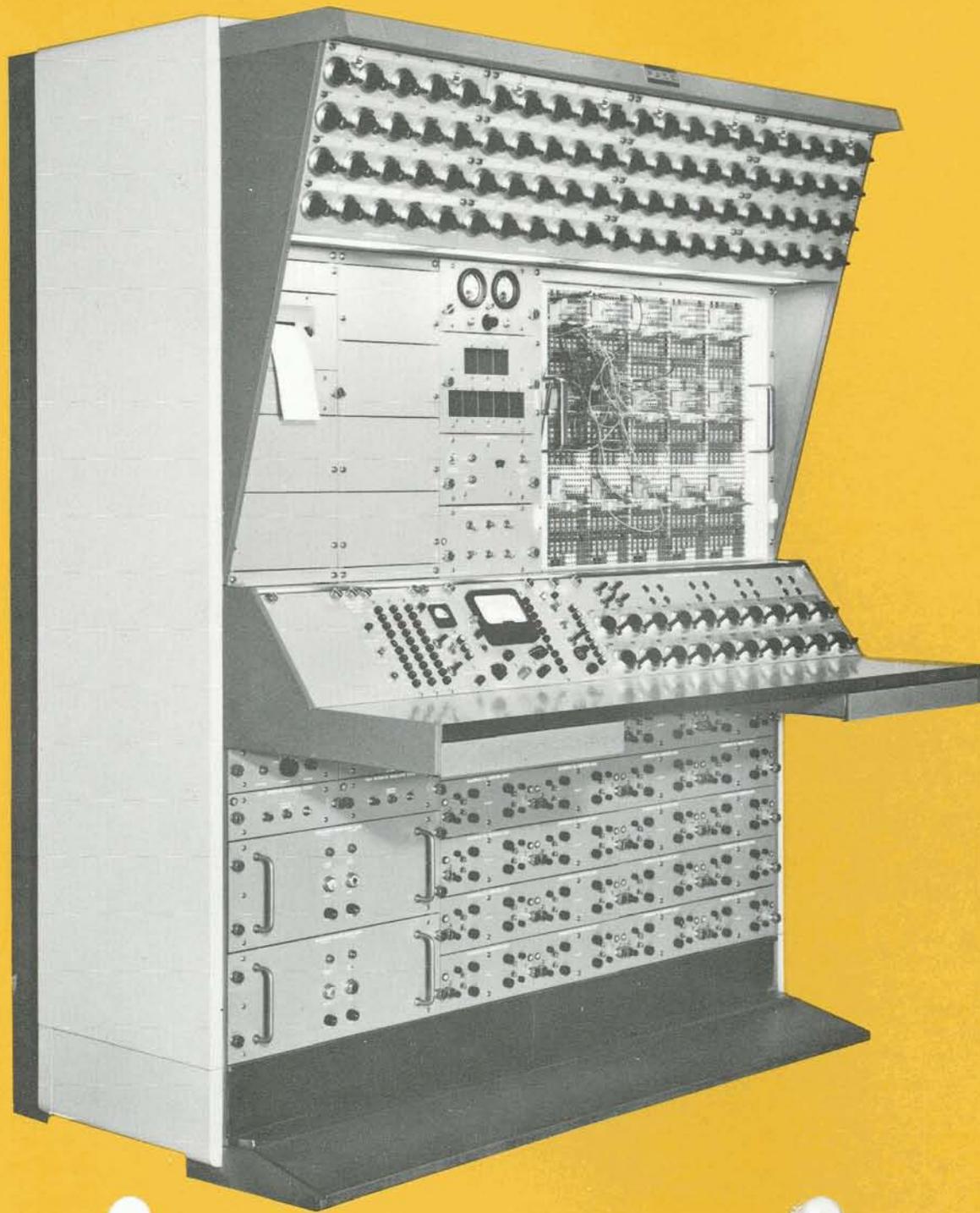


PACE[®] 231R *analog computer*





from Electronic Associates, Inc.

... the **PACE**® 231R... a new standard in analog computation

Today general purpose analog computers are playing an important role in scientific and engineering progress. Automobiles, machine tools, jet aircraft, atomic submarines, inter-continental missiles, satellites and space vehicles are just a few of the many hundreds of products designed by simulation on analog computers. Over 70 per cent of the precision general purpose analog computers now in use have been designed and built by EAI. From this depth of experience came the new general purpose analog computer—the *Pace 231R*.

Built in the same tradition of quality as its famous predecessors, the *Pace 31R* and the *Pace 131R*, it is designed

specifically to meet the requirements of industrial and military groups faced with the increasingly complex problems of this space era.

The *Pace 231R* provides new standards for speed, accuracy, reliability and economy in the field of analog computation. It can handle everything from the complicated details of routine engineering problems to the most complex and sophisticated missile designs.

