PROJECT SILO TECHNICAL MEMO #9

INVESTIGATION OF A METHOD OF PACKAGING MULTI-PATH CORES

by F. A. Schultz

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ABSTRACT: A design for packaging multi-path cores has been created. Layouts, details, and wiring pattern studies, have been made. Experimental work has been conducted to obtain information about the questionable steps of the chemical process associated with the design. Molded models have been constructed and processed.

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INVESTIGATION

OF

A METHOD OF PACKAGING MULTI-PATH CORES

INTRODUCTION

This particular design appears to be the most promising of all the core packaging methods explored to date. The creation of this design can possibly be attributed to the two following factors:

1. The establishment of a philosophy of limiting the number of conductors through each hole of a core to one.

2. The exploratory work conducted previously, (see Silo Technical Memorandum # 7) which revealed the working limits of some of the chemical techniques that possibly could be used for core packaging applications.

This report describes the design, the associated chemical process, the experimental work conducted towards obtaining answers to the individual problems with the design, and the work done with molded models of a one bit section of an array in an effort to prove the design feasible.

A brief description of Mr. H.P. Luhn's method for packaging toroidal cores is also contained in this report.

I. THE BASIC SCHEME

It is my opinion that the most significant feature of the printed wiring art is that it is possible to interconnect components to form an electronic circuit, without handling the interconnecting wires. Consequently the printed wiring approach that has been followed with this multi-path core packaging work seems to be the most reasonable and should result with the greatest advantages.

The design described herein utilizes a combination of individual features of other core packaging schemes. In addition, a new principle of electroplating a homogeneous conductor over a discontinuous surface formed by two mechanical parts is employed.

A representative multi-path core and a core with its associated wiring is shown in Figure 1 and Figure 2, respectively. The contemplated high speed core plane contains 16 x 32 (512) cores.

An exploded view of the proposed packaging design is shown in Figure 3. A one bit section of a plane is shown. The plug and the holder are molded parts. The broad basic chemical process steps that will be used in conjunction with the design follow.

1. The cores are vibrated into the cavities of the holder.

2. The plugs are placed over the cores.

3. The entire assembly is dipped into an adhesive thereby sealing the gaps between the plugs and the holder and the gaps inside each hole. The adhesive is also used to bond conductors in the channels.

4. The entire assembly is vacuum metallized with copper.

5. The unit is copper plated and subsequently tin-lead plated.

6. The bottom and top surfaces are finally sanded or ground leaving conductors in the channels. It might be possible to apply a plating resist on the raised surfaces after metallizing thereby relieving this final step.

II. POSSIBLE PROBLEMS

The basic scheme and the associated process relys upon answers to some questions before feasibility can be ascertained.

The pertinent questions are:

1. Can the mechanical parts be molded with the necessary tolerances and with materials that possess the desired electrical properties?

2. Is an adhesive available that will serve as a conductor bonding agent, seal all the gaps, not plug the holes during dipping, and possess drying and curing properties that will not be disturbed by the vacuum metallizing and electroplating operations?

3. Is it possible to vacuum metallize and to electroplate over ferrite material?

4. Is it possible to vacuum metallize and to subsequently electroplate the holes formed by the core and the molded mechanical parts?

5. Is it possible to lay out an electrically balanced winding configuration in the channels to conform with the wiring shown in Figure 2.

6. Is it possible for the cores to operate within a desired temperature range after they are packaged with this scheme?

It is apparent that other possible problems that might be encountered in plating and vacuum metallizing are no barrier, since these are proven techniques.

III. THE WINDINGS

Before any layouts could be made of the scheme, it was necessary to conduct a study of the various possible methods of orienting wires to form a core plane. The objective was to minimize both the number of feed through holes and the number of different type plugs while still having an electrically balanced sense winding. Figure 4 shows the necessary path of the sense wire with respect to the drive wires to gain a balanced condition. It was eventually decided that the winding shown in Figure 5 most nearly meets all of the requirements. Although a sixteen-bit array is shown, the wiring pattern can be expanded for a full size plane.

A plane was made without cores and consisting only of printed wires, with this wiring pattern. The electrical group will make measurements on this plane to evaluate the electrical characteristics such as noise pickup on the sense winding, the total impedance of the array, etc. Registration problems and subtractive process limitations made it difficult to make this plane. However, a photograph of the "dummy" plane is shown in Figure 6. This experimental plane was made after the design and test work, which will be described later in this report, was completed.

IV. THE DESIGN

The wiring pattern that was decided upon controls the vertical and lateral spacing of the cores. A layout study was made to determine the spacing of the cores in conjunction with the spacing of the conductor channels. Figure 7 portrays this study. The cores are located on a .300" grid system and the channels are on a .062" grid system. The overall dimensions of a 512 core plane would be approximately 10.5" by 6.0".

Further layouts were made of a one bit section of a plane with a typical plug. Figure 8 is a detail drawing of a one bit section of the molded plane holder. The associated plug and the assembly drawing of this one bit section are shown in Figure 9 and Figure 10 respectively. Two different type plugs are required.

Upon completion of these layouts, it was decided to construct a mold of a one bit section to evaluate:

A. The feasibility of molding the parts to the mechanical limitations.

B. The complete chemical process with the molded parts.

The holder and plug molds are shown in Figure 11. The parts from these molds are shown in Figure 12. The parts were molded with Resinox 3700. It should be noted that the nominal diameter of the holes is 0.025".

V. BASIC EXPERIMENTAL DATA

A good deal of experimental work was conducted for the purpose of obtaining answers to the questionable points of the chemical process. This work was aimed at packaging the five hole core shown in Figure 1.

An adhesive hole-plugging test and an adhesive gap-bridging test were conducted with Armstrong Cork Co. adhesive N178, in the hope of finding a ratio of solvent to adhesive that would bridge the gaps of the mechanical design and simultaneously would not plug the holes. The specifications of N178 indicate that the adhesive would meet the other requirements which were outlined previously. Figure 13 and Figure 14 show the data and the probable limit curve, respectively, of the hole-plugging test. Figure 15 and Figure 16 show the data and the probable limit curve of the gap-bridging test. From this data, it appeared that with an adhesive ratio of 6:1, it was possible to bridge the gaps and not plug the holes of the mechanical design for the five hole core in question.

The general limitations of vacuum metallizing a hole were revealed in STM #7. It was decided to further verify the vacuum metallizing operation to the specific conditions of this design. The results of this test are shown in Figure 17.

Figure 18 shows the results of a conductive coating test. This was considered as a possible method of replacing the vacuum metallizing step. No success was enjoyed with getting the conductive material through the holes with the method shown.

Another test was conducted which proved that it was possible to coat ferrite material with an adhesive and subsequently vacuum metallize and electroplate copper over the surfaces. Torroidal cores were used for the pupose.

A preliminary test was conducted with determining the size holes through which molten Wood's metal can be poured. The test was conducted with holes ranging from 0.015" to 0.030" in a 0.094" thick XXXP board. The only significant conclusion that can be made is that it will be necessary to use pressure to force the metal through the holes.

VI. MOLDED MODEL PROCESS DATA

Having proved that it is possible to mold a one bit section of a core plane, work was conducted to determine the feasibility of the process outlined in Section I, with the use of some molded parts. All of the molding work was performed by R. Bell of the Plastics Laboratory. Typical parts used for all tests are shown in Figure 12.

Ferrite cores were simulated by machined pieces of brass as per Figure 1. The adhesive used for all tests was Armstrong Cork Company's N178. The plating solutions listed below were operated according to the manufacturer's recommendation.

1. Pyrophosphate copper electroplating bath. (Unichrome Copper Plating Solution by Thermit Corp., N. Y., N. Y.).

2. Tin-lead electroplating solution (Baker and Adamson Products).

The initial tests, Figure 19, were aimed at determining the ratio of adhesive to the solvent for the process, the number of adhesive dips required, hole plugging data, and general observations. The results were not satisfactory or consistent.

The tests of Figure 20 were specifically aimed at determining the virtues of horizontal or vertical drying, and determining the number of adhesive dippings required to bridge all the gaps. Compressed air was used for blowing out the holes whenever necessary. These results indicate that three dippings are required to bridge the gaps with this adhesive, regardless how the units are held during drying.

Figure 21 contains the data that proves the process feasible. Cross sections of the hole conditions are shown in Figure 22.

VII. TEMPERATURE STABILIZATION

There was some question about whether or not it would be possible to stabilize the temperature of the multi-path cores when packaged with this design. Several fruitless calculations were made in an effort to mathematically determine the temperature conditions of a core operating under the severe condition. The number of unknowns are too great even though some reasonable assumptions can be made.

A ferrite core with the dimensions shown in Figure 1 was packaged with some molded parts and subjected to a heat test. It is almost conclusive that these particular type cores will have to be immersed into some kind of a liquid in order to stabilize the operating temperature range. Heat transfer by convection will thus be employed.

Consequently, the packaged core was immersed in a container of Freon #11 when tested. It operated at simulated conditions of the 2 microsecond memory without adverse effects. Another test, simulating the operating conditions of the 1/2 microsecond memory, was not conclusive but gave an indication that the design would not limit temperature stabilization.

VIII. CONCLUSIONS

1. The basic mechanical design with its associated process is feasible for packaging multi-path cores containing 0.025" diameter holes with a minimum of 0.015" between the holes. The possibility of utilizing the packaging scheme for cores with 0.020" diameter holes and 0.010" between holes, is questionable. It will be necessary to prove the scheme feasible for this type core.

2. Further development work should be done with the chemical process in order to improve it. The possibility of finding an adhesive that only requires one dipping and the possibility of applying a plating resist after the metallizing step, requires exploring. One adhesive vendor has already been contacted and is going to send samples for evaluation.

3. Plastic molding materials should be investigated in order to assure the proper selection of materials for the molded parts.

4. Preliminary tests have indicated that it is possible to stabilize the operating temperature of the core in the package. The general problem of temperature stabilization requires further study.

5. Further mechanical design is required to make a more reliable design at less cost.

H. P. LUHN'S CORE ROD METHOD

FOR PACKAGING TOROIDAL CORES

A group in the Product Development Laboratory under H. P. Luhn's direction has been developing a method of wiring toroidal cores.

The basic scheme is shown in Figure 23. Prestrung cores (3 wires through each core) are spirally wound around plastic molded core rods which contain positioning cavities for each core. Three other wires are subsequently threaded through the cores in a lateral direction with reference to the axis of the rods.

Modifications of this scheme have been considered. One such scheme is shown in Figure 24, where core holders are attached to a thin tape which is spirally wound around rods. Figure 25 is a picture of a fixture that was built for winding prestrung cores onto rods. Figure 26 is a detailed view of prestrung cores being wound on a rod with the use of the fixture.

SYM.	DATE	CHANGE NO.				DEVELOPMENT NO.	Q/M
						7066-43	

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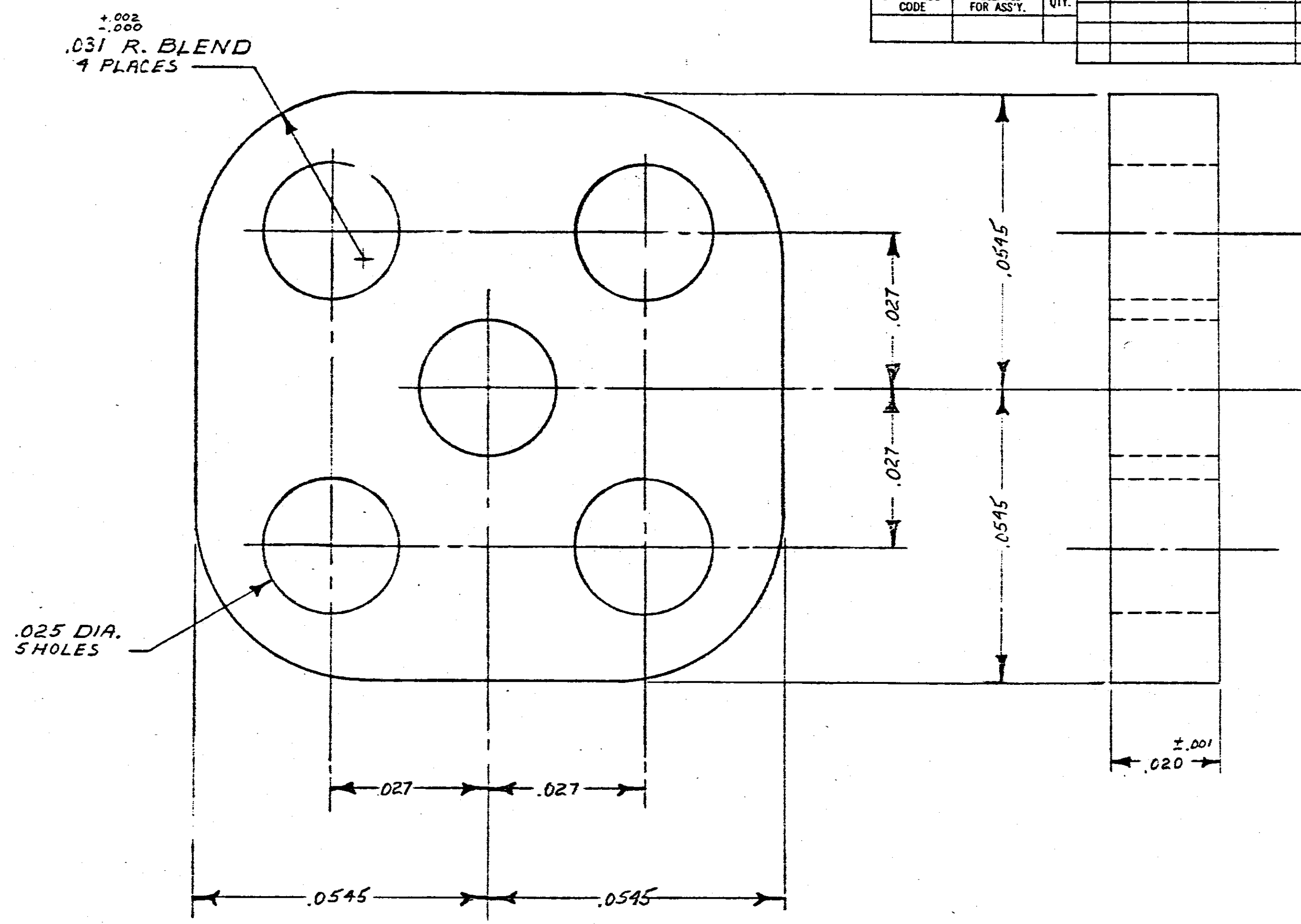


