general

electric

announces

the
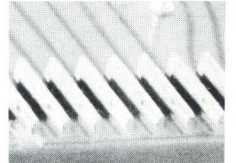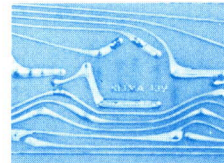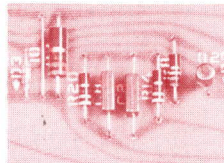
flexible

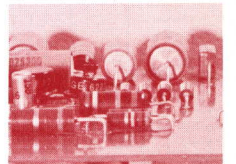*new*
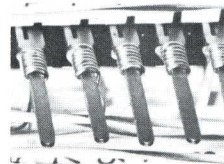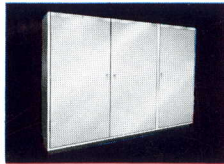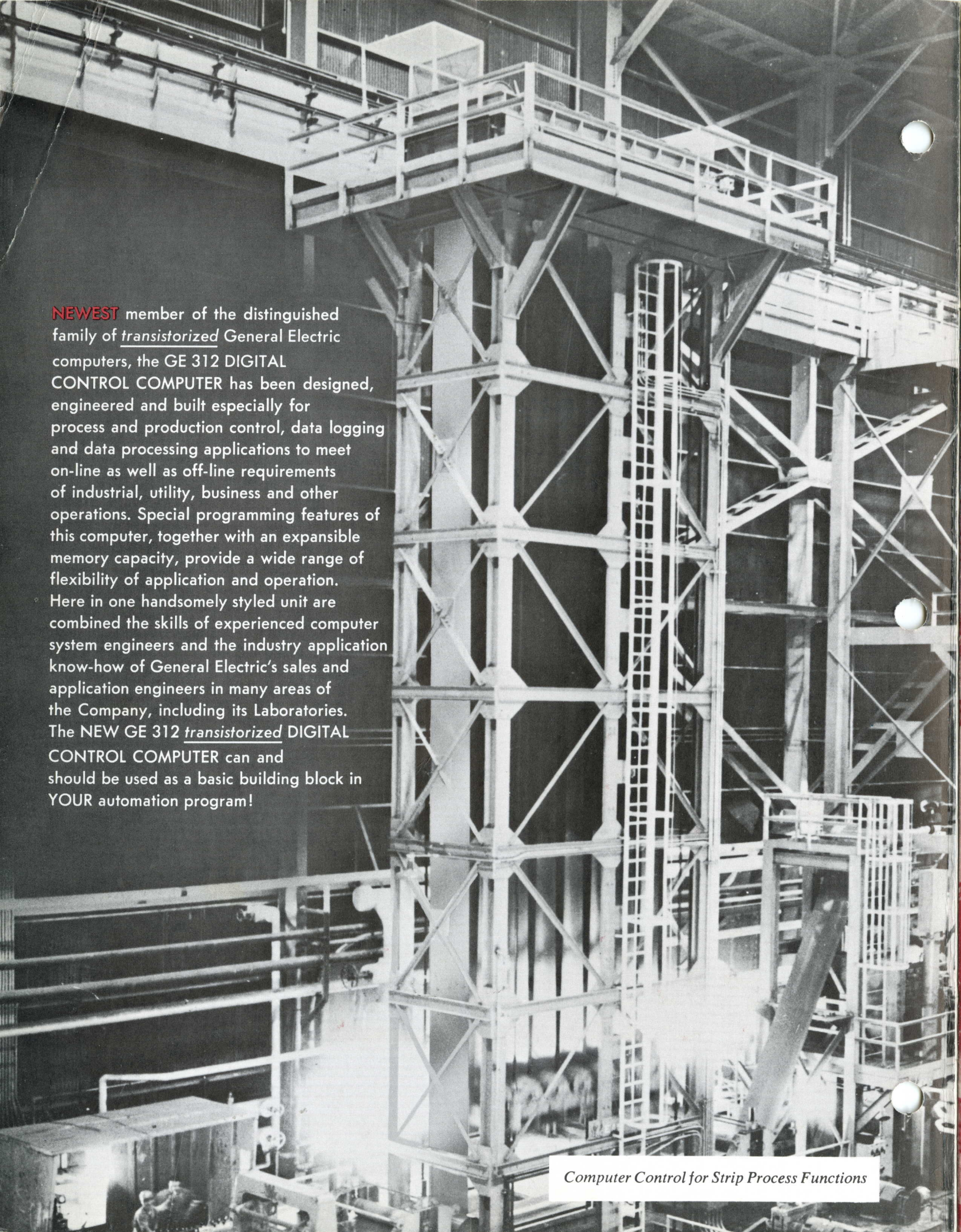
GE **312**

DIGITAL
CONTROL
COMPUTER

GENERAL ELECTRIC
COMPUTER DEPARTMENT

for industrial and utility systems

NEWEST member of the distinguished family of *transistorized* General Electric computers, the GE 312 DIGITAL CONTROL COMPUTER has been designed, engineered and built especially for process and production control, data logging and data processing applications to meet on-line as well as off-line requirements of industrial, utility, business and other operations. Special programming features of this computer, together with an expansible memory capacity, provide a wide range of flexibility of application and operation. Here in one handsomely styled unit are combined the skills of experienced computer system engineers and the industry application know-how of General Electric's sales and application engineers in many areas of the Company, including its Laboratories. The NEW GE 312 *transistorized* DIGITAL CONTROL COMPUTER can and should be used as a basic building block in YOUR automation program!