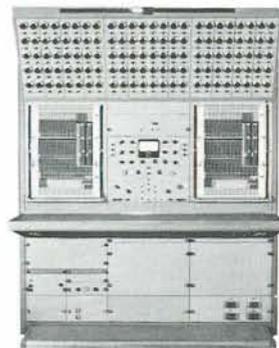
This modern *Pace* computer opens new fields to analog techniques and offers significant reductions in programming and maintenance time. In design, in quality of workmanship—here, indeed, is the finest analog computer ever produced.

new **PACE**® 231R *analog computer combines experience-proven*



Model 16-24 A

1952



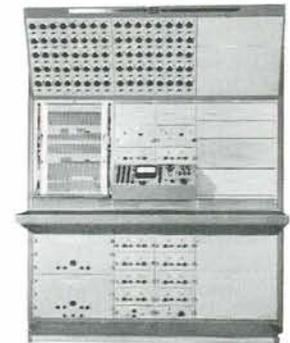
Model 16-24 D

1953



Model 16-31 R

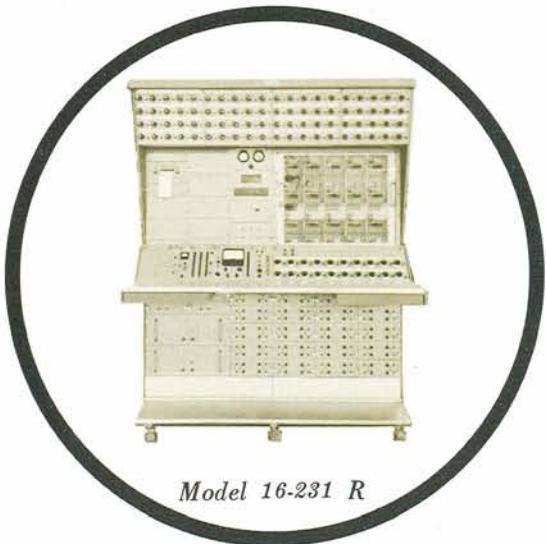
1954



Model 16-131 R

1957

features with new advances . . .