Figure 1

MATERIAL SPECIFICATIONS	NO. 03-270		
BRASS			
CASE DEPTH			
HARDNESS			
SURFACE TREATMENT		SPEC. NO.	
		TECH. SERVICES APPRO.	DATE

TOLERANCE UNLESS OTHERWISE NOTED		
DECIMALS	± .0005	
FRACTIONS		
ANGLES		
CORNERS AND/OR EDGES BROKEN	OUTSIDE	.003 MAX.
	INSIDE	.003 MAX.

ALIGNMENT WITHIN	NOTE I
CONCENTRIC WITHIN	TOT. IND. READING NOTE II
FLAT WITHIN	NOTE III
PARALLEL WITHIN	NOTE IV
STRAIGHT WITHIN	NOTE V
SQUARE WITHIN IN INCHES	NOTE VI

INTERNATIONAL BUSINESS MACHINES CORP.			
NAME	TEST PIECE		
DESIGN.		MODEL	
DETAIL	[illegible]	SCALE	50/1
CHECK.		DRAW.	
APPRO.		CHECK	

DEFIANCE NO. 107H

SYM.	DATE	CHANGE NO.				DEVELOPMENT NO.	Q/M
						7066-45	

STANDARDS CODE	RELEASED FOR ASS'Y.	QTY.

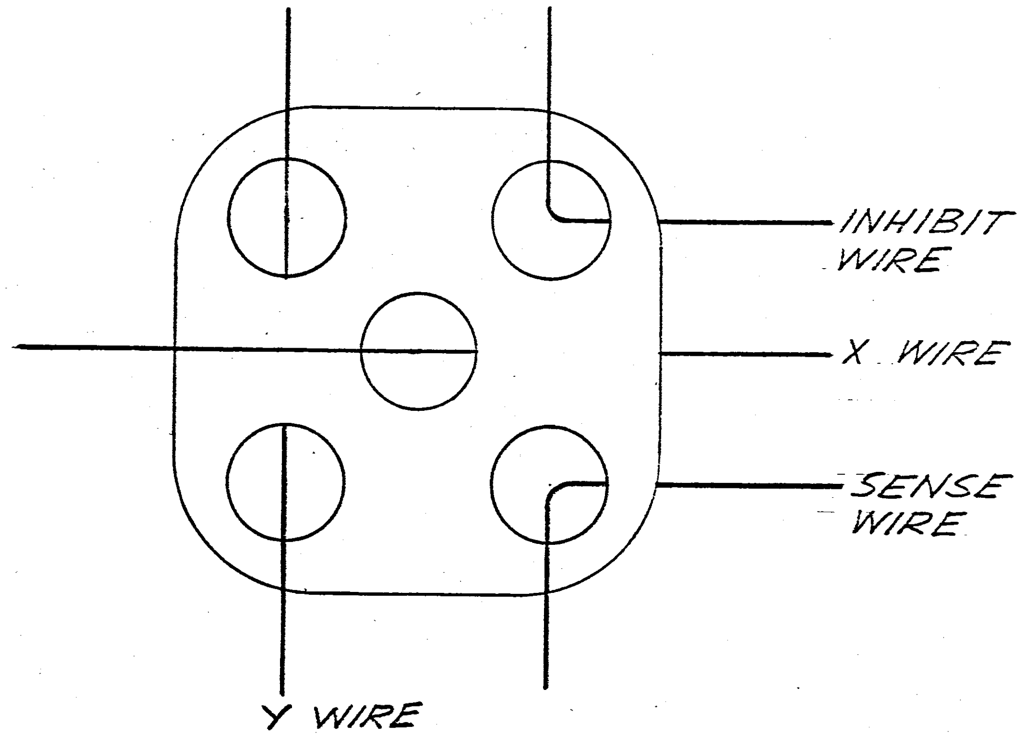


Figure 2

MATERIAL SPECIFICATIONS	NO.
CASE DEPTH	
HARDNESS	
SURFACE TREATMENT	SPEC. NO.

7066-45

TECH. SERVICES APPRO.	DATE

TOLERANCE UNLESS OTHERWISE NOTED	
DECIMALS	
FRACTIONS	
ANGLES	
CORNERS AND/OR EDGES BROKEN — OUTSIDE	
CORNERS AND/OR EDGES BROKEN — INSIDE	

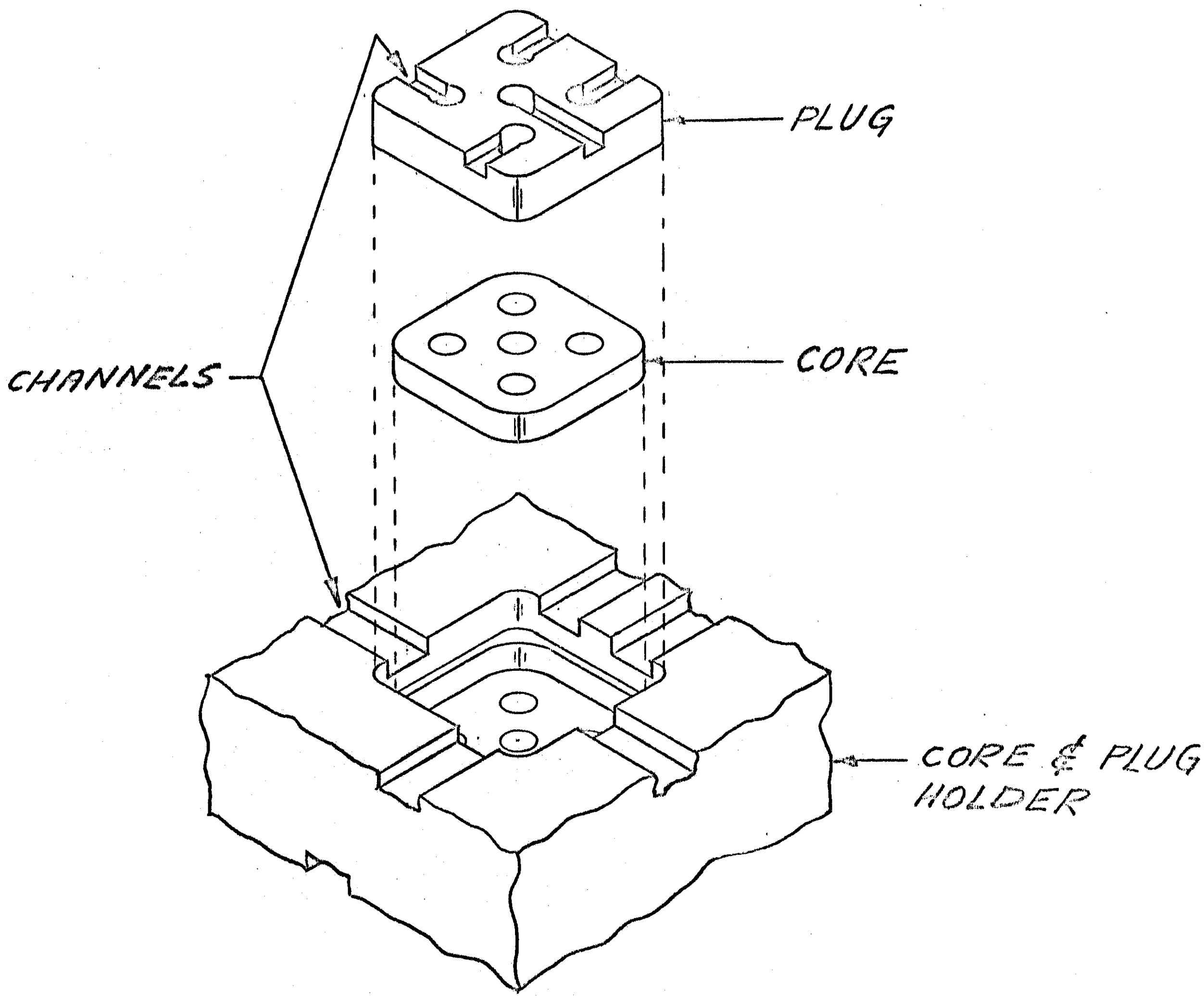
ALIGNMENT WITHIN	NOTE I
CONCENTRIC WITHIN	TOT. IND. READING NOTE II
FLAT WITHIN	NOTE III
PARALLEL WITHIN	NOTE IV
STRAIGHT WITHIN	NOTE V
SQUARE WITHIN IN	INCHES NOTE VI

INTERNATIONAL BUSINESS MACHINES CORP.

NAME: HIGH SPEED CORE WIRING METHOD

DESIGN.			MODEL	
DETAIL.	E.M.	10/8/56	SCALE	25/1
CHECK.			DRAW.	
APPRO.			CHECK	

DEFIANCE NO. 167H 3607



One Bit Section Of Core Plane
Figure 3

SYM.	DATE	CHANGE NO.			

STANDARDS CODE	RELEASED FOR ASS'Y.	QTY.