Computer Control for Strip Process Functions

GENERAL ⊕ ELECTRIC

PAPER TAPE PUNCH

COMPUTER

COMPUTER CONSOLE

ELECTRIC TYPE-WRITER

PAPER TAPE READER
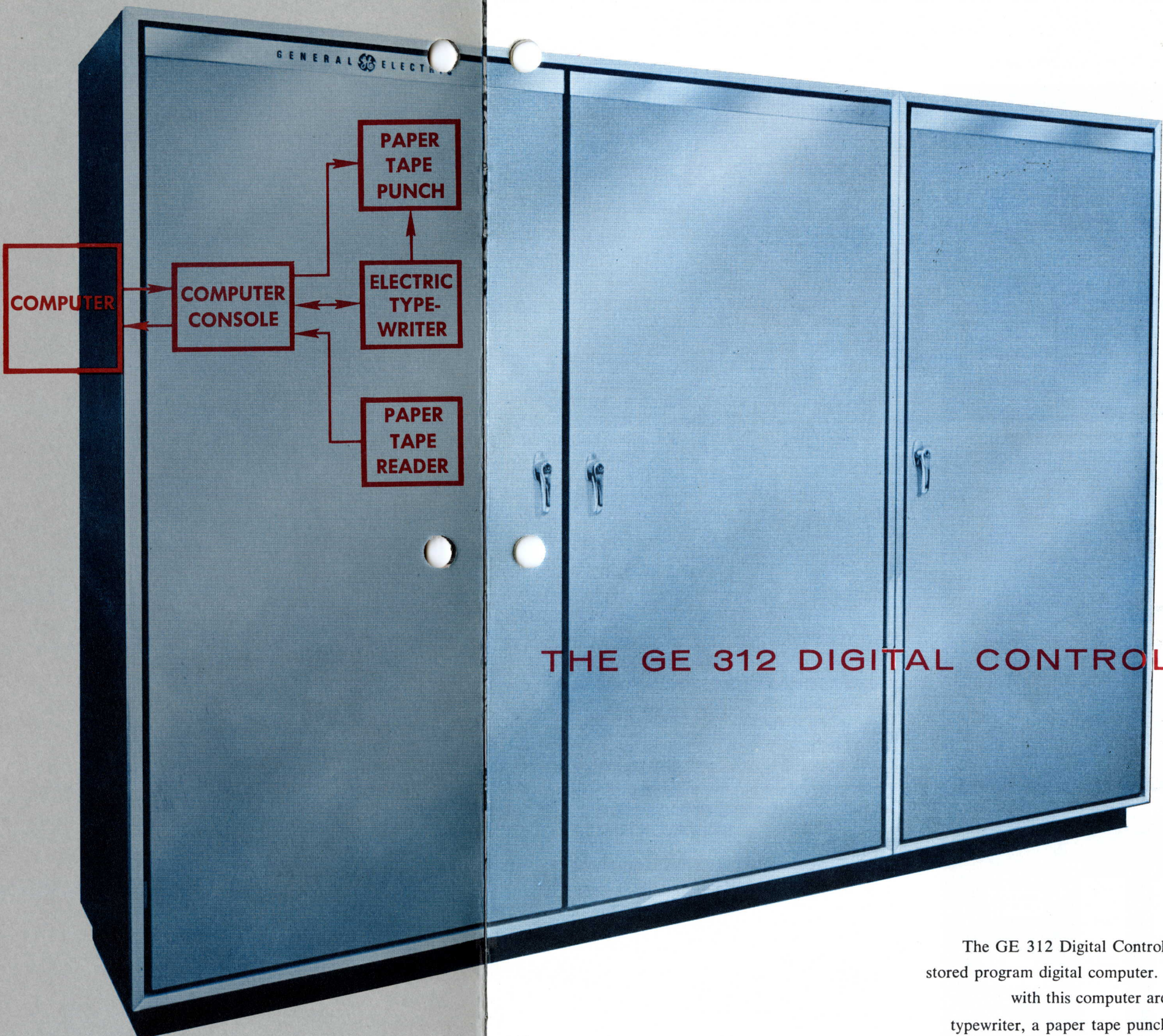
THE GE 312 DIGITAL CONTROL COMPUTER

The GE 312 Digital Control Computer is a general purpose stored program digital computer. Provided as standard equipment with this computer are a computer console, an electric typewriter, a paper tape punch and a paper tape reader. With appropriate auxiliary equipment, it is capable of handling large quantities and varieties of analog and digital input and output signals.
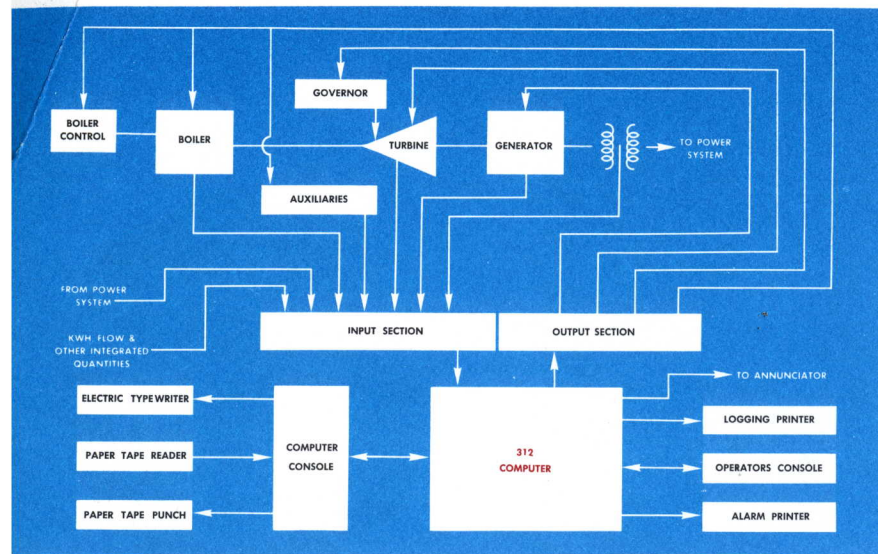
Representative applications of these two systems are:

System control function — electric utility steam generating station

Metal processing

Paper processing
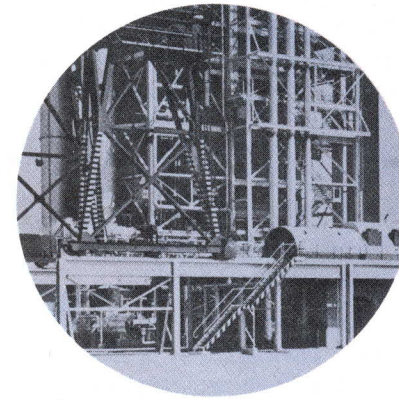
Steam generating station
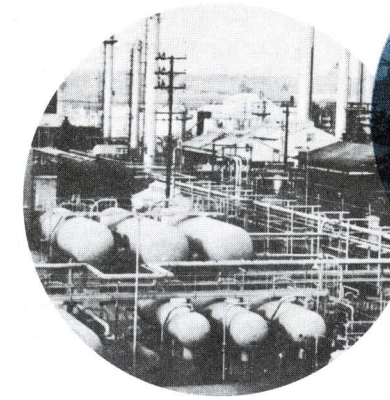
Petroleum refining
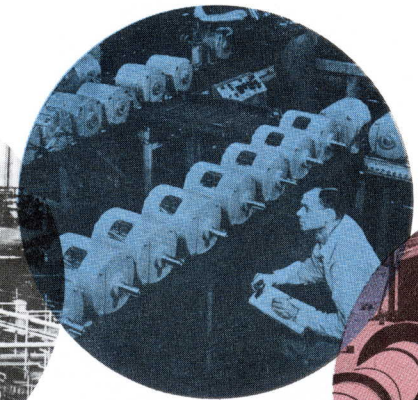
Production control

Cement production

Strip process function — annealing line
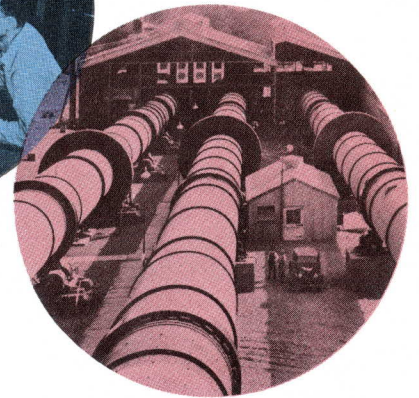
IF YOUR OPERATION involves any of the functions described here, or if you are planning on MODERNIZATION THROUGH AUTOMATION, investigate the application possibilities of the GE 312 *transistorized* DIGITAL CONTROL COMPUTER for . . .

- **Increased Profits**
  —as the result of reduced operating costs

- **Higher Plant Output**
  —through increased production efficiency

- **Product Quality Improvement**
  —through greater and more exactingly maintained uniformity with minimized waste

- **Increased Process Utilization**
  —as a result of closer control of process variables
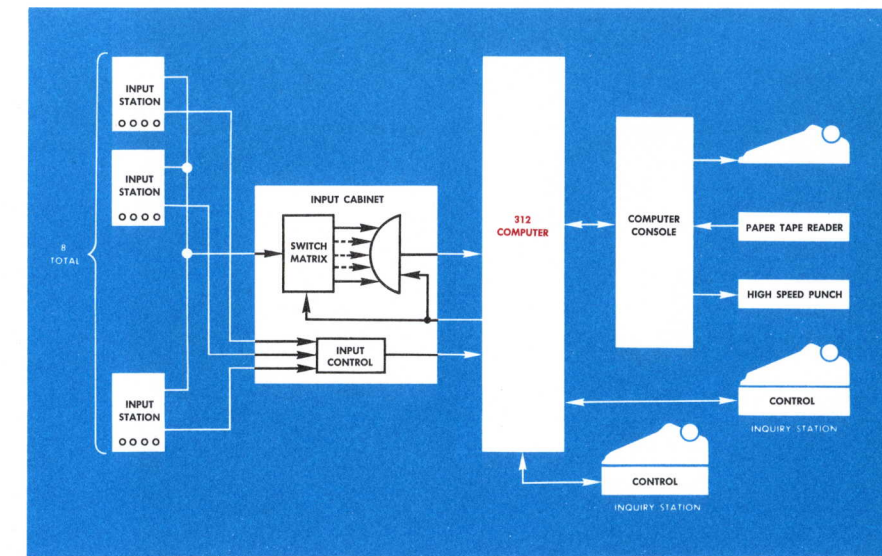
Data process function — production control