Model 16-231 R

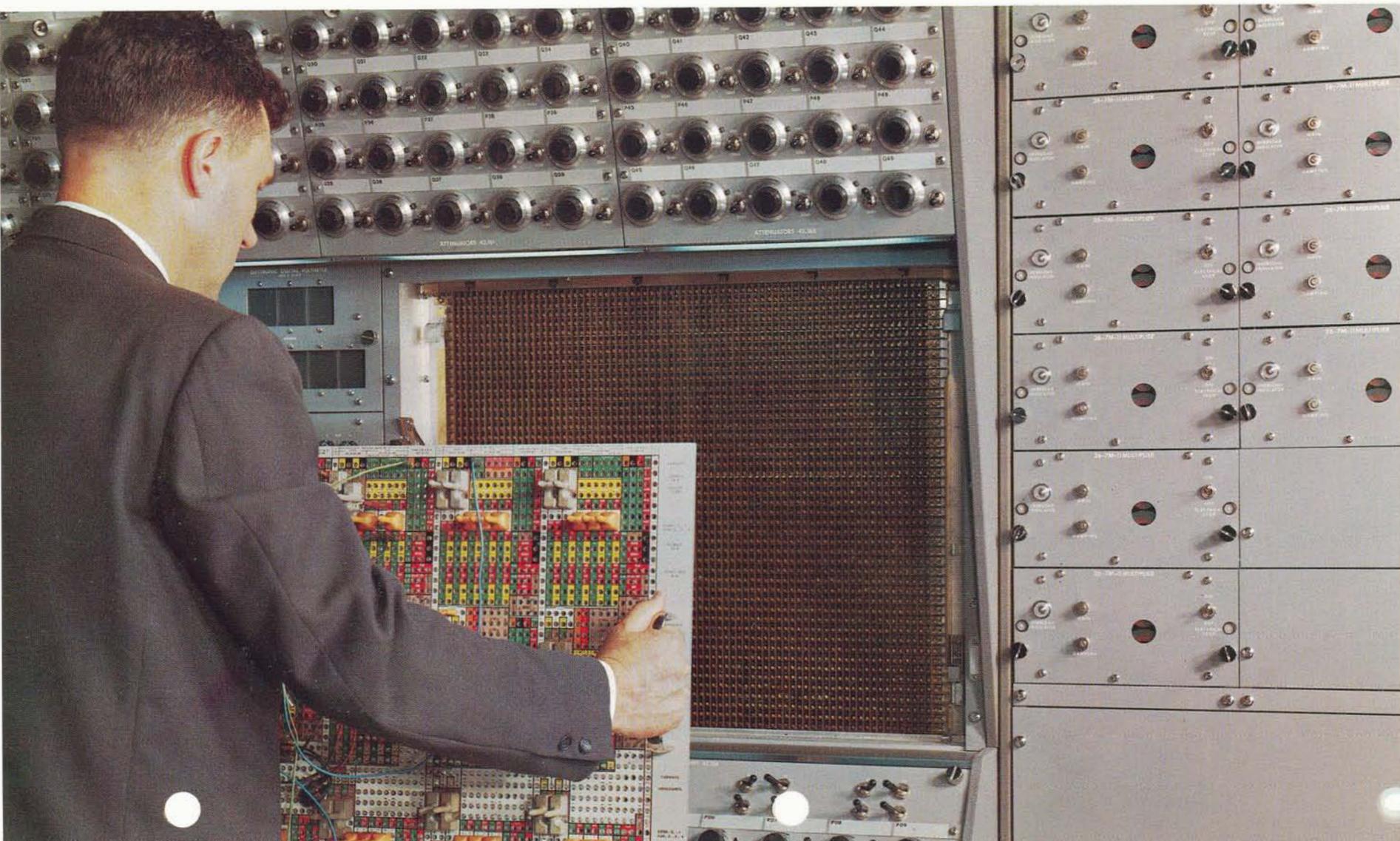
Experience Proven Features

- *The basic console is a self-contained computer which may be easily expanded by the addition of plug-in components.*
- *All operating controls are centrally grouped for exceptional ease of operation.*
- *All metal pre-patch panel eliminates warping, assures positive patch-bay contacts.*
- *All active computing components are removable from the front of the computer.*
- *Vivid color-coding and high legibility of patch panel simplifies problem patching.*
- *All critical computing components are housed in a thermostatically controlled oven.*
- *Console contains visual and audible overload alarm.*
- *Critical conductors are fully shielded to reduce cross talk to a minimum.*
- *Console and racks feature rugged construction and forced ventilation.*
- *Centrally located, push-button signal selector facilitates complete system monitoring.*
- *Any number of fully expanded computing systems can be controlled from a single console.*
- *“Automatic Hold” simplifies problem trouble shooting.*
- *“Problem-check” feature promotes patching accuracy and assures proper component performance.*

New Advances

- *Individual integrator mode control.*
- *Large 3450-hole patch panel with strategic grouping of components largely eliminates patch panel clutter.*
- *High-speed electronic digital voltmeter and printer provide five figure read out—plus address of monitored component.*
- *Push-button mode control.*
- *Most complete automatic digital input-output system available.*
- *High-speed servo-set potentiometer and function generator system.*
- *Automatic time-scale changes available as standard accessories.*
- *No re-patching required for conversion to high-speed repetitive mode of operation.*
- *Advanced amplifier design facilitates wider range of computer applications.*

PAGE 231R provides new standards of accuracy and reliability . . .



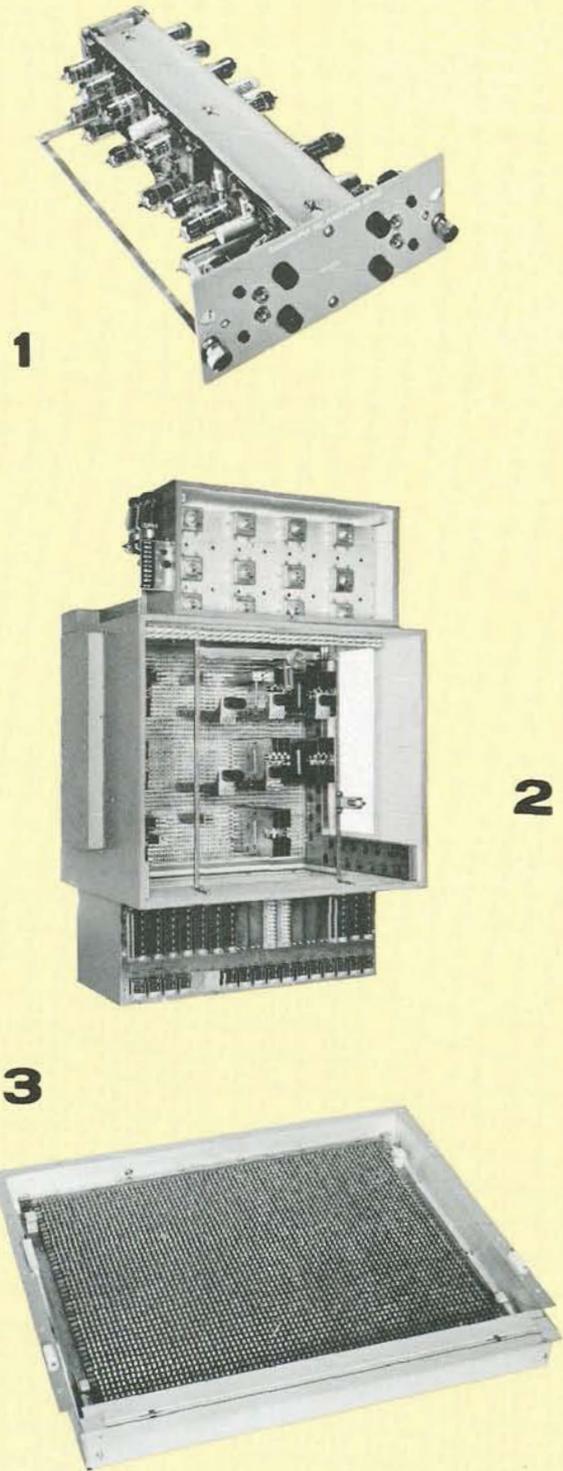
The exceptionally high accuracy of the *Pace 231R* Computer stems from the newly developed d-c amplifier package. Each position contains four independent, extremely low drift d-c amplifiers, which provide high linearity over a wide band width.

To provide protection against cross talk, the *Pace 231R* features elaborate signal shielding from patch cord to component. All patch cords and bottle plugs are of coaxial type. A unique brass gridwork forms individual shielded cells for the 3450 contacts in the patch bay. To assure maximum accuracy at low voltages, each of these contacts is plated with 24 carat gold. Each of the precision computing networks is individually shielded in a metal can.

For added protection against drift, all computing networks and integrating capacitors are housed in a thermostatically controlled oven. All operational amplifiers and computing networks are trimmed to better than 0.005% and the hermetically-sealed, polystyrene, integrator capacitors are adjusted to 0.01%.

New solid state computing elements improve dynamic accuracy for real time or repetitive mode of operation and permit multiplication and other non-linear operations with signal frequencies in the kilocycle range.

