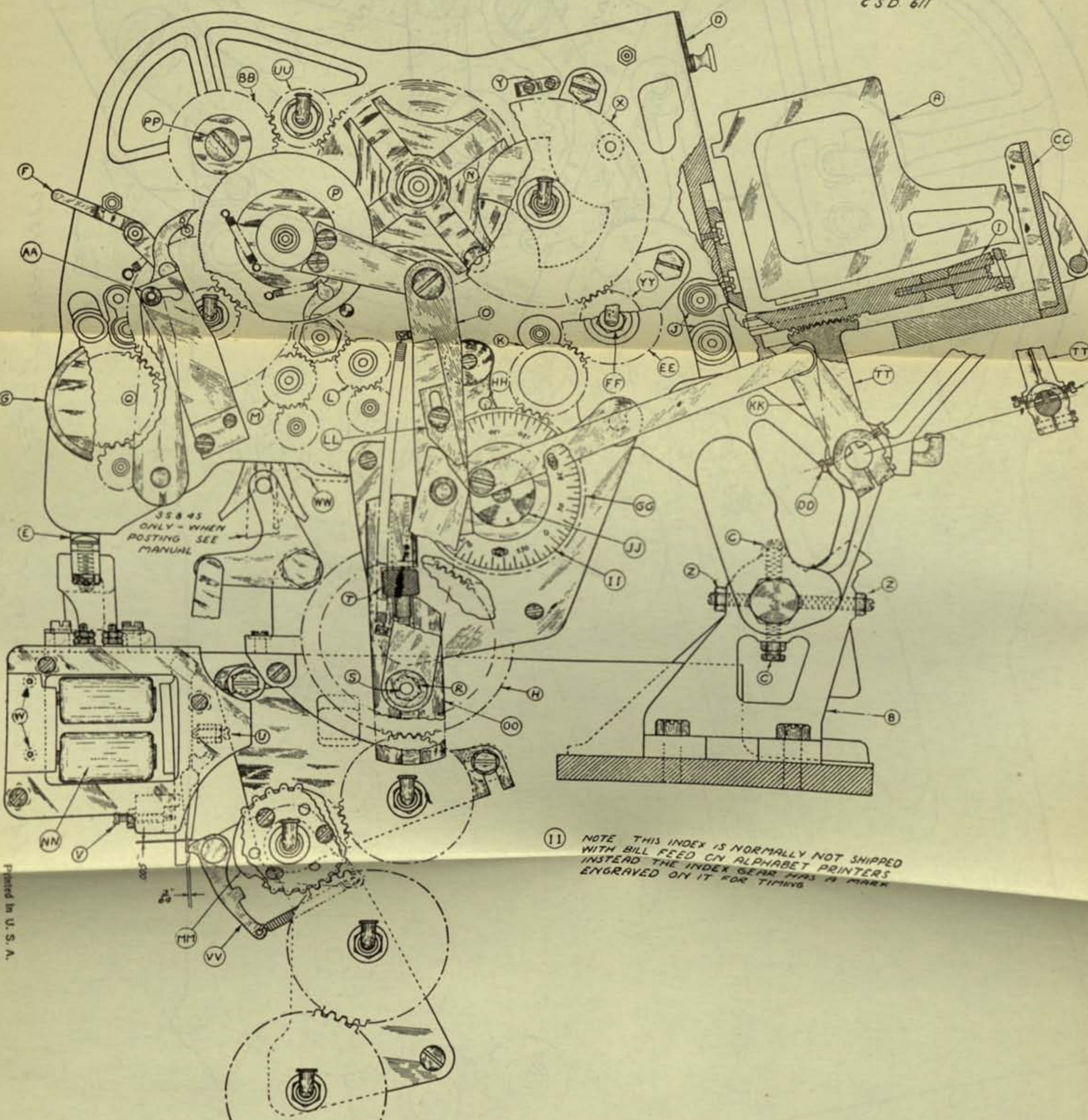
The solid link is used on bill feeds on the Alphabetic Printer equipped with single revolution clutch disc. The solid link is used in special cases on Type 3 only, when list ejecting, and on the Type 3 and Type 4 for listing and ejecting on a reset cycle without totalling.

The collapsible link is used on bill feed devices driven from the total print shaft on all numerical printers when printing totals. It is used entirely on two revolution clutch disc types installed on Alphabetical Printers. On list shaft driven types, a solid link or a collapsible link will be used depending upon the printing specifications.

When using a solid link, the platen will be turning during 180 degrees of the printer cycle. If the time between printing and the time the bill feed is being latched up is less than 180 degrees of the printer cycle, it is necessary to cut down the time that the platen is turning, to eject one bill and head space the following bill.

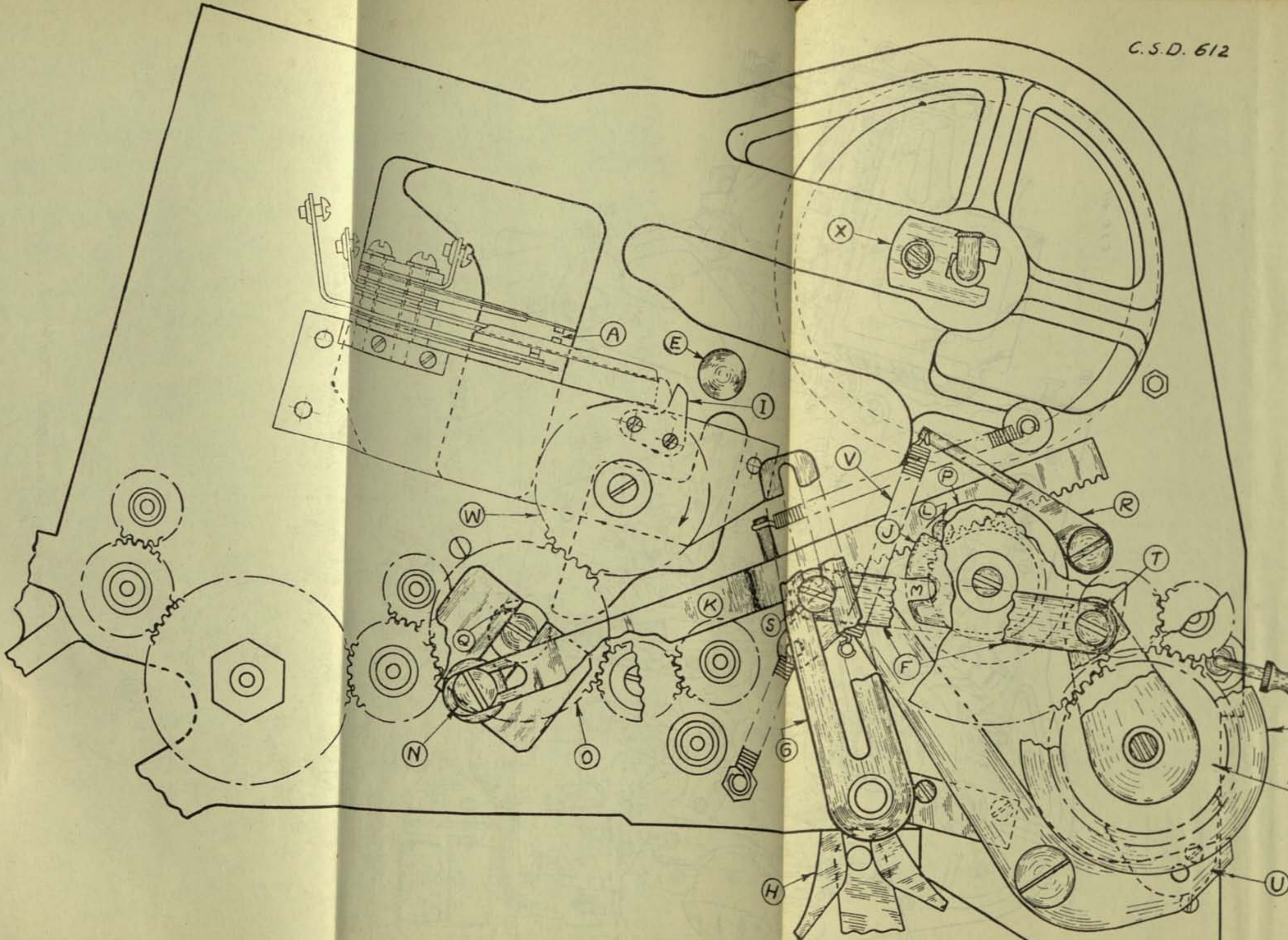
This platen movement of less than 180 degrees can be obtained by adjusting the collapsible link accordingly. The collapsible link can be converted into a solid link by placing the cam block (LL) Fig. 2, low enough so that no collapsing is obtained.

C S D 611



(II) NOTE: THIS INDEX IS NORMALLY NOT SHIPPED WITH BILL FEED ON ALPHABET PRINTERS INSTEAD THE INDEX GEAR HAS A MARK ENGRAVED ON IT FOR TIMING

RIGHT END VIEW OF BILL FEED MECHANISM
FIG. 2



LEFT END VIEW OF BILL FEED MECHANISM
FIG. 3

OPERATION OF LINE SPACING MECHANISM — Fig. 3

The line spacing mechanism is located at the left side of the machine in place of the conventional ratchet wheel. Two small friction roller clutches (see Fig. 4) of a design similar to that of the head space clutch are used. Any spacing from 3 to 8 lines per inch can be obtained by moving the rear end of the link (F) up or down in the slot of the lever (G).

The line spacing mechanism functions to space the platen between listed items and to space the platen for the total when the total is printed under the last listed item.

The fork arm (H) is operated by the standard spacing mechanism on the numerical printer and by the platen feed cam and connecting linkage on the Alphabet Printer. Each time that the arm (H) is operated, it oscillates the shaft to which it is fastened, which in turn causes the arm (G) to move back and forth. This causes the platen roll to revolve on the backstroke of the arm (G), by means of the link (F) and the platen clutch assembly (C), an amount depending upon the setting of the link (F) in relation to the slot (G).

If predetermined total line is being used, the pin (L) will not be in the slot (M) and this pin, which is riveted to the gear, will move in a clockwise direction a distance equivalent to one space on the platen. This pin should be placed in the slot at all times except when using a predetermined total line.

If the total is being printed directly under the last listed item, the pin (L) will be placed in the slot (M) and the stud (N) in the center of the gear (O). This causes the predetermined total mechanism to be inoperative. The total will then be printed the same distance below the last listed item as the distance between listed figures. This space is obtained by the line space mechanism.

The feed rolls above the plates are rotated by a train of gears at the left end of the platen roll. The feed roll below the platen is turned by a gear train at the right end of the platen roll.

PREDETERMINED TOTAL LINE OPERATION — Fig. 3

When using the predetermined total features, the total will always be printed on the same line, regardless of the number of previously listed items, within of course the designed space between the first line and the predetermined total line. The pin (L) is removed from the slot (M) and the stud (N) is placed in the slot of the gear (O) at a position depending upon the location of the predetermined total line.

Each time that the platen spaces for listing, the pin (L) will move in a clockwise direction. The total amount of pin travel will be determined by the number of listed items before the total. During a total cycle the gear (O) will revolve, moving the rack (K), clutch assembly (P), and the arm (J). The arm (J), after catching the pin (L), will space the platen to the predetermined line for the total on the upstroke of the type bars on a reset cycle.

This mechanism is also used in conjunction with certain other spacing operations as follows:

1. When using a long bill and listing one or several items on each bill and ejecting the bill, it is necessary to move the "tail end" of the bill out of the lower feed rolls to prevent overlapping of the bill when buckling back of the platen.

2. When listing, and total printing under the last listed item on the Alphabetic Printer. If the last printing is more than 1-9/16″ above the bottom edge of the bill, this mechanism is used to move the bill past the feed roll underneath the platen in order to prevent the following bill from overlapping the previous one.

BILL BUCKLING — Fig. 1

Bill feeds are designed for both platen buckling and feed roll buckling. The platen roll buckling is used as standard, and the feed roll buckling as special. The feed roll buckling is used only when a predetermined total must be printed higher on the bill than 1-9/16″ from the lower edge.

OVERLAP OF BILLS — Fig. 1

The last front feed roll is equipped with rubber rolls, the purpose of which is to feed the bill up on the top of the roll after it leaves the last pair of rolls. This is necessary to clear the way for the next bill which in some cases must be fed up in back of the first bill. The rubber rolls can be adjusted laterally.

They should be divisioned so that they do not run over any printed part of the bill, in order to prevent smudging. See stacker adjustments.

AUTOMATIC STOP — Fig. 1

A card lever contact (E) is placed between the first and second pair of feed rolls, or between the second and third pair, depending upon the type of bill feed. When the picker knives fail to feed a bill this contact will open, thus causing the printer to stop.

The card lever contact is placed between the second and third pair of feed rolls (dotted position, Fig. 1) when the bill feed is equipped with a cam contact. (See paragraph on **Two Revolution One Notch Clutch Disc**). This card lever contact is used to control the printer so that a bill will be in a printing position in time for the first item. This contact may be used on special bill feeds without a cam contact, for the same purpose.

ADJUSTMENTS

Mounting Screws — Fig. 2. The hexagonal bolts (Z) located at the back of the bill feed device should be adjusted so that the platen is ⅛" from the type face. The bolts (C) should be adjusted so that the platen roll is not higher on one side than the other in relation to the type unit, but is level.

An adjusting bolt (E) is provided on each end of the bill feed supporting bar to allow for raising or lowering of the front of the bill feed device to line up the center of the platen roll with the type.

Picker Knives and Throat — Fig. 2. The adjustment for the projection of the picker knives and the adjustment of the throat opening will vary, depending of course, on the thickness of the bill. These adjustments will also vary depending upon the condition of the paper being used and should be changed to obtain the best feeding condition.

The following adjustments are given, as an example, for bills .005" thick and should be used more or less as a standard for setting these parts:

1. Picker knives should have .004" to .0045" even projection.
2. The throat should be adjusted for .0065" to .007" clearance between the throat block and throat knife.
3. The magazine side plates should be adjusted for .010" over the width of the bill.

In addition to the adjustment for the projection, the knife assemblies must be adjusted as follows:

1. The picker knife assemblies must be adjusted so that they are exactly in line and parallel to the first set of feed rolls. This is obtained by positioning the individual knife operating sector (TT) on the shaft, by means of adjustng screw (QQ).
2. Adjust the operating arm (KK) by means of screws (DD) on the end of the knife operating shaft so that the knives will be approximately 1/32" beyond the rear edge of the bills in the magazine, when the knives are at the extreme limit of travel to the rear.

NOTE — If a bill should jam, be sure to remove all paper pieces as the least bit of paper left in the machine will cause the bill to tear.

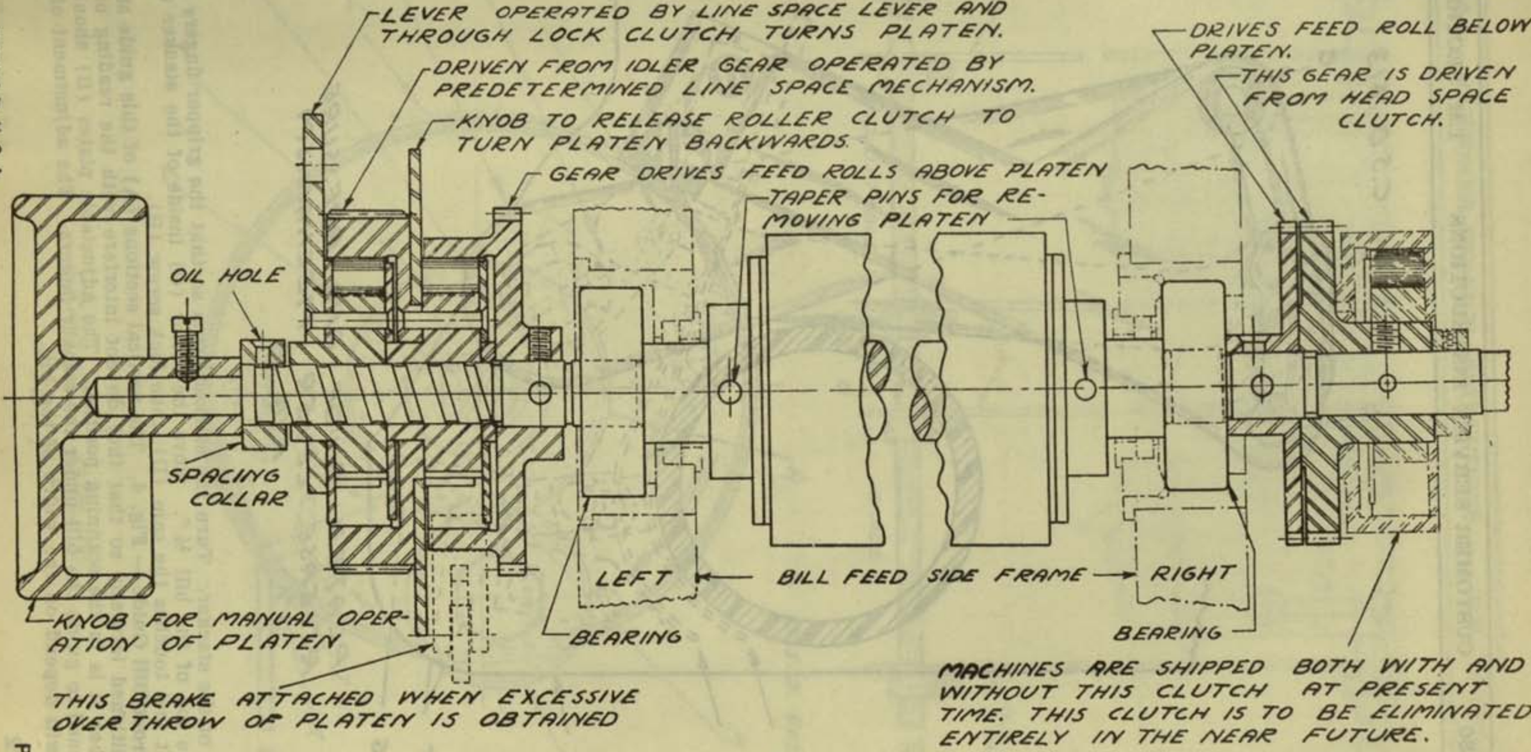
Drive Clutch — Fig. 2. The drive clutch is used to declutch the entire bill feed drive from the bill feed drive gears on the printer. This should be adjusted as follows:

1. The clutch latch stop screw (U) should be adjusted for 3/64" overlap of the latch on the pawl lever when the magnets are de-energized.
2. The armature stop screw (V) should be adjusted so that there will be an unlatched clearance of 1/64" between the latch and the pawl lever when the magnets are energized.
3. The magnet coils should be adjusted by loosening the screws (W) and shifting the magnet yoke assembly for .008" clearance between the armature and the cores when the armature is in its attracted position.
4. When the clutch stop plate is against the latch there should be a clearance of .005" between the keeper and the clutch stop.