DEVELOPMENT NO.	Q/M

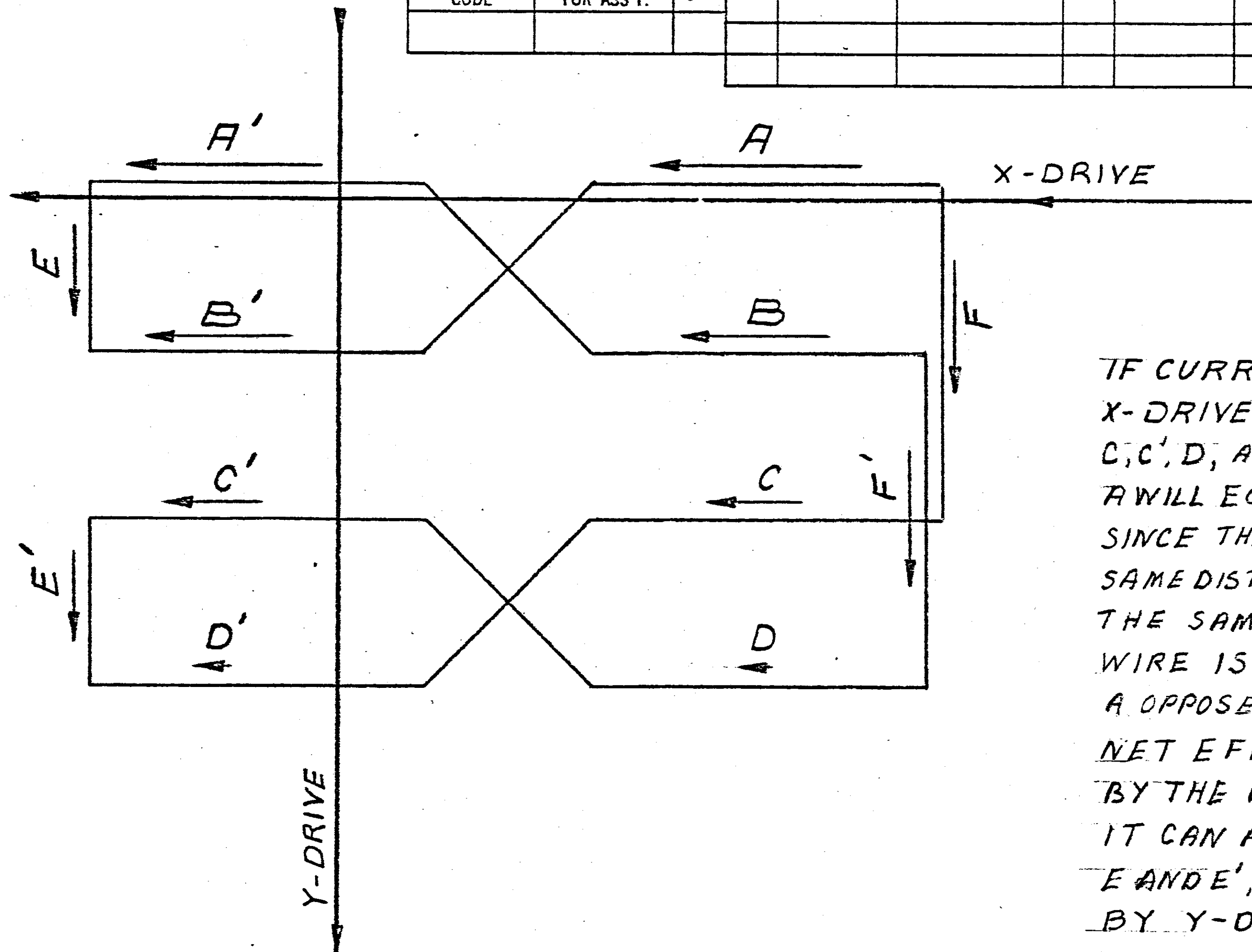


Figure 4

IF CURRENT IS PASSED THRU X-DRIVE; VOLTAGES A, A', B, B' C, C', D, AND D' WILL BE INDUCED. A WILL EQUAL A'; B, B'; C, C' AND D, D' SINCE THEY ARE RESPECTIVELY THE SAME DISTANCE FROM X-DRIVE AND THE SAME LENGTH. THE SENSE WIRE IS WOUND SUCH THAT A OPPOSE A'; B, B'; C, C'; D, D'. THE NET EFFECT OF NOISE INDUCED BY THE DRIVE WIRE WILL BE ZERO. IT CAN ALSO BE SEEN THAT E AND E', AND F AND F'; INDUCED BY Y-DRIVE WILL CANCEL EACH OTHER

MATERIAL SPECIFICATIONS	NO.
CASE DEPTH	
HARDNESS	
SURFACE TREATMENT	SPEC. NO.
TECH. SERVICES APPRO.	DATE

TOLERANCE UNLESS OTHERWISE NOTED	
DECIMALS	
FRACTIONS	
ANGLES	
CORNERS AND/OR EDGES BROKEN	OUTSIDE
	INSIDE

ALIGNMENT WITHIN	NOTE I
CONCENTRIC WITHIN TOT. IND. READING	NOTE II
FLAT WITHIN	NOTE III
PARALLEL WITHIN	NOTE IV
STRAIGHT WITHIN	NOTE V
SQUARE WITHIN IN INCHES	NOTE VI

INTERNATIONAL BUSINESS MACHINES CORP.

NAME	NOISE IN SENSE WINDING FROM DRIVE WIRES		
DESIGN.	[illegible]	MODEL	
DETAIL.		SCALE	
CHECK.		DRAW.	
APPRO.		CHECK	

STANDARDS CODE	RELEASED FOR ASS'Y.	QTY.	SYM.	DATE	CHANGE NO.				DEVELOPMENT NO.	Q/M
									7066-48	

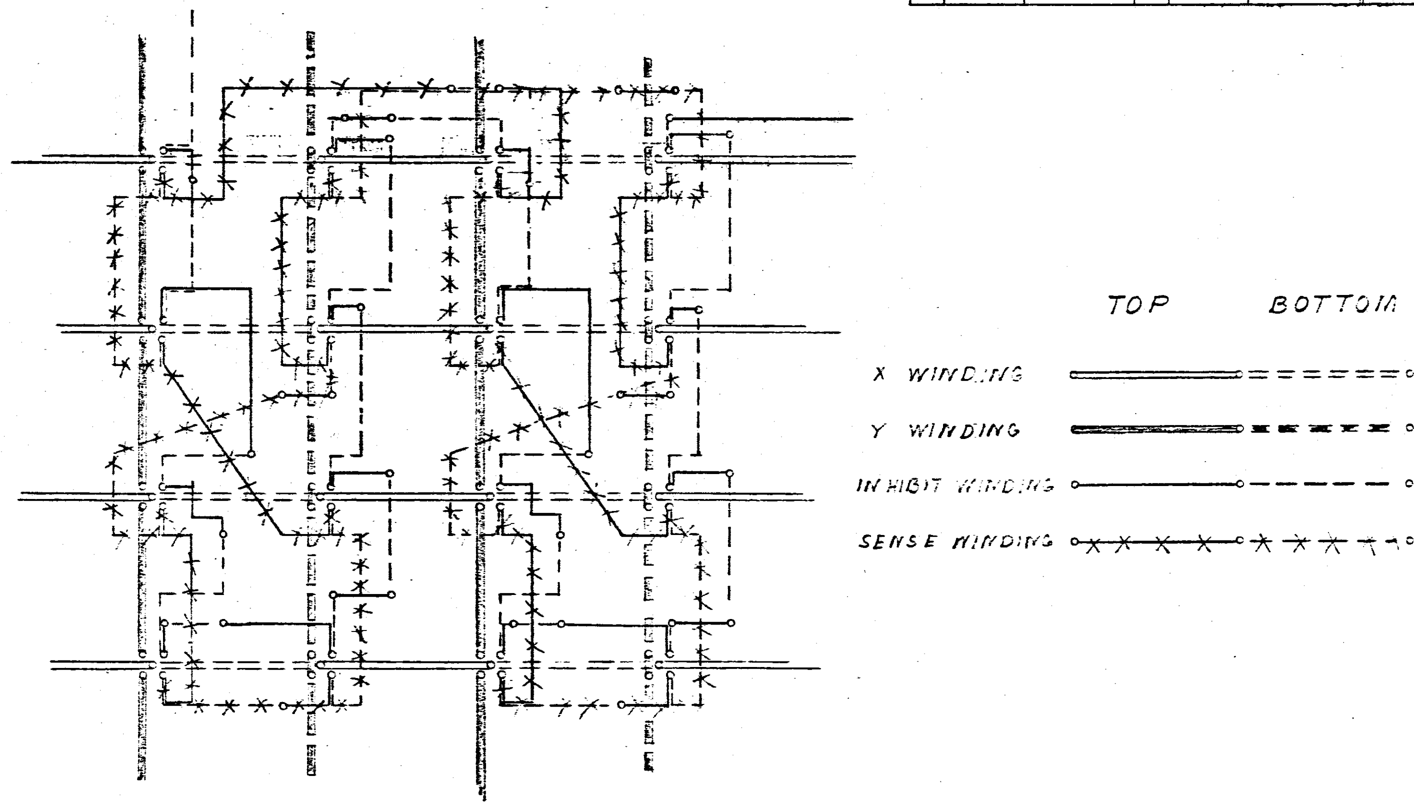


Figure 5

MATERIAL SPECIFICATIONS	NO.	TOLERANCE UNLESS OTHERWISE NOTED		ALIGNMENT WITHIN	NOTE I
CASE DEPTH		DECIMALS		CONCENTRIC WITHIN TOT. IND. READING	NOTE II
HARDNESS		FRACTIONS		FLAT WITHIN	NOTE III
SURFACE TREATMENT	SPEC. NO.	ANGLES		PARALLEL WITHIN	NOTE IV
	TECH. SERVICES APPRO. DATE	CORNERS AND/OR EDGES BROKEN	OUTSIDE	STRAIGHT WITHIN	NOTE V
			INSIDE	SQUARE WITHIN IN INCHES	NOTE VI

INTERNATIONAL BUSINESS MACHINES CORP.

NAME	WIRING PATTERN #3 FOR		
	H.S. CORE PLANE		
DESIGN.		MODEL	
DETAIL.		SCALE	
CHECK.		DRAW.	
APPRO.		CHECK	

7066-48

DEFIANCE NO. 167H

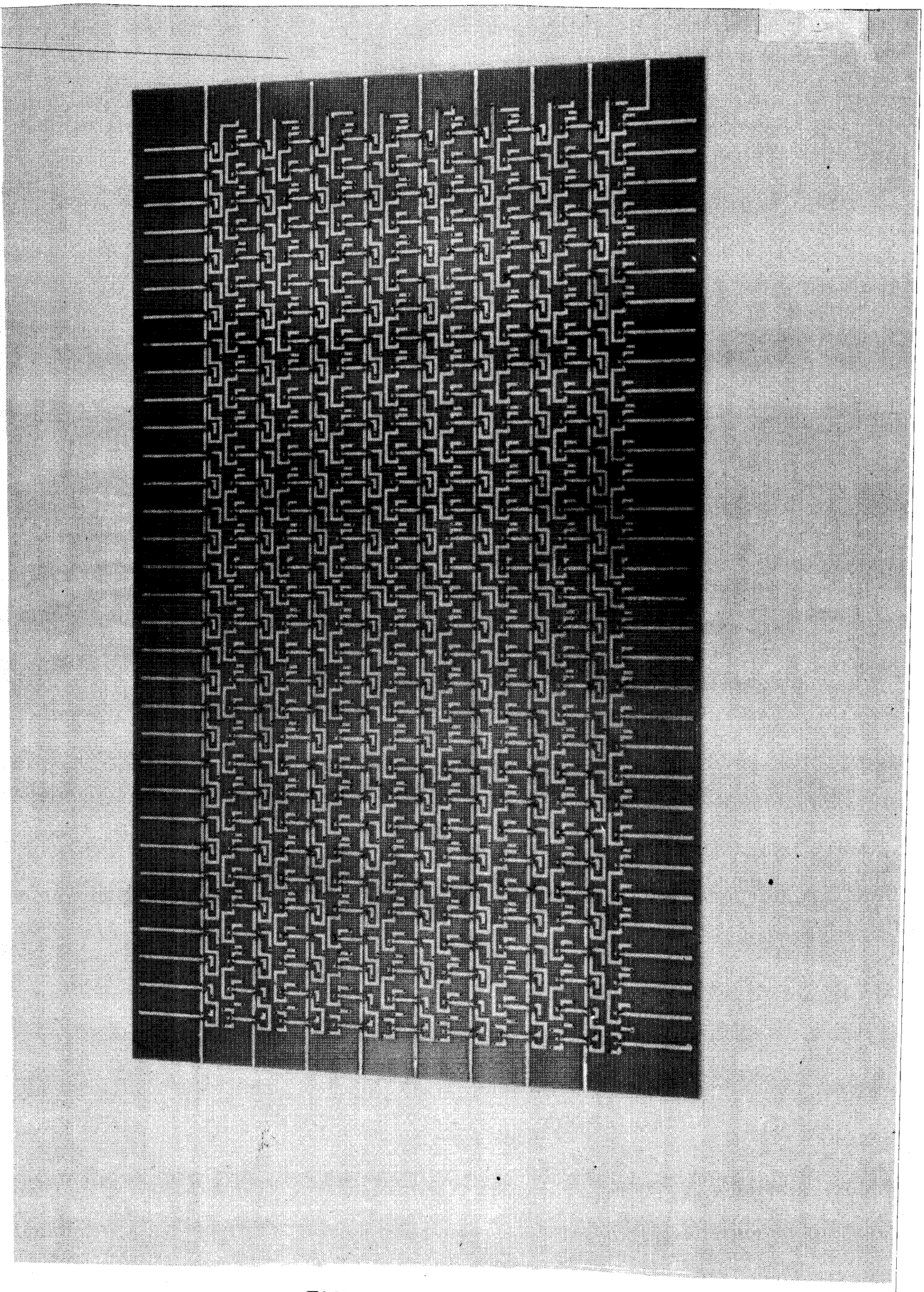
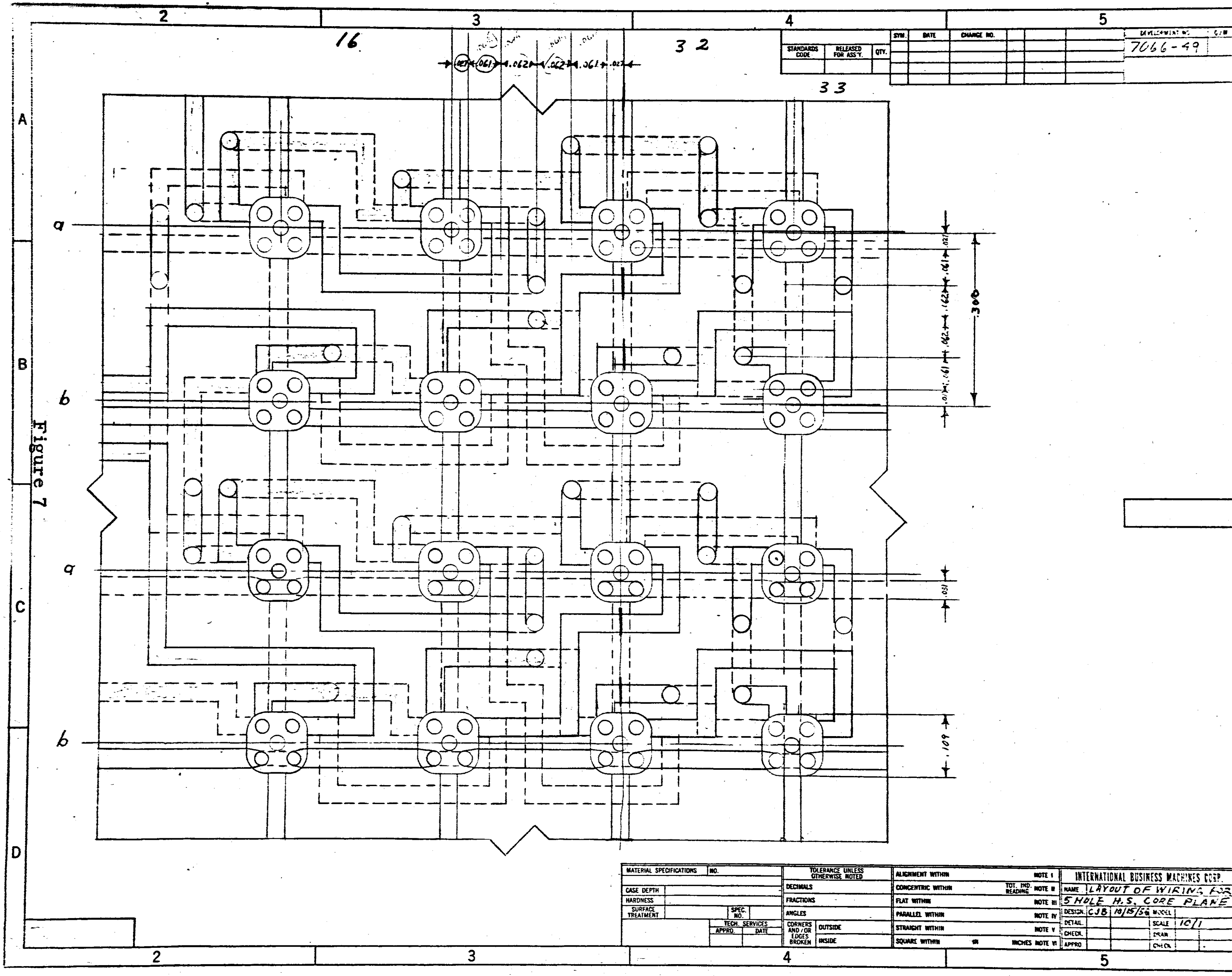