- 1 *New d-c amplifier design assures exceptionally high accuracy.*
- 2 *Thermostatically-controlled oven guards precision elements against drift.*
- 3 *Cellular patch bay shield protects problem solutions from errors due to cross-talk.*

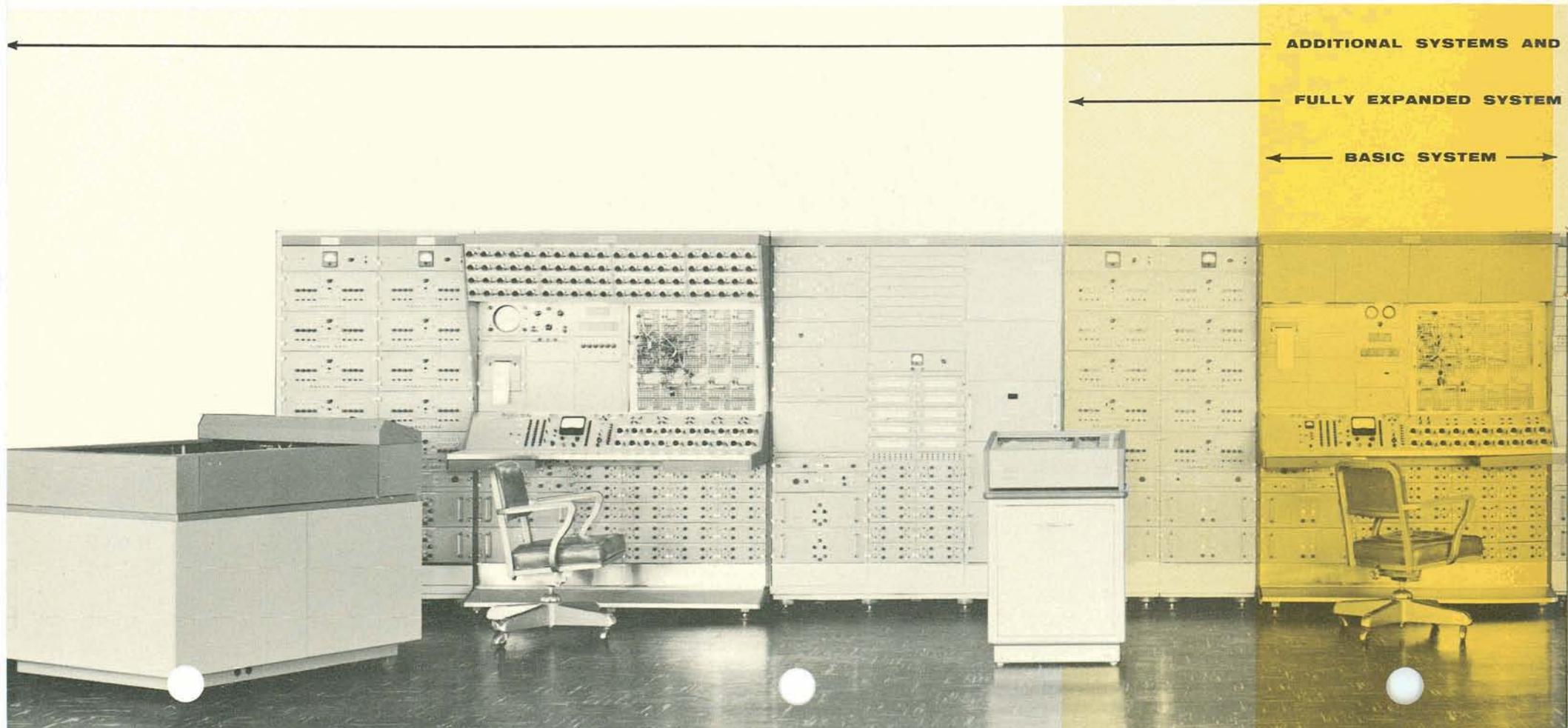


PACE 231R *offers unique versatility and expandability*

Opens New Fields to Analog Techniques

The *Pace 231R* can handle a wide range of engineering problems. Individual control of all system integrators is now available at the patch panel. As a result, with the *Pace 231R*, it is now possible to solve multi-stage type problems formerly beyond the capabilities of standard general purpose analog computers.

High-speed repetitive operation provides solution rates up to 50 times per second. With this feature, analog techniques can be applied to statistical analysis and other studies requiring high-speed calculations.



Monitored external signal trunks facilitate tie-in with external or computer controlled equipment.

"Building Block" Design Permits Expansion

The Pace 231R is designed to be expanded easily to meet your needs for increased computing capacity. You can start with a single console containing 20 operational amplifiers (or less)—then expand by adding standard plug-in components, stock harnesses and hardware. There is no soldering, no cable lacing, no metal work required.

