

## **A New Concept in Computers**

In this age of automation there has been need for a high-speed computer which can solve the mathematical problems of an industrial or academic research staff, and do double duty by performing difficult control functions in the fields of business and industry.

All of this must be obtainable at a price within the reach of thousands of organizations who can not justify the high costs usually associated with electronic computers.

This was the new concept in computers — a goal which Bendix, a world leader in electronics, set for itself several years ago. Today it announces with pride that this goal has been achieved in

## **The New and Different Bendix G-15 All-Purpose Computer System**

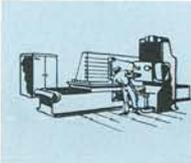
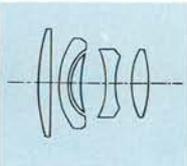
For the first time there is available in a single integrated system, tailored to the needs of the user, a complete computational facility which can include —

● **A General Purpose Digital Computer of high performance.**

● **A Digital Differential Analyzer combined with the General Purpose Computer to provide a new and powerful mathematical tool.**

● **A wide selection of input/output media:**

**Paper Tape, Magnetic Tape, Punched Cards, Graphs, Printed Copy.**



# Who should have an Electronic Computer?

The answers to this question are just beginning to take shape and are being found in the imaginative application of new mathematical and data processing methods to the problems of industry and science. Many organizations — both industrial and academic — who now consider themselves “too small” to support an electronic computing facility will find that the low cost Bendix G-15 All-Purpose Computer can save time and money, enabling them to keep ahead of competition.

The G-15 is especially suited for application to projects where a complex mathematical problem must be solved. Of the many examples which could be cited, here are a few:

## Mathematical Analysis for Industrial and Academic Research:

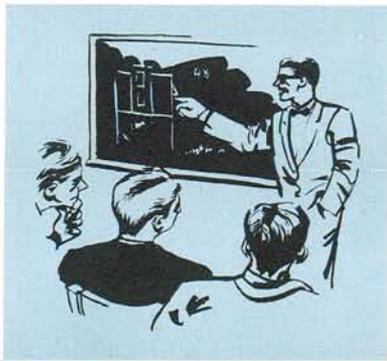
In the designing of many new products and devices for today's world, physical conditions are often encountered which are outside the realm of common experience. To meet the challenge of these conditions and to keep costs competitive, reliable electronic computers are absolutely essential. The G-15 ideally meets many of these needs.

## A Teaching Tool for Universities:

Every university offering graduate degrees in physical sciences and mathematics should have electronic digital computing facilities. Without such facilities, students cannot be properly trained for research, design and production engineering in many fields. The G-15 combination General Purpose Computer and Digital Differential Analyzer is the most versatile computer on the market. It is therefore ideally adapted for instruction and experimentation in techniques in the expanding sphere of digital computation.

## Construction Engineering:

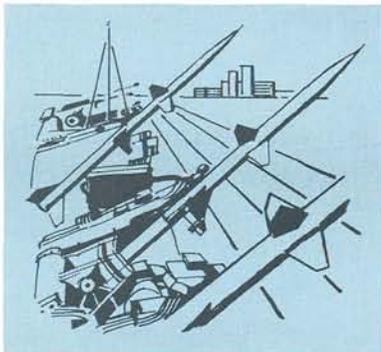
A G-15 Computer can often save its cost on a single road-building or other type construction job. For example, in cut and fill computations for road-building, the G-15 and one operator can do the work of 45 mathematicians with mechanical desk calculators. Delays are thus reduced to a minimum. With greatly reduced computation costs, more accurate estimates of job costs and work schedules can be made. On other types of construction engineering similar economies can be realized in stress analysis, etc.