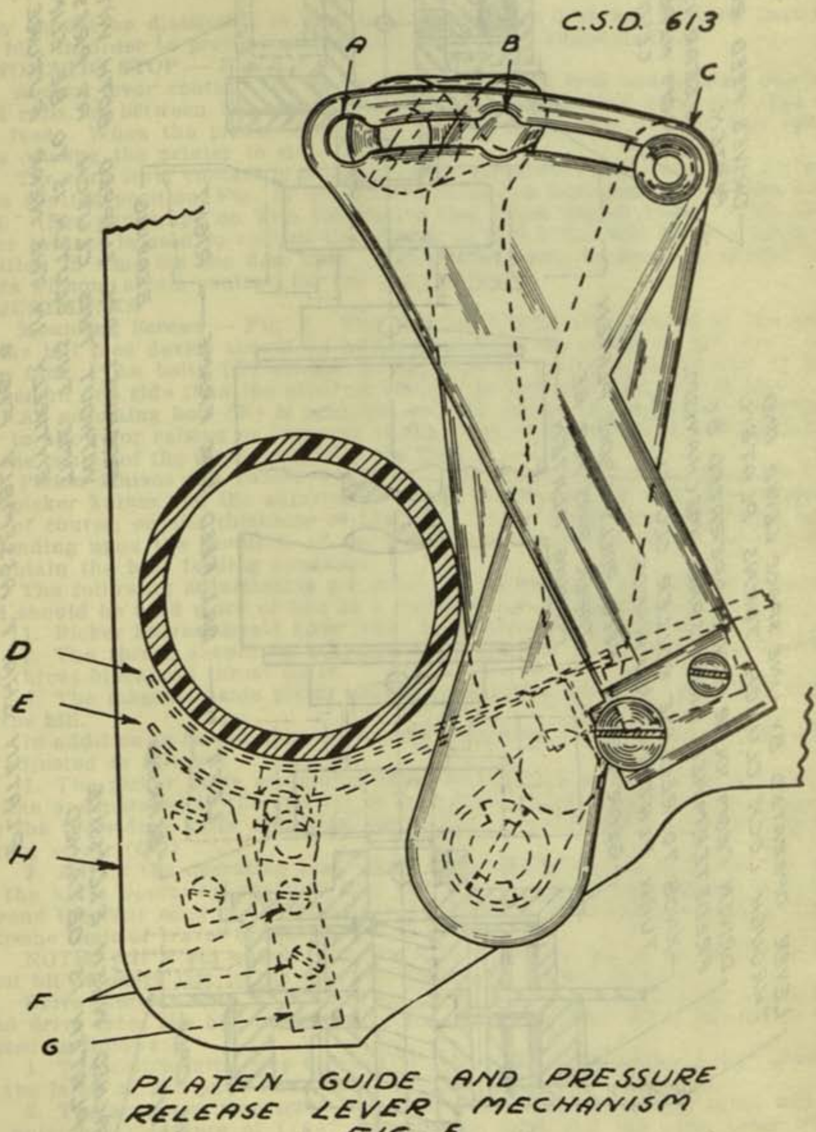
Stacker — Fig. 7

1. Loosen the screw (H) which holds the lock plate at the left end of the stacker shaft, and turn the stacker shaft so that the springs begin to open 5/16" above the fingers of the stacker plate (K).
2. Place a bill on top of the last set of feed rolls, and loosen the screw (B)

C.S.D. 623



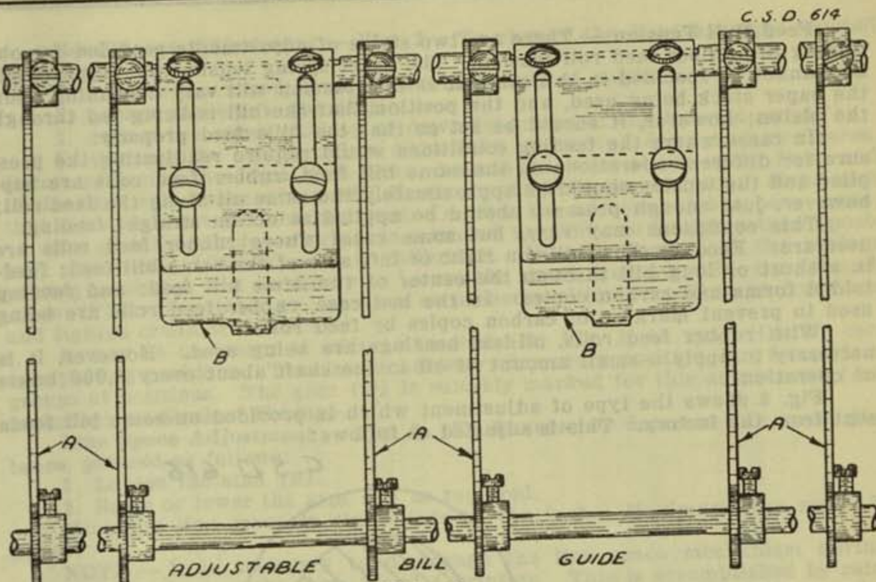
PLATEN SHAFT ASSEMBLY FIG. 4



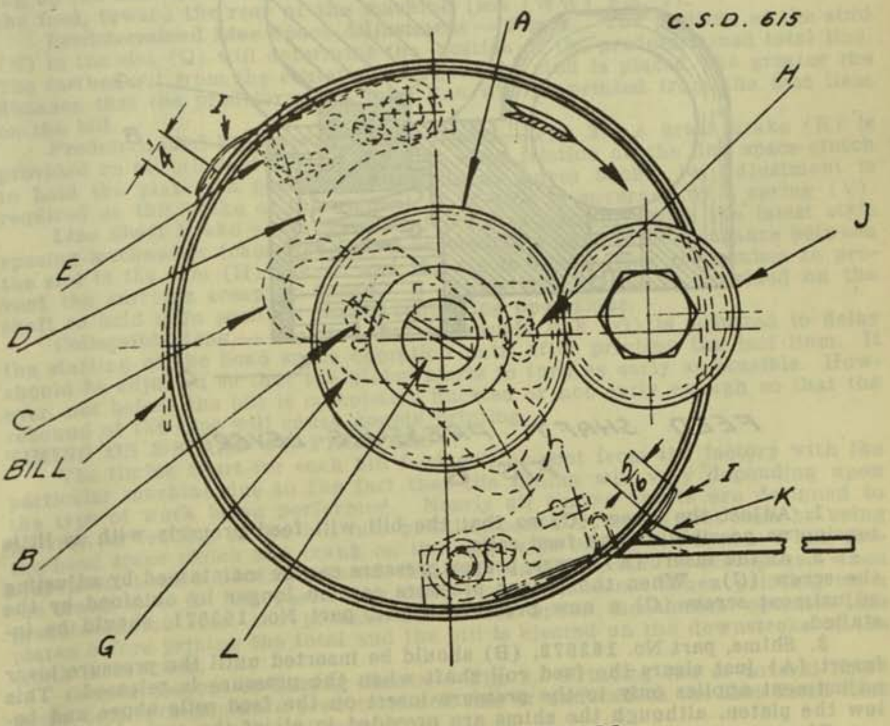
PLATEN GUIDE AND PRESSURE RELEASE LEVER MECHANISM
FIG. 5

inside of the stacker. Turn the stacker drum so that the gripper fingers overlap the top of the bill ¼". Move the roller (C) inside of the stacker drum until it just touches the cam (D), then lock screw (B).

Front Bill Guide — Fig. 6. The vertical sections (A) of this guide should be positioned laterally so that they do not interfere with the reading of the bill when it is in the scanning position. The adjustable plates (B) should be positioned to guide the bill under the stacker fingers. The adjustment of this plate will depend on the width of the bill.



ADJUSTABLE BILL GUIDE
FIG. 6



STACKER DRUM
FIG. 7

Feed Roll Tension — There are two styles of adjustments provided for obtaining the proper feed roll tension. The exact spring tension for proper feeding cannot be specified in this manual as this tension will vary depending upon the paper stock being used, and the position that the bill is being fed through the platen; however, it should be set so that the bills feed properly.

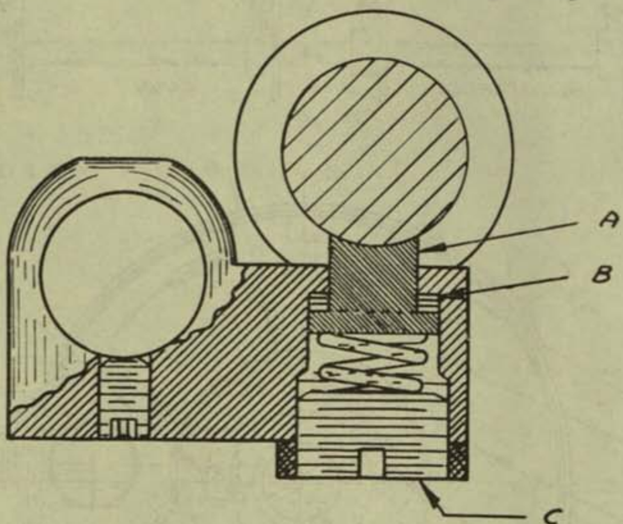
In cases where the feeding conditions would require readjusting the pressure for different operations on the same bill feed, rubber feed rolls are supplied and the tension should be approximately the same all along the feed roll; however, just enough pressure should be applied to obtain straight feeding.

This conditions may vary, but some cases where rubber feed rolls are used are: Feeding short bills on right or left side of the same bill feed; feedin a short or long bill through the center of the same bill feed; and feeding folded forms and carbon copies. In the last case, rubber feed rolls are being used to prevent marking of carbon copies by feed rolls.

With rubber feed rolls, oil-less bearings are being used. However, it is necessary to apply a small amount of oil to the shaft about every 1,000 hours of operation.

Fig. 8 shows the type of adjustment which is provided on some bill feeds sent from the factory. This is adjusted as follows:

C.S D 616



FEED SHAFT PRESSURE LEVER
FIG. 8

1. Adjust the screw (C) so that the bill will feed properly with as little tension as possible on the feed rolls.
2. As the insert (A) wears, proper pressure can be maintained by adjusting the screw (C). When the proper pressure can no longer by obtained by the adjustment screw (C) a new pressure insert, part No. 162571, should be installed.
3. Shims, part No. 162572, (B) should be inserted until the pressure lever insert (A) just clears the feed roll shaft when the pressure is released. This adjustment applies only to the pressure insert on the feed rolls above and below the platen, although the shims are provided in all of the assemblies.

The pressure lever insert (A) should be covered with a thin film of oil every six months. An excess amount of oil should be avoided.

Head Space Adjustment — Fig. 2. To change the head spacing, proceed as follows:

1. Remove the round cover at the right side of machine.
2. Loosen the crank nut (R).
3. Adjust the crank stud up or down by means of the knurled nut (T).

To increase the head spacing, adjust the crank stud down and vice versa. Before adjusting the crank stud down, depress the lever at the upper front end of the right side frame which will disengage the head space clutch. Make sure that the crank nut is tightened securely after the adjustment has been made.

On all bill feeds for which it is intended to print one line at a time (posting) the crank, (OO) Fig. 2, is calibrated. When adjusting to the various posting positions, it is necessary to loosen the crank stud nut (R), turn thumb screw (T) until pointer on crank is at proper position according to markings and tighten crank stud nut (R).

It may be necessary to adjust the stud (N) Fig. 3, on gear (O) for certain posting positions. This is not necessary for every position, but for certain groups of positions. The gear (O) is suitably marked for this adjustment (see paragraph on **Stacker Timing**).

Line Space Adjustment — Fig. 3. To increase or decrease line space distance, proceed as follows:

1. Loosen the stud (S).
2. Raise or lower the arm (F) as required.

Minimum line space is eight lines to the inch. Maximum line space is 9/16″.

NOTE — It is necessary to disengage the line space mechanism during posting operations on the Type 3 and 4 printers. This is accomplished by raising up the bill feed and pushing the line space mechanism fork, which is under the feed, toward the rear of the machine (see (WW) Fig. 2).

Predetermined Line Space Adjustment — Fig. 3. The position of the stud (N) in the slot (Q) will determine the location of the predetermined total line. The farther out from the center of the gear the stud is placed, the greater the distance that the predetermined total line will be printed from the first item on the bill.

Predetermined Line Space Clutch Brake — Fig. 3. A brass brake (R) is provided on all bill feed devices to apply some friction on the line space clutch to hold the platen in position as the clutch moves back. No adjustment is required on this brake as the amount of friction is governed by a spring (V).

Line Shaft Brake — On numerical printers equipped with the latest style spacing mechanism (cam type), it is necessary to have some clearance between the slot in the arm (H) Fig. 3, and the pin in the spacing mechanism to prevent the carriage creeping ahead. A brake (U) Fig. 3, is provided on the shaft to hold it in position during tabulating operations.

Collapsible Link — Fig. 2. The collapsible link (O) is adjusted to delay the starting of the head space operation until after printing the last item. It should be adjusted so that the platen starts to turn as early as possible. However, not before the bill is completely buckled or not early enough so that the rebound of the type will cause double printing.

TIMING ON 3-S AND 4-S PRINTERS

The timing chart for each bill feed will be sent from the factory with the particular machine due to the fact that the timing will vary depending upon the type of work being performed. Nearly all timing charts are designed to provide for feeding of the bill into printing position for the first item by using the head space clutch and crank on the right side of the bill feed. When several listed items are being printed, the bill feed clutch will be disengaged when the crank is at or just past lower dead center position. When printing on a predeterminted line, the predetermined line space mechanism operates the platen before printng the total and the bill is ejected on the downstroke of the crank mechanism.

General Layout of Timing Charts — Fig. 9. Printing one or several listed items, total printing on a predetermined line or underneath the last listed item (bill feed driven from total print shaft).

1. The bill feed runs from zero degrees to 360 degrees and therefore should be timed in at zero degrees when the total print shaft is latched up.

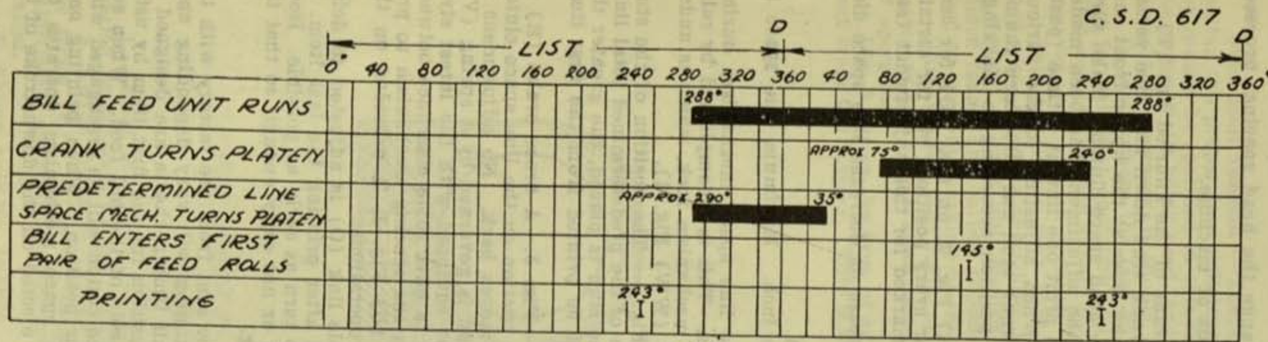


FIG. 10 3 7/8" BILL
LIST SHAFT DRIVEN

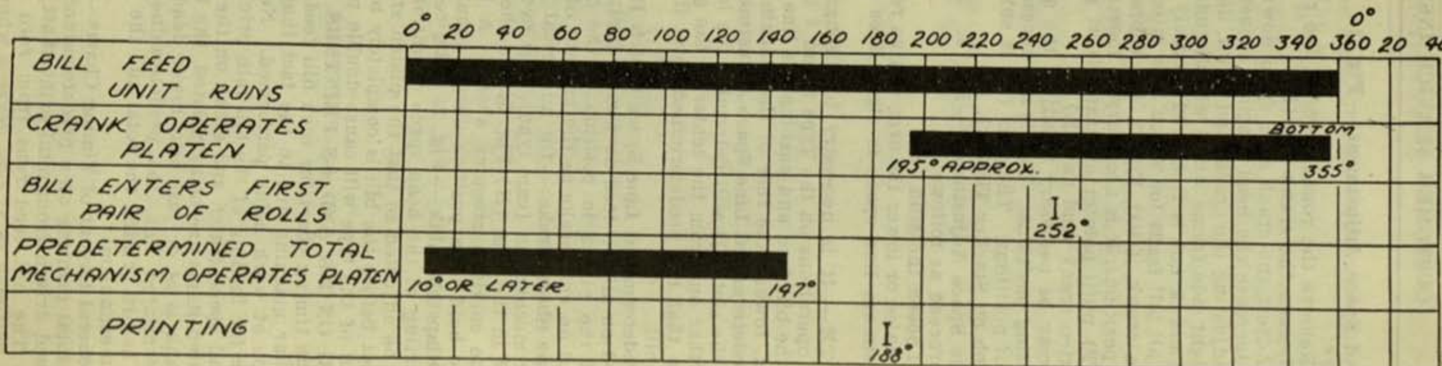


FIG. 9 5" BILL
RESET SHAFT DRIVEN
BILL FEED TIMING CHARTS FOR 3S AND 4S PRINTERS

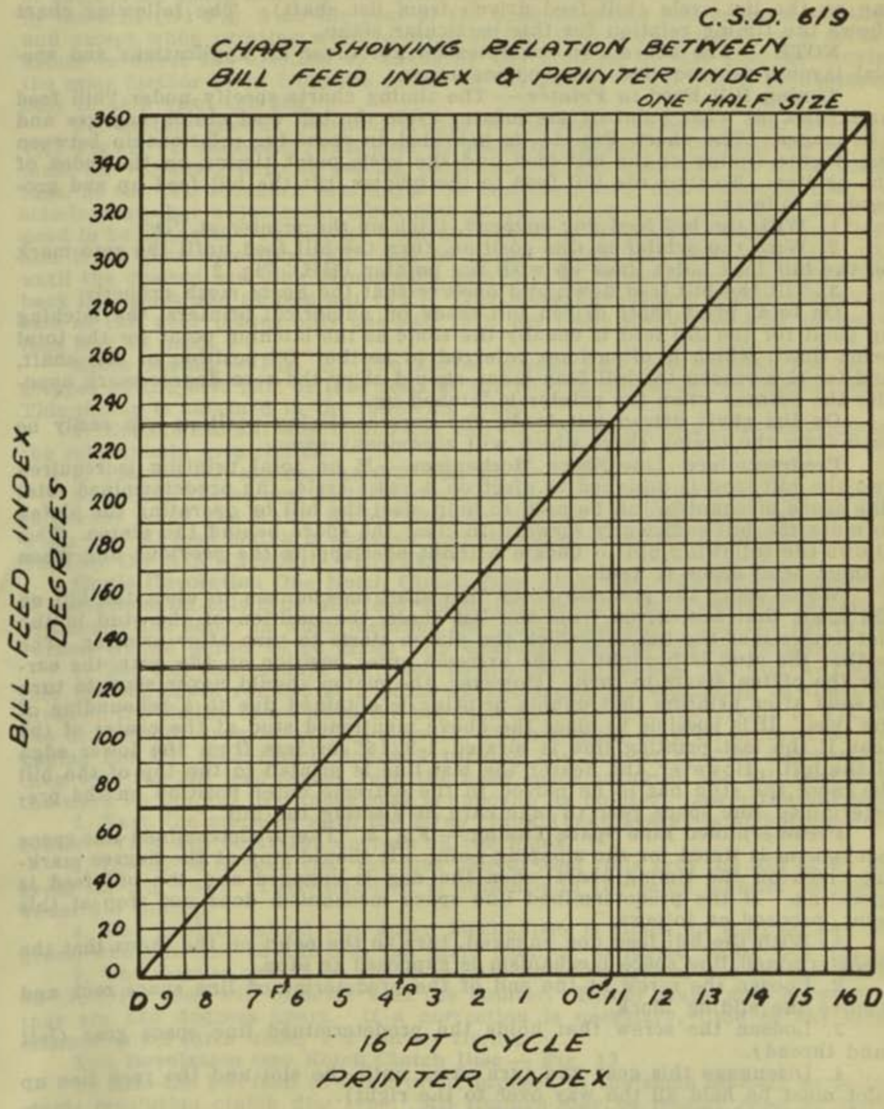


FIG. 11

2. The crank starts to operate the platen for head spacing at approximately 195 degrees. It will be noticed that the printing took place at 188 degrees, but that the eject stroke was delayed until 195 degrees. A collapsible link is used to provide this delayed action and should be adjusted accordingly.