The 231R basic computer is capable of handling a wide variety of engineering problems and consists of the following equipment:

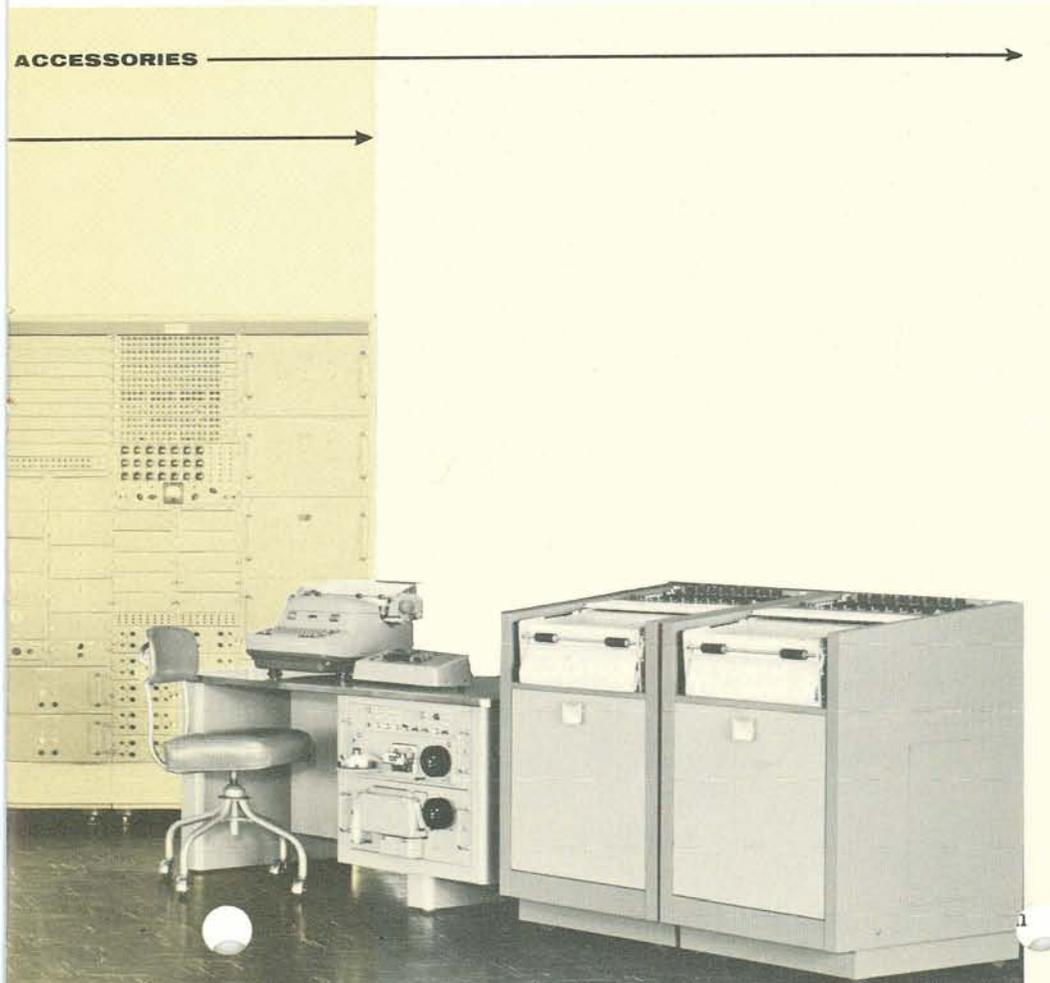
	Quantity
● Three-bay console with power supplies	1
● 3450 hole metal pre-patch panel	1
● Operational amplifiers (8 summer-integrator combinations and 12 summers)	20
● Coefficient potentiometers	20
● Single-pole, triple-throw function switches	4
● Push button automatic extended readout system	1
● Static problem check feature	1
● Rate test for checking integrator capacitors	1
● Dual overload alarm with automatic hold feature	1
● Extended range vacuum tube voltmeter with pre-amplifier	1
● Network oven, with heater unit, circulation blower and thermostatic control	1
● Trunks (20 monitored)	40
● Assorted patch cords and bottle plugs	199

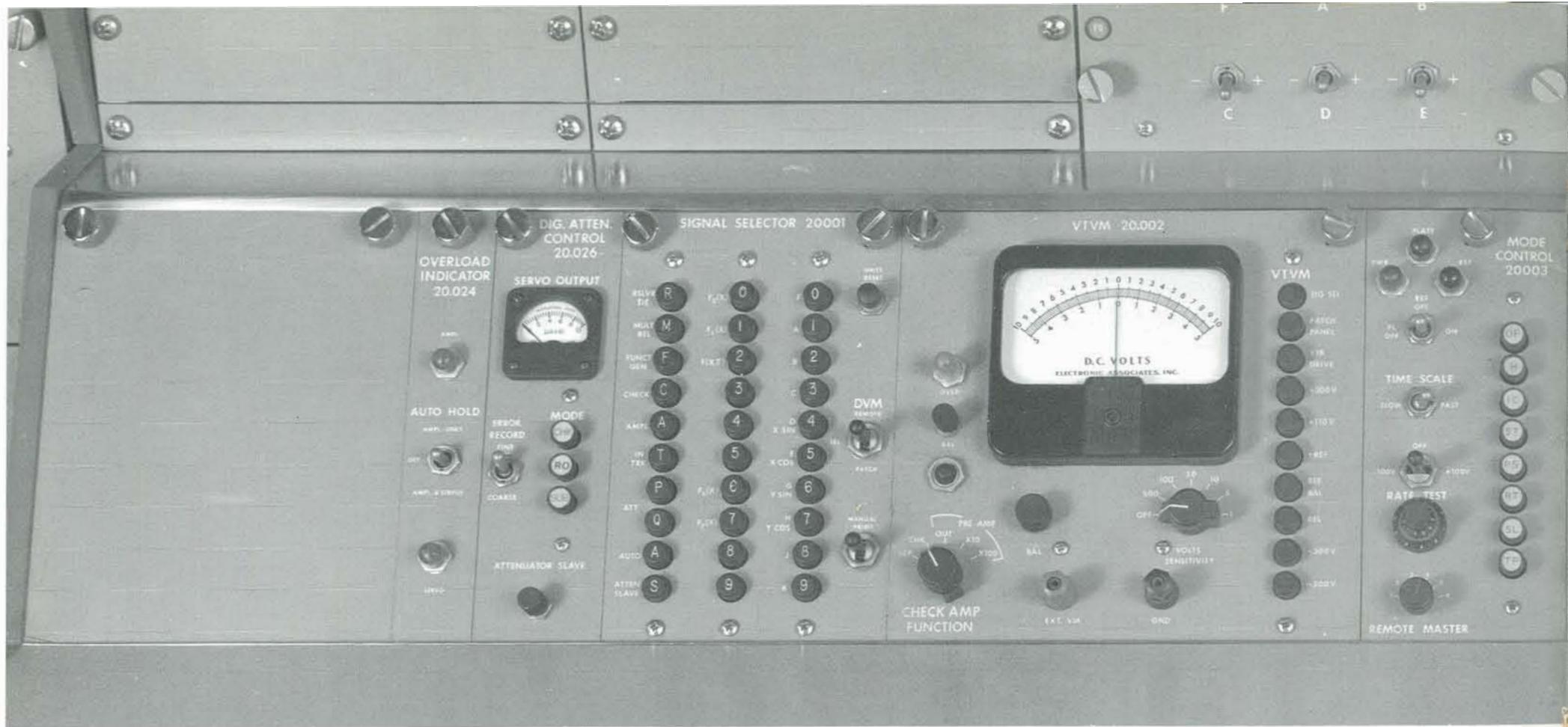
To handle more complex problems, this basic 231R may be expanded to include the following total quantities of computing equipment:

	Quantity
● Operational amplifiers (30 summer-integrator, 45 summers, 25 inverters)	100
● Potentiometers (servo or hand-set)	150
● Multipliers	
Electronic Time Division (2 products/chassis)	10 chassis
Electronic Quarter Square* (3 products/chassis)	10 chassis
Servo* (5 products/chassis)	10 chassis
● Diode function generators(10 segment)	20
● Rate or position resolvers	5
● Transistorized comparators, including transistorized amplifiers and double-pole, double-throw relay	10
● Diode limiter packages	15
● Time scale check	1
● High-speed repetitive operation and display console	1
● Noise generator	1
● Single-pole, triple-throw function switches	20
● High-speed electronic digital voltmeter, ± 120 volt range, .01% accuracy	1
● Digital printer (3 lines/sec., five figures plus sign and address)	1
● Automatic digital input-output system (desk console, keyboard, paper tape punch and reader, electric typewriter)	1
● External trunks (100 monitored)	200
● Variable time delay unit	5

* Quarter-square and servo-chassis are interchangeable. A total of ten chassis may be included.

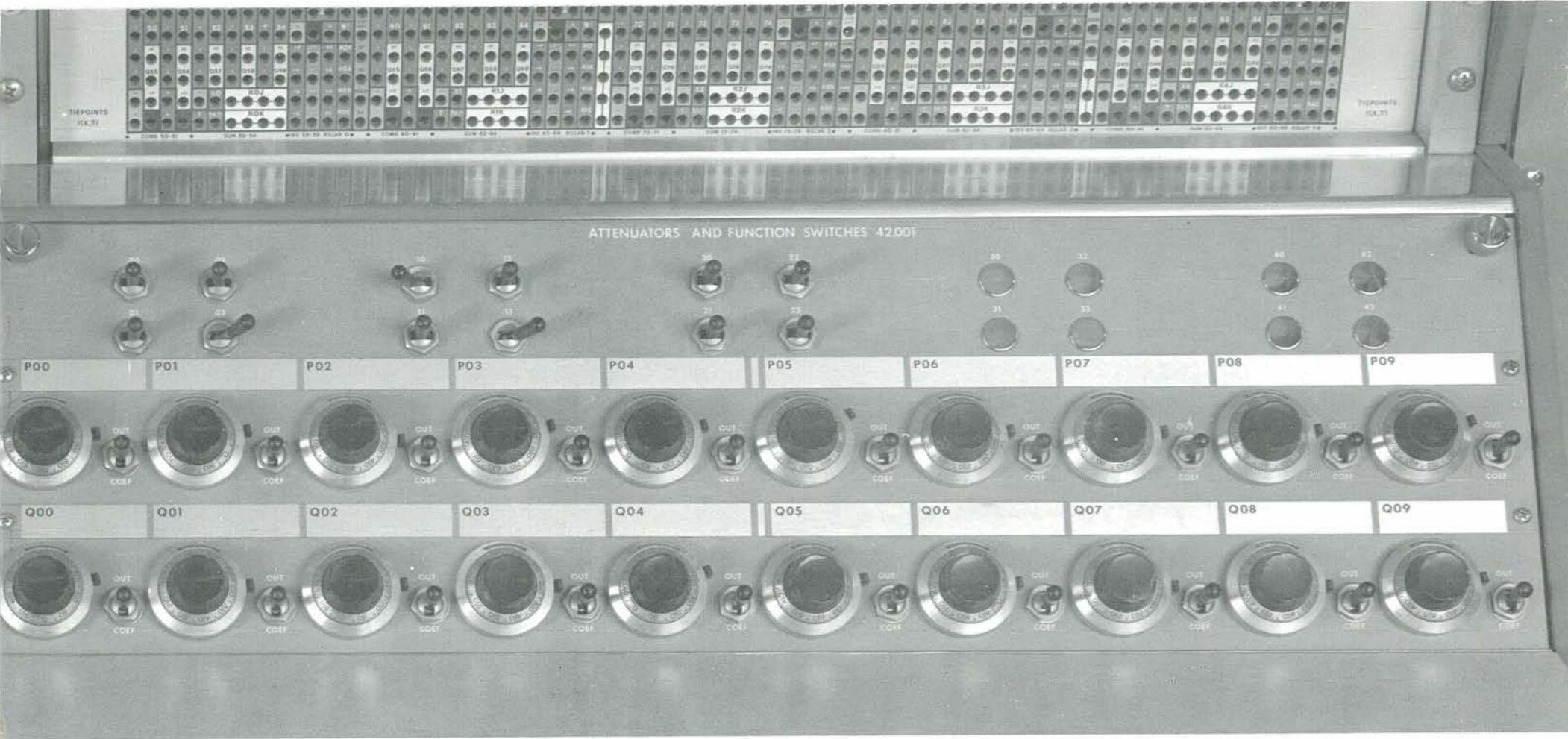
Additional fully-expanded systems can be constructed from a single console.