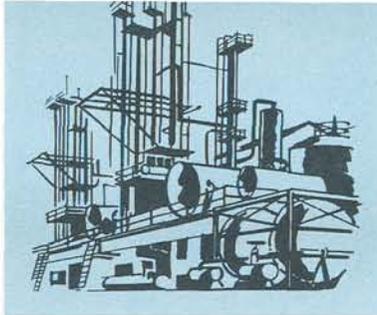
### **Electrical Transmission and Pipe Lines:**

A G-15 Computer is useful in designing and operating electrical transmission systems and pipe lines carrying natural gas, petroleum or water. The operating costs of existing systems can be reduced by computing optimum utilization patterns. Studies also can be made to plan for most efficient expansion.



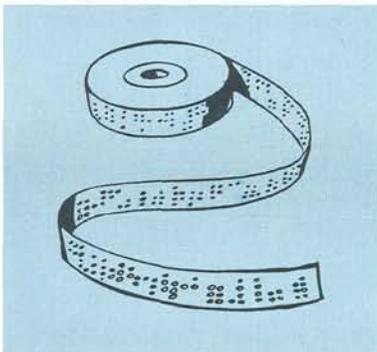
### **Trajectories and Missile Performance:**

A G-15 combination General Purpose Computer and Digital Differential Analyzer is an efficient and accurate instrument for calculating and plotting the path or trajectory of a missile. This All-Purpose Computer is also an aid in the mathematical analysis of aerodynamic, stability and power plant problems.



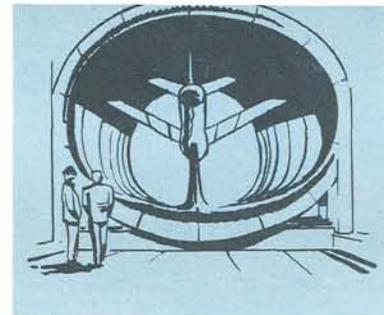
### **Petroleum Exploration and Refining:**

A G-15 Computer reduces the time and cost required to analyze seismic and other geophysical data used in exploratory projects for new sources of crude oils and to increase production in old fields. The G-15 is also useful in analyzing data to improve efficiency in the refining and marketing of various types and qualities of crude.



### **Numerical Control of Machine Tool Operations:**

In one application of the G-15 in the machine-tool field, the Computer translates design information into detailed and exact directions for the efficient production of precision aircraft metal parts. Related applications which could be performed by the same machine include tool designing and machine-load scheduling.



### **Real-Time Data Processing for Aircraft Industry:**

During a wind-tunnel or a flight test, the G-15 Computer translates measurements as they are recorded into understandable tabular or graphical form to visualize for the engineers exactly what is happening at the moment. This enables the engineers to exercise judgment during the tests.



### **Correlation of Hydroelectric Factors**

In a large hydroelectric system, a G-15 Computer is used to relate stream flow and reservoir storage to power generation and transmission operations. Correlation of all the hydroelectric factors will assure maximum power output from the installed generating capacity. The involved calculations may be computed on a daily basis, resulting in increased efficiency and economy.

## The Command System

The G-15 Command System is unique. In most computers the programmer is limited to a list of less than fifty fixed commands. To solve a problem the programmer must select a sequence of commands. Sometimes the exact command needed is not in the command list, so devious methods, which are wasteful of time, must be taken. With the G-15, on the other hand, the command is composed of eight independent parts. Each part represents only a portion of the total command. By spelling out the command, part by part, it is possible for the programmer to instruct the computer to do precisely what he wants it to do, without waste of time.

The G-15 magnetic drum memory includes twenty channels, each of 108-word capacity, four channels of four-word capacity, three channels of two-word capacity, and one channel of one-word capacity. A command usually specifies the transfer of information from a "source" to a "destination."