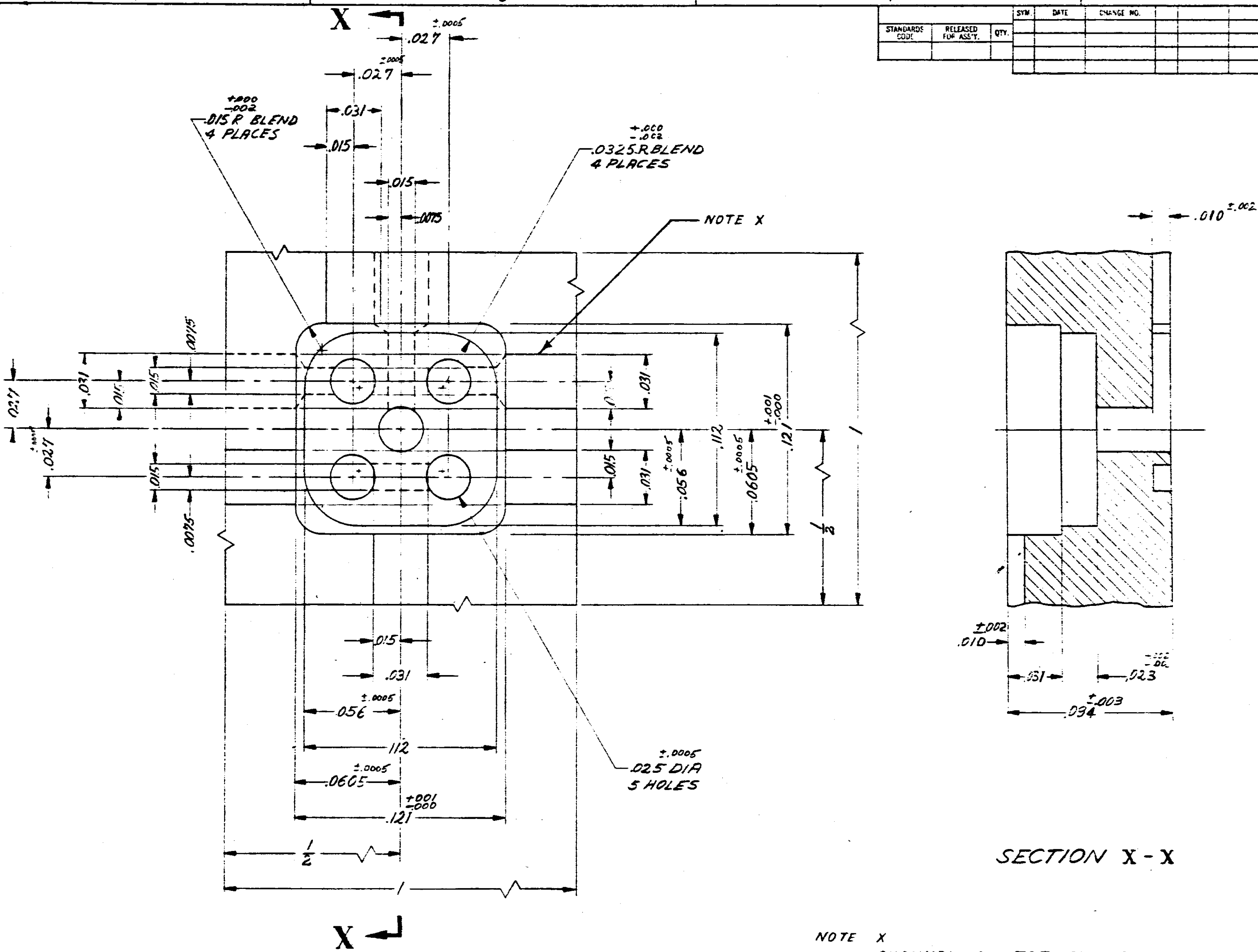
FIGURE 6



16
32
33
7066-49
STANDARDS CODE
RELEASED FOR ASS'Y.
QTY.
SYM.
DATE
CHANGE NO.
a
b
a
b
.300
.109
MATERIAL SPECIFICATIONS
NO.
CASE DEPTH
HARDNESS
SURFACE TREATMENT
SPEC. NO.
TECH. SERVICES
APPRO.
DATE
TOLERANCE UNLESS OTHERWISE NOTED
DECIMALS
FRACTIONS
ANGLES
CORNERS AND / OR EDGES BROKEN
OUTSIDE
INSIDE
ALIGNMENT WITHIN NOTE I
CONCENTRIC WITHIN TOT. IND. READING NOTE II
FLAT WITHIN NOTE III
PARALLEL WITHIN NOTE IV
STRAIGHT WITHIN NOTE V
SQUARE WITHIN IN INCHES NOTE VI
INTERNATIONAL BUSINESS MACHINES CORP.
NAME LAYOUT OF WIRING FOR 5 HOLE H.S. CORE PLANE
DESIGN. CJB 10/15/56
MODEL
DETAIL.
SCALE 10/1
CHECK.
DRAW.
APPRO.
CHECK.

Figure 7

Figure 8

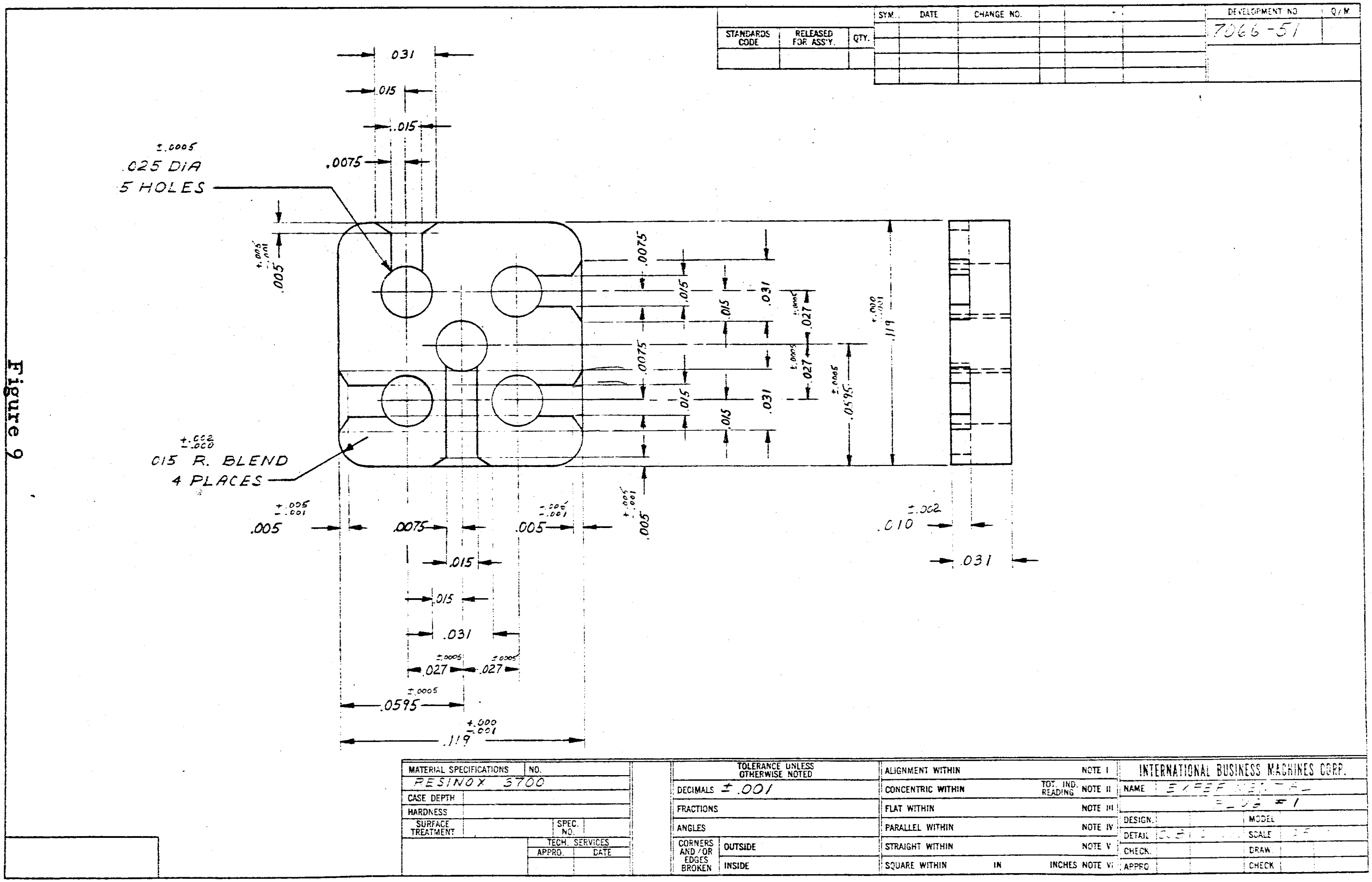


NOTE X
CHANNEL ON TOP SURFACE
AND BOTTOM SURFACE

DEVELOPMENT NO. 7066-52

MATERIAL SPECIFICATIONS	NO	TOLERANCE UNLESS OTHERWISE NOTED	
RESINOX	3700	DECIMALS	±.001
CASE DEPTH		FRACTIONS	±1/64
HARDNESS		ANGLES	
SURFACE TREATMENT		CORNERS AND/OR EDGES BROKEN	OUTSIDE / INSIDE

INTERNATIONAL BUSINESS MACHINES CORP.	
NAME	EXPERIMENTAL CORE & PLUG HOLDER
DETAIL	ZM 10/17/56
SCALE	25/1



.025 DIA ±.0005
5 HOLES
.015 R. BLEND +.002 -.000
4 PLACES
.031
.015
.0075
.005
.027
.0595
.119 +.000 -.001
.010 ±.002
SYM.
DATE
CHANGE NO.
STANDARDS CODE
RELEASED FOR ASS'Y.
QTY.
DEVELOPMENT NO
Q/M
7066-51
MATERIAL SPECIFICATIONS
NO.
RESINOX 3700
CASE DEPTH
HARDNESS
SURFACE TREATMENT
SPEC. NO.
TECH. SERVICES
APPRO.
DATE
TOLERANCE UNLESS OTHERWISE NOTED
DECIMALS ±.001
FRACTIONS
ANGLES
CORNERS AND/OR EDGES BROKEN
OUTSIDE
INSIDE
ALIGNMENT WITHIN
NOTE I
CONCENTRIC WITHIN
TOT. IND. READING
NOTE II
FLAT WITHIN
NOTE III
PARALLEL WITHIN
NOTE IV
STRAIGHT WITHIN
NOTE V
SQUARE WITHIN
IN
INCHES
NOTE VI
INTERNATIONAL BUSINESS MACHINES CORP.
NAME
DESIGN.
DETAIL
CHECK.
APPRO
MODEL
SCALE
DRAW
CHECK