PACE® 231R *designed for ease of operation and control.*





Human Engineered Control Panel contributes to faster, more accurate problem solving. Push buttons and switches are laid out in individual sections according to the operation they serve. Panel is inclined to put all controls within easy reach and view of operator.

Extended Read Out system lets you monitor all active computing components on digital or vacuum tube voltmeter—minimizes problem set-up, trouble-shooting and problem checking time. You can read out both non-linear and linear equipment right from the control panel.

Automatic Extended Read Out System speeds problem checking, scans and prints component outputs at rate of 3 lines per second.

Automatic Hold Facility automatically “holds” problem when

any computing component is overloaded—aids in location of scaling errors and component malfunctions.

Vacuum Tube Voltmeter allows you to monitor power supply voltages by simply pushing a button. Offers full-scale sensitivities from 500V down to 10 millivolts, a real aid in equipment trouble shooting and maintenance.

Static Problem Check Feature permits monitoring of all integrator initial derivatives and subsequent comparison to scaled equations. Assures correct patching and proper static operation of components.

Electronic Digital Voltmeter reduces manual pot setting time by 50%, permits high-speed print-out.

High-Speed Printer prints output of electronic digital voltmeter manually or automatically at operator's option.

panel simplifies programming

Since a major part of an over-all computing cycle is devoted to programming, EAI engineers have placed special emphasis on pre-patch panel design.

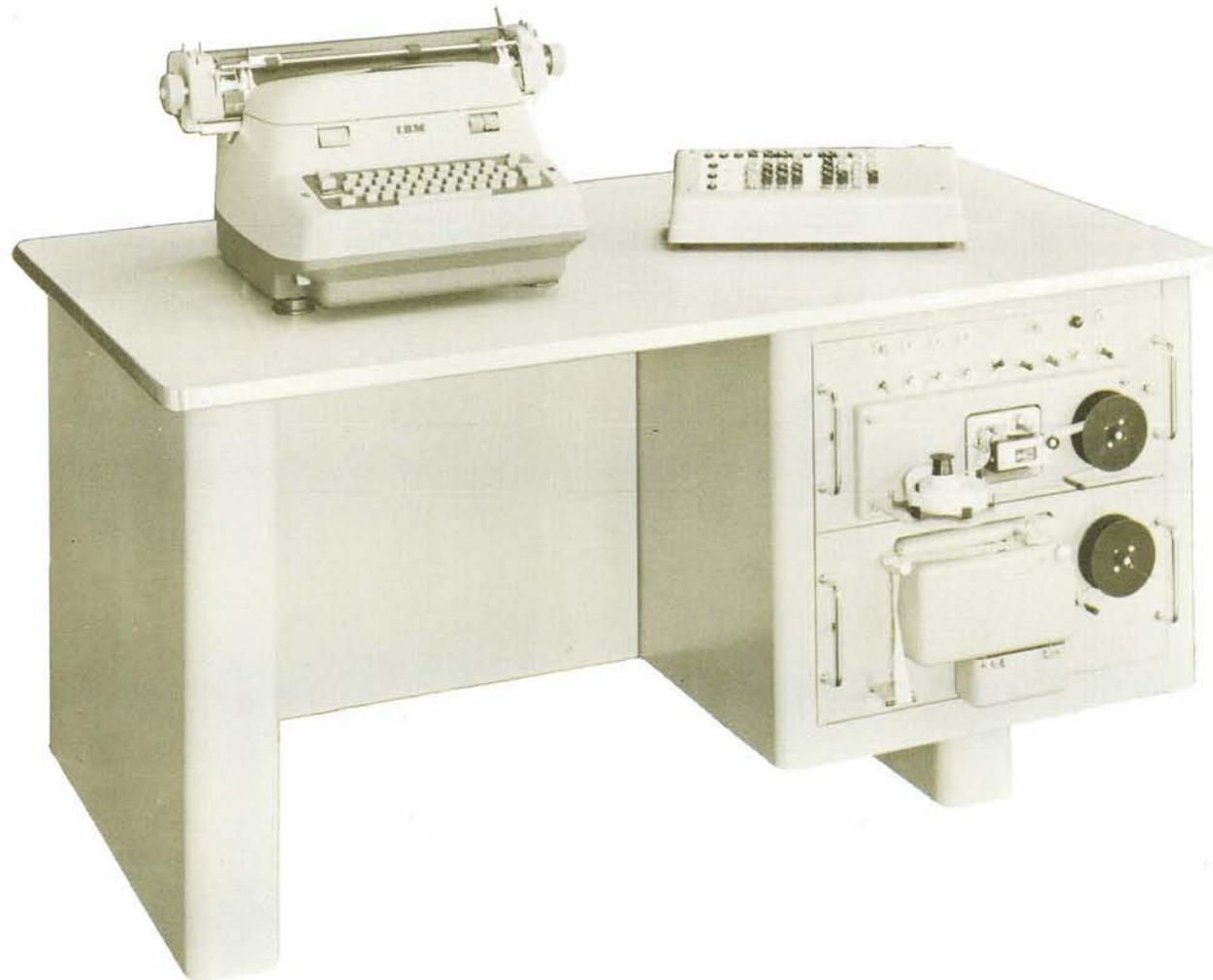
The panel is laid out in a series of modules, with each module terminating a complete set of computing components. With this design, patch panel clutter is largely eliminated. Long, across-the-panel patching is cut to a minimum. Problem patching, checking and trouble shooting are more easily accomplished and there is less chance of patching errors. Sharp, vivid color coding and large, clear lettering help make patching faster, surer.