### *The command parts are:*

1. **Source:** The sources available include all channels, logical combinations of some channels, a zero source and other sources.
2. **Destination:** Destinations include all channels, zero test and others.
3. **Characteristic:** A number is usually stored in the memory as absolute value and sign. It is frequently desirable to modify this representation during transfer. Four transfer characteristics are provided: add, subtract, absolute value, and transfer.
4. **Single or double precision:** The word length may be 29 bits (single precision) or 58 bits (double precision).
5. **Immediate and deferred commands:** One single- or double-precision word is transferred by a deferred command, but a block of words of arbitrary number may be transferred by an immediate command.
6. **Timing number:** This specifies the address or time at which a command is executed or the duration of execution of a command.
7. **Next command:** The address of the next command is specified as a part of each command.
8. **Break point:** Any command may or may not include a break point.

If the "destination" 31 is specified, then the command is special and does not involve information transfer in the usual way. Commands of this type are those for input, output, magnetic tape read, write or search, tests for signs, tests for arithmetic overflow, multiply, divide, shift, normalize and others.



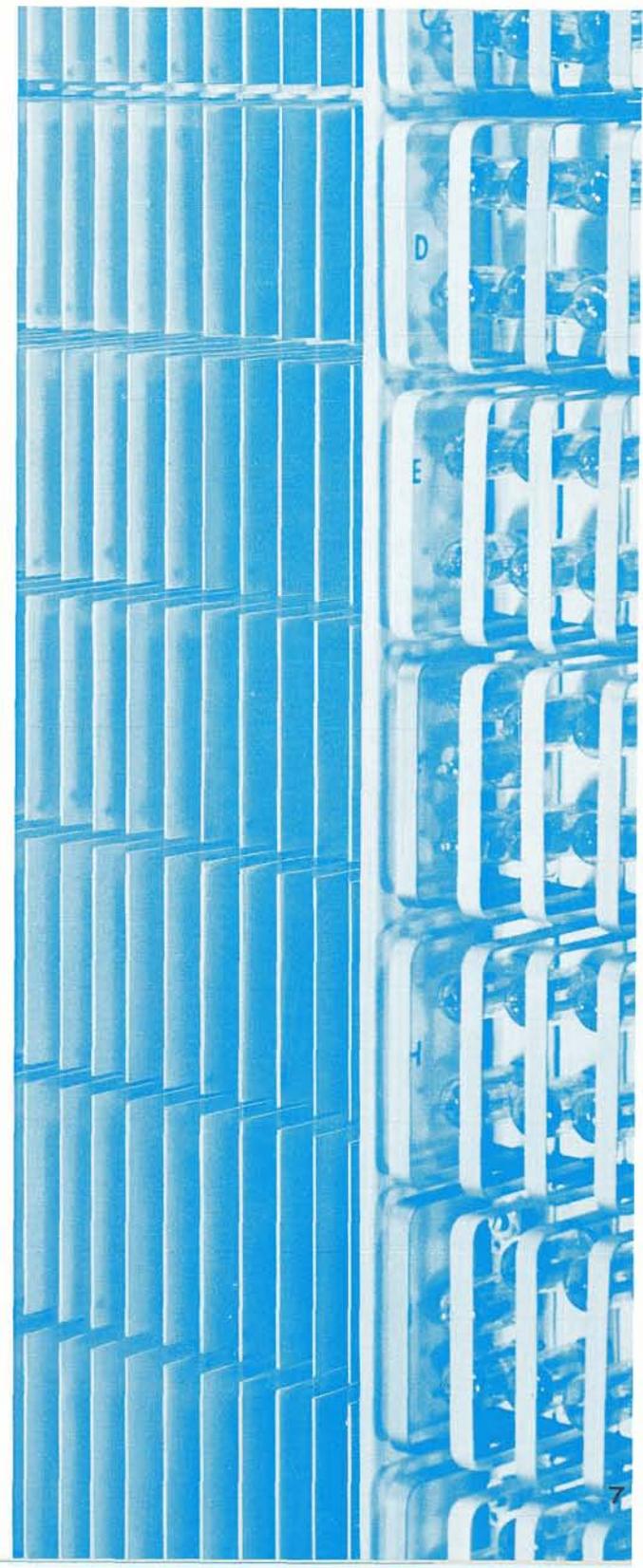
## Simplified Programming

The G-15 Command System permits true minimum access and other programming refinements so that exceptionally efficient programs and subroutines may be prepared. There are many problems which require relatively little machine time or for which only a few solutions will ever be required. For these problems the cost of programming may be more significant than the cost of machine solution time. For these applications greatly simplified programming systems using interpretive codes have been designed and are available to Bendix customers.