Figure 9

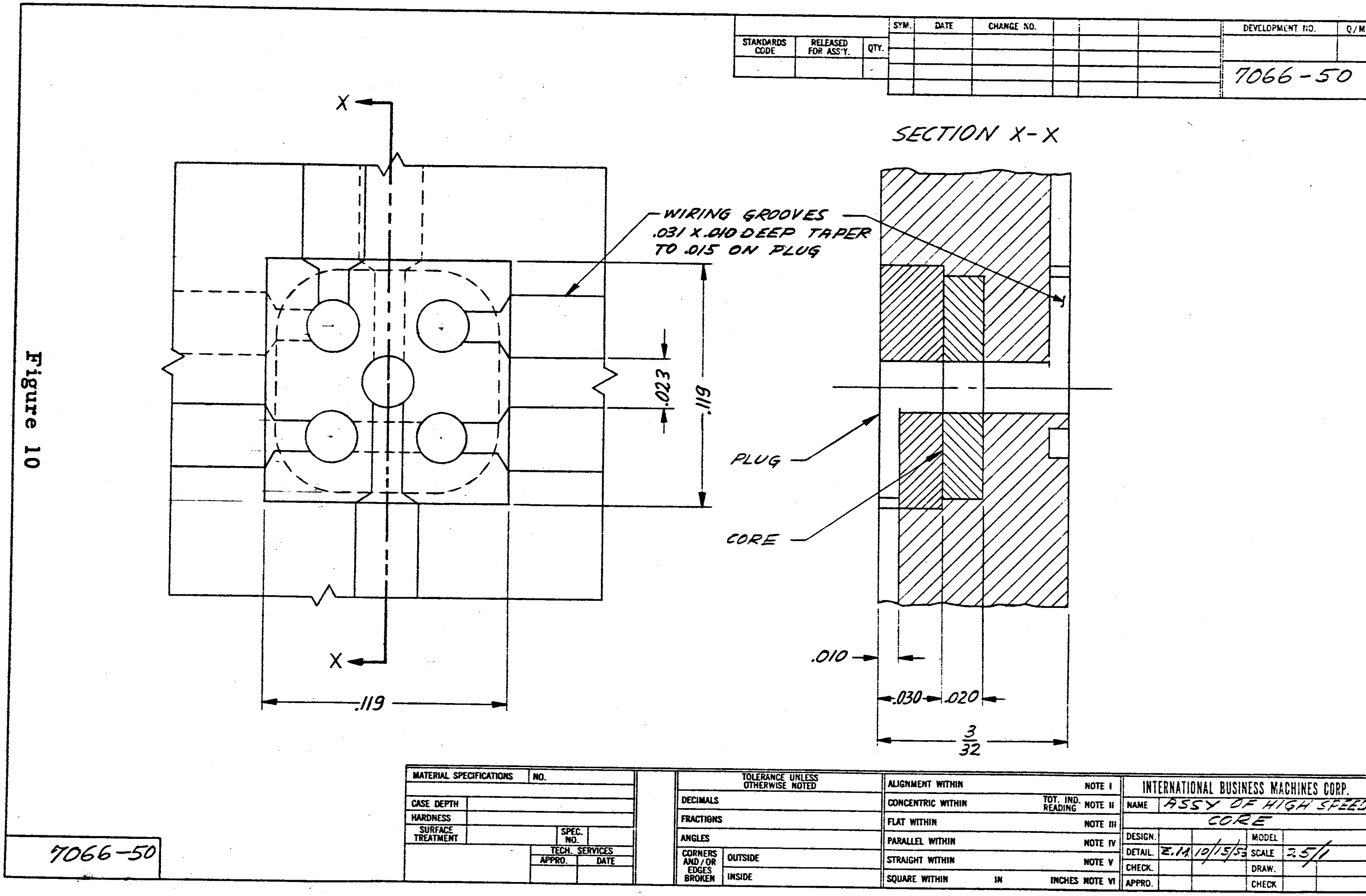

SYM.
DATE
CHANGE NO.
DEVELOPMENT NO.
Q/M
STANDARDS CODE
RELEASED FOR ASS'Y.
QTY.
7066-50
SECTION X-X
X
X
WIRING GROOVES .031 X .010 DEEP TAPER TO .015 ON PLUG
.023
.119
.119
PLUG
CORE
.010
.030
.020
3/32
MATERIAL SPECIFICATIONS
NO.
CASE DEPTH
HARDNESS
SURFACE TREATMENT
SPEC. NO.
TECH. SERVICES
APPRO.
DATE
TOLERANCE UNLESS OTHERWISE NOTED
DECIMALS
FRACTIONS
ANGLES
CORNERS AND/OR EDGES BROKEN
OUTSIDE
INSIDE
ALIGNMENT WITHIN
NOTE I
CONCENTRIC WITHIN
TOT. IND. READING
NOTE II
FLAT WITHIN
NOTE III
PARALLEL WITHIN
NOTE IV
STRAIGHT WITHIN
NOTE V
SQUARE WITHIN
IN
INCHES NOTE VI
INTERNATIONAL BUSINESS MACHINES CORP.
NAME
ASSY OF HIGH SPEED CORE
DESIGN.
MODEL
DETAIL.
Z.M. 10/15/53
SCALE
25/1
CHECK.
DRAW.
APPRO.
CHECK
7066-50

Figure 10

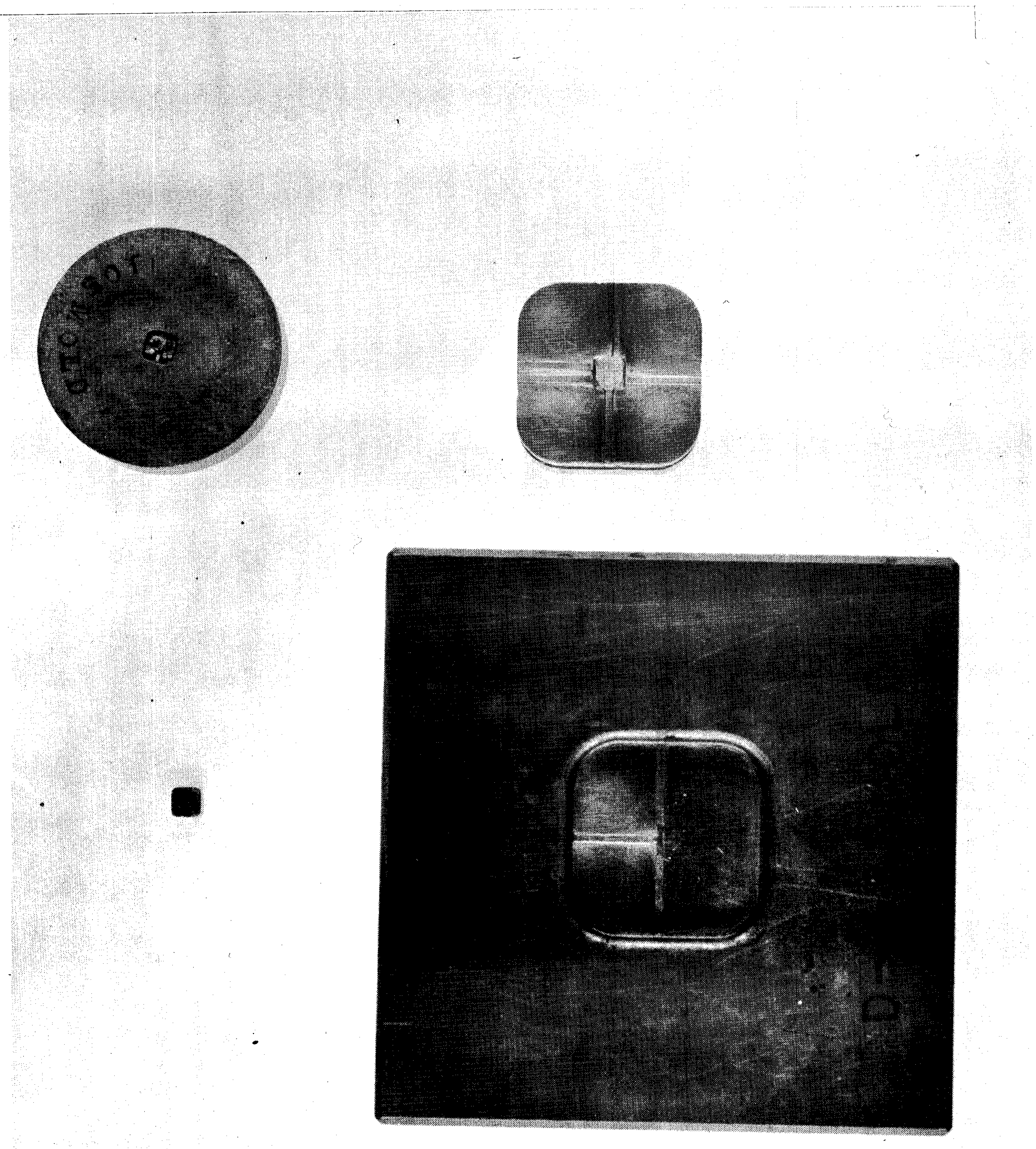


FIGURE 11

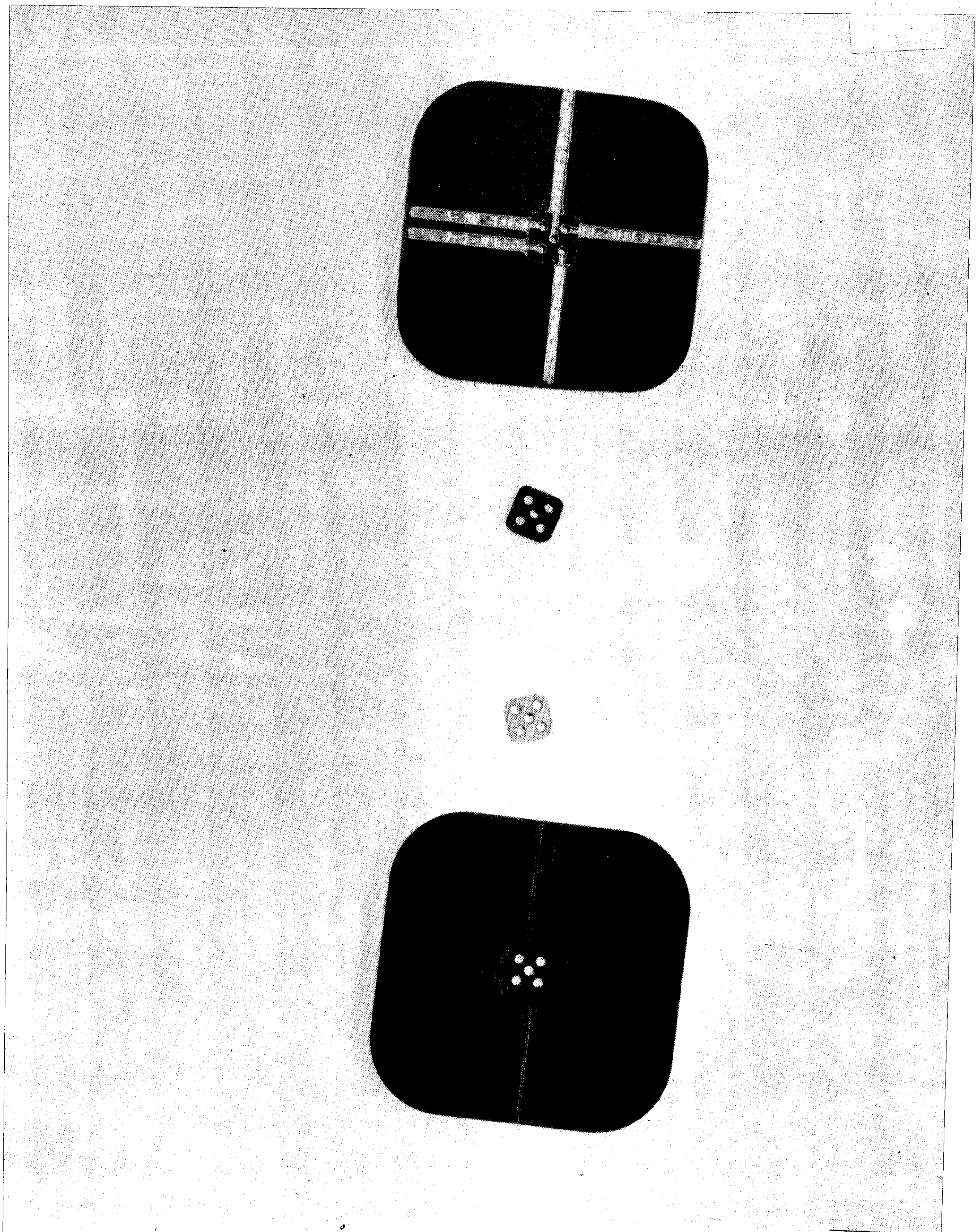


FIGURE 12

ADHESIVE HOLE PLUGGING TEST DATA

Adhesive: Armstrong N 178 (Rubber Base, 30% Solids)
Solvent: Methyl Ethyl Ketone
Mixture: Ratio of solvent to adhesive by volume
Application: Dipped in mixture and oven dried.