3. The bill enters the first pair of feed rolls at 252 degrees.

4. The predetermined total mechanism stops operating the platen at 147 degrees and should be timed accordingly. If the predetermined total mechanism is not used, the pin (L) will be in the slot (M) and the stud (N) will be in the center of the gear (O) Fig. 3.

Fig. 10 — Printing one or several listed items with no total and eject-

ing on the list cycle (bill feed driven from list shaft). The following chart shows the timing relation for this particular setup.

NOTE — The above two examples do not cover all applications and special layouts are required in many instances.

Timing Bill Feed to Printer — The timing charts specify under "bill feed unit runs" at what point of the printer cycle the bill feed clutch engages and disengages. The chart, Fig. 11, is provided to show the relationship between the degree timing of the bill feed and the cycle point timing on the index of the printer. To time the bill feed to the printer, tilt the bill feed up and proceed as follows:

1. **With the bill feed dog engaged**, latch up the printer at "D."
2. With the printer in this position, turn the bill feed until the zero mark on the bill feed index lines up with the pointer (HH) Fig. 2.
3. Tilt the bill feed down and observe that the gears mesh properly.

On total print shaft driven bill feeds on numerical printers, the latching up point for the bill feed is usually the same as the latching point for the total print shaft, which is oftentimes referred to as the "D" position of this shaft, and for this reason the bill feed index should show the zero degree mark opposite the pointer when the printer is latched up.

On list shaft driven bill feeds, the correct timing position can easily be read from the timing chart which will accompany same.

Predetermined Line Space Mechanism — If no total printing is required and the bill feed is designed to eject on a reset cycle, the predetermined total line space mechanism can be used to help eject the bill by operating the platen to move the bill sufficiently forward to clear the space behind the platen. This allows the following bill to buckle without overlapping the previous bill, when a short head space is used.

When using the predetermined line space mechanism to eject the bill on bill feeds that are driven from the list shaft, the position of the stud in the slot determines the time at which the platen starts to turn after printing. The farther the stud is brought to the extreme outer position on the gear, the earlier the platen starts to turn. However, the platen should never start to turn so soon after printing that double printing is obtained due to a rebounding of the type. It is possible to place the above mentioned stud at the center of the gear if the last printing line is located 1-9/16" or less from the lower edge of the bill. However, the nearer the last line is printed to the top of the bill the more the stud has to be moved to the extreme outer position on the predetermined line space gear to take care of ejecting the bill.

Predetermined Line Space Timing — Fig. 3. The predetermined line space mechanism is timed for the stopping point. It should stop at the degree marking given on the timing chart when the dog is engaged and the bill feed is operating. If the predetermined line space mechanism does not stop at this point, proceed as follows:

1. With the bill feed dog engaged, turn to the point on the index that the predetermined line space mechanism is supposed to stop.
2. Loosen the screw at the end of the predetermined line space rack and remove the sliding block.
3. Loosen the screw that holds the predetermined line space gear (left hand thread).
4. Disengage this gear and turn same until the slot and the rack line up (slot must be held all the way over to the right).
5. Remesh the gear in this position.
6. Replace the block and the screws and check timing.

Stacker Timing — Fig. 2. When the printing conditions are known, the stacker will be timed and the gear (X) marked accordingly at the factory. If the bill feed is used for more than one type of work or if no special instructions are supplied, it may be necessary to time the stacker in the field.

The timing of the gear (X) governs at which time in a cycle the stacker will be in a stationary position.

This gear should be removed and timed to give the proper stacking operations as this timing will vary for different sized bills. The timing of the stacker is effected by the position of the printing on the bill and is different for short and long head spacing. For short head space and many listed items or same head space and one line printing. The stacker timing is also effected by the stud (N) Fig. 3 on the gear of the predetermined line space mechanism and except when printing a predetermined line it is even possible to a certain extent to effect the ejection by changing the position of this stud by moving the same farther away from the center of the gears, which would be necessary only to help eject the bill.

For certain posting positions it may be necessary to adjust gear assembly (X) Fig. 2. If necessary, this gear is suitably marked to indicate its adjustment for various groups of posting positions. If the gear has no other markings, as the two standard markings 180 degrees apart, this indicates that the standard stacker adjustment takes care of all posting conditions and does not need to be changed. To change from one marking to another, loosen nut (FF) and bring gear assembly (YY) out of mesh. Then turn gear assembly (X) until the desired marking is opposite pointer (Y), bring gear assembly (YY) back into mesh and tighten nut (FF). The markings on this gear are in duplicate as this gear makes only one-half turn per cycle and either pair of markings may be used.

Knife Timing — Fig. 2. The knives should be timed so that the bill is gripped by the first pair of feed rolls at the time specified on the timing chart. This timing is obtained in the following manner:

1. Engage the bill feed clutch dog and turn to the point on the index where the rolls should grip the bill.
2. Place a bill against the first pair of feed rolls.
3. Loosen the screws on the index gear cap (JJ) and turn the cap moving the crank until the knife projection just touches the rear edge of the bill, when the bill feed clutch is engaged and the index is at the proper point.

TIMING ON ALPHABETIC PRINTER

Single Revolution One Notch Clutch Disc—Fig. 12. The general sequence of operations on this type bill feed when installed on the alphabetic printer is practically the same as when installed on the 3-S machine. Fig. 12 shows the various timing points to be taken into consideration for timing purposes.

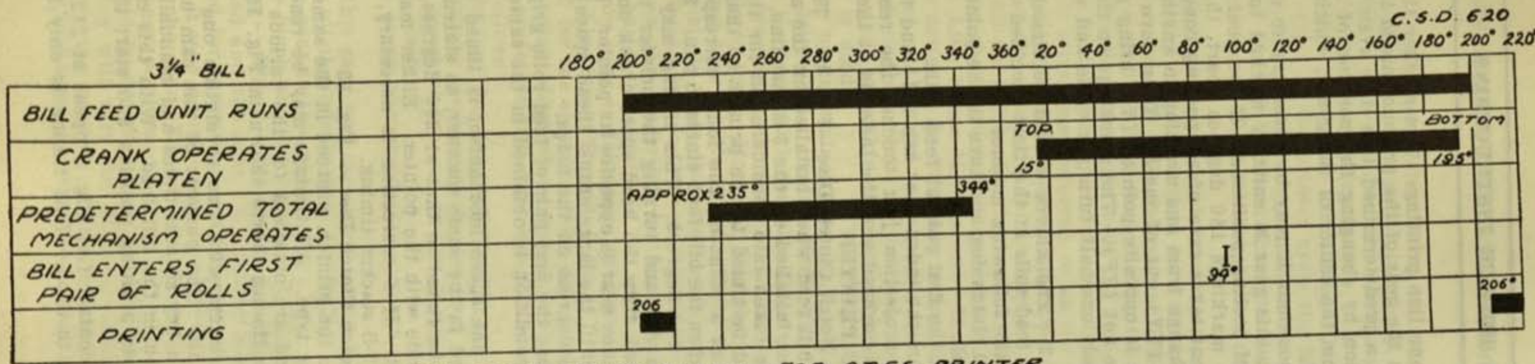
1. The bill feed should be timed to the printer so that the dog will drop into the one tooth ratchet at a point on the index corresponding to the time given on the timing chart when the bill feed starts to run. Referring to Fig. 12 the dog should drop in at 200 degrees. This timing may be secured by engaging the bill feed clutch dog and turning the printer to 200 degrees and then with the bill feed raised, turn the head space crank on the bill feed until the mark on the bill feed index gear is opposite its pointer. Lower the bill feed.
2. Turn the machine until the large crank (head space) is at bottom dead center. This will be at 195 degrees on the index.
3. It will be noticed that the first pair of feed rolls grip the bill at 94 degrees for 3¼″ bill. This condition is obtained in the same manner as stated under 3-S timing.
4. The predetermined line space mechanism is timed to stop at 344 degrees, which is also obtained in the same manner, as stated under 3-S timing.
5. The stacker should be timed so that at 200 degrees, one of the marks on the drive gear will coincide with the pointer. Either mark may be used as they are 180 degrees apart. If a correction is necessary, time in the same manner as set forth under 3-S stacker timing.

Two Revolution One Notch Clutch Disc — Fig. 13

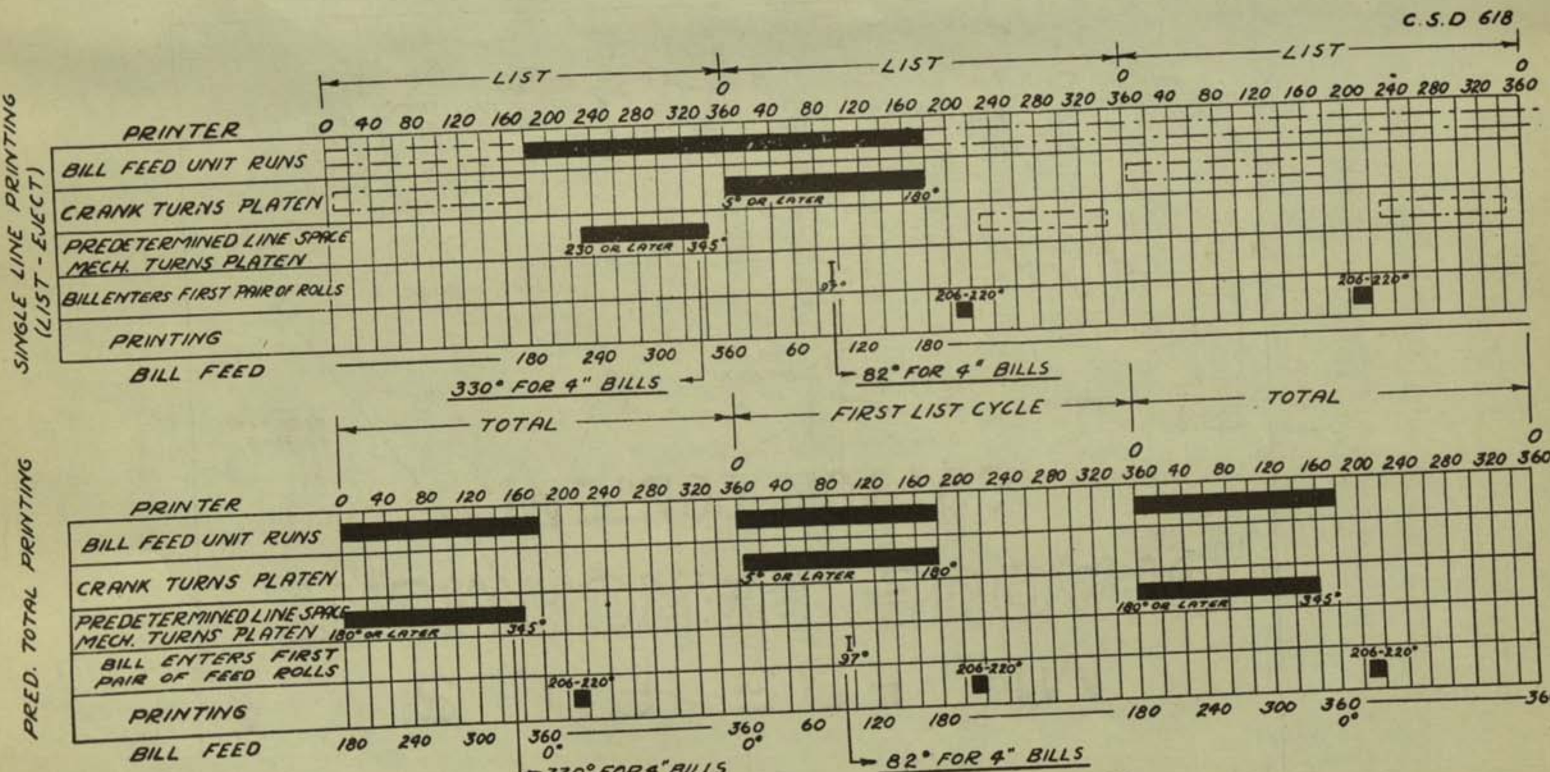
To time the bill feed to the printer, proceed in the same manner as in the single revolution clutch disc type. All timings may be readily seen by referring to the timing chart and are obtained for the various parts in the same manner as heretofore. The timing charts shown in Fig. 13 are for standard size bills from 3¼″ to 5″.

At present, alphabet printers with two revolution one notch clutch discs are equipped with a cam unit. The purpose of this cam unit is to eliminate the necessity of depressing a key several times and manually feeding the first bill into the printing position in the bill feed. With this cam unit, it is possible to feed the first bill into printing position and start the bill feed by depressing the key only once.

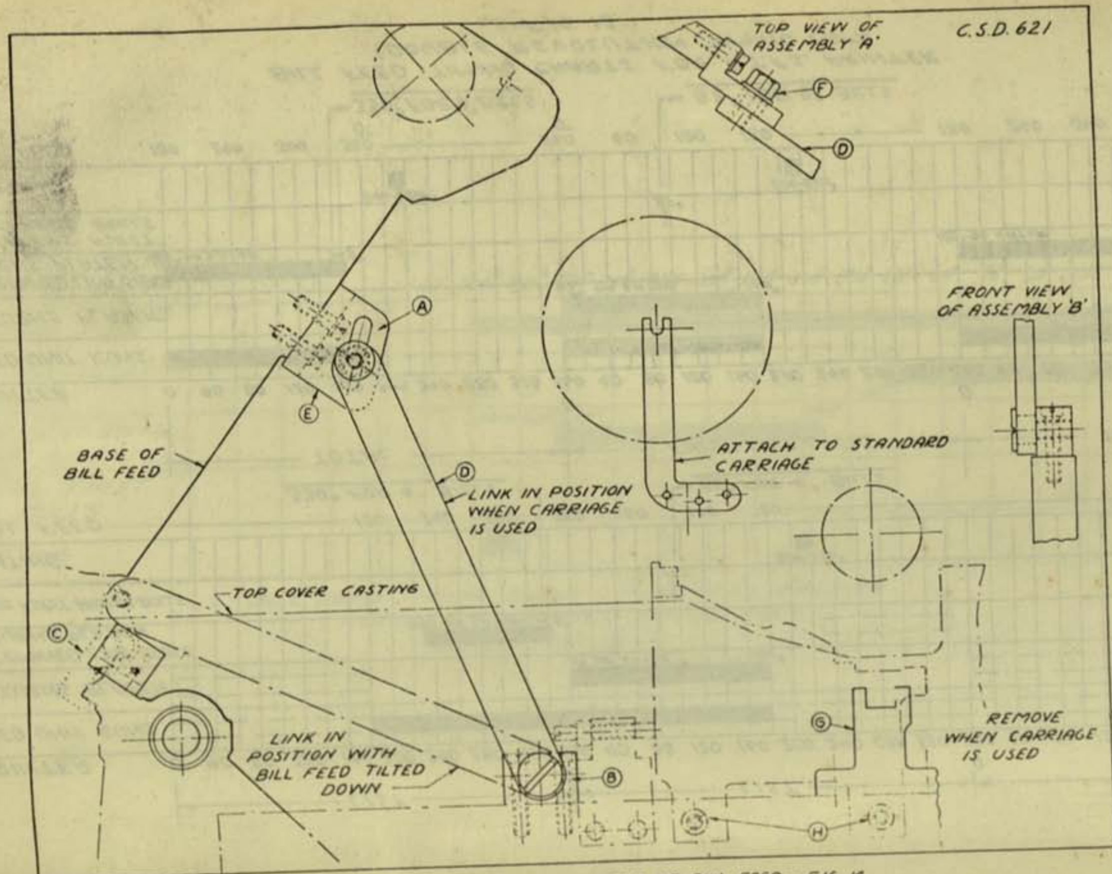
It is timed so that the contact (A) Fig. 3 opens at 212 degrees when the cam allows the center strap to drop. This timing is only for bill feeds with



BILL FEED TIMING CHART FOR A.T.F.S. PRINTER
(SINGLE REVOLUTION TIMING CAM)
FIG. 12



BILL FEED TIMING CHARTS FOR A.T.F.S. PRINTER
(DOUBLE REVOLUTION TIMING CAM)
FIG. 13



LOCATION OF PARTS USED WITH TILTED UP BILL FEED – FIG. 14

a two revolution clutch timed as shown in timing chart Fig. 13.

The cam unit should be timed by turning the printer around to 212 degrees on the printer index with the bill feed clutch engaged. Then, if the cam is not timed correctly, disengage gear (W) Fig. 3 and remesh so that the cam (I) has just released the center strap (see dotted position of cam (I) Fig. 3).

NOTE — The timing charts used in this manual are given only for examples, and reference should always be made to the timing chart which accompanies the particular bill feed which is being timed as the timing charts will vary depending upon the particular type of work being performed.

CIRCUITS

No attempt will be made in this manual to cover the circuits used in conjunction with the bill feed device as these vary depending upon the work being performed. A circuit write-up will be sent with each bill feed.

PROCEDURE FOR REMOVING STACKER DRUMS

If it is necessary to remove the stacker drum, this part may be taken out of the bill feed without removing the side plates as follows:

1. Remove the upper covers on both sides of the bill feed.
2. Take out the pin in the hub of the gear on the right end of the stacker drum.
3. Drive the taper pin out of the right stacker drum support casting.
4. Unscrew the stacker drive shaft (PP) Fig. 2 (right hand thread).
5. Remove the stacker lock plate (X) Fig. 3 at the left end of the stacker shaft.
6. Push the stacker shaft to the extreme right (facing the front of the machine) and the stacker assembly can be removed.

PROCEDURE FOR REMOVING PLATEN

If it should be necessary to remove the platen, the platen shaft can be pulled out at the left end of the bill feed, after removing the following major parts (Fig. 4).

1. Right knob.
2. Gears on the right end of the platen shaft.
3. Both taper pins in the platen hubs and stud (T) Fig. 3 at the left end of the platen shaft.

The ball bearing at the left side will come with the shaft, whereas the bearing at the right end will remain in the housing.

INSTRUCTIONS TO CHANGE FROM BILL FEED TO CARRIAGE ON ALPHABETIC PRINTER — Fig. 14

1. Tilt the bill feed up until the support bracket latch (C) engages.
2. The bill feed supporting link (D) attached to the left hand side frame of the Printer should be screwed to the upper bill feed supporting link bracket (E) on the left bill feed side frame by means of the hexagonal headed screw (F) supplied with the machine.
3. Disconnect the upper end of the platen feed connecting link from the line space bell crank and remove the line space bell crank bracket with the bell crank attached.
4. Remove the bill feed support bar, front support bracket right and front support bracket left (G).
5. Install carriage and fasten it to the left and right side frames. Use long dowel screws (H). Holes are provided in the cover casting to make it possible to fasten the carriage casting to the left side frame without removing the cover. On the right side, insert the long dowel screw through the clearance provided for same in the clutch latch magnet plate assembly. The carriage is ready for use after the platen feed connecting link is slipped on the stud of the carriage arm.