Flow process function — chemical production
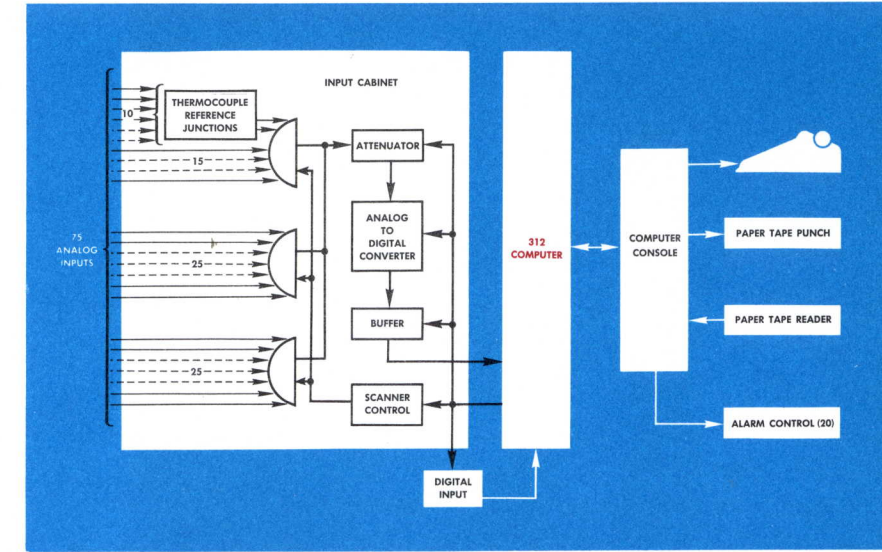
Materials handling function — iron ore sintering
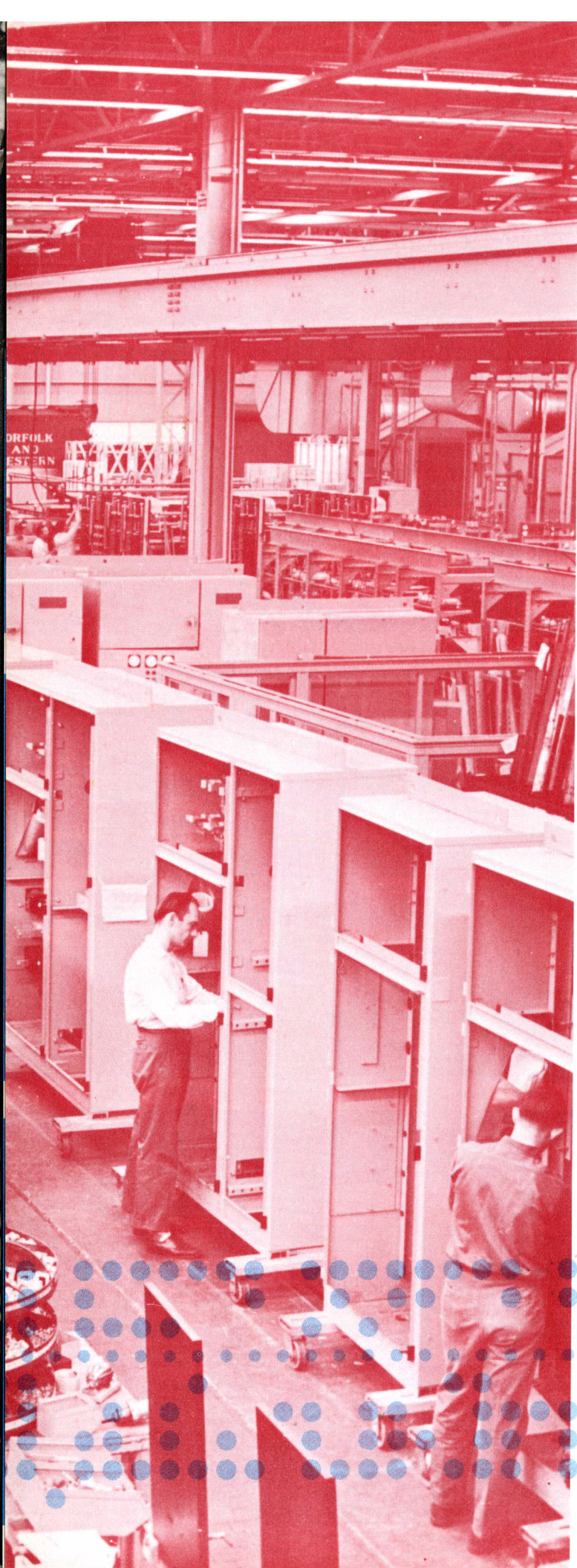
Its speed of operation, flexible command structure, analog input-output, and sturdy construction make the GE 312 DIGITAL CONTROL COMPUTER ideally suited for operation in industrial and utility applications.

In on-line operation it is coupled to process instrumentation, thereby becoming the key link of a PROCESS COMPUTING SYSTEM for the acquisition, monitoring and calculation of process data. With its expansible features and wide range of input and output capacity, the 312 computer can be used in a COMPUTER CONTROL SYSTEM. This can be accomplished by adding the necessary output equipment for coupling to controllers on the process, and making the appropriate modifications to the computer program to include calculation of control outputs.