Mixture	2:1			3:1			4:1			5:1			6:1			7:1			9:1			15:1		
Test Board Number	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
Size Hole Inches																								
.020	PP	PP	PP	PP	PP	PP	PO	PO	PP	PP	PP	PO	OO	OO	OO	OO	OO	OO	OO	OO	OO	OO	OO	OO
.025	PP	PP	PP	PP	PP	PP	PP	PO	PO	PP	PO	PP	OO	OO	OO	OO	PO	OO	OO	OO	OO	OO	OO	OO
.030	PP	PP	PP	PP	PO	PP	OO	OO	OO	OO	PO	OO	OO	OO	OO	OO	OO	OO	OO	OO	OO	OO	OO	PO

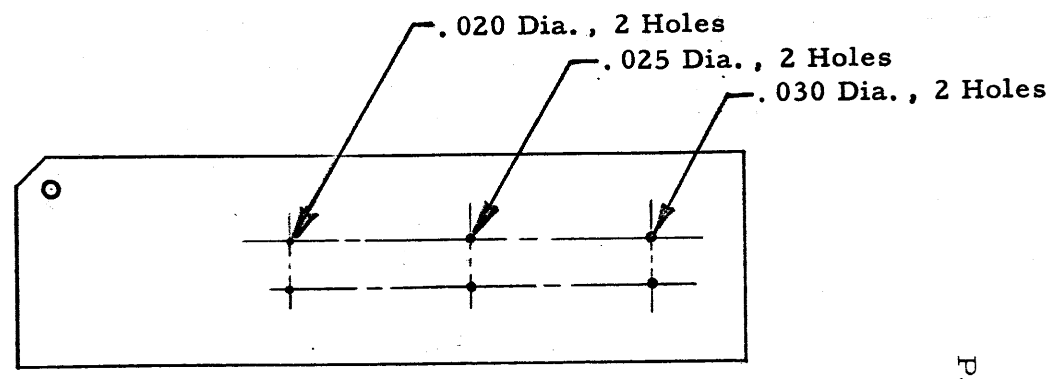
Figure 13

CODE:

P Plugged
O Open

TEST BOARD DATA:

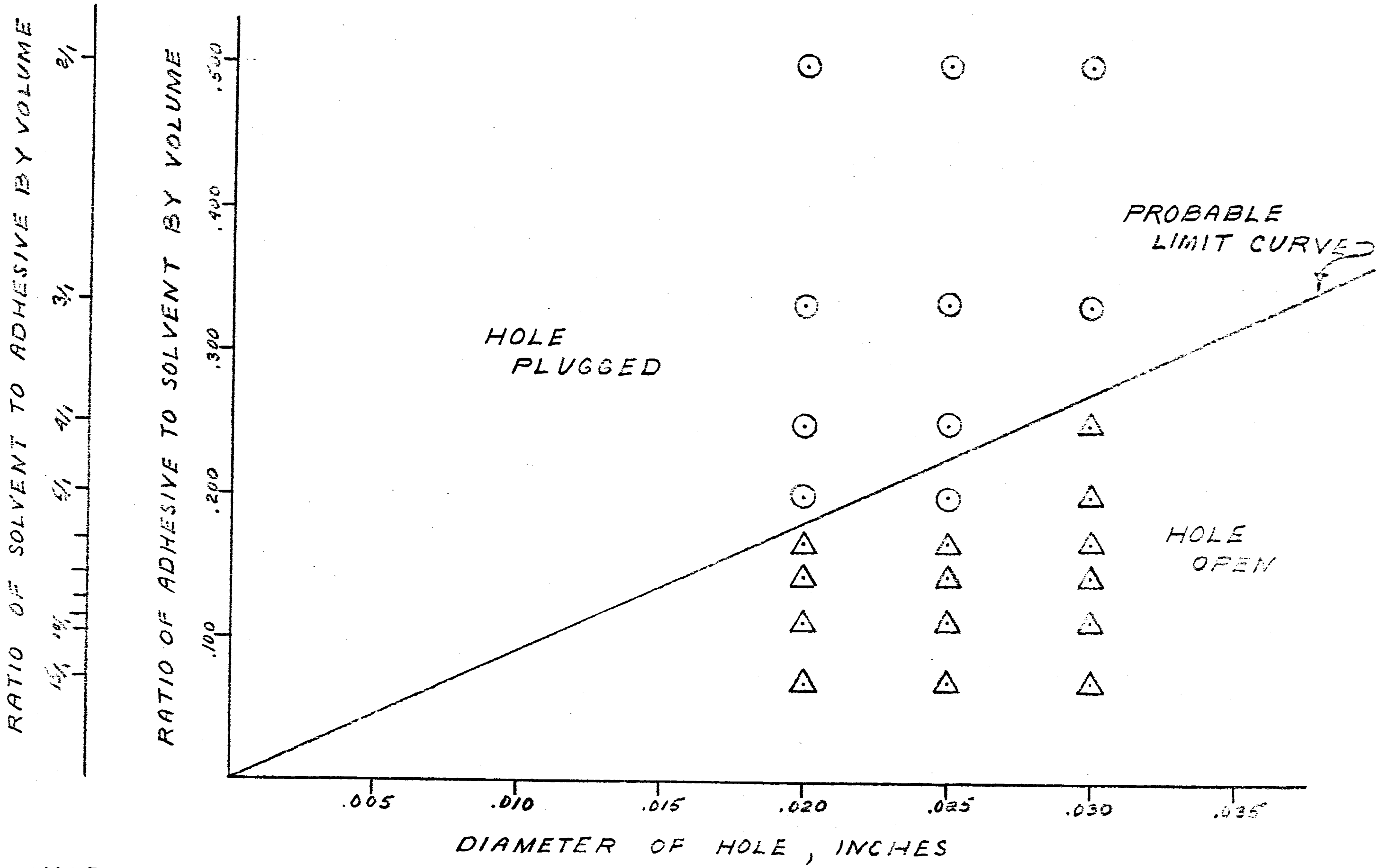
Material: XXXP
Thickness: 0.093 inches
Two holes of each size in each test board.



TEST PIECE
Actual Size

10/25/56

Figure 14



HOLES WERE CONSIDERE PLUGGED IF MORE THAN ONE OF THE SIX HOLES TESTED OF A GIVEN DIAMETER WITH A GIVEN MIXTURE OF ADHESIVE WAS PLUGGED.

ADHESIVE HOLE PLUGGING TEST

⊙ HOLE PLUGGED

△ HOLE OPEN

CARL J. BLIEM OCT 26, 1956

ADHESIVE GAP TEST DATA

Adhesive: Armstrong N 178 (Rubber base, 30% solids)
Solvent: Methyl Ethyl Ketone
Mixture: Ratio of solvent to adhesive by volume
Application: Dipped in mixture and oven dried.

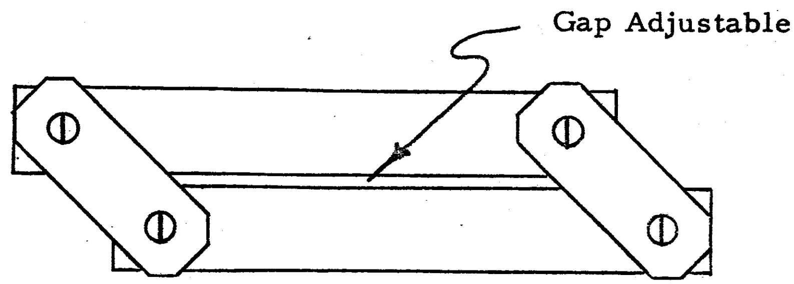
GAP Inches	.001	.002	.003	.004	.005	.006	.007	.008	.009	.010	.011	.012	.014	.015	.019	.020	.025	.035
MIXTURE																		
15:1	A	A			B			C										
9:1		A	B		B		B	B		C								
6:1			A	B	B	B	B	B	C	C		C	C	C				
4:1								A	A	B	B		B		C			
2:1										A		A		A		B	B	C

CODE:

A Bridged Gap
B Partially Bridged Gap
C Did not Bridge Gap

THICKNESS OF COATING:

Mixture	Inches
2:1	.0009
4:1	.00035
6:1	.0003
9:1	.00025
15:1	.00015



TEST PIECE
Actual Size
Thickness: .0625 inches
Material: XXX P

10/25/56

Figure 15

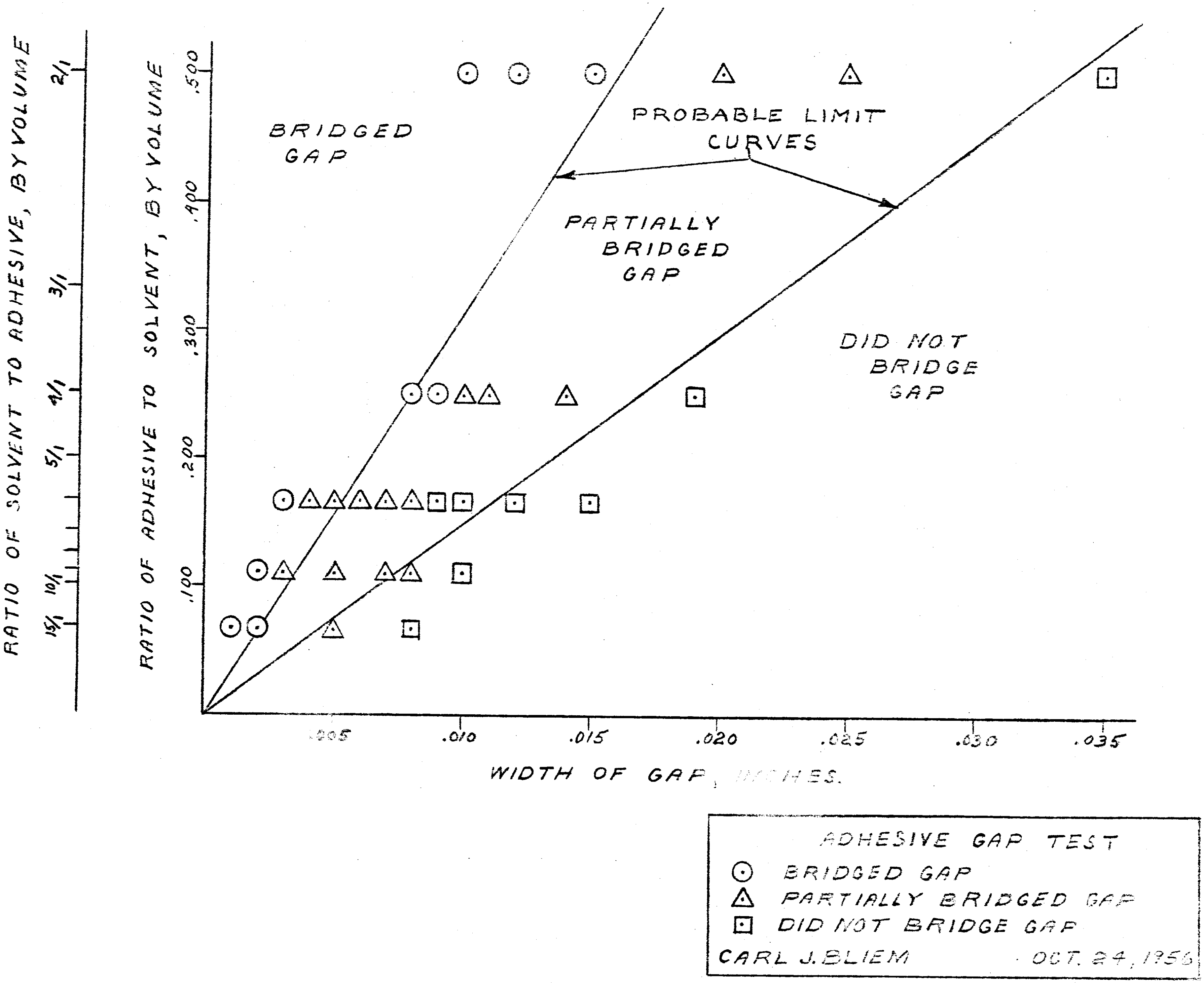

RATIO OF SOLVENT TO ADHESIVE, BY VOLUME
2/1
3/1
4/1
5/1
10/1
15/1
RATIO OF ADHESIVE TO SOLVENT, BY VOLUME
.500
.400
.300
.200
.100
BRIDGED GAP
PROBABLE LIMIT CURVES
PARTIALLY BRIDGED GAP
DID NOT BRIDGE GAP
.005
.010
.015
.020
.025
.030
.035
WIDTH OF GAP, INCHES.
ADHESIVE GAP TEST
BRIDGED GAP
PARTIALLY BRIDGED GAP
DID NOT BRIDGE GAP
CARL J. BLIEM
OCT. 24, 1956