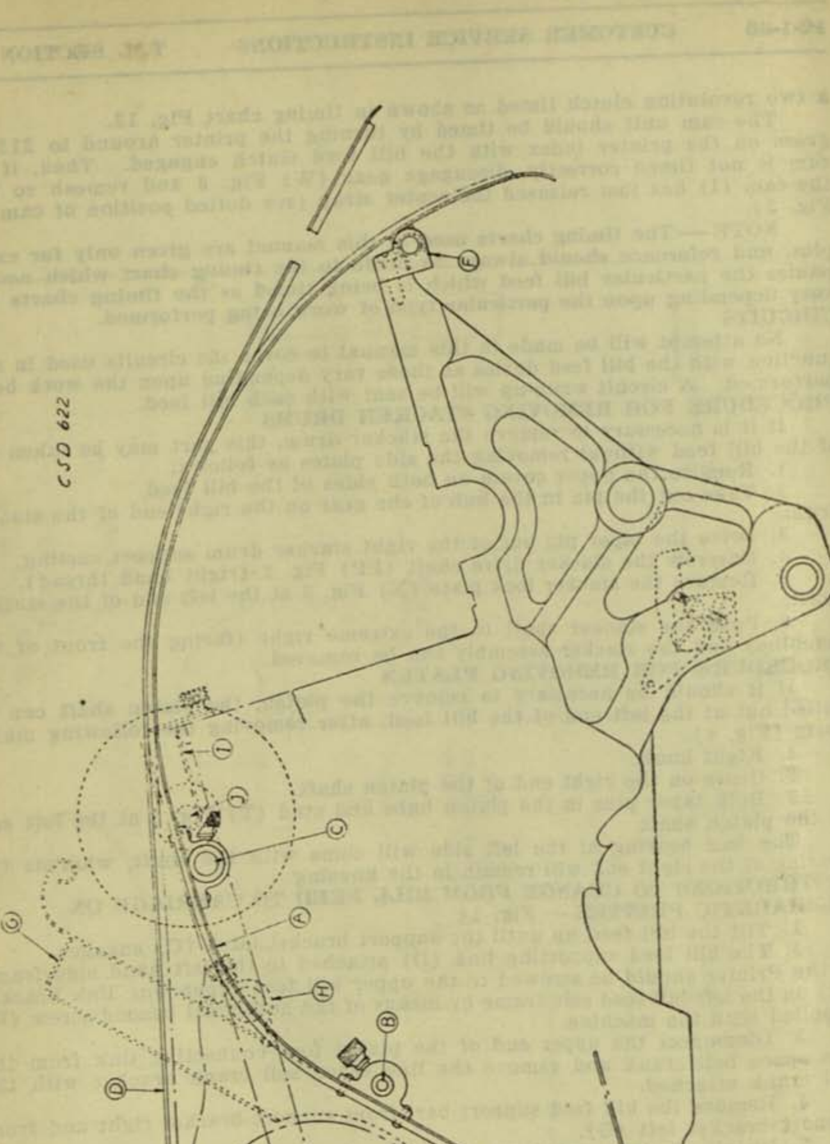
In order to change to the bill feed follow the above instructions in the reverse order.

FANFOLD GUIDES

If ordered special, some bill feeds are equipped with fanfold guides, which eliminates, to a certain extent, the necessity of using a carriage in conjunction with the bill feed.

To install fanfold guides remove the following parts:

1. Adjustable front guide assembly (G) Fig. 1.



CSD 622

BILL FEED CHUTE AND FANFOLD GUIDES FIG. 15

2. Pressure plate (A) Fig. 1.
3. Stacker plate (F) Fig. 1.

Insert lower paper guide assembly (A) Fig. 15. The location of the front lower paper guide supporting rod (B) is the same as that of the stacker plate support bar of the stacker plate which was previously removed. The other supporting rod (C) slides in the slot which is provided in the left and right side frame. The spring clips (F) hold the lower paper guide assembly to the same support rod that the magazine side frames are fastened to. Attach upper paper guide assembly (D) to bill feed using the two thumb screws (E) on top of the bill feed side frame to fasten this guide to. the machine.

When using fanfold forms, feed them from the paper box located behind the machine, over the lower paper guide (A), sliding along the guide strip on the left lower paper guide to obtain straight feeding, until the paper touches the platen. Then turn the platen and feed the forms through the rollers on top of the platen allowing them to slide back over the upper paper guide into another compartment of the paper box. It is very important that the edge of the paper which is caught by the platen is cut straight and at right angles to the sides.

Bill Feed Chute

If the bill feed specifies manual feed a chute assembly (G) Fig. 15 is shipped with the machine. This makes it possible to feed single sheets which are too large to be fed through the bill feed automatically from the hopper.

To install the bill feed chute, remove the pressure plate and stacker plate. Insert lower paper glude assembly (A). The location of the bill feed chute supporting rod (B) is the same as that of the stacker plate support bar of the stacker plate previously removed. The other supporting rod (H) slides in the slot which is provided in the left and right side frame.

AUTOMATIC CARRIAGE
Type 921

CONTENTS

New York, New York
Printed in U.S.A.
Form 22-5878-1

REMOVAL PROCEDURE — EJECT MECHANISM

IN ORDER that adjustments may be made on the line spacing mechanism, it is best to remove the center casting and ejecting mechanism as an assembly. Refer to Figures 1 and 2 for the following removal procedure:

1. Remove covers.
2. Remove wires from the following:
   a. Short speed contact
   b. Sector contact
   c. Cable clamp
   d. Two-line contact
   e. Eject magnet
3. Remove the two-line contact support bracket.
4. Remove the dowel screw and support bracket for the two-line contact pawl. Remove the bracket carefully, as it is positioned with a dowel.
5. Remove the pinion block by loosening setscrews.
6. Remove the screw from the pinion gear shifter assembly on the right side of the carriage.
7. Remove the screw from contacts 1 and 2 operating arm to release the contact bracket support link.
8. Push the sector to a forward position manually, leaving the take-up mechanism in the normal restored position.
9. Remove screw from the feed clutch drive disc .
10. Remove the taper pin from the platen clutch lock cam lever assembly on the right side of carriage housing.
11. Remove the adjusting screw from the detent lift cam assembly on the right side of the carriage housing and turn the cam out.
12. Remove the three remaining dowel screws and the eject mechanism as a unit.
13. Reverse the above procedure to reinstall the eject mechanism.

LINE SPACING MECHANISM ADJUSTMENTS

FIGURE 3 illustrates the line spacing mechanism.

Note: The following line space adjustments are made with the eject mechanism removed from the unit.

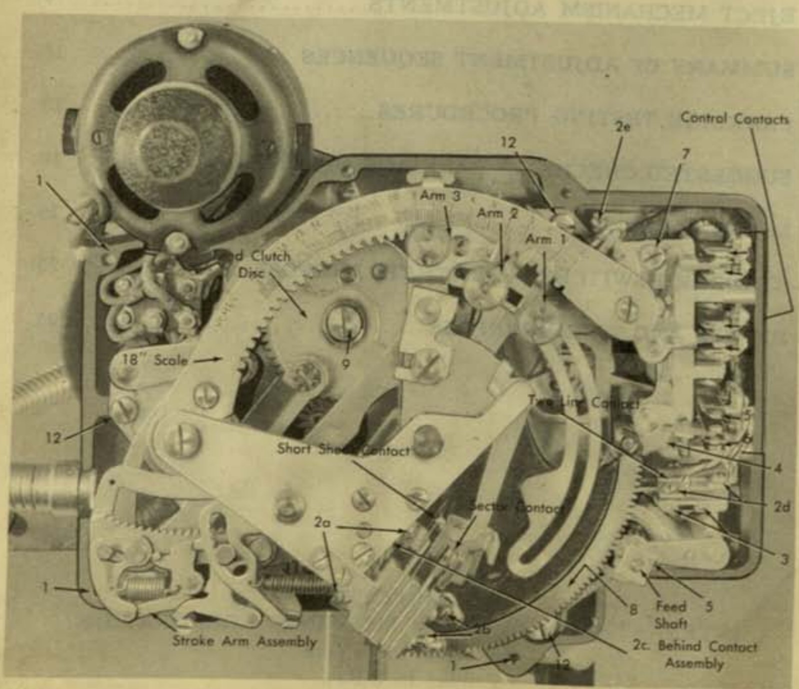


Figure 1

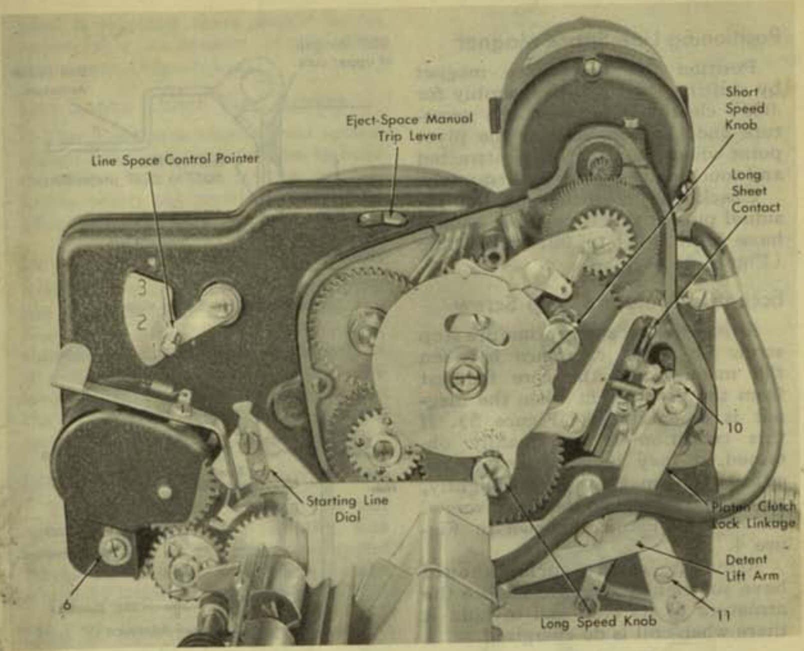


Figure 2

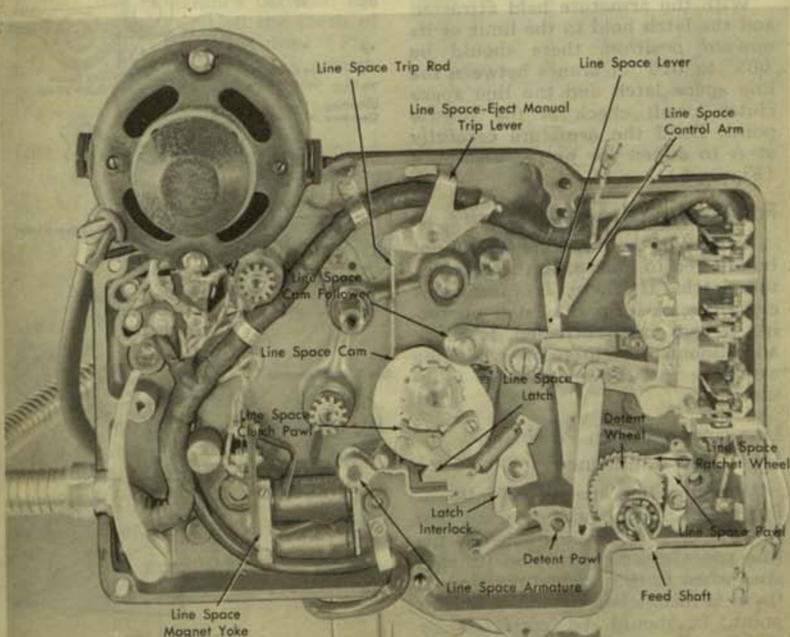


Figure 3

Positioning Line Space Magnet

Position the line space magnet by shifting the magnet assembly for .003″ clearance between the armature and the core nearest the pivot point when the armature is attracted and touching the lower core squarely.

Check the condition of the residual pins at this time. They should have from .005″ to .007″ projection (Figure 4).

Eccentric Armature Stop Screw

Adjust the eccentric armature stop screw for .053″ clearance between the magnet and the core farthest from the pivot point when the magnet is de-energized (Figure 5). If this condition is not readily obtained, it may be necessary to readjust the magnet cores slightly, pivoting the yoke on the upper screw. Recheck adjustment shown in Figure 4.

Armature return spring should have sufficient tension to restore the armature to its stop and to hold it there when coil is de-energized.

Line Space Clutch Pawl Unlatching Clearance

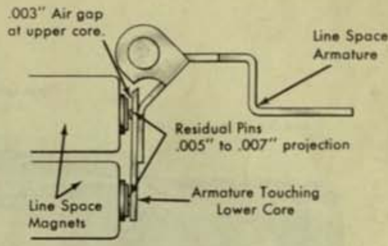
With the armature held attracted and the latch held to the limit of its *upward position,* there should be .005″ to .010″ clearance between the line space latch and the line space clutch pawl; check at the release point. Bend the armature carefully at A to adjust for proper clearance (Figure 6).

Forming Line Space Armature

The tip of the armature should not be allowed to bottom in the notch of the latch. If there is insufficient clearance, re-form the latch operating tongue until corrected. Recheck adjustment in Figure 6 after bending armature for above clearance (Figure 7).

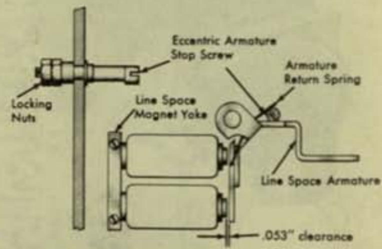
Line Space Clutch Pawl and Stop Stud Clearance

With the line space cam follower in the low dwell of the cam, see that there is .010″ clearance between the line space clutch pawl and its stop stud when in the latched position. If there is insufficient clearance at this point, it should be corrected by grinding the back of the line space clutch pawl. When the armature is attracted and the line space clutch



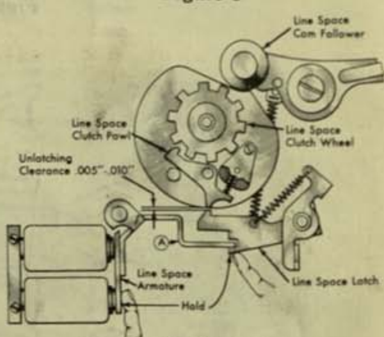
Positioning Line Space Magnet

Figure 4



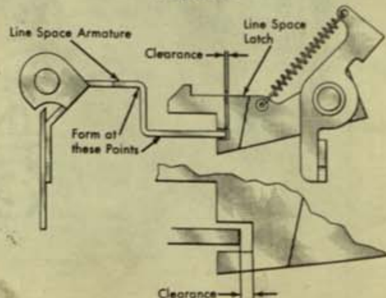
Eccentric Armature Stop Screw Adjustment

Figure 5



Line Space Clutch Pawl Unlatching Clearance

Figure 6



Forming Line Space Armature

Figure 7

pawl is released, there should be no appreciable movement of the line space cam (Figure 8).

Line Space Clutch Pawl Spring

The line space clutch pawl spring should have sufficient tension to hold the pawl bottomed in the ratchet tooth, when the pawl is unlatched (Figure 8).

Line Space Latch Manual Trip Rod

When the trip rod which connects the manual space-eject lever to the line space armature is replaced, it should be formed *at the bend* so that it will not be necessary to move the lever to the end of the slot before the armature will release the line space clutch pawl (Figure 9).

Line Space Detent Clearance

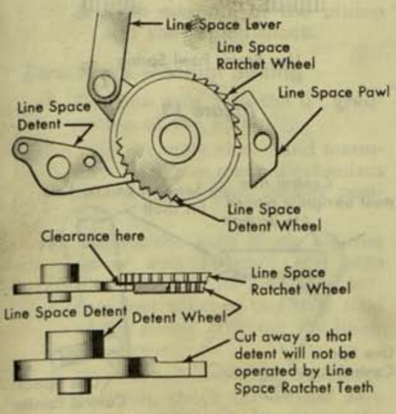
The line space detent must not rub against the teeth of the line space ratchet wheel when engaged in the teeth of the line space detent wheel (Figure 10 below, left).

Stop Screw — Line Space Pawl

With the line space pawl in the normal position, adjust the eccentric stop screw so that there is approximately .005″ clearance between the line space pawl and all the teeth of the line space ratchet wheel (Figure 11 below, right). This adjustment must be checked again after the eject mechanism is installed.

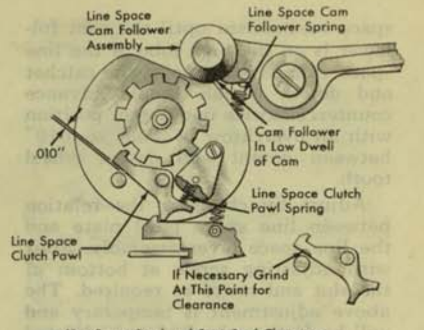
Line Space Pawl Plate

With the line space control pointer set for single spacing, turn the line



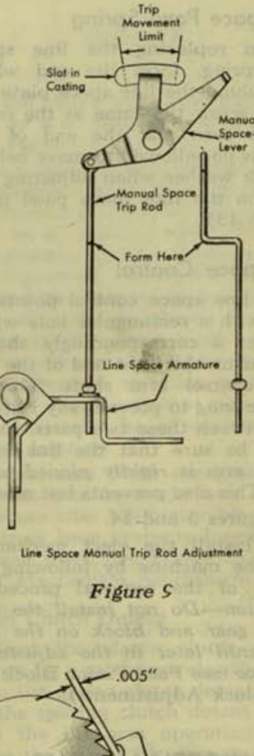
Line Space Detent Clearance Adjustment

Figure 10



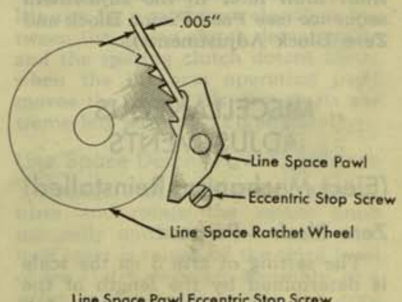
Line Space Pawl and Stop Stud Clearance

Figure 8



Line Space Manual Trip Rod Adjustment

Figure 9



Line Space Pawl Eccentric Stop Screw

Figure 11

space mechanism until the cam follower is on the high lobe of the line space cam. At this point the ratchet and detent wheels should advance counterclockwise one detent position with an overthrow of .005" to .010" between detent and detent wheel tooth.

Adjust by changing the relation between line space pawl plate and the line space lever assembly. Start with adjusting screw at bottom of the slot and move as required. The above adjustment is temporary and will be further checked and adjusted with eject mechanism installed (Figure 12).

Line Space Pawl Spring

When replacing the line space pawl spring, form the end which rests behind the line space plate adjusting screw the same as the original. Be sure that the end of the spring is not allowed to move behind the lock washer when adjusting the screw on the line space pawl plate (Figure 13).

Line Space Control

The line space control pointer is made with a rectangular hole which fits over a correspondingly shaped shoulder on the right end of the line space control arm shaft. This fit *must be snug* to prevent any lost motion between these two parts. In addition, be sure that the line space control arm is *rigidly pinned* to its shaft. This also prevents lost motion.

See Figures 3 and 14.

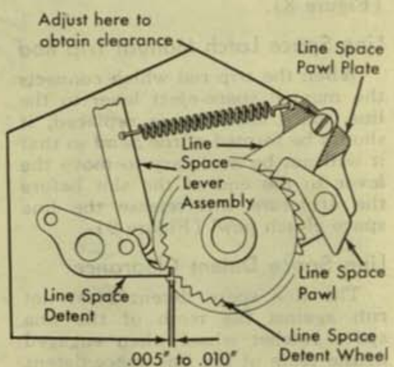
Note: Install the eject mechanism upon the machine by following the reverse of the removal procedure. *Exception—Do not install the feed pinion gear and block on the feed shaft until later in the adjustment sequence* (see Feed Pinion Block and Zero Block Adjustments).