The panel is made of solid aluminum. It is sturdy, light, easy to handle and will not warp. Its low cost makes practical the purchase of additional panels for problem storage.

Pre-Patch Panel

- *3450 holes*
- *Modular design*
- *Sharp, vivid color coding*
- *Large, clear lettering*
- *Solid aluminum*
- *Light weight*
- *Sturdy*
- *Low cost*
- *Precision hole spacing*

Automatic Digital Input Output System (ADIOS)



multiplies dividends on computer investment

ADIOS Performs These Key Computing Functions Automatically from Punched Paper Tape or Manual Keyboard . . .

1. Selects and adjusts coefficient potentiometers and diode function generators.
2. Monitors coefficient potentiometers and diode function generators.
3. Reads out and records all signal voltages monitored by console.
4. Controls computer modes.

ADIOS Features . . .

- . . . fast coefficient potentiometer setting, average rate of 30 per minute.
- . . . coefficient potentiometer settings accurate to 0.01 per cent.
- . . . Problem checking is both digital and automatic.
- . . . Electronic Digital Voltmeter for faster, more reliable operation.
- . . . simplified keyboard for faster tape preparation and manual control of ADIOS.
- . . . control of ADIOS operation by problem signals for unattended operation.
- . . . complete record of all computer operations automatically obtained in sequence.
- . . . "ERRORS ONLY" ADIOS operation mode for faster problem checkout. (Types only those settings in error, if desired.)
- . . . "RE-PROGRAM" ADIOS operation mode to facilitate problem storage for subsequent re-programming.
- . . . highly flexible, easily selected, output data presentation format.

Here's Why ADIOS Assures Most Productive Use of Computer Time

- Problem setup time is reduced by the automatic and accurate setting of coefficient potentiometers and diode function generators.
- Problem checkout is speeded by the error sensing mode of ADIOS operation which automatically compares the desired value of signal voltage with the actual value.
- Series of computer runs involving problem parameter changes can be programmed so that the entire group of solutions can be obtained automatically.
- Complete sequential record of computer operation automatically obtained for each problem run when controlled by ADIOS.
- Re-run of stored problems and multi-shift computer operation are facilitated by the convenience and speed with which problem change-over can be accomplished.

ADIOS System

The ADIOS system is mounted in a desk and includes an IBM electric typewriter, an input keyboard, paper tape punch, paper tape reader, precision remote controlled voltage divider and necessary control relay circuitry to perform the various coding and data storage functions.

Multi Computer Control

Can control one or several computing systems.

Physical Description

The ADIOS with all equipment installed, excluding the typewriter and keyboard, has the following physical characteristics:

Height	28½ inches
Length	53 inches
Depth	29½ inches

the industry's most complete line of



analog computing components

Servo Multipliers — Over a dozen types of servo-multipliers are available to satisfy specific requirements for speed, accuracy and cup configuration. They fall into three general model classifications: Model 16-7M for highly accurate, medium speed computation. Model 16-7N for high speed computation with medium degree of accuracy. Model 16-7S for unusually high speed applications, provides dynamic operation far surpassing the characteristics of any previously available servo-driven computing unit.

Servo Resolvers — Servo Resolvers are available to satisfy the widest variety of applications. The Model 16-8B Servo Resolver, regarded as the standard of the industry, accomplishes polar to rectangular conversion to accuracies exceeding .07%. The Model 8.010 series Resolver has been designed to provide medium accuracy computation with a more extended bandwidth than that of the Model 16-8B. The Model 26-8H series makes use of a special 400 cycle servo system which permits accurate operation at extremely high rates of change of input variable. If continuous resolution is desired, Electronic Associates' Model 8.020 series Servo Rate Resolver may be used. This unit will accept an angular input in the form of either position or rate and is therefore especially applicable in the analysis of continuously rotating systems. All model resolvers contain