Figure 16

VACUUM METALLIZING TEST DATA

TEST BOARD NO.		1	2	3	4	5
Diamter of Hole						
.0145 inches	Continuity	C	C	C	N	C
	Resistance	33	19	250		95
.020 inches	Continuity	C	C	C	N	C
	Resistance	3.2	3.0	14.5		4.6
.025 inches	Continuity	C	C	C	C	C
	Resistance	2.0	2.5	8.5	150	1.8
.0296 inches	Continuity	C	C	C	C	C
	Resistance	1.0	1.9	5.0	470	3.5

Figure 17

CODE:

C Continuity
N No Continuity
Resistance Values are in ohms

Copper Used: Electrically Polished 99.9% Pure Copper Shot
Material Test Boards: XXXP - .096 THICK
Distance of Boat to Test Boards: Five inches
Length ofBoat: Four inches
Boat Material : Tungsten

11/1/56

CONDUCTIVE COATING TEST

TEST BOARD NO.	1	2	3	4	5	6
Diameter of Hole	NC	NC	NC	NC	NC	NC
.0145 inches	NC	NC	NC	NC	NC	NC
.020 inches	NC	NC	NC	NC	NC	NC
.025 inches	NC	NC	NC	NC	NC	NC
.0296 inches	NC	NC	NC	NC	NC	NC

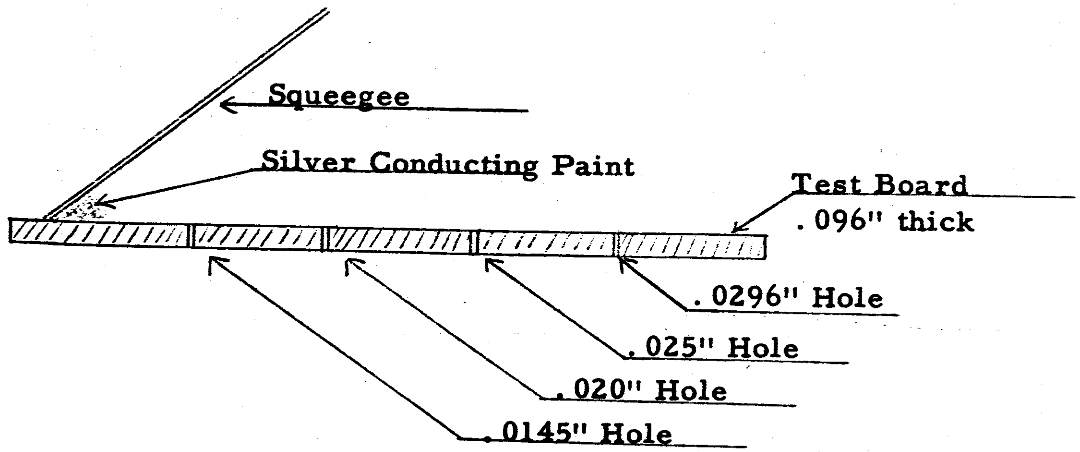


Figure 18

CODE:

C Continuity
NC No Continuity

Test Board Material: XXXP .096 thick.
Conductive Coating: DuPont # 6371 silver conducting paint.

1. Coating applied by squeegee per sketch.
2. Oven dried - 10 minutes at 120° C.
3. Both sides coated.

11/14/56

PRELIMINARY PLATED PLUG ASSEMBLY TESTS

Test Piece Number	Ratio of Solvent to Adhesive	Times Dipped Into Adhesive	Oven Drying Time First Dip	Oven Drying Time Second Dip	No. of Holes Plugged	Copper Plating Time	Remarks
1	7:1	2	10	30	0	30 minutes	Continuity to Core - 3 out of 5 holes.
2	7:1	2	30	30	5		All test pieces were dipped and dried horizontally with core cover up.
3	6:1	2	30	30	5		All test pieces from #6 on were dipped in M. E. K. prior to dipping in adhesive cover side up.
4	5:1	2	30	30	5		
5	4:1	1	30		4		
6	5:1	1	30		0	one hour	Bottom side- Continuity all holes to core. Top side- Continuity center hole and one other to core.
7	6:1	1	30		0	one hour	Bottom side- Continuity all holes to core. Top side - Continuity center hole and one other to core.
8	6:1	1	10		1		
9	5:1	2	10	30	3		Holes plugged after second dip.
10	5:1	1	30		0	one hour	Bottom side- Continuity all holes to core. Top side- No continuity to core.
11	6:1	1	30		0		Crazing occurred after metalizing. Reason was not determined.
12	4:1	1	30		0	one hour	Bottom side- Continuity all holes to core. Top side- No continuity to core.
13	6:1	1	30		0	15 minutes	Each hole on bottom side of cover was flared. Adhesive was dried vert. Continuity top side - All holes to core. Continuity bottom side - All holes to core.

Figure 19

11/30/56

PRELIMINARY PLATED PLUG ASSEMBLY TESTS

Test Piece Number	No. of Horiz. Dips Plug side up	Drying Time Horiz.	Drying Time Vert.	Continuity on top side to core	Continuity on bottom side to core	REMARKS
14	1	30		0	5	Crazing occurred after metalizing first side.
15	1	--	30	5	4	same as above
16	2	30	--	4	5	Compressed air used to clear holes after second dip. Crazing occurred after metalizing both sides.
17	2	--	30	5	5	Same as above
18	3	30	--	5	5	Compressed air used to clear holes after second and third dip. No crazing occurred.
19	3	--	30	5	5	Air used to clear holes after all dips. No crazing occurred.

Figure 20

NOTE: Adhesive to solvent ratio by volume - 1 to 6.
All but #6 dipped in M. E. K. (solvent) before first dip.
Vacuum metalized each side separately then copper plated.

12/10/56

PLATED PLUG ASSEMBLY TEST

Test Piece Number	No. of Horizontal Adhesive Dips	Drying Time Horiz.	Continuity Top Side To Core	Continuity Bottom Side To Core	Remarks
20	3	30	5	5	Compressed air used after each adhesive dip to clear holes. Some crazing occurred after metalizing on all pieces.
21	3	30	5	5	
22	3	30	5	5	
23	3	30	5	5	
24	3	30	5	5	
25	3	30	5	5	

Figure 21

NOTE:

Adhesive to solvent ration- 1:6
All cleaned in M.E.K. (solvent) before first dip
Vacuum metalized each side separately then copper and tin lead plated
Raised area sanded.