MISCELLANEOUS ADJUSTMENTS

(Eject Mechanism Reinstalled)

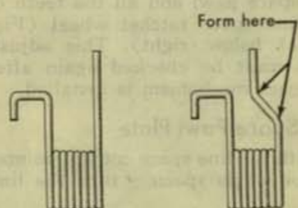
Zero Block — Purpose

The setting of arm 3 on the scale is determined by the length of the paper form. It controls the full amount of the paper movement by positioning the starting point of the sector in its forward travel. The zero block (mounted on arm 3) serves as a stop for the sector in its restored position. It is adjustable and it augments the setting of arm 3 on the scale in determining the *precise starting point* of the movement of the sector.



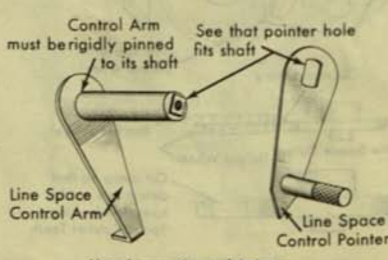
Line Space Pawl Plate Adjustment

Figure 12



Line Space Pawl Spring

Figure 13



Line Space Control Pointer

Figure 14

The zero block adjustment is used to obtain the following conditions:

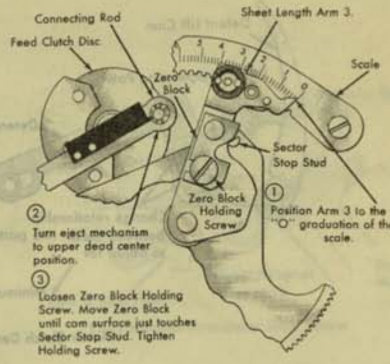
1. Assuming the end position of the forward movement of the sector or travel to be fixed, any variations in this travel must, therefore, be compensated for at the *starting position* of the sector. The zero block may be adjusted to correct for variations of one line (1/6" increase or decrease) in the overall forward travel of the sector. Thus, the zero block must position the sector so that when it is moved from the fully restored position (against the zero block) to the extreme forward position by means of the line space and/or the eject mechanisms, the overall sector movement will coincide in length with the setting of arm 3, i.e., the total sector movement expressed in 1/6" multiples *must be equal to* the 1/6" multiples contained in the sheet length setting of arm 3 on the scale.

2. The zero block is further adjusted so that the line space detent in its fully seated position shares the load of the restored sector with the zero block. This insures that the sector forward movement always starts from a fully detented feed shaft and platen position.

3. A correctly adjusted zero block provides for
   a. Correct length of ejections (in conjunction with pinion gear and block adjustments).
   b. (With the sector against the zero block)
      1. Fully seated line space and platen detents.
      2. Platen clutch tooth clearance of .005".
      3. Free meshing of the pinion and the pinion block.

Zero Block — Initial Setting

1. Position arm 3 to the 0" graduation of the scale.
2. Trip the eject clutch and manually turn the eject mechanism to the *upper dead center* position.
3. Loosen the zero block holding screw and position the zero block so that its camming surface just touches the stop stud of the sector. Tighten the holding screw.
4. With arm 3 retaining the above position, check this initial zero block setting by operating the eject mechanism under power. Observe the sector; it should not move, since the setting is for a 0" sheet length. Refer to Figure 15.



Zero Block Adjustment — Initial Setting

Figure 15

Note: A correctly adjusted zero block on most carriages is positioned in approximately a *central location* relative to its holding screw. Because of variations in the dimensions of arm 3 pointers, however, it is possible that the setting of arm 3 may vary one scale graduation in either direction; the zero block setting (above procedure) must compensate for this pointer variation and thus, on some machines, the zero block will necessarily be offset from the *central location.*

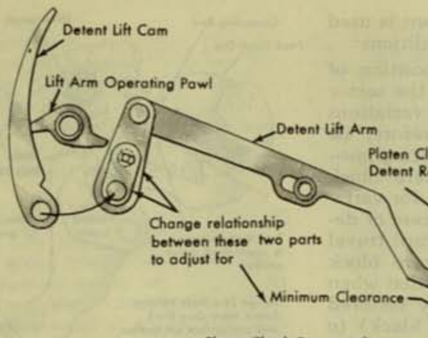
A *final* zero block check and adjustment is to be made later in the procedure after the pinion block and gear have been properly inserted on the feed shaft. See Figure 25 under Eject Mechanism Adjustments.

Platen Clutch Detent

Adjust the platen clutch detent lift arm for a minimum clearance between the platen clutch detent roller and the spacing clutch detent teeth, when the lift arm operating pawl moves the detent lift cam to its extreme left position (Figure 16).

Line Space Detent Pawl Clearance

Engage the eject clutch mechanism and rotate the motor knob manually until the feed clutch disc lock lever is raised by the third level of the clutch disc cam assembly, at a point in the cycle where the connecting rod is just past upper dead center.



Platen Clutch Detent Adjustment

Figure 16

At this time adjust the start contact operating arm to obtain .005" clearance between the line space detent and line space detent wheel (Figures 17 and 34).

Platen Clutch Tooth Clearance

With the line space and platen detents *fully seated* the platen clutch teeth should have .005" clearance.

To adjust for this clearance loosen the three holding screws in the pinion feed shaft gear and shift the gear relative to the flange to obtain the .005" clearance. Check for a uniform clearance at various detent positions (Figure 18).

Line Space Pawl Eccentric Stop Screw

Recheck the .005" clearance between the line space pawl and ratchet wheel teeth. If necessary, adjust the line space pawl eccentric stop screw to obtain this clearance. Refer to Figure 11.

Note: Remove the two-line contact and its operating bracket assembly to observe and make this adjustment; also, check the following adjustment while these assemblies are removed.

Line Space Pawl Plate

With the carriage completely reassembled, check the line space linkage for full line spacing movement on single, double and triple line space operations. Hold the platen clutch detent roller clear of the spacing clutch detent teeth and operate the manual trip lever for line spacing so that the platen moves ahead several lines. Then lower the detent roller into the detent teeth and

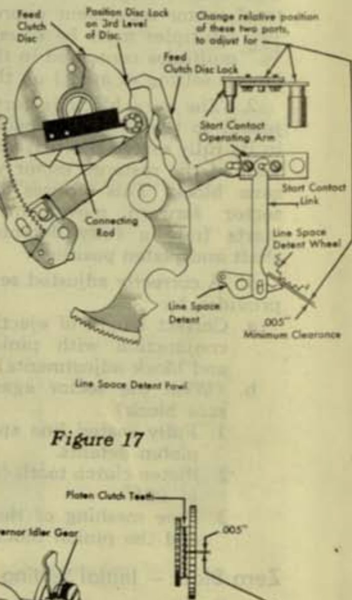


Figure 17

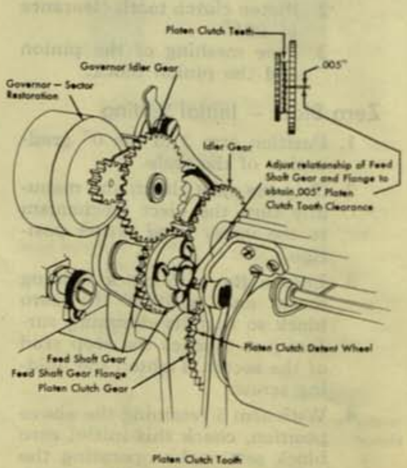


Figure 18

watch for any forward or backward movement of the platen.

To correct any movement that may be present, repeat *line space pawl plate* adjustment until the platen is carried to a fully detented position (Figure 12, page 6).

EJECT MECHANISM ADJUSTMENTS

Eject Magnet Armature

The eject magnet armature tip is ground back at an angle of approximately 20°. When the armature rests against its eccentric stop screw, there should be ½ to ¾ overlap of the armature thickness on the latching surface of the feed clutch pawl. Adjust the eccentric stop screw to secure this condition (Figure 19).

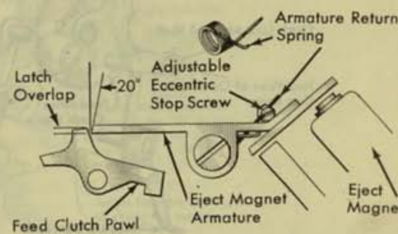


Figure 19

Eject Magnet Yoke Assembly

1. Position the eject magnet yoke assembly for .008" to .010" unlatching clearance between the feed pawl and the tip of armature, with armature held in the attracted position against core farthest from armature pivot.
2. At the same time, position the magnet yoke assembly for .005" clearance between armature and core nearest the pivot point of armature.
3. Check armature return spring for sufficient tension to return and hold the armature in the de-energized position (Figure 20).

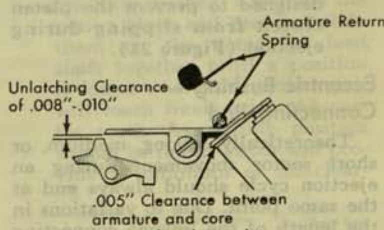


Figure 20

Take-Up Mechanism — Platen Clutch Lock

At this point in the adjustment procedure it is advisable to check the operation of the stroke arm or take-up mechanism and the platen clutch lock assembly.

Checking Procedure

1. Trip the feed clutch and turn the motor knob counterclockwise until the clutch lock cam lever drops off the clutch lock cam.
2. At this time check for sufficient unlatching clearance between the take-up cam and the take-up cam lock to insure a positive release of the take-up cam.
3. With the take-up cam released check to determine that the take-up rack has been cammed

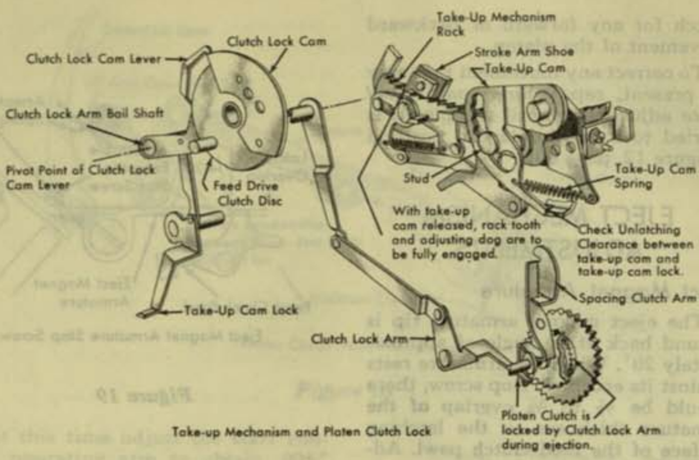


Figure 21

toward the front of the machine to a point where one of its teeth is fully and positively meshed with the stroke arm adjusting dog. Should this condition not exist, examine the take-up mechanism for binds and loose studs; also, check the tension of the take-up cam spring for sufficient tension.

4. Check to see that the platen clutch is positively locked at this time. This locking action is designed to prevent the platen clutch from slipping during ejection (Figure 21).

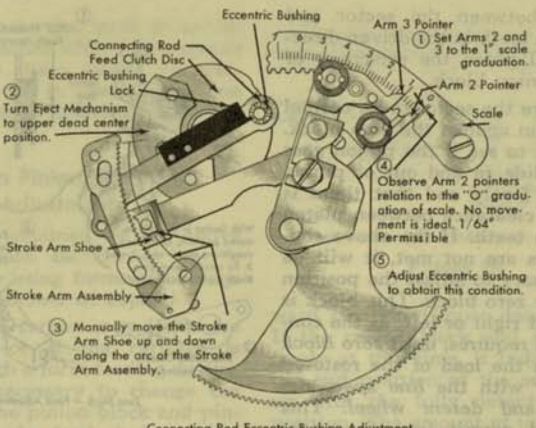
Eccentric Bushing — Connecting Rod

Theoretically, a long, medium, or short sector movement during an ejection cycle should always end at the same point. Due to variations in the length of the linkage connecting the take-up mechanism to the feed clutch disc, it is possible for the sector movement *end position* to vary when the ejection stroke is started from different points along the arc of the take-up mechanism.

The eccentric bushing is provided to alter the length of the connecting rod, which will permit a correcting adjustment to be made in this rod. Thus, this eccentric bushing, when correctly adjusted, will cause the sector to be driven to the same corresponding point at the sector stroke end for both long or short sheet ejections or sector movements.

Adjustment Procedure

1. Set arm 3 to the 1″ position on the scale. This is suggested to facilitate checking and adjusting; also, position skip arm 2 to the 1″ position on the scale.
2. Unlatch the eject feed clutch and turn the mechanism to the point where the connecting rod is positioned at upper dead center. (Feed pinion gear and block not on feed shaft at this time.)
3. The adjustment of the eccentric bushing in the connecting rod may be checked by moving the stroke arm shoe up and down with a screwdriver along the entire arc of the stroke arm assembly. Observe the pointer of arm 2 in relation to the scale to detect sector movement. The ideal condition provides no movement at this time. A movement of $\frac{1}{64}$″ is permissible and should cause no trouble. Movement in excess of $\frac{1}{64}$″ requires that the eccentric bushing be adjusted. The *end position* of the ejection stroke will vary between short and long ejections if this condition is present and is not corrected.
4. Release the retaining spring and turn the eccentric bushing until a minimum movement of the sector is obtained when checking as outlined above. If this adjustment is correctly made, the check should result



Connecting Rod Eccentric Bushing Adjustment

Figure 22

in a relatively smooth and easy movement of the stroke arm shoe along the stroke arm assembly, with little or no movement of the sector (Figure 22).

Note: In case it is impossible to secure a sector movement of $\frac{1}{64}$" *or less* by adjusting the eccentric bushing, the following is suggested:

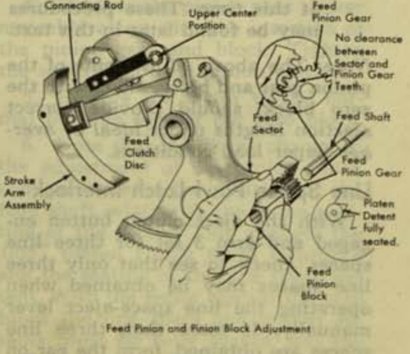
Remove the stroke arm assembly from the machine and carefully examine the surface over which the stroke arm shoe slides. This surface should be smooth and there should not be any high or low sections in this arc. If these conditions are not met, it may be necessary to replace the stroke arm assembly in order to achieve correct sector movements for both long and short ejections.

Feed Pinion Block and Zero Block Adjustments

In order that the exact movement of the sector may be reflected in a corresponding platen movement, it is necessary to insert the pinion block and gear *accurately* between the feed sector and the octagonal feed shaft. When the sector reaches its maximum point of movement at ejection end, the platen should also be at its extreme limit of movement. This latter limit is a *fully detented platen position.* This relation is determined by the *correct positioning* of the pinion gear and block on the feed shaft.

Adjustment

1. Trip the eject feed clutch and turn the mechanism to the upper dead center position.
2. The feed pinion gear and block and pinion gear shifter assembly are to be inserted into position at this time (Figure 23).
3. Before continuing, be sure the *platen detent* is fully seated. Hold the platen clutch gear train so the platen clutch teeth are fully meshed. Assemble the pinion block and gear and slide them on the octagonal feed shaft together until a position is found where the pinion gear will mesh freely with the sector teeth. A meshing position should be found which will provide a minimum or no clear-



Feed Pinion and Pinion Block Adjustment

Figure 23

ance between the sector and pinion teeth in the driven direction. Tighten the setscrews of the pinion block.

4. Restore the sector to its normal position against the zero block. Check to see if the pinion gear will slide in and out of pinion block freely and that there is .005" clearance between platen clutch teeth. If the above conditions are not met, it will be necessary to adjust the position of the zero block. This block is moved right or left, as the condition requires, until *zero block* shares the load of the restored sector with the *line space detent and detent wheel.* This should permit free disengagement and engagement of the pinion block and the gear and restore the platen clutch tooth clearance to its .005" dimension. This is important because when an ejection operation ends (sector is against the zero block), these platen clutch teeth must mesh accurately to insure proper line spacing or ejection on the succeeding operation (Figure 24).
5. After the zero block adjustment has been made, turn the eject mechanism manually to upper dead center. Check to see that the platen is driven to the fully detented position; at this time the pinion block and gear should disengage and engage freely, if the adjustments have been properly made.
6. To check the adjustment of the zero block further for correct operation it is suggested that tests 1 and 2 of the Carriage Testing Procedures be applied at this time. These procedures may be found later in this text.

Note: The above adjustments of the pinion gear and block, along with the zero block, should provide correct ejection lengths under *ideal* or *average* paper load conditions.

Line Space Pawl Latch Interlock

With the eject clutch button engaged and arm 3 set for three line spaces, check to see that only three line spaces may be obtained when operating the line space-eject lever manually. If more than three line spaces are obtained, form the ear on the line space pawl latch so that the

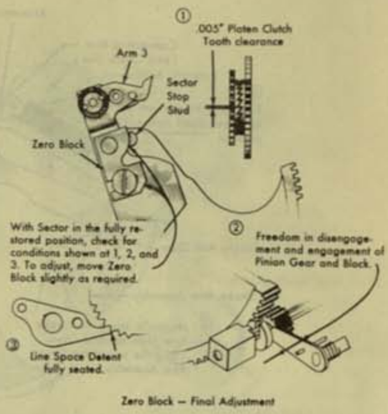


Figure 24

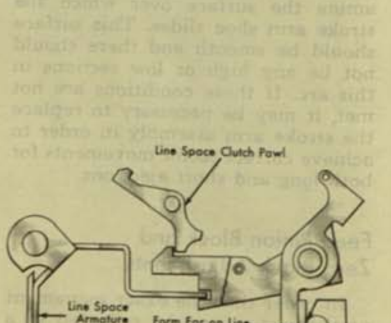


Figure 25

sector pin locks the latch in an inoperative position after 3 line spaces (Figure 25). Care should be exercised so as not to destroy the line space armature adjustment, when forming ear.

Variations in Pinion Block and Zero Block Adjustments

A setting obtained by the above method should be correct for a new carriage using forms of average length and number of copies.

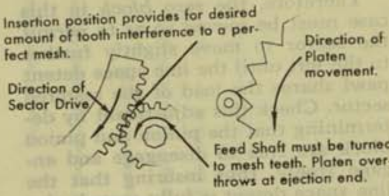
If multiple carbon copy forms are being used or if the carriage is equipped with a form feeding device, it may be necessary to change the position of the pinion block and pinion gear on the feed shaft so that the torque due to load may be compensated for and the platen carried to a fully detented position.

During any ejecting operation the sector should always move to the identical end position. By changing the position of the pinion gear and block on the octagonal feed shaft, it is possible to cause the platen detent to underthrow or overthrow the fully detented end position slightly. This is desirable as stated above so that load variations may be compensated for and thus make it possible to end the ejection in the proper platen detent position. Adjusting for the above conditions is possible because the feed shaft which holds the pinion block is octagonal and the pinion gear has 15 teeth (model 18) or 22 teeth (model 12). Since the number of teeth is not equally divisible by 8, there is a slight advancement or retardment in the relation of the teeth on the pinion gear to the teeth on the sector. The positioning of the pinion block and gear on the octagonal feed shaft to obtain either the advanced or the retarded relationship of these gear teeth will provide for either an overthrow or an underthrow of the platen detent, respectively.