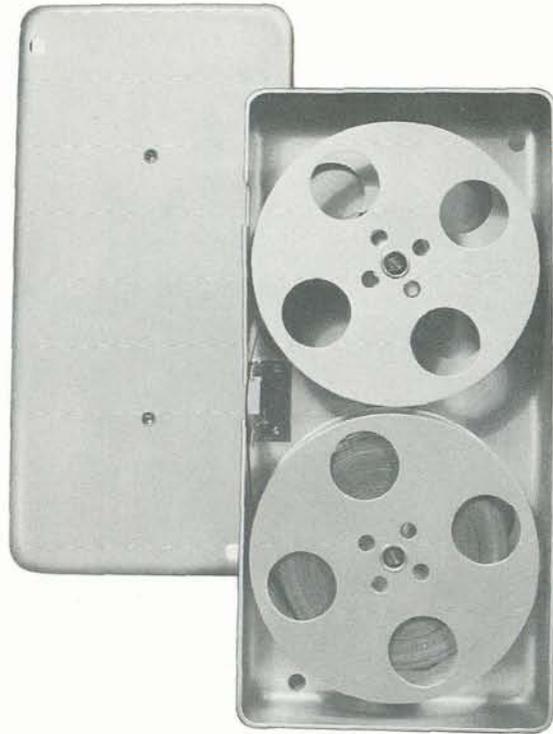
Interpretive codes are presented in self-sufficient manuals which enable a person without computer experience or training to prepare a problem for solution by the G-15. These codes are lists of "orders" or instructions which are extremely simple to use. A problem is programmed in terms of these orders, and a paper tape is punched to represent the orders along with the numerical constants associated with the problem. The interpretive code tape and the problem tape are entered into the Computer, using preloaded tape magazines and the high speed photo tape reader. The interpretive routine will then inspect each of the program orders in turn and cause the Computer to execute the required operations.

In more technical language, these routines permit operation of the G-15 as a decimal, floating-point, single-address computer with B registers. Several of the long memory channels are used to store the interpretive routine. The remaining general memory is used to store orders and numerical constants. This mode of operating is effective in a G-15 because its internal command system permits the subroutines and the interpretive routine to be compact and efficient.

These codes are representative of the simplified and automatic programming techniques which are possible with the G-15. Bendix has a staff of specialists in this field and additional techniques will be made available as they are perfected.

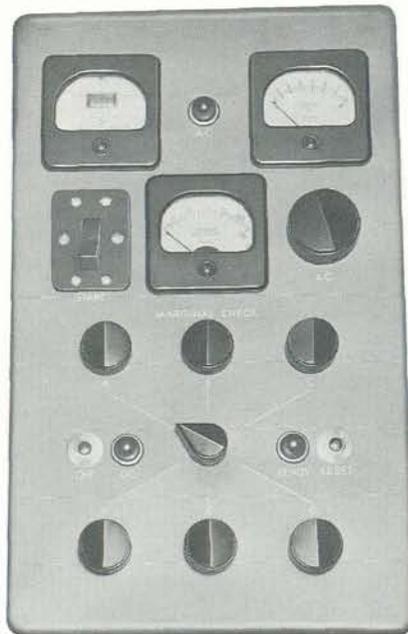


# SIMPLIFIED



## Punched-Tape Equipment

The Bendix high-speed photoelectric tape reader reads information at 200 characters per second from punched-paper tape contained in a convenient, inexpensive magazine. Programs, subroutines and commonly used data may be filed in individual magazines for use as desired. All instructions and information relative to a standard problem may be stored in a single magazine, and the G-15 may be set up for solution of this problem by a simple insertion of the appropriate magazine. The tape reader is mounted for easy access on drawer slides together with the punch and reel of blank tape. The punch may be used to prepare program tapes and record problem solutions.