12-18-56

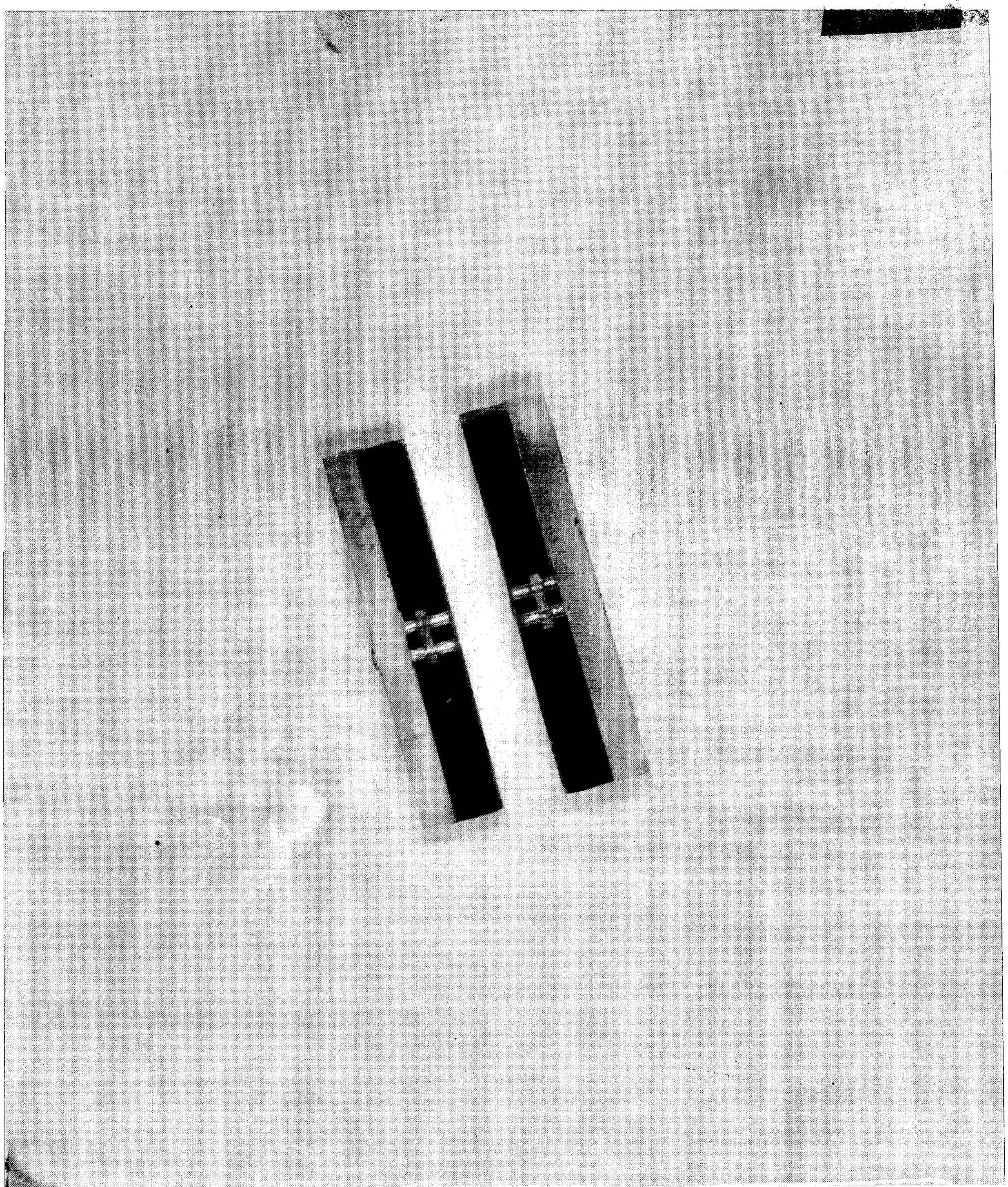


FIGURE 22

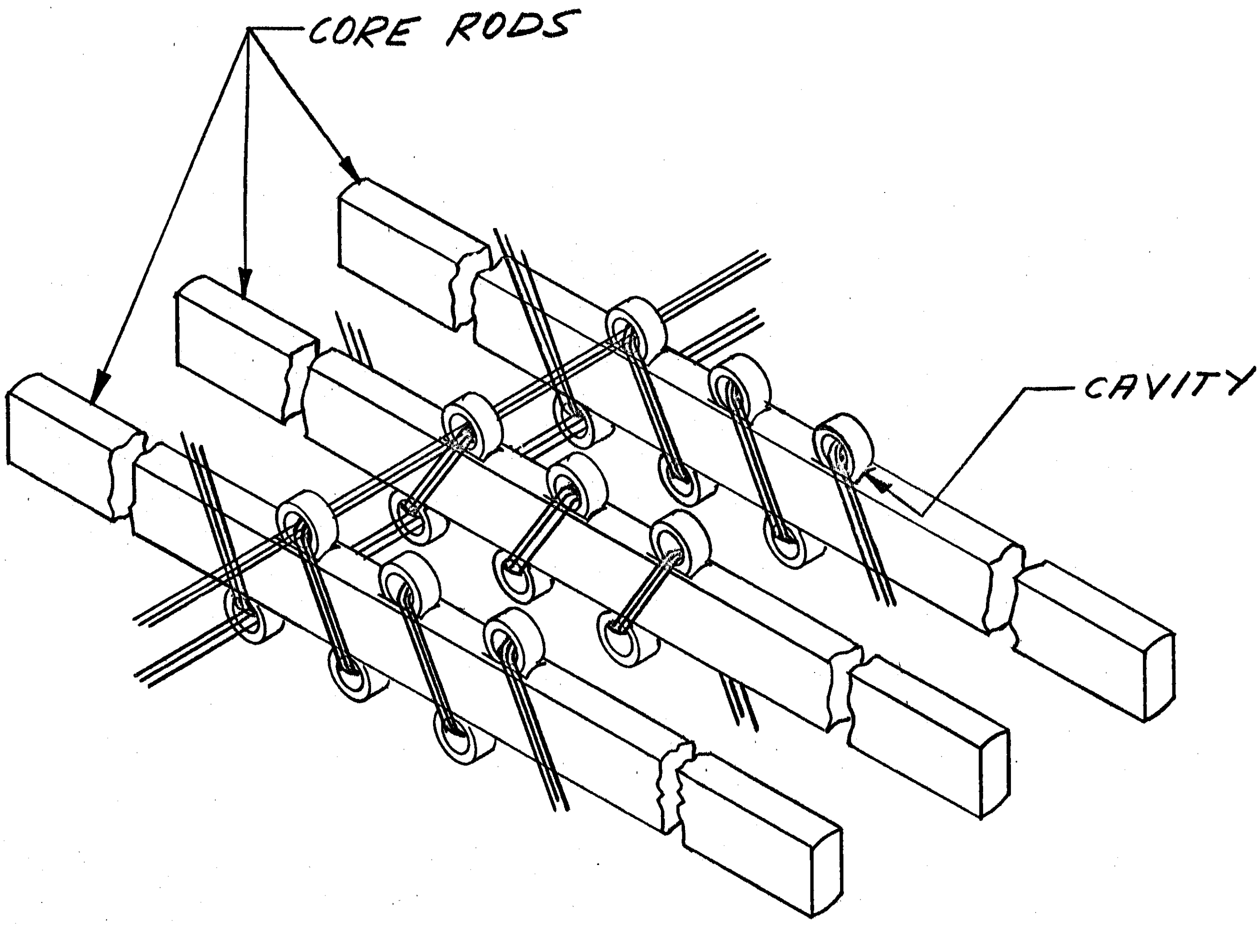


Figure 23

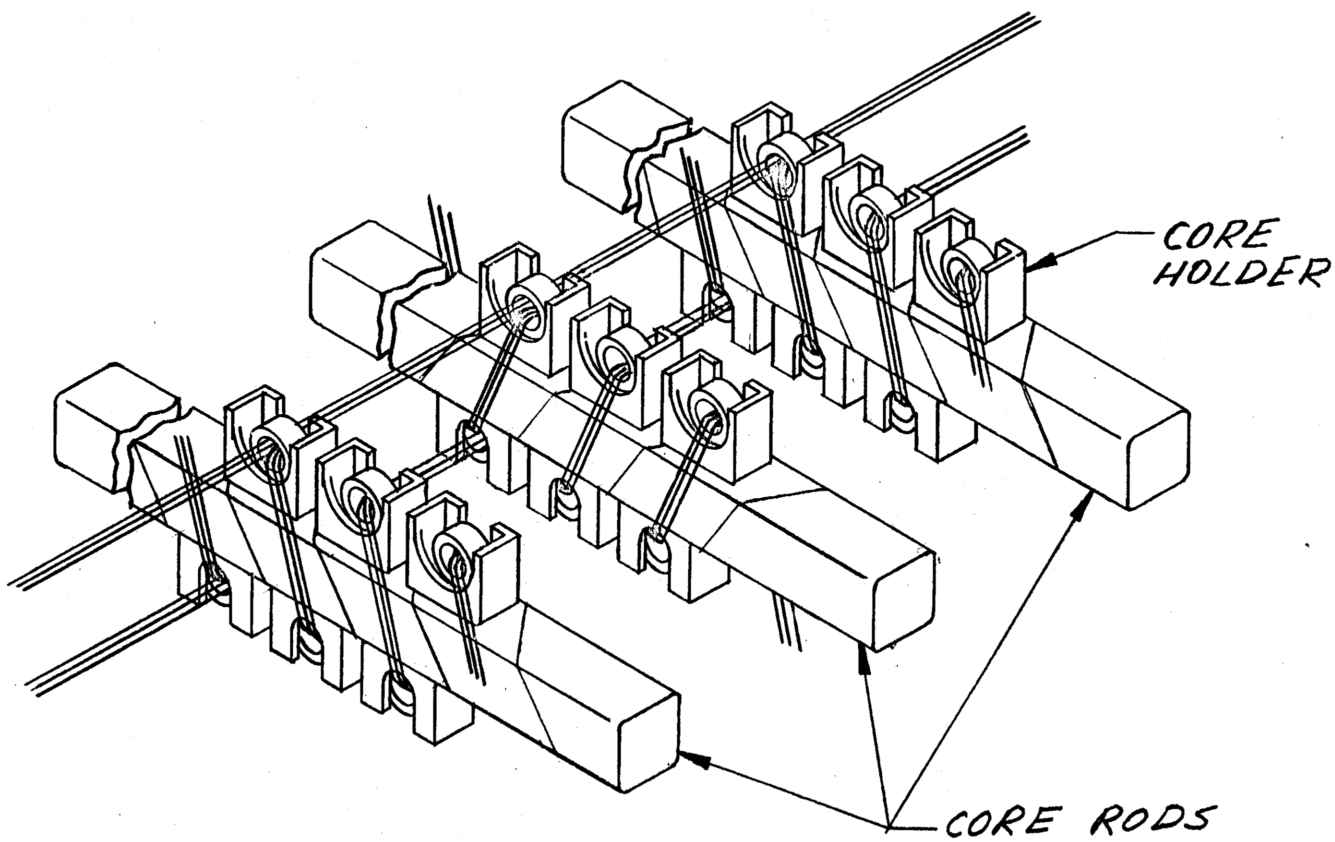


Figure 24

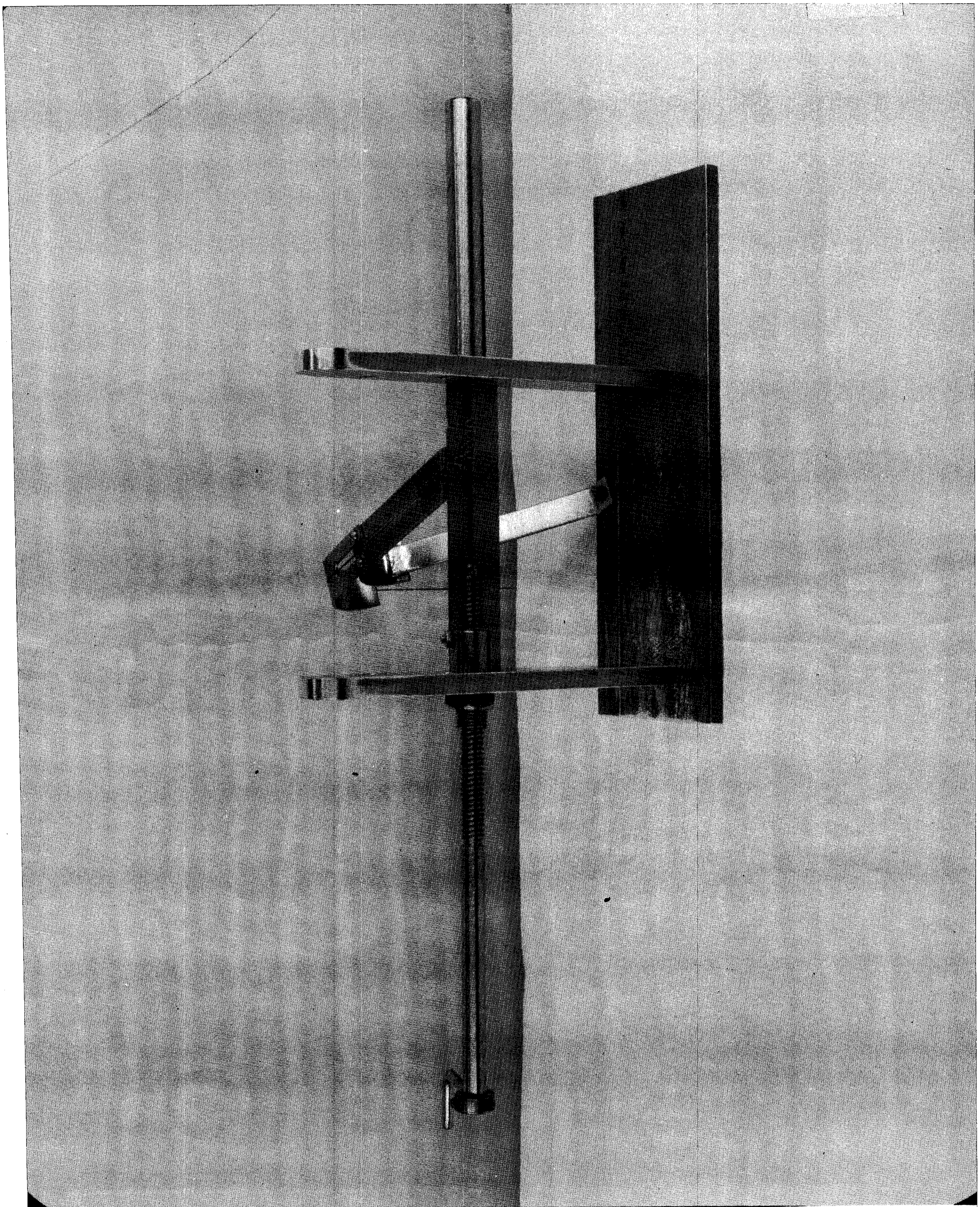


FIGURE 25

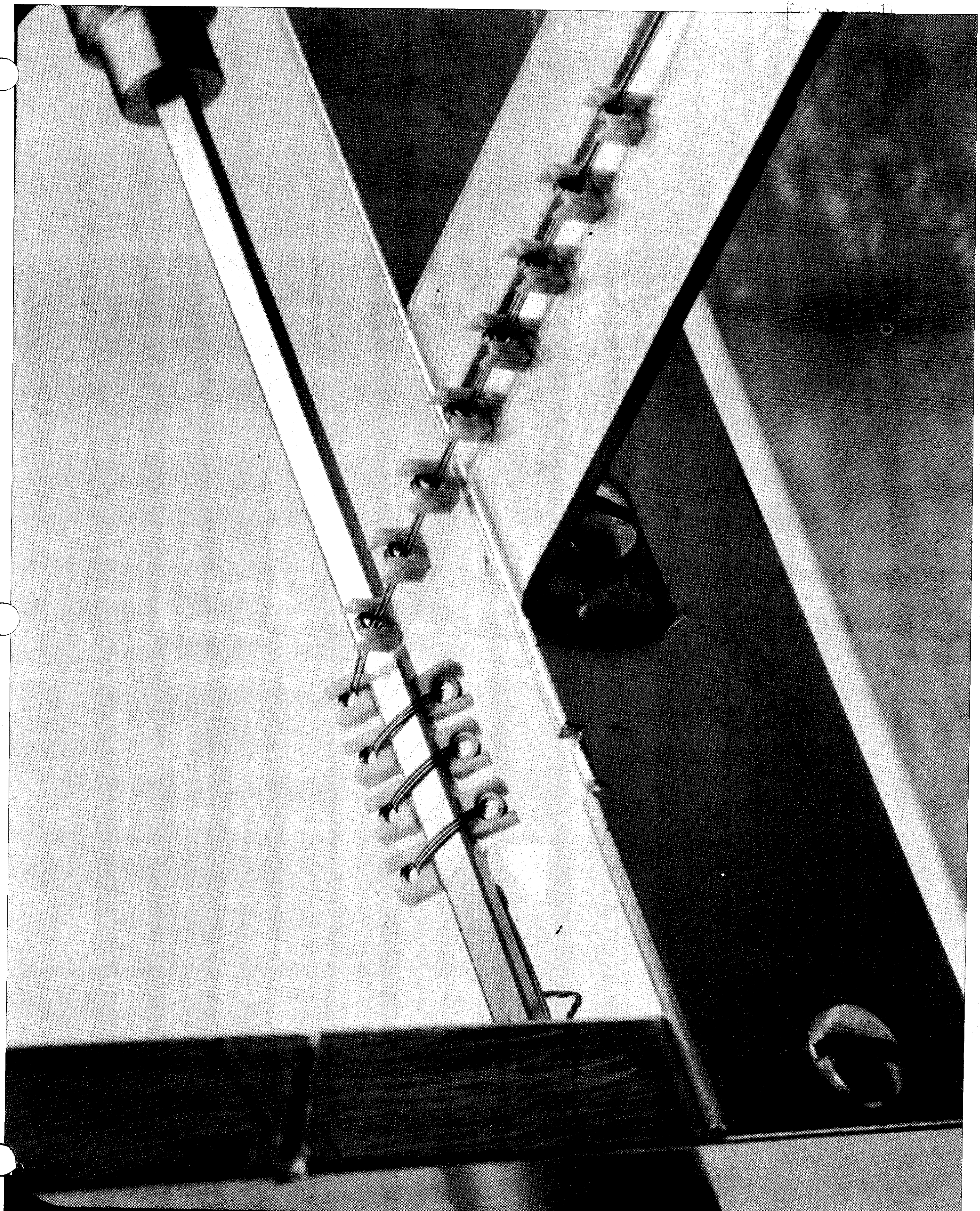


FIGURE 26

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