Adjustment Variations — Heavy Form Ejecting

In order to compensate for heavy paper loads during ejection it is often necessary to adjust to obtain a slight overthrow of the platen detent. The following adjustments apply to this condition:

1. With the eject button engaged, trip the eject clutch and manually advance the sector to its extreme for-



Pinion Gear and Block Adjustment — Heavy Load

Figure 26

ward position (upper dead center). If the pinion block and gear mesh freely at this time, it indicates that the end position of the sector lines up with the fully detented platen position. The amount of interference to a perfect mesh of block and pinion indicates the amount ahead or behind a fully detented position.

2. Continue the procedure by removing the feed pinion *block and gear* from the feed shaft. The feed pinion shifter assembly must be removed with the above parts.

3. Mesh the pinion gear and pinion block and slide them on the octagonal feed shaft together in such a position so as to provide for a slightly advanced relationship of the pinion gear teeth to the sector teeth (see Figure 26). This can readily be observed as the pinion gear is moved in on the feed shaft against the sector. Since the sector has been driven to its extreme forward position in order to mesh these two gears, it is necessary to turn the feed shaft counterclockwise, thus producing an overthrow of the platen detent. The amount of this overthrow may be varied within limitations by increasing the above advanced relationship (see Figure 27).

4. Replace the pinion gear shifter assembly along with the insertion of the pinion gear and block. Tighten the setscrews of the pinion block.

5. Restore the sector to the normal position against the zero block.

6. Note that the above change in the adjustment of the pinion block and gear altered the position of the feed shaft relative to the home position of the sector. This changes the .005″ platen clutch tooth clearance and the seating of the line space detent. With the sector against the zero block the line space and platen detents *must be* fully seated and the .005″ platen clutch tooth clearance *must be* maintained.

Therefore, the *zero block* in this case must be moved so as to permit the sector to move slightly further to the left until the line space detent pawl shares the load of the restored sector. Check this adjustment by determining that the pinion and pinion block are free to disengage and engage freely, thus insuring that the line space detent is fully seated; also check for the .005" platen clutch tooth clearance. Note that any change made in the position of the pinion block and gear will require that the zero block be readjusted (see Figures 24 and 27).

7. When the sector is turned to its extreme forward position and the pinion block and gear are disengaged, it will be found that they will not mesh freely after the above adjustments have been completed. The amount of interference to a perfect mesh indicates the amount of overthrow for which the mechanism is adjusted.

8. With arm 3 set for three lines, test the carriage by line spacing one line and ejecting two lines. If the platen is not advanced two lines on ejection, it means that the zero block is set too far to the left and should be repositioned. After readjusting the zero block, return the sector to normal.

9. A second test may be made by taking two line spaces and then an ejection. If the platen moves ahead two lines on ejection, the zero block is set too far to the right.

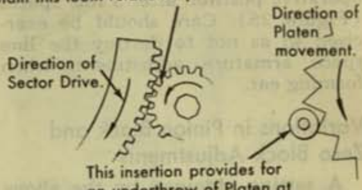
The zero block is used to correct for variations of one full line. The pinion block is used to correct for fractions of one line.

10. At this time the line space mechanism mechanical interlock adjustment should be rechecked (Figure 25).

Adjustment Variations-Momentum

If there is momentum from the weight of the form device which is being moved, it may be necessary to change the pinion block and gear so that the platen may not be quite carried to a fully detented position when operated by hand. This is done by repositioning the pinion block from the standard position on the feed shaft, as required.

1. In order to provide for an underthrow in regard to the platen detent at the ejection end, the same



Pinion Gear and Block Adjustment — Momentum

Figure 28

general procedure is to be followed as in the adjustment for an overthrow condition. In this case it is necessary to insert the pinion block and gear on the feed shaft in such a position that the relation between pinion gear teeth and sector teeth will provide a retardment or underthrow of the platen detent (Figure 28, above).

2. The zero block must be adjusted in this case also. With the sector against the zero block, adjust so that the same conditions in regard to the line space detent and the platen clutch tooth clearance are obtained.

3. Apply the same tests as given above to check for correct operation.

Sector Scale

Position of the sector scale will affect the length of ejection from different sheet length settings. This should be checked by setting sheet length arm at zero, at the middle of the scale and at the end, checking that the platen clutch clearance does not change from the required .005" dimension. Correction is made by raising or lowering the left end of the scale.

Figure 29 demonstrates the variations in the position of arm 3 obtained by moving the scale.

Note: A new sector scale is now being used which incorporates an adjustable stroke arm take-up mechanism unlatching cam. This cam cannot be installed on the old style scale (cam riveted). Refer to CEIM #988.

This adjustable cam may be positioned to allow for variations in position of the take-up mechanism due to manufacturing tolerances. It

AVERAGE PAPER LOAD ADJUSTMENTS

ADJUSTMENT OBJECTIVES

Successful ejection operations of Average paper loads require adjustments which will cause the platen to be driven to an exact fully detented platen position at eject stroke end.

EXAMPLE: 15" Sheet Length — Average and Light Loads

← Zero Block — Normal Eject End →

← Above length requires platen to move exactly 90 detent positions →

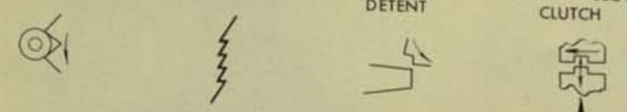
← Assume ejection starts here — Sector advanced to end of stroke →

Platen driven to exact fully detented position →

ADJUSTMENT PROCEDURES AND RESULTS

(1) With Sector Advanced to End of Stroke (upper dead center), adjust the relation of pinion gear teeth to sector teeth (Figure 23) to obtain following relative conditions.

PLATEN DETENT	PLATEN CLUTCH	LINE SPACE DETENT	PINION — BLOCK CLUTCH

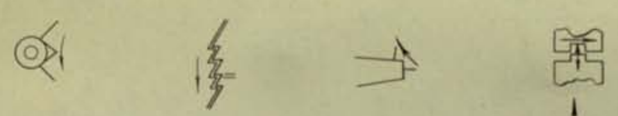


Fully seated	Hold in no clearance position	Alignment	Free movement

(2) Restore Sector to Zero Block

← Zero Block (position variable) — Ejection End →

(3) Adjust Zero Block to provide correct sector starting position and to obtain the following conditions;



Fully seated	.005" Clearance	Fully seated	Free movement

(4) Result — Correct ejections for all Average paper loads →

← Zero Block — Ejection End →

HEAVY PAPER LOAD ADJUSTMENTS

ADJUSTMENT OBJECTIVES

To compensate for shaft twist and deflections in the eject mechanism, due to heavy paper load conditions. To slightly increase the ejection stroke length to insure the platen being driven to the correct detent position at ejection end.

EXAMPLE: 15" Sheet Length — Heavy Loads

← Zero Block — Normal Eject End →

← Above length requires platen to move exactly 90 detent positions →

← Assume ejection starts here — Heavy loads cause loss in eject length →

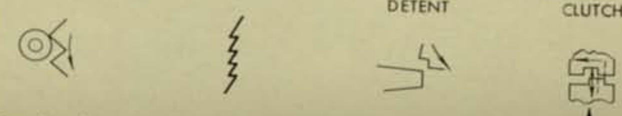
To compensate for heavy loads, ejection stroke is lengthened →

ADJUSTMENT PROCEDURES AND RESULTS

(1) With Sector Advanced to End of Stroke (upper dead center), change relation of pinion and sector gear teeth (See Figure 26) to obtain the following conditions:

No load ejection length increased as required →

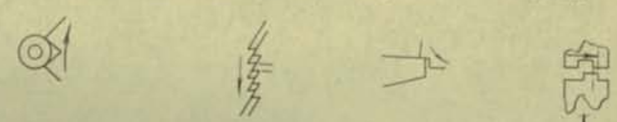
PLATEN DETENT	PLATEN CLUTCH	LINE SPACE DETENT	PINION — BLOCK CLUTCH



Overdrive full detent position	Hold in no clearance position	Clearance	Interference

(2) Restore Sector to Zero Block

(3) With sector against zero block the following relative conditions exist.



Settles back (as shown)	Fails to mesh	Clearance	Interference

(4) Adjust zero block to permit sector to settle back enough to provide for the sector's new starting position. Obtain following conditions;

Fully seated	.005" Clearance	Fully seated	Free movement

(5) Summary

← Original position of Zero Block — Normal Ejection End →

No load ejection end position altered by change of pinion and Sector relation →

← New zero block position (new start position of sector)

New ejection length — Light or average load conditions →

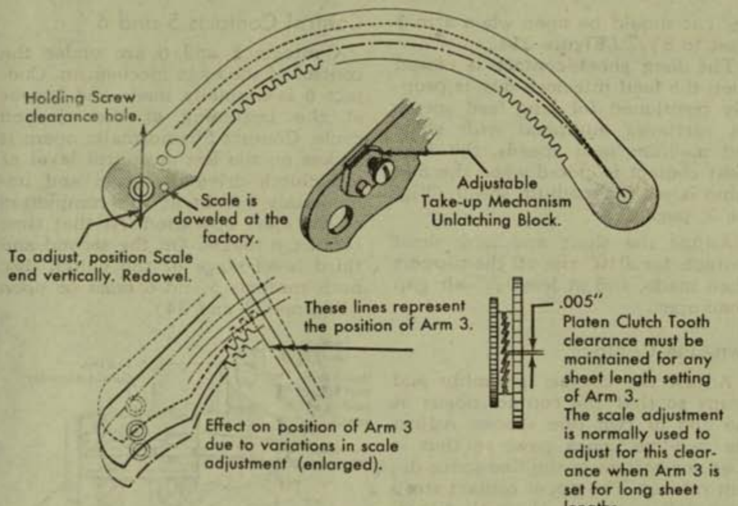
New ejection length — Heavy load conditions →

Ejection length decreased due to shaft deflections, etc. →

Note: It is assumed under average or light load conditions that platen will be driven beyond full detent position, then settle back to the correct detent position at eject stroke's end. Under heavy load, due to shaft twist, etc., platen should be driven just to the full detent position.

Pinion Block and Gear — Zero Block Adjustments

Figure 27



Sector Scale Adjustment

Figure 29

should be adjusted to unlatch the take-up mechanism just before this mechanism reaches the limit of its upward movement during an ejection cycle.

Dog Release Latch Lever Eccentric Stud

When the sector is in the home position, adjust the eccentric stud so that the take-up mechanism will be raised to its latched position.

Adjust the stud to obtain a slight relatching clearance between the dog release latch and the dog release restorer (see Figure 30).

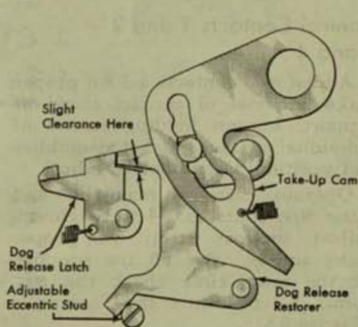
Warning: Be sure the eccentric stud is not adjusted too high as breakage of the casting may result. Refer to *Suggested Checks (d)*, page 19.

Sector Contact

Set arm 3 to 1" on the scale and adjust the sector contact operating arm to close the sector contact as the sixth line space is taken (Figure 31).

Short and Long Sheet Contacts

Short sheet contact should be made when arm 3 is positioned for sheet lengths of 1/6" to 3⅔". With arm 3 setting of 3⅚" this contact should be open. On medium-long speed carriages the short sheet contact is made for settings of 1/6" to



Take-Up Mechanism Eccentric Relatch Stud

Figure 30

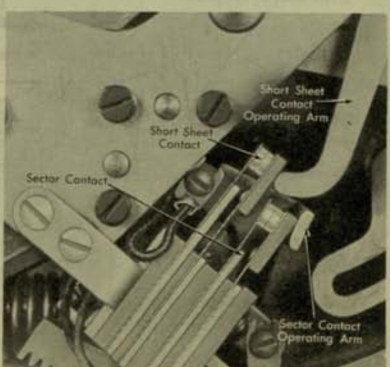


Figure 31

8½"; it should be open when arm 3 is set to 8⅔" (Figure 31).

The long sheet contact is closed when the feed interlock disc is properly positioned for long feed speed. On carriages equipped with short and medium feed speeds, the long sheet contact is closed when the machine is set for medium speed (Figure 2, page 3).

Adjust the short and long sheet contacts for .010" rise off the support when made, and at least $\frac{1}{32}$" air gap when open.

Two-Line Contact

Adjust the contact assembly and straps so that the contact opens at the end of two line spaces. Adjust the two-line space pawl so that it *does not bottom* in the line space detent ratchet. The upper contact strap must follow the pawl at all times; adjust the tension for the correct operation. This is important (Figure 32).

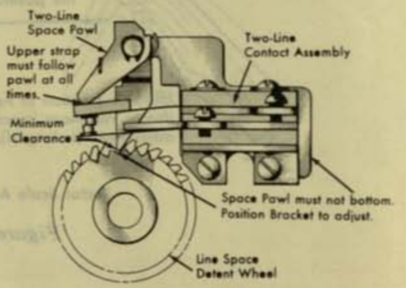
Control Contacts 1 and 2 — 3 and 4

Adjust N/C contacts 1-3 for proper make and rise of contact strap off support. Loosen holding screws of individual contact bracket assemblies and position assemblies to adjust.

Operate carriage manually and cause N/O contacts 2-4 to be closed. Adjust support strap for proper make and $\frac{1}{64}$" rise off the support. At the same time check the N/C points 1-2 to insure they are open (Figure 33).

Control Contacts 5 and 6

Contacts 5 and 6 are under the control of the eject mechanism. Contact 6 is normally made and breaks at the beginning of the ejection cycle. Contact 5 is normally open; it makes on the last or fourth level of the clutch drive disc cam and immediately breaks at the completion of the eject operation. At that time contact 6 makes. On the second and third level stage of the clutch disc both contacts 5 and 6 *must be open* (Figures 33 and 34).



Two-Line Contact Assembly Adjustments

Figure 32

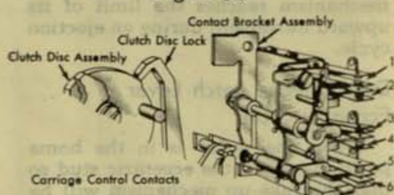
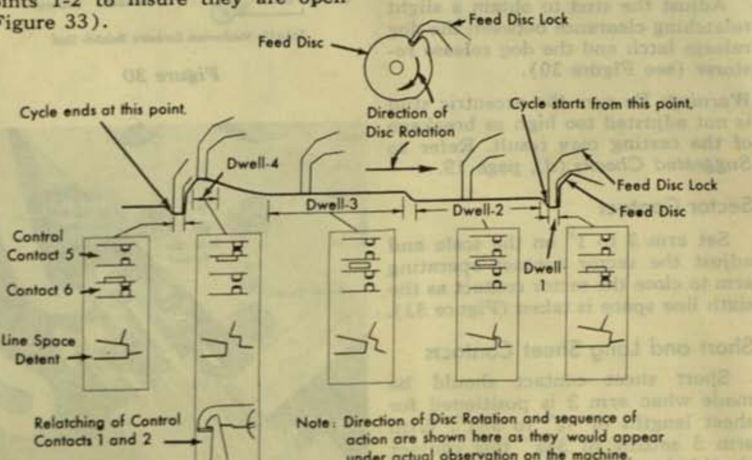


Figure 33



Functions of Feed Disc and Disc Lock

Figure 34

Skip Arms 1 and 2

These arms must be properly located and adjusted to cause the control contacts 1-2 and 3-4 to be unlatched and transferred at the proper time. As either of these arms move from 1/16" scale graduation to the 0 graduation, unlatching of their respective contacts takes place.

Adjustment

1. Set arm 3 to 2" on the scale. Restore the sector.
2. Set pointer of arm 1 to 1" on the scale.
3. With power on, manually trip the line space mechanism to take five line space operations. At the end of the fifth operation the skip arm 1 should just move its respective skip lever latch without unlatching contacts. If this condition is not present, move arm 1 to obtain it (Figure 35).
4. With power off, trip the line spacing mechanism and manually rotate the motor knob to turn the machine through the sixth cycle of operation. The contacts should be unlatched approximately in the middle of this sixth line space operation, as the individual arm pointer moves toward the zero scale graduation.
5. Restore the sector to normal, and, if arm 1 has been moved from its original setting of 1" to obtain proper contact unlatching, it will be necessary to form the skip arm index pointer to coincide with the 1" graduation.
6. Adjust the tension of the small flat spring under the cam of the skip lever latch for contacts 3 and 4, to hold the cam in operating position. This cam should snap above the skip arm after contacts have been unlatched, to prevent a second unlatching of the 3-4 contacts. Check the relatching of contacts 3 and 4, after the line space operation (Figure 35).
7. The checking and adjusting of arm 2 in regard to its unlatching of control points 1 and 2 is to be made in a similar manner to that outlined above for arm 1 and contacts 3 and 4.

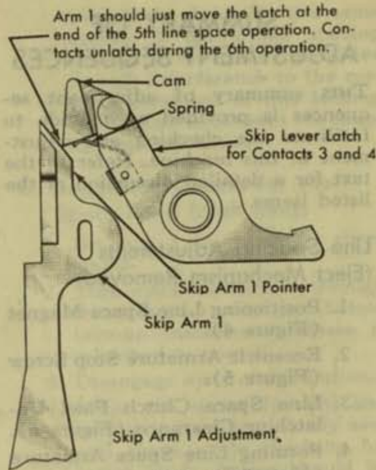


Figure 35

Relatching Control Contacts 1-2

Turn the eject drive disc up to within 1/4" of relatching, and with the eject clutch drive disc lock on the high point, the contact latch for contacts 1 and 2 should be relatched with a slight clearance of .005" (Figure 36).

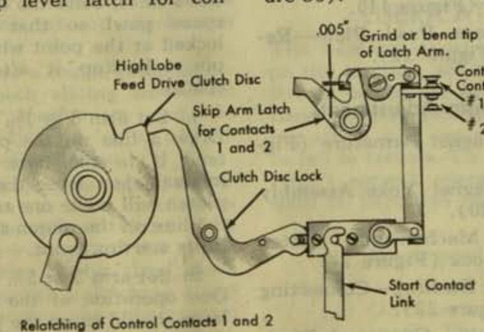


Figure 36

SUMMARY OF ADJUSTMENT SEQUENCES

THIS summary of adjustment sequences is provided as a guide to facilitate the checking and adjustment of this machine. Refer to the text for a detailed discussion of the listed items.

Line Spacing Adjustments (Eject Mechanism Removed)

1. Positioning Line Space Magnet (Figure 4).
2. Eccentric Armature Stop Screw (Figure 5).
3. Line Space Clutch Pawl Unlatching Clearance (Figure 6).
4. Forming Line Space Armature (Figure 7).
5. Line Space Clutch Pawl and Stop Stud Clearance (Figure 8).
6. Line Space Detent Clearance (Figure 10).
7. Stop Screw—Line Space Pawl (Figure 11).
8. Line Space Pawl Plate (Figure 12).
9. Line Space Control (Figure 14).

Miscellaneous Adjustments (Eject Mechanism Reinstalled)

1. Zero Block — Initial Setting (Figure 15).
2. Platen Clutch Detent (Figure 16).
3. Line Space Detent Pawl Clearance (Figure 17).
4. Platen Clutch Tooth Clearance (Figure 18).
5. Stop Screw—Line Space Pawl Recheck (Figure 11).
6. Line space Pawl Plate—Recheck (Figure 12).