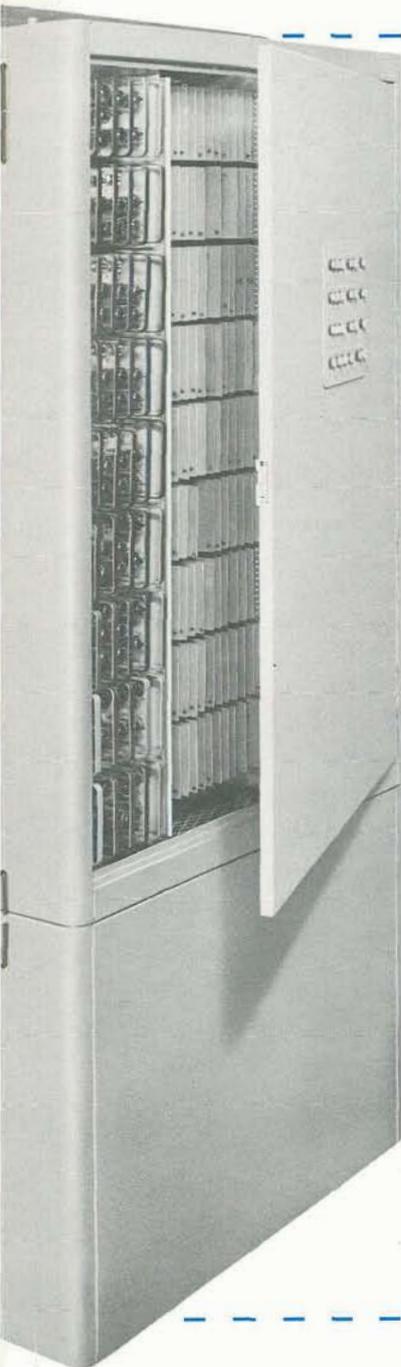


## Power Panel

The power panel contains all meters and switches necessary for the adjustment and control of power in the Computer. The Computer is turned on and off from this position, and voltage levels within the Computer may be measured. It is unnecessary to adjust these controls during operation of the machine. Facilities are provided for changing voltages within limits to make a marginal check of Computer operations. There is also included a running time meter accumulating operating hours so that regular maintenance as a function of use may be scheduled.

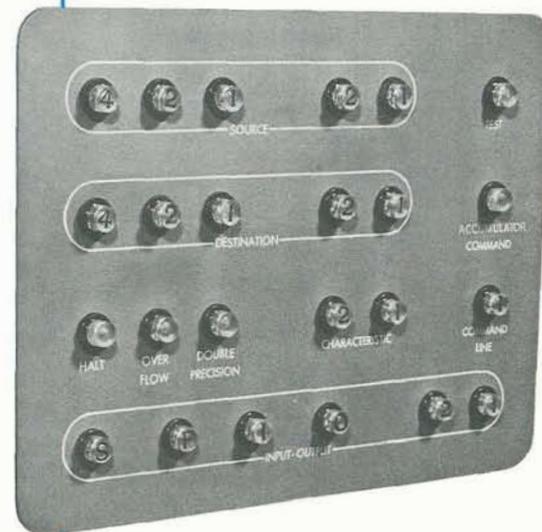


# OPERATION



## Command Indicator Panel

During the check-out of a new program, it may be desirable to stop at selected points in a program to check operations to that point. The command indicator panel, when the Computer is stopped, indicates the last executed command instruction. The indication is by a neon lamp display which shows the source, the destination, the transfer characteristic, the line from which the command was read, the present status of the input/output system and other desirable information relative to the execution of the command. When the Computer is computing, the display changes rapidly but such information as the state of the input/output system may still be useful to the operator.