Vital process information is recorded at optimum intervals. Process operating data are computed automatically and quickly, providing data when it is needed. All necessary control, scaling, linearizing, averaging, and computations on input signals are accomplished by the computer, thus freeing the operator to make more accurate and timely decisions concerning the operation of the process or system itself. Produced as a permanent record, data from the digital control computer is available to management for guidance and decision, thus permitting accurate analysis of process dynamics.

The GE 312 has been designed and built for compatibility with industrial control system problems. Its design characteristics bring into focus the application of digital computer techniques to the industrial process, helping to make possible the increased economies of improved operation. It is economically suited for application to the process problems of gas and electric utilities, steel mills and other metal processing plants, cement, petroleum, chemical and petrochemical industries — in fact, to any process where the application of computer techniques to dynamic data processing problems holds the key to new economies through:

- **Better Control**
- **Increased Yield**
- **Better Product Quality**
- **Reduced Operating Cost**

FEATURES

EASE AND FLEXIBILITY OF PROGRAMMING . . . ADVANCED PROGRAMMING AIDS . . . RELIABILITY . . . WIDE RANGE OF INPUTS AND OUTPUTS . . . EXPANSIBLE MEMORY CAPACITY

● *Instruction System*

Designed for flexible programming, the GE 312 offers a repertoire of more than 60 commands including special instructions for process applications and double-length register for greater accuracy in multiplication and division. Under program control, information may be written into or read from all data tracks on magnetic drum memory. Provision for automatic instruction modification is also included.

Two instruction systems, either the single-address or one-plus-one mode, may be intermixed in the program. This unique dual system results in two main advantages:

1. An instruction which can be executed in one word time — such as add or subtract — can be stored in one location by writing it in the single address mode, allowing storage of more commands than is possible in the one-plus-one mode.

2. Instructions which require more than one word time —that is, multiply, divide, and operations referring to data which cannot be optimally stored — will be written in the one-plus-one mode, making it possible for the programmer to optimize general routines, with consequent increased speed of operation.

Other special features of the instruction system include conditional transfer commands causing branching on internal machine and data status or external equipment status; extremely fast shift commands; commands tailored to work efficiently with system inputs and outputs.

● *Automatic Modification of Instruction Address*

The inclusion of an automatic instruction modification is a powerful feature, unique to the GE 312 among equipment of similar size and cost. The advantages of an automatic instruction modification include reduced storage requirements for the program, reduced programming cost, and increased speed of the operating program.

● *Advanced Programming Aids*

This computer is *easily programmed*. A package of advanced programming aids available to the user reduces the time, cost and complexity of programming and provides several programming tools which enhance the power of the computer in industrial, utility and business process applications. Included in this package are:

- Assembly and optimizing programs

- Routines for elementary functions (square root, natural logarithm exponential, etc.)

- Service routines (to load instructions, convert decimal to binary numbers, convert binary to decimal numbers, etc.)

- Program debugging aids

- Curve fitting and interpolation techniques

The availability of these programming aids allows the user to employ the powerful features of the digital control computer to full advantage without the necessity for a large staff of experienced programmers. The programmer is relieved of many of the clerical chores of programming, and is free to concentrate on the process operation.

● *Reliability*

Improved performance and life are provided by the exclusive use of transistors, diodes and other solid state devices — eliminating the use of vacuum tubes. For accuracy and reliability, transistors are operated at a fraction of their full rating. Design includes sturdy construction of cabinets, filtered air intakes and gasketed doors which may be locked shut. An air-conditioning unit is an integral part of the equipment, providing added assurance of greater component reliability.
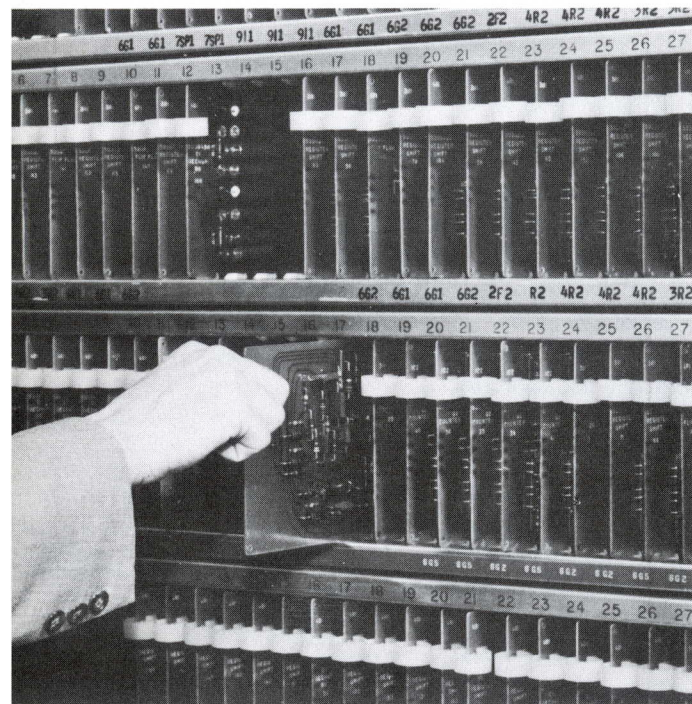
Rack and module construction permits routine circuit testing from front of cabinet

More reliability is built into the equipment through the use of a modern wire-wrapping technique which eliminates solder joints and loose solder pieces. Normal maintenance can be accomplished quickly and easily from the front of the cabinet, due to the rack and module construction which incorporates plug-in printed-wiring boards. Approximately 50% of the boards in the computer are identical, thus minimizing spare parts requirements. All boards are coded to indicate proper location, with test points for in-operation circuit checks located directly below the handle on each board.