Eject Mechanism Adjustments

1. Eject Magnet Armature (Figure 19).
2. Eject Magnet Yoke Assembly (Figure 20).
3. Take-up Mechanism — Platen Clutch Lock (Figure 21).
4. Eccentric Bushing—Connecting Rod (Figure 22).
5. Feed Pinion Gear and Block (Figure 23).
6. Zero Block (Figure 24).
7. Line Space Pawl Latch Interlock (Figure 25).
8. Sector Scale (Figure 29).
9. Dog Release Latch Eccentric Stud (Figure 30).
10. Sector Contact (Figure 31).
11. Short Sheet Contact (Figure 31).
12. Long Sheet Contact (Figure 2).
13. Two-Line Contact (Figure 32).
14. Control Contacts 1, 2, 3, and 4 (Figure 33).
15. Control Contacts 5 and 6 (Figure 34).
16. Skip Arms 1 and 2 (Figure 35).
17. Relatching Control Contacts 1 and 2 (Figure 36).

CARRIAGE TESTING PROCEDURES

IT IS suggested that the following tests be used as an aid in determining correct machine operation:

1. With arm 3 set for ½", test the carriage by line spacing one line and ejecting two lines. If the platen is advanced one line on ejection, it means that the zero block is set too far to the left and should be repositioned.

2. A second test may be made by taking two line spaces and then an ejection. If the platen moves ahead two lines on ejection, the zero block is set too far to the right.

3. Set arm 3 to ½". When the manual line space lever is operated, the platen should move three lines. If the platen moves more or less than three lines, bend the ear on the line space pawl so that the latch is locked at the point where the sector pin will stop it after three line spaces.

4. Set arm 3 at 1⅚" or 11 spaces. Draw a line on the platen and extend it to the base. Operate the manual eject lever three times; the platen will make one revolution, and the line on the platen should be back to its starting point.

5. Set arm 3 at 5⅚" or 33 spaces. One operation of the manual eject lever should cause the platen to turn one complete revolution and bring the line back to its starting point.

6. Set arm 3 at 11″ or 66 spaces. On one operation of the manual eject lever the platen should make two revolutions and bring the line back to its starting point.

7. Set arm 3 at 16$\frac{3}{16}$″ or 99 spaces. One operation of the manual eject lever the platen should make three revolutions and bring the line back to its starting point. Test after each ejection for free movement of the pinion gear when engaged and disengaged with the pinion block.

SUGGESTED CHECKS ON CARRIAGE OPERATION

A. Suggested Checks on Failure of Sector to Restore

1. Operating linkage binding at pivot points.
2. Sluggish governor action.
3. Bent line space feed shaft.
4. Take-up mechanism rack worn, causing sluggish return.
5. Mechanism in need of lubrication.
6. Two-line contact operating pawl positioned too deeply in detent wheel.
7. Start contact link binding.
8. Platen clutch ratchet not sliding freely during sector return.
9. Failure of start link to release line space detent pawl.

B. Suggested Checks for Take-Up Mechanism Binds

1. Set arm 3 to 1″ on the scale.
2. Turn the eject mechanism to upper dead center.
3. With a screwdriver, raise and lower the feed sector stroke arm and check for a smooth sliding action of the stroke arm shoe along the take-up mechanism surface.
4. In case of a rough, jumping action, check sliding surface of take-up mechanism and the stroke adjusting dog for a rough or burred condition.
5. Trip the eject clutch and manually turn the eject mechanism until the platen clutch lock cam lever drops off the clutch lock cam. At this time check for adequate unlatching clearance between the take-up cam lock and the take-up cam. Also, check for the proper locking of the platen clutch by this same action. A malformed spacing clutch arm often provides enough interference to the correct movement of this locking mechanism to prevent the take-up cam unlatching.

C. Suggested Checks for the Space Feed Shaft Binds

1. Set arm 3 to maximum sheet length.
2. Turn eject mechanism through its cycle to a point just before take-up mechanism release is relatched to normal.
3. Disengage eject clutch button.
4. Move the sector forward and permit it to return slowly several times while checking for sector binds. Action should be smooth and positive.
5. With machine in this same setting, hold the platen clutch disengaged. Rotate the pinion gear feed shaft which should now be free to check for freedom of movement.

D. Suggested Checks on Eject Clutch Drive Disc Restoration

1. Turn eject mechanism manually through its cycle until eject clutch pawl is latched on the feed magnet armature.
2. Check to see that the clutch disc lock falls into the V cut of the clutch disc assembly.
3. In case the above does not occur, check the take-up mechanism, dog release latch eccentric screw adjustment. This screw should not be so positioned as to prevent the clutch drive disc turning to its locked position.

LUBRICATION

THE NEW governors now being used on the carriage are extremely sensitive to oil on the shoes. Any oil on these surfaces increases the governing action and can cause the sector to fail to restore. To insure this governor's correct operation the shoes must be kept free from oil.

IBM 6

(1) Bearings of drive motor.

IBM 9

(1) Oil lines under drive gear cover. These lubricate the drive gear bearings.

(2) Drive gear teeth.
(3) Contact assembly pivots.
(4) Eject cam pivots.
(5) Sector pivot.
(6) Feed pinion gear.
(7) Clutch disc lock pivot.
(8) Clutch lock cam lever pivot.
(9) Connecting rod pivots.
(10) Take-up mechanism pivots. Take care not to get oil on stroke arm shoe sliding surface.
(11) Stroke arm shoe pivot.
(12) Platen drive gear bearings.
(13) Platen bearings.
(14) Platen pressure roll bearings.
(15) Platen detent roller.
(16) Any time center casting is removed all of the line space pivot points should be lubricated with IBM 9.

BM 21

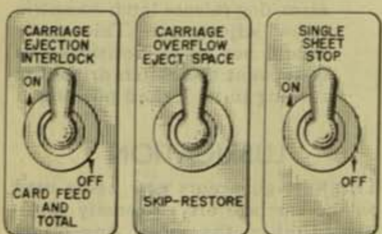
(1) Pinion feed shaft ball bearing race.

STANDARD SWITCHES AND THEIR PURPOSE

THE switches illustrated in Figure 37 supplement the control panel wiring in controlling operation of the automatic carriage. They have the following functions:

Carriage Ejection Interlock Switch

This switch is effective only when the carriage is set for short-sheet ejection. Otherwise the interlock is automatic, and the switch may be disregarded.



Automatic Carriage Switches

Figure 37

With the switch ON, the interlock provides an idling cycle and sufficient time for successive ejection when one group of heading cards is followed directly by a second group of heading cards punched with a different control number. This also is true when one set of detail cards is followed directly by a second set of detail cards punched with a different control number.

The switch also provides an interlock to prevent a total cycle from taking place when used with a before-total ejection operation.

When there is wiring for a before-total ejection with the successive ejection switch (rear) ON, R23 will be prevented from picking up by R41BL points opening. Failing to close the R23B points under L9 will hold up the total print operation until the before-total ejection is completed, thus causing an idling cycle.

Carriage Overflow Switch

This switch should be set to EJECT-SPACE when heading cards are being used. When heading cards are not being used, it should be set to SKIP-RESTORE if it is important that printing on the overflow sheet begin on the first printing line. If ejecting speed is the more important factor, the switch should be set to EJECT-SPACE. When the switch is set to EJECT-SPACE and an overflow occurs, the ejection is followed by two line spaces. The two extra spaces are obtained only on overflow ejection when the switch is set to EJECT-SPACE.

In most overflow applications there will be additional wiring in the control panel to cause an ejection as a result of a control change. If the change takes place before the overflow arm has reached 0, relay 20 will not be picked up; therefore, the ejection will not be followed by two line spaces.

When the switch is set to SKIP-RESTORE and an overflow occurs, the operation is overflow skipping (high speed line spacing) from the last printing line on one form to the first printing line on the succeeding form, followed by restoration of the mechanism.

Single Sheet Stop Switch

This switch is provided to facilitate manual insertion of single sheets. When ON, it stops the accounting machine as the sheet is ejected.

This switch shunts around R42AU point, which opens on an after-total ejection, and R33BU points, which open at the end of ejection, regardless of whether the before or after-total eject relays are energized. When in the ON position, the hold circuit or R12 will be broken every ejection operation.

RELAYS AND THEIR PURPOSE

(Print Number 128450T)

R17 digit successive ejection control pickup is in parallel to the eject after-total relay pickup coil and is used to control short sheet ejection when used in applications such as single item ejection. This is important on print 128450F and earlier prints, since R43 has no R43AU hold point.

R17AL holds R17 through CB29 and 30.

R17BL N/C point is used to keep R43 energized after R17 hold becomes de-energized.

R17BL N/O point permits R43 to be energized to cause short speed single item ejection after R42 has become de-energized at the end of the first ejection. R42H is again energized through R43AU point.

R19 head control X and NX is energized whenever the head control relay R29 is energized and used to control the circuits necessary to indicate that a heading card has passed the lower brushes. The contacts of R19 operate in conjunction with R27 to control the circuits which indicate that heading cards are followed by heading cards after ejection, or that detail cards follow detail cards after ejection.

R19AU is the hold point for the hold coil of R19.

R19AL N/C is connected to the head control exit X, the control panel hub and it operates in conjunction with CF28 and R27AL in order to prevent the re-establishment of a skipping circuit which was initiated to control skipping before the first heading card enters the lower brushes.

R19BU transfer contact operates in conjunction with the head control relay contact points R27BU and controls the impulse to the UEJ (unchanged ejection) control panel hub whenever R19BU and R27BU are transferred following an ejection. This indicates that detail cards are following detail cards after the ejection, or that heading cards are following heading cards after the ejection, such as would be the case in a voucher check application where the detail cards are missing (see R27BU).

R19BL transfer contact operates in conjunction with the head control relay contact points R27BL whenever the interlock successive ejection switch 22 is set to ON (open). This controls interlocking the card feed and causes a machine idling cycle whenever successive ejections are to occur, either because of an overflow, in cases where the heading cards of one group are followed by heading cards of another independent group, or where detail cards of one group are followed by detail cards of another independent group. See R27BL.

R20PU sheet overflow control is connected to the exit 2 control panel hub, which when wired to any other control panel hub such as the L-OF (list overflow) or eject D hub, will become energized when arm 2 passes 0 on the scale and closes the eject contact 2.

R20PL sheet overflow control is connected to the exit 1 control panel hub, which when wired to any other control point hub such as the L-OF (list overflow) or eject D hub, will become energized when arm 1 passes 0 on the scale and closes the skip auto start contact 4.

R20A is used to maintain the holding circuit for the sheet overflow control R20 holding coil and also for the pickup of R21; it maintains this holding circuit until it is interrupted by CF36 or R33BL opening.

R20B N/C points operate in conjunction with the skip-restore section of S21 (rear) and are used to control normal sheet ejection through the normally closed contacts of R20B when the switch is in the skip-restore position and R20 is not energized. The N/O contacts of R20B when closed (because of an overflow) control the circuit to the sheet overflow relay pickup coil of R46. This controls the circuits necessary to advance the carriage sector to the limit of travel, so that the first printing line of the succeeding form will have been reached by line spacing before the carriage sector is restored to normal.

R21A is used to interlock the card feed and print clutches whenever a sheet overflow occurs with the carriage sector set to short sheet. This prevents the card feed from running until after the paper is positioned.

R21B, when closed and operating in conjunction with the normally opened contact of R31AL, controls the energization of the sheet overflow relay R46 pickup coil and thereby controls the circuits to cause two line spaces following the sheet overflow ejection.

R22 two-ejection relay is normally energized under control of an impulse which is emitted from the UEJ control panel hub.

Billing applications often use the multi-heading, high-speed invoice setup, which requires that a form be equally divided into three sections: heading, body, and from the last body line to the first heading line. An invoice 8½ inches long set up in this way would require that arm 3 be set to 2⅚ inches. When an ejection or restoration occurs without a change from detail (NX) card to head (X) card as determined by the upper brushes, an impulse is received from the UEJ control panel hub at the end of ejection.

In this case, with UEJ wired to the 2-eject hub, the carriage is caused to eject twice, thereby advancing the paper from the last listed line of one form to the first body line of the succeeding form.

R22AU is used to maintain the holding circuit for R22 hold coil and maintains this circuit under the control of R31AL and R44BL.

R22BU contact closes to energize the pickup coil of R42PL and R17PU, in order to control the circuits necessary to cause two ejections under control of the UEJ hub, as used with short sheet applications.

R22BL N/C contact opens to prevent restarting the card feed until the two ejections initiated by R22BU have been completed. The contact, therefore, prevents listing during the two-eject operation by interlocking the card feed.

R23 auto total interlock is energized under the control of the timed impulse through CB31. This relay interlocks the circuits through CB21 so that on successive ejection and a before-total operation, the total will be held up until after the paper has been positioned.

R23A is the hold point for the hold coil of R23; it maintains this holding circuit under control of CB32.

R23B N/O contact point closes to complete the circuit through CB21 whenever the pickup coil of R23 has been properly energized by CB31 and 32.

R24 long sheet control relay is picked by the long sheet contact when the machine is set for long sheet operation. Primarily, it is used to interlock the carriage motor circuits.

R24AU N/C points control the resistance for the field when arm 3 is set for short speed operation. The N/O points control the resistance for the field when the long sheet contact is closed and R24 is energized.

R24AL completes the circuit to the motor when the long sheet contact is held closed by the interlock disc.

R24BL N/C contact opens whenever the carriage sector is set to eject long sheets. The opening of this point places the automatic total interlock relay pickup coil R23, and the auto start pickup coil R11, directly under the control of the eject before-total point R40B, or the eject after-total contact points R42B, thereby suppressing the card feed or total print operations until ejection has been completed.

R25PU coil is connected to the BT control panel hub (before total) and will accept any kind of impulse. It is energized to cause an ejection without interfering with the normal controls. This relay is used in applications where it is desired to eject before totals after one ejection has been completed; therefore, R25PU controls its R25B contact points to shunt R32BL.

R25PL heading card eject coil is connected to the heading card eject control panel hub (HC). This control panel hub may then be wired to the shunt row of the group control (unequal impulses). This method of wiring provides an independent class of control which does not necessarily have to be associated with the normal class of sheet ejection.

The pickup coil of this relay is energized whenever an eject class of control change occurs during cycles in which heading cards are passing the lower brushes. The energization of this relay establishes the circuits necessary for automatic ejection whenever a disagreement between heading cards occurs.

R25A, when closed, establishes the holding circuit for the heading card eject holding coil R25, under the control of CB29 and 30.

R25B N/O contact point controls the energization of the eject before-total relay R40PU, in order to establish the circuit necessary for automatic sheet ejection.

If a heading card of one control group is passing the lower brushes and is followed at the upper brushes by a heading card of a different control number, an eject from this class of control change will occur.

R26 heading control relay, when wired to the upper brushes, is used to establish the circuits necessary to control listing of the heading cards as well as interlocking the card feed after the last heading card passes the lower brushes.

R26AU N/O contact provides pickup circuit for R27.

R26AL N/O is the hold point for the hold coil of R26 in conjunction with CB29 and 30.

R26B N/O contact shunts R29BL points in order to control the energization of the auto start relay R11 as long as heading cards are feeding past the upper brushes.

After the last heading card has passed through the upper brushes, the N/C points of R26B operate in conjunction with the normally opened points of R29BL and R29AL to control the energization of the minor GI relay pickup coil R56, to establish the circuits necessary for group indication control during the first card feed cycle following the last heading card. At the same time it allows the heading control NX hub to emit an impulse to cause skipping if connected by wire to skip to 1.

R27AU is the holding point for the hold coil of R27 in conjunction with CF15 and 16.

R27AL N/O contact point is connected to the head control exit X hub and operates in conjunction with CF28 and R19AL to complete a circuit to cause skipping before the first heading card enters the lower brushes. This is used in voucher-check printing applications where the head control exit X hub is wired to the carriage skip to 1 or skip to 2, X or D hub.

R27AL is also used in conjunction with R45BU and CB45 to cause the skipping circuit impulse to be emitted from the head control exit X at the beginning of an ejection. In conjunction with R31BL N/O, R27AL will cause the skipping circuit impulse to be emitted from the head control exit X at the end of an ejection.

R27BU contact operates in conjunction with the head control X-NX R19BU and controls an impulse to the UEJ (unchanged eject) hub, wherever R27BU operates independently of R19BU, thereby indicating that detail cards follow detail cards after an ejection (such as in sheet overflow condition), or that heading cards follow heading cards as in a three eject form where the heading cards are missing. This is a signal that the form should be advanced over the space between forms and also over the succeeding heading section.

R27BL transfer contact operates in conjunction with the head control X-NX R19BL point whenever the interlock successive ejection switch is set ON (open circuit), and controls interlocking the card feed whenever successive ejections are to occur as a result of either an overflow or the heading cards of one group being followed by the heading cards of another independent heading group. Whenever detail cards are followed by heading cards, the card feed is not interlocked by R27BL.

R28AU is the hold point for the hold coil R28; it operates in conjunction with CF15 and 16.

R28AL N/C contact opens to prevent the energization of the minor group indicate relay R56 whenever a heading card is advanced toward the lower brushes. This contact remains open during the total cycle which precedes heading cards, thereby preventing the establishment of the group indication circuits until after the heading cards have passed the lower brushes.

R28BU closes to control energization of the print clutch relay R16, to control listing all the heading cards when the list switch 1 is in the non-list position.

R28BL N/C contact opens to prevent the energization of the carriage skip relays by a wire to head control exit NX whenever a heading card is in a position to enter the lower brushes. This contact insures that the heading will be listed in the heading portion of the invoice.

R29AU is the hold point for the hold coil of R29 and is used in conjunction with CB29 and 30.

R29AL operates in conjunction with R29BL N/O and, when closed, controls the energization of the minor group indicate relay R56, whenever the last heading card is passing the lower brushes.

R29BU N/O contact closes to control the energization of the heading card eject relay R25 pickup coil whenever a change in eject class of control occurs during cycles in which heading cards are passing the lower brushes. This may be an unequal condition between heading cards or the last heading card and the first detail card.

R29BL N/O point is connected to the head control exit NX which, in turn, may be wired to the carriage skip to 1D hub of the carriage skip relay R34.

The energization of R34, when controlled through R29BL N/O, suppresses the card feed cycles and causes automatic skipping into the body of the bill. Head control exit may also be wired to the carriage skip to 2D hub if desired. The normally closed points operate in conjunction with R26B and complete a circuit from CB31 to the auto start R11 pickup coil during all card feed cycles in which heading cards are not passing the lower brushes.

R30 head control suppression is energized with an impulse read from the lower brush in the same column used to pick up R26PU, which is wired to the head control upper hub.

R30A closes to provide a hold circuit for R30 through CB29 and 30.

R30B is used to prevent normal group control whenever a heading card passing the lower brushes is followed by a detail card with a sub-control number which is not punched in the heading card. It prevents a total cycle from taking place when heading cards of one group are followed by detail cards of the same group with an additional control number punched in them, such as head card 123 followed by detail card 123-01. This feature can also be used in applications not involving heading cards.

R31 contact points control the circuits necessary for automatically restarting the accounting machine following ejection, by allowing the interlock circuits to return to their normal position. It is also used in conjunction with the heading control exits NX card and X control panel hubs to cause skipping following ejection. It also controls the circuits necessary to cause skipping after ejection.

R31AU N/O contact operates in conjunction with the head control relay point R28BL and closes at the end of the ejection cycle. If head control exit NX is wired to skip either to 1 or skip to 2D control panel hubs, the circuit will cause skipping when detail cards are followed by more detail cards of the same group. It will also cause skipping if a group of detail cards is followed by detail cards of another control number, by which the absence of heading cards for the second group of detail cards would be recognized.

R31AL N/C transfer contact operates in conjunction with R44BL in order to de-energize the two-ejection control relay R22 hold coil. When the UEJ eject exit is wired to eject 2, successive ejections will start. R44BL will hold R22 energized at the end of the first ejection, and at the end of the second ejection both R31AL N/C and R44BL will be open, allowing R22 hold to drop.