## Master Writer

All operations of the Computer are controlled from the Master Writer which is an electric typewriter mounted on a base containing switches and other control facilities. Information may be entered into the Computer directly from the keyboard. The Computer output may be tabulated by the Master Writer. The Master Writer also may be used to start computation, to initiate input operations, to stop computation, cause a single command to be executed, cause printout of the accumulator or the next command, or control any of several other operations which are useful and convenient to the operator or programmer.



# Input and Output

The G-15 input/output system is unique in its class. An input or output operation for as many as 108 words may be initiated by a single command. The operation will then proceed without intervention and terminate itself on completion. During this operation the Computer may continue to compute with full efficiency. In most computers no computation can be accomplished during input or output, so problem-solving time is the sum of actual computing time and time for input and output. In many applications of the G-15 output may be concurrent with computation resulting in a significant increase in effective computer speed.

This feature also permits application of the G-15 to real-time data processing where input must be accepted during computation.

The G-15 Computer system offers the following complete range of input and output equipment:

**Standard Equipment:** Electric typewriter input and output, high-speed photoelectric paper tape reader, and paper tape punch.

**Magnetic Tape:** One to four magnetic tape units, each capable of storing 300,000 words of information on a single reel, may be connected to each G-15 Computer. Magnetic tape may be searched effectively at six times the reading or writing speed.

**Punch Cards:** Equipment for reading and punching cards directly by the G-15 is available so that it can be integrated directly into a punch card data-processing system.



# The Digital Differential Analyzer

The Bendix All-Purpose Computer is a new concept. This combination of the General Purpose Digital Computer and the Digital Differential Analyzer provides, in one low-cost computer, the advantages of both. It gives the wide applicability of the General Purpose Computer and the simple programming for the solution of linear and nonlinear differential equations which is characteristic of the Digital Differential Analyzer. As a general purpose computer it is identical with a standard G-15. As a differential analyzer it has greater capacity with speed comparable to that of other existing digital differential analyzers. When used as a combination machine it is a new and powerful tool for solving the problems of engineering and automatic control.

The differential analyzer of this combination incor-

porates many features of the Bendix Model D-12 Digital Differential Analyzer. These include coding, which is simplified to the bare essentials, improved stability and accuracy resulting from ternary transfer of incremental information, improved performance of servo and adder units, and the facility for efficient use of tabular empirical functions.

## ***Graph Plotter and Graph Follower:***

Available as optional equipment associated with the Differential Analyzer is a graph plotter and a graph plotter/follower. The Computer may be programmed to cause the plotter or plotter/follower to draw graphical representations of computed functions. The plotter/follower may be used as a device for direct input of graphically represented data to the Computer.



# Training, Maintenance, and Mathematical Services

When you buy a G-15 Computer you get a complete ready-to-use package: the Computer itself, complete with input and output equipment, installed and operating in your place of business. In addition, there are provided five weeks of operational and maintenance training in two stages, for those members of your staff who will program and maintain the Computer.

These instructions are given by a professional teaching staff and include lectures and operational and maintenance experience with a Computer of the model you buy.

A library of subroutines, interpretive routines and solu-

tions to common problems, a periodical news letter reporting additions to the subroutine library and new techniques and applications, and a set of complete operational and maintenance manuals are additional aids which are provided.

All these, ~~and a 90 day free maintenance service policy~~ and a one-year warranty of material and workmanship, are included as part of the initial cost of the Computer.

Back of your staff and your Bendix Computer stands the Bendix field service organization which is ready to provide assistance or, if desired, a complete maintenance service.

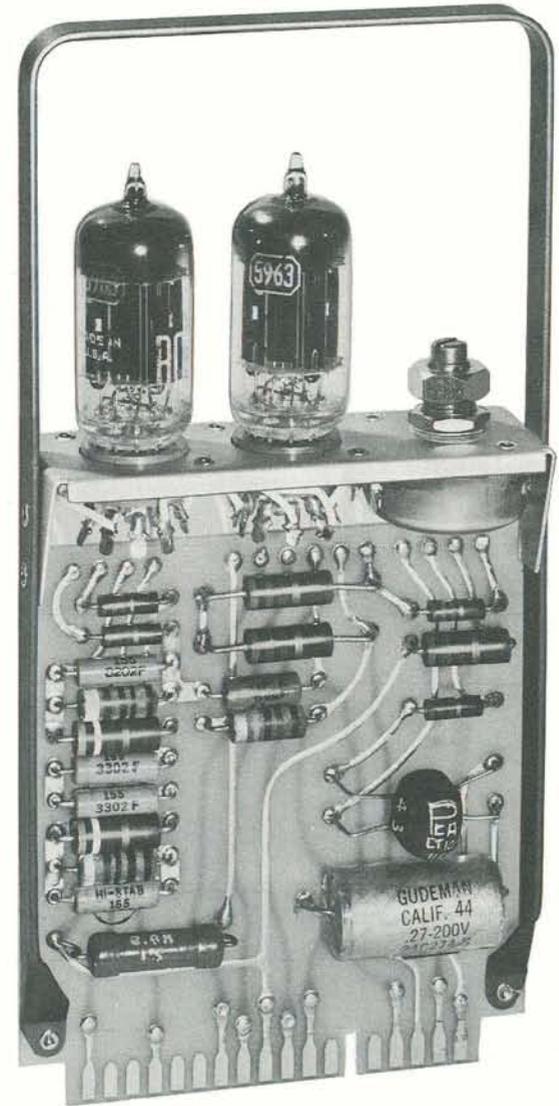
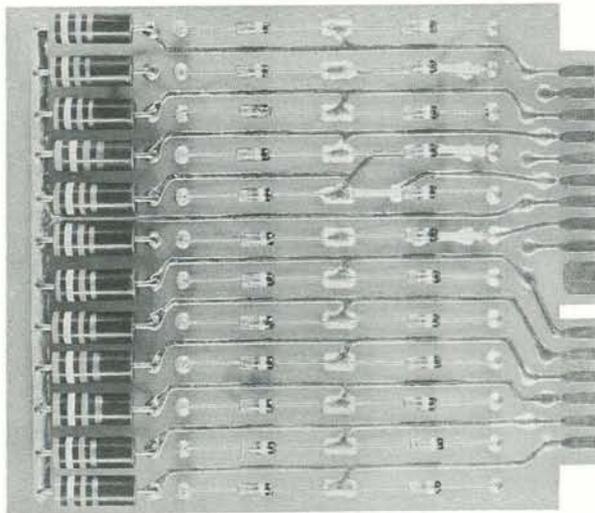


# Large Capacity, Low Price . . .

The G-15 is a new and different computer. Because of its simplified, exclusive design, the problem of maintenance has been reduced and its reliability has been increased.

Bendix Computers are built by a world leader in the mass production of precision electronics. In some respects the company is unique. In the strength of its engineering staff and in its experience in the mass production of precision instruments its record is unsurpassed.

It has applied this engineering and mass-production experience to the design and manufacture of Bendix Computers. To assembly-line techniques Bendix has added such production features as plug-in sub-assemblies, printed circuits and dip-soldering. These design and production economies enable us to offer large computing capacity at an unusually low price.



## GENERAL PURPOSE OPERATIONS

Addition:		All Times Include  Minimum  Access To Command
Single Precision	0.54 msec	
Double Precision	0.81 msec	
Subtraction:		
Single Precision	0.54 msec	
Double Precision	0.81 msec	
Multiplication:		
Single Precision	16.7 msec	
Double Precision	33.1 msec	
Multiplication of arbitrary precision is possible; the factors may be up to 57 binary digits plus sign with the operation time equal to 0.27 msec for command access plus 0.54 msec per digit of the multiplier.		
Division:		
Single Precision	16.7 msec	
Double Precision	33.1 msec	

- Shift and normalize:  
 Automatic tally for convenient floating point operation
- Extract and assemble
- Conditional transfer of control based on:
- Sign of accumulator
  - Arithmetic overflow
  - State of input/output system
  - Presence or absence of any digit or digits in a word or group of words
- Number storage:
- Absolute value and sign
  - Word length of 29 or 58 binary digits
- Command system:  
 See pages 6 and 7

## INTERNAL MEMORY

- Magnetic drum with high speed all electronic switching
- General store:
- 2160 words
  - Random access time 14.5 msec (average)
- Quick access store:
- 16 words
  - Random access times 0.54 msec (average)
- Arithmetic registers:
- Three 2 word
  - One 1 word

## EXTERNAL MAGNETIC TAPE MEMORY

- Optional one to four units
- Capacity:  
 300,000 words per reel
- Tape:  
 Standard 1/2" width, maximum 10 1/2" dia. NARTB reel
- Block length:  
 Arbitrary to 108 words
- File length:  
 Arbitrary number of blocks
- Read/write speed:  
 7 1/2" per sec.
- Search speed:  
 45" per sec.

## INPUT/OUTPUT

- Number system:  
 Decimal or sexadecimal
- Standard Equipment:
- |                           |  |
|---------------------------|--|
| Master Writer             | 8 characters per sec.                            |
| Paper Tape Punch          | 17 characters per sec.                           |
| Photoelectric Tape Reader | 200 characters per sec. from paper tape magazine |
- Punch Cards:  
 Serial punch card equipment may be coupled to the G-15
- |                                |                                |
|--------------------------------|--------------------------------|
| Input: 17 characters per sec.  | } With type 526 card equipment |
| Output: 11 characters per sec. |                                |
- Input/Output Commands:
- Type out
  - Punch paper tape
  - Type and punch paper tape
  - Type out accumulator
  - Write on magnetic tape
  - Punch cards
  - Type in
  - Read punched paper tape
  - Read magnetic tape
  - Read punched card
  - Search magnetic tape forward
  - Search magnetic tape backward
  - Reverse paper tape
- Computation proceeds during input/output

# S P E C I F I C A T I O N S

## DIGITAL DIFFERENTIAL ANALYZER (Optional)

### Capacity:

108 integrators, 108 constant multipliers

### Program input:

Normal G-15 equipment including –  
Punched paper tape  
Master Writer  
Punched cards  
Magnetic tape

### Data Input:

Normal G-15 equipment  
Digital Plotter/Follower:  
Photo-electrically reads graphical representations in 0.01" increments from paper up to 12" x 18" in size

### Output:

Normal G-15 equipment  
Digital Plotter:  
Plots the relationships between any two variables generated by the Computer in 0.01" increments on paper up to 12" x 18" in size  
Digital Plotter/Follower:  
May be used as plotter for output

### Mathematical:

Binary internal operation and ternary transfer of incremental information result in efficient scaling, reduced error, and high stability.

### Speed:

34 iterations per sec. (equivalent to 68 binary transfer iterations per sec.)

## PHYSICAL SPECIFICATIONS

### Basic G-15 Computer

#### Size:

32" deep x 27" wide x 61" high

#### Weight:

850 lbs.

#### Power Input:

3.8 KVA, 110 - 120 volts, 60 cycles, single phase

#### Cooling:

Internal forced air

#### Plug-in etched circuit packages:

180 tube packages  
300 diode packages

### Magnetic Tape Unit

#### Size:

22" deep x 24" wide x 60" high

#### Weight:

175 lbs.

#### Power Input:

640 VA, 110 - 120 volts, 60 cycles, single phase

#### Cooling:

Internal forced air

### Digital Differential Analyzer

#### Size:

22" deep x 24" wide x 60" high

#### Weight:

300 lbs.

#### Power Input:

1 KVA, 110 - 120 volts, 60 cycles, single phase

#### Cooling:

Internal forced air



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