● *Wide Range of Analog and Digital Input-Output*

The 312 uses punched paper tape input and electric typewriter and punched paper tape output. Additional types of digital output, such as fast punched paper tape and punched cards, are available as optional features. When coupled to process instrumentation, analog or digital inputs may be accommodated within limits which virtually are determined only by the requirements of the user. Analog or digital output control signals can also be supplied to meet the requirements of the process. This flexibility of input and output is an an important feature in applying this computer to the data acquisition, data processing, or control system problems of industrial processes and utility operations.

● *Basic Speed*

Speed of operation becomes particularly important in considering real-time on-line applications where the computer has only a finite time to perform all required operations. With its fast arithmetic operations, special programming characteristics, and unique features, the GE 312 computer offers great speed of operation.
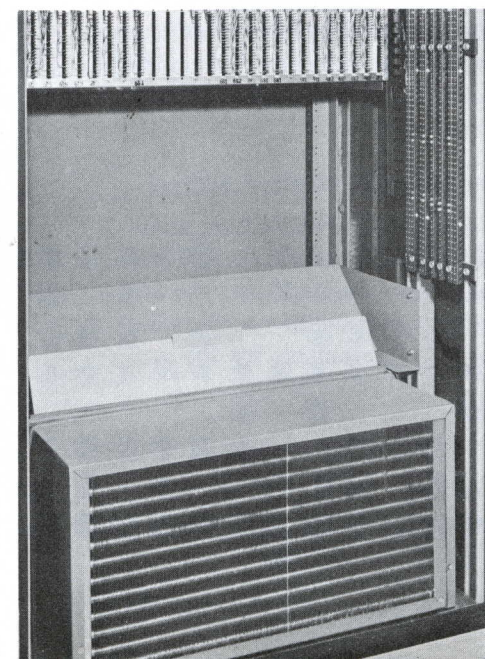
Integral air conditioning for increased component reliability; rugged construction for industrial applications
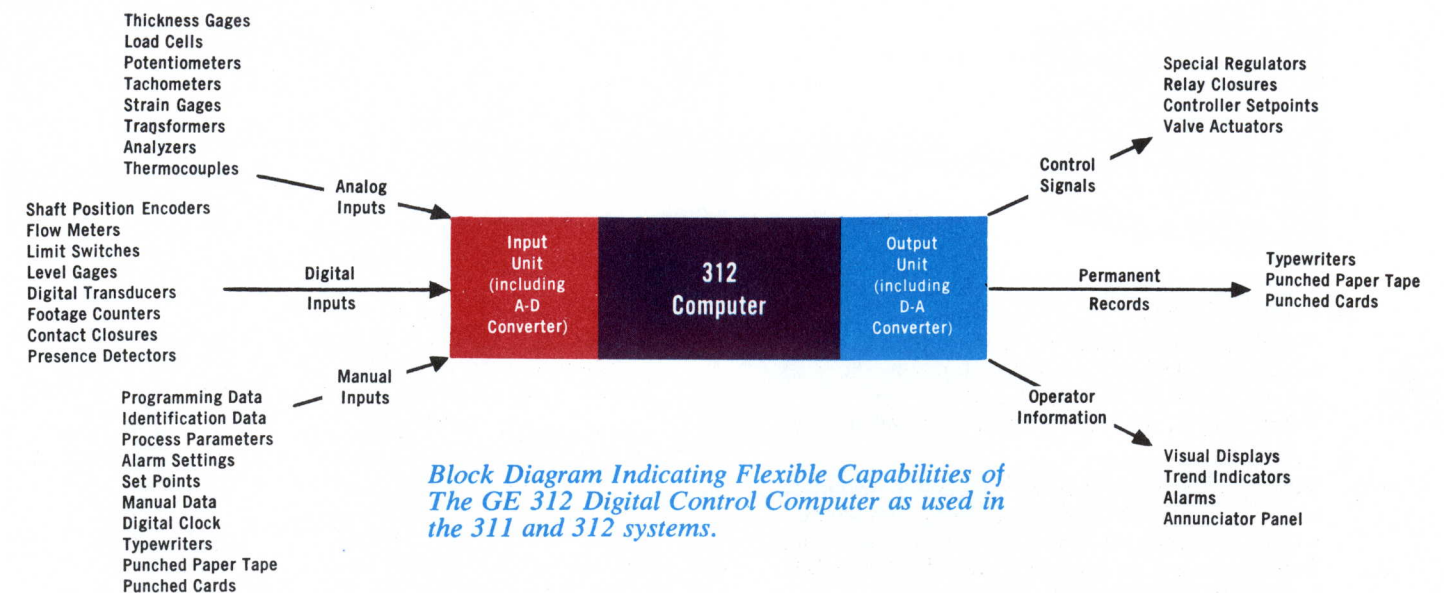
Block Diagram Indicating Flexible Capabilities of The GE 312 Digital Control Computer as used in the 311 and 312 systems.

● *Number System*

Word length in the system is nineteen binary digits plus one sign bit. Number representation is binary, fixed point. Decimal numbers, alphabetics, and special symbols can all be handled by this computer.

● *Expansible Memory Capacity*

The requirement for memory capacity is largely determined by the application — the amount of data to be stored and the size of the program required to process the data. The storage medium in the system is a magnetic drum, offering proved reliability. The memory size can be increased from the basic 2,048 words to 16,384 words at the option of the user. In addition, from 16 to 512 words of fast-access storage can also be provided.

This expansible memory capacity, plus the wide range of input-output capability and the inherent flexibility of a stored-program digital control computer, fit the GE 312 to growing application needs. With the availability of new instrumentation or control devices, or increasing requirements for the acquisition and processing of process and system data, this computer can be expanded to meet these new application requirements.

Front View

1 Off-center pull-out handle for easy removal of board

2 Coding to assure proper location of board

3 Silicon varnish protective coating

4 Individual gold-flashed phosphor-bronze four-point-of-contact terminal pins

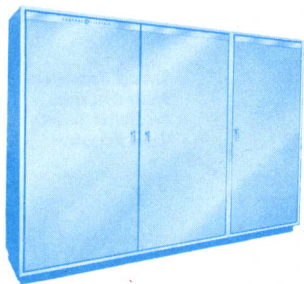**Rear View**

5 Key slots for correct insertion of board

6 Test points for checking circuit from front of cabinet

7 Coding for re-ordering of additional boards
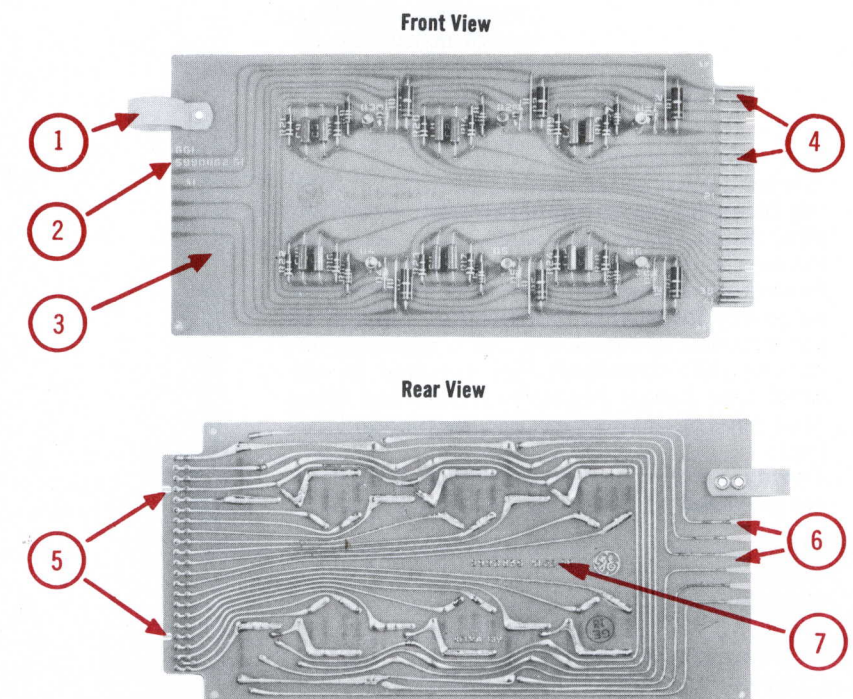
Plug-in printed-wiring boards allow ease of maintenance

SPECIFICATIONS

A. *Number System*

Number representation: binary, fixed point, fractional, decimal numbers, alphabetics, and special symbols can be handled
Word length: 19 binary digits plus one sign bit

B. *Instruction System*

The more than 60 instructions may be either single address or $1 + 1$ address, intermixed within the programs at the user's discretion. Some instructions use the operand address bits for instruction decoding.

1. Single address (one word command)
   a. Operand address — 13 bits for 8000-word storage, 14 bits for 16000-word storage
   b. Command — 4 bits
      One bit denotes whether the instruction uses the automatic modification of instruction address.
2. $1 + 1$ address (two words that include a single address instruction plus address of next instruction)
   a. First word — Operand address:
      13 bits for 8000-word storage,
      14 bits for 16000-word storage
      Command: 4 bits
      One bit denotes whether instruction uses the automatic modification of instruction address.
   b. Second word — Next instruction address: 14 bits

C. *Instruction Highlights*

Twelve branch commands are provided, including branches on accumulator odd, overflow, plus, minus, zero, index high, index low, and unconditional. An eleven bit automatic modification of instruction address is provided for automatic instruction modification, linkage for sub-routines, counters, etc. All commands, including shift commands, are executed in one word time except Multiply, Divide and Store (exclusive of drum access and instruction loading).
Twenty console breakpoint or control switches are provided.

D. *Memory Unit*

Type: Magnetic drum
Capacity: 2,048 to 16,384 words
Average access time: 6.25 milliseconds
Drum speed: 4,800 rpm
Optional: fast access storage can be provided

E. *Arithmetic and Control Unit*

Components — All solid state
Operation — Serial by bit
Speed: (with optimum storage location)

	Single address	$1 + 1$ address
Add or subtract	.192 ms	.288 ms
Multiply (full length)	Variable from .288 to	2.0160 ms max.
Divide (full length)		2.5920 ms max.
Branch	.192 ms	.192 ms
Load	.192 ms	.288 ms
Store		.384 ms

F. *Digital Input System*

1. Standard equipment: Paper tape reader with a speed of twenty characters per second.
2. Optional equipment: Additional or alternative paper tape readers with speeds up to 240 characters per second.

G. *Digital Output System*

1. Standard equipment: Electric typewriter with speed of ten characters per second maximum, paper tape punch operating at typewriter speeds.
2. Optional equipment:
   a. Long-carriage typewriters
   b. Paper tape punches with speeds of 60 characters per second
   c. Multiple typewriters and punches

H. *Operator's Control Panel*

1. Controls with indicator lights: POWER ON, POWER OFF, PROGRAM START, PROGRAM STOP, SINGLE STEP.
2. Indicator lights: STANDBY and WARNING. Register and flip-flop state indicators.
3. Controls: 20 Program break-point switches, circuit and register selector switches.

I. *General Characteristics*

1. Size: 75 inches high, 108 inches long, 24 inches deep, plus input-output equipment.
2. Weight: approximately 3,000 pounds.
3. Power requirement: 4 KW, 120 volts, $\pm$ 10%, 60 cps
4. Air conditioning: self-contained. Maximum ambient temperature 105°F with 95% relative humidity.

Electric Utility Steam Generating Functions
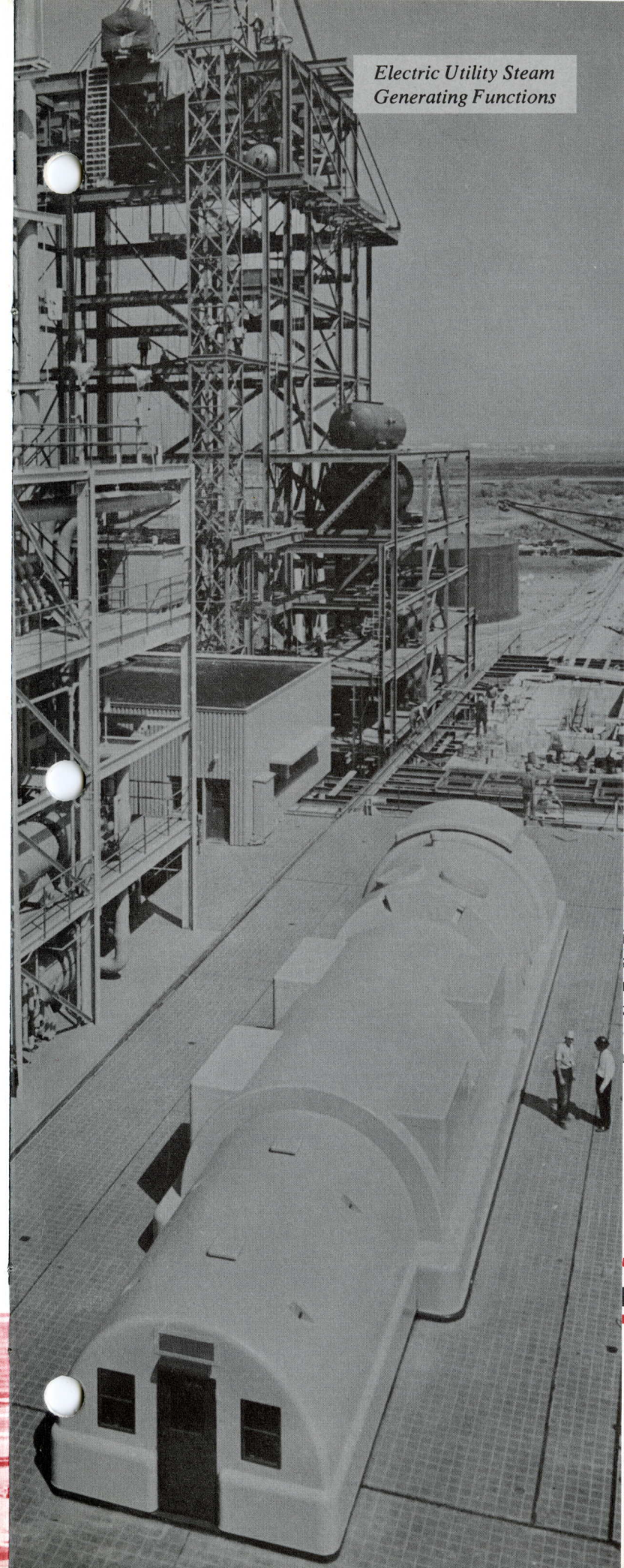
Computer Control for Petroleum Refining Functions

OTHER PRODUCTS AND SERVICES

From this new headquarters facility of General Electric's Computer Department in Phoenix, Arizona, come equipments and services of value to industry, business, and science including . . .

The GE 302 Data Accumulator

The GE 307 Miniaturized a-c Network Analyzer

The GE 308 Economic Dispatch Computer

The GE 309 Gage Logging System

The GE 310 Data Acquisition System for process monitoring

Systems and products utilizing characters written in magnetic ink as inputs

Computing Services — including mathematical analysis, programming and machine time

Product Service — nation-wide and available on all Computer Department products

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PROCESS CONTROL *AUTOMATED BY GENERAL ELECTRIC*

Inquire today!

For more information or assistance in applying the GE 312 DIGITAL CON-
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to your process or operation, contact your nearest General Electric Appa-
ratus Sales District Office, or General Electric Company, Computer Depart-
ment, Deer Valley Park, Phoenix, Arizona.

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