The N/O side of this transfer contact operates in conjunction with the sheet overflow control R21B point in order to control the energization of the pickup coil of the sheet overflow relay R46. Whenever a sheet overflow occurs and the skip restore and eject space switch 21 (rear) is set to EJECT-SPACE, R46 will be picked up to give two line spaces.

R31BU N/C contact opens in conjunction with R31BL and controls the time that R43P and R44P may be energized whenever ejection is completed.

R31BL N/C point is used as a hold point for the after-total relay R42 and R43 and the eject before-total relays R40 and R41. These circuits are de-energized under control of R31 contact point whenever the eject auto start contact 5 of the carriage closes to energize B31 coil.

R31BL N/O points, in conjunction with R27AL head control NX-X relay, will cause an impulse from the head control exit X. This control panel hub is normally wired to a skip 1 or skip 2 relay, and this will cause skipping before heading cards may be listed.

R32 energizes the control circuits required to cause an ejection on an overflow, when it is wired from the UEJ hub, as in the case of a two-part statement and remittance stub form.

R32AU closes to complete the holding circuit for the R32 holding coil, and maintains this circuit through CF15 and 16.

R32AL N/O contact closes in conjunction with R31AL N/O to complete a circuit to the UEJ control panel hub upon completion of an eject cycle. It prevents an impulse to the UEJ hub when R20 and R21 alone are picked up to energize R46 on an overflow operation.

R32BL prevents the before-total eject hub from accepting an impulse following one ejection operation, until after the next card feed cycle has allowed R32H to become de-energized.

R33AU N/O points close after every sheet ejection to control the circuit from CF10 and CF11 to the carriage exit EJ hub in order to control certain carriage group indication applications. It may be used to impulse the counter plus or minus relays for one cycle following an ejection. The N/C points control the de-energizing time of the R45 holding coil.

R33AL contact closes after every ejection, and controls the energization of the eject after-total relay R44 whenever a second ejection is required; in turn, it is controlled by the eject after-total relay R42AL point.

R33BU operates in conjunction with the single sheet stop switch 20 and the eject after-total relay points R42AU. With the single sheet switch turned on, it prevents automatically restarting the card feed after any feed ejection.

R33BL N/C contact opens to de-energize the sheet overflow control relay R20 holding coil and R21 whenever sheet ejection is completed following an overflow.

Whenever the skip-restore switch 21 (front) is set to *skip-restore*, R33BL controls the de-energization of the sheet overflow relay holding coil of R46.

R34PU coil of this relay will control the circuits to cause skipping, similar to that caused by R34PL. However, this coil will accept only 11 and 12 impulses, usually from the card, to initiate skipping.

R34PL coil of this relay is used to control the circuits necessary to cause skipping until the automatic carriage arm 1 passes 0 on the scale. It also controls the circuits necessary to suppress the card feed cycle operations on total cycle of operations until such time as all skipping has been completed.

The carriage skip D pickup control panel hub, when wired to the head control exit NX control panel hub, energizes R34PL to cause skipping from the last listed heading card to the first line reserved for the first detail card in the body of a bill.

On an ejection from the body of one bill to the heading portion of the succeeding bill, if heading cards are missing or if there are more detail cards following, an impulse is emitted from the head control exit NX hub to energize carriage skip 1 relay R34PL. This is necessary to skip over the head portion of the bill to the first body line so that the detail card will be listed in the body of the bill.

R34A closes to complete the holding circuit for the carriage skip relay R34 holding coil; it also controls the pickup of R35. These two relays will remain up until arm 1 crosses 0 on the scale and opens the skip stop contact 3.

R34B contact point opens the total control circuit from L9 through

CB21 to prevent a total from being printed whenever the carriage is ready for a skipping operation.

R35AL N/C contact opens to prevent the energization of the auto start relay R11 pickup, or the auto total interlock relay R23 pickup coil, whenever the carriage skip circuits have been set up to cause automatic skipping through the energization of the line space magnets. With R35AL points open, the card feed clutch and the print clutch will not operate.

R35BL N/C point of this transfer contact is used to control the holding circuit for the carriage first card in R8. This contact opens to de-energize R8, so that after skipping, the upstroke space controlling cam PM11 will not be effective during the first list cycle following the skipping operation. This causes the first item after skipping to be listed on the line for which the arm was set.

The N/O point of R35BL completes the circuit to the line space magnet through interlock contact 6 and R46AL in order to cause skipping until arm 1 is brought to coincide with 0.

R36. This carriage skip relay R36 normally may be wired to the minor, intermediate or major before-total hub in order to control skipping to a predetermined total line. It also may be impulsed by a digit or an X.

R36A closes to complete the holding circuit for the carriage skip to 2 relay coil R36 and also completes the circuit for R37. This circuit is maintained under the control of sheet stop contact 1 which is operated by arm 2.

R36B N/C point opens to prevent the energization of the auto start relay R11, pickup coil, and the auto total interlock relay R23 pickup coil, in order to prevent either the card feed clutch or print clutch from operating during a skipping operation.

R37AL N/C contact opens the circuit from L9 through CB21 to the print clutch magnets and the total switch plate magnets, in order to suppress the total printing operations whenever the line space magnet is energized under the control of the carriage skip to 2, R37BL N/O contact point. Carriage skip contact R37AL is used in operations such as a predetermined total control.

R37BU closes to control the energization of the skip overflow interlock relay R39PL whenever skipping is controlled by the carriage skip R36 and R37.

R37BL N/O side of this contact closes to control the energization of the line space magnet in order to control skipping to a predetermined point under the control of the sheet stop contact 1 and arm 2.

The N/C point of this transfer contact is used to control the carriage circuit for the first card in relay R8. This contact opens to de-energize R8 so that after skipping, if listing is to continue, the next listed item will be listed on the same line for which the carriage arm 2 is set.

R38 skip overflow interlock pickup coil becomes energized whenever the carriage skip to 1 or skip to 2 relays (R35BL or R37BL points) operate in order to control skipping.

R38AU N/O point closes to complete the circuits required in order to control listing the first card following a skipping operation; it parallels R56BL or R28BU whenever list switch 1 is set to NON-LIST (TAB). This contact becomes effective whenever the skip to R34 or skip to 2 R36 have been energized.

R38AL closes for a hold circuit for the skip overflow R38 and maintains this circuit under control of CF15 and 16.

R38B N/C point opens to prevent the energization of the sheet overflow control R20 pickup coils whenever the carriage eject contact 2 or skip auto start contact 4 are closed when arm 1 or 2 crosses 0 on the scale through a skipping operation. It is assumed that if skipping is the means of advancing arm 1 or 2 to 0, ejection will occur under the control of a class of ejection control change and not from an eject exit hub.

R39PU coil is energized whenever the eject contact 2 closes at the time that arm 2 crosses 0 on the scale and, through its R39B contact point, prevents the setting up of the skip to arm 2 skipping circuit. The energization of R39PU, therefore, prevents the predetermined total circuits from being established after the eject contact 2 has been closed.

R39 skip overflow interlock PL coil is energized whenever the carriage skip relay R37BU contacts close for skipping to arm 2.

R39A closes to establish the holding circuit for the skip overflow interlock relay R39. The holding circuit is maintained under control of the carriage interlock contact 6 which opens during an ejection.

R39B N/C opens to prevent energization of the skip to arm 2 relay R36PL if arm 2 has already reached 0 and closed eject contact 2.

R40PU eject before total coil is energized to control the circuits required for causing sheet ejection before printing the eject class of total. When used in conjunction with the heading card eject relay R25B, this relay is energized to control sheet ejection upon completion of a card feed cycle in which heading cards are followed by detail cards of a different control number.

R40PL eject before total coil is energized under the control of the carriage sector contact to control the energization of the sheet eject magnet through the associate R41 relay contact point R41AL. This circuit is effective only when a sheet overflow occurs and the skip-restore and eject-space switch 21 rear is set to SKIP-RESTORE.

R40A closes to complete the holding circuit for R40 through R31BL N/C until the end of an ejection, at which time eject auto contact 5 closes and picks up R31-32.

R40B N/C point opens to prevent energization of the auto start relay R11, or the pickup coil of R23 auto total interlock relay, in order to interlock both the card feed clutch and the print clutch until the before-total ejection is completed. This point may be shunted by the successive ejection switch in the off position on short sheet operation. There will not be a shunt circuit when arm 3 is set for a length greater than 3⅔ inches and R24B points are open.

R41AU N/O contact closes to control the energization of the sheet eject magnet through CB33, during the same cycle in which the eject before-total relay pickup coil of R40 is energized. This contact controls sheet ejection before printing any class of total, and also causes sheet ejection whenever the eject before-total relay R40PU is energized under control of the heading card eject relay contact point R25B.

R41AL, operating in conjunction with the sheet overflow relay contact R46BL N/O and the sector contact, closes to control the energization of the sheet ejection magnet through CB33, whenever an overflow occurs and the skip-restore and eject-space switch 21 rear is set to SKIP-RESTORE. R41AL closes whenever the carriage sector contact closes after the carriage sector has reached the limit of its travel.

R41BU is used to complete the skip circuit to the line space magnet through R46AL N/O whenever an overflow condition and a control change occur in the same cycle in which the eject before-total relays R40 and R41 coils are energized. R41BU is used principally in conjunction with the skip-restore and eject-space switch 21 set to SKIP-RESTORE.

R41BL operates in conjunction with the ON position of the interlock successive ejection switch 22 (rear) and opens to interlock the print clutch circuit under control of the auto total interlock relay R23 pickup coil whenever short sheet ejections before and after a specific class of total are required. If it is desired to eject before and after a minor class of total, the sheet ejection before total would occur first and would be completed before the minor total printing cycle started. The ejection after the total would be normal.

This interlocking before-and-after totals is necessary because the before-and-after total ejection relays would otherwise be energized at the same time. At the end of the first ejection, when the eject auto start contact 5 closes, both the before-and-after total hold relays would be dropped; therefore, R23B delays the total cycle until after the before-total ejection is completed. Then, when PM2 N/O points close, the after total ejection relays may be energized and cause the ejection following the total. Successive ejection switch 22 is set to the ON position.

R65AL and R70BL shunt R42B in order to allow the auto total interlock relay R23 to pick up during the minor or intermediate total print cycles, respectively.

R42PU eject after total #2 is normally impulsed from the Class of Total hubs, through the AT eject hub of the control panel. Its point, in conjunction with those of R43, serve to initiate the eject after-total circuits.

R42PL eject after total #2 may be impulsed on either a card feed or a total cycle and, in conjunction with R43, will cause an eject operation at the end of the cycle. It is connected to the D eject hub of the control panel and, therefore, may be energized at any time during the cycle.

R42AU N/C point is used in the hold circuit of the start interlock relay R12. When the single sheet stop switch is set to its ON position and an after-total eject operation takes place, R42AU points open to de-energize R12, thus suppressing an automatic start of the card feed mechanism.

R42AL serves as a hold point for the R42 hold coil. It also holds R43 coil energized in conjunction with R43AU.

R42BL N/C points provide an interlock to suppress the energization of the auto start relay R11 and the auto total interlock relay R23 during an after-total ejection operation.

R43 eject after total coil is in parallel with the R42 holding coil and energizes through R17B N/O points. On points where R43 has no R43AU holding points, R43 will pick up a second time through R17B N/C, as the R17 hold is under the control of CB29 and 30 which will open at 270°. In either case this circuit will remain energized until it is interrupted by the opening of the eject interlock and auto start contact R31BL N/C.

R43AU provides a hold point for the hold coil of R43, thus eliminating a close timing in the single item ejection application, R43AU points also provide a pick circuit to the hold coil of R42 after the first single item ejection cycle.

R43AL eliminates a possible second ejection after a total (controlled form to form) ejection, when the single sheet stop is turned ON. This N/O point is in parallel with R70AU N/O point. This permits the continuously running shaft to operate (idling control machines) during after total sheet ejections.

R43BU N/O contact closes to control sheet ejection under control of CB33. The closing of this contact will not become effective until after the minor and intermediate contacts R64BL and R69BU have closed upon completion of the minor and intermediate total printing cycles.

R43BL is connected in series with the carriage eject exit 2 hub, and the sheet overflow control relay R20PU, opens to prevent a circuit from being completed through R20PU after the eject after-total relay R42 has been energized. These conditions would occur if the minor class of total were connected to the eject AT hub. Assuming that an intermediate control change occurred, there would be a possibility of energizing R20PU if a sheet overflow occurred during the downstroke space of the minor total cycle or the upstroke space of the intermediate total cycle.

R44 eject after total #1 pickup coil is energized under control of R33AL and R42AL and is used in the circuits necessary to cause double ejection. The pickup coil is energized only after one ejection has been completed under control from an overflow source, and the second ejection is initiated by energizing R42PL through R22BU.

R44AU is the holding point for the hold coil of R44 and is controlled by CF15 and 16, which will not open until 225° of the card feed cycle following ejection.

R44AL opens to prevent R46 hold coil from being energized whenever a double ejection initiated by the UEJ hub occurs. If an overflow condition has been sensed by other wiring in the panel at the same time the UEJ emitted an impulse, the ejection will not be followed by two line spaces.

R44BU opens to prevent a second impulse from being emitted from the UEJ hub until after the card feed has restarted and CF15 and 16 open to cause R44 holding coil to be de-energized.

R44BL opens at the beginning of the second ejection cycle in order to permit the two-ejection control relay R22 holding coil to be under the control of the normally closed points of R31AL, which opens upon the completion of the eject cycle.

R45 eject-space interlock pickup coil is energized whenever the sheet eject magnets are energized, and it is under control of CF30.

R45AU is used to maintain a holding circuit for the carriage skip relays R36 and R37 whenever these relays are energized to cause skipping after ejection. On an ejection, arm 2 passing 0 on the scale would open sheet stop contact 1 and drop R36 and 37 hold. This is not necessary with skip stop contact 3, as on an ejection the line space cam holds the skip stop contact in the latched position when arm 1 passes 0.

R45AL closes to maintain a holding circuit for the eject line space interlock relay holding coil R45 and maintains this holding circuit until interrupted by R33AU N/C points, which open at the end of the sheet eject cycle.

R45BU operates in conjunction with CB45 and R27AL in order to control skipping after ejection so that heading cards may be listed in the heading section of a voucher check application.

R45BL opens to suppress all line spacing or skipping operations as soon as R45 is picked up by CF30. This will take place even before interlock contact 6 opens.

R46 sheet overflow coil is energized to control the circuits required to cause line spacing for either the skip-restore or eject-space sheet overflow spacing control.

R46AU is used to maintain a holding circuit for the sheet overflow relay holding coil R46.

R46AL N/O side of this transfer contact closes in order to cause skipping whenever an overflow occurs.

Whenever the eject-space and skip-restore switch 21 is set to the SKIP-RESTORE position, R46AL N/O controls skipping to the first printing line of the succeeding form before the carriage sector is restored.

Whenever switch 21 is set to EJECT-SPACE, R46AL controls skipping for two line spaces beyond the point reached after overflow ejection. The normally closed contact points of R46AL open the circuit from the line space magnet to the carriage skip relay contacts R35BL and R37BL.

R46BU is in the pickup circuit for R11 to prevent the card feed from operating until after spacing is completed.

R46BL N/C points of this contact operate in conjunction with the sector contact to control the energization of the sector overflow control relay R47PL. This controls the energization of R47PL when the sector contact closes through normal line spacing.

The energization of R47PL closes its R47B points to cause upstroke spacing following the restoration of the carriage sector, thereby eliminating overprinting of listed items at the point where a "sector overflow" occurred.

R46BL N/O points, in conjunction with the sector contact and R41AL, complete a circuit to energize the sheet eject magnet in an overflow operation when switch 21 (rear) is set to SKIP-RESTORE.

R47A is used to maintain a holding circuit through CF27.

R47B is used to control upstroke spacing during the first listing cycle following restoration of the carriage sector whenever the carriage sector contact closes during line spacing operations and thereby eliminates overprinting of listed items at the point where a sector overflow occurs.

R48 minor group indicate is energized with R56. The purpose for R48 is to prevent summary punching an indication when a control change takes place and the first card of the new group is a heading card. If, following the total, heading cards are present, R28AL will be open to prevent R56 from picking up. This would leave R56BU closed and allow a summary punching of indication. Since R48 does not pick up, it prevents this. On the first detail card R48 and R56 are picked up, but R56 holds only through one card feed cycle following a control change. R48 remains up, keeps R48B closed, and allows group indication summary punching from body or detail cards.

R48A closes to establish a holding circuit for the minor group indicate relay R48 and to maintain this holding circuit through TSD1 contact. R48 is de-energized at the start of the minor total cycle preceding heading cards.

R48B N/O contact closes to complete the circuits required for group indication control through the interlock contact I8, when used in conjunction with the duplicating type of summary punch. R48B operates in conjunction with R56BU and prevents the group indication circuit from being completed until after the first detail card following heading cards has passed the lower brushes.

R343 form stop provides a control in the start interlock R12 hold circuit to stop the machine when the report form supply is depleted. This condition is indicated by the closing of the form stop contact which will cause R343 to energize immediately or following the next ejection. It operates in the form stop circuit along with R344, R345, R346, the form stop switches #1 and #2, and the form stop contact.

R343AU N/O point, in conjunction with R12BL, causes R344 line space interlock relay to be energized immediately following the de-energization of R12 by the opening of the R343B point.

R343AL N/O serves to establish a holding circuit for R343, form stop relay, and to maintain this holding circuit until the form stop contact is opened by the insertion of another report form.

R343BL N/C contact point serves to open the holding circuit of the start interlock relay, R12. This condition indicates that the last report form is passing through the carriage and the machine must stop to permit the report form supply to be replenished. The start key must be depressed to start the machine again.

R344 line space interlock serves to interlock the line space magnet circuit should any of the skipping controls (carriage skip #1, carriage skip #2 or sheet overflow) be initiated on the same cycle in which the depletion of the report form supply is recognized.

R344AL N/O, in conjunction with R12BL, holds R344 hold coil energized. This circuit will be maintained until the forms are replenished and the start key is again depressed, thus opening R12BL.

R344BL N/C point opens to interlock the line space magnet circuit in case one of the skipping circuits should be effective simultaneously with the form stop circuits.

R345 eject interlock is energized each time an ejection or restoration operation occurs through the ejection circuits and CF30. With form stop switch #1 OFF and form stop switch #2 set to the eject position, this relay serves to interlock the form stop circuit and delay the energization of R343. As the last report form advances and permits the form stop contact to close, R343 cannot be picked until R345 is energized during the next ejection or restoration cycle. Therefore, the last form may be completed before the machine is stopped.

R345AL N/O completes a circuit to R345 hold coil in conjunction with the R31BL N/C point and will be maintained until the end of the ejection or restoration cycle when R31 is picked.

R345BL N/O serves to complete the circuit to R343 form stop relay at eject time when it is desirable to complete the last report form printing before the machine is stopped. This point is effective only when form stop switch #2 is set to the eject position. With this switch set to the immediate stop position R343 may be picked or energized as soon as the form stop contact closes, thus stopping the machine immediately.

R346 list-total interlock is energized only during listing and total printing cycles. This is controlled by print clutch relay, R16A point and the normal print clutch circuits for listing and total printing cycles. It provides an interlock in the R343PU circuit when form stop switch #2 is set to the immediate stop position. This is necessary to prevent R343 from picking as soon as the main line switch is turned ON or while the machine is idling.

R346BL N/O point permits R343 to be energized through form stop switch #2 only during active list or total print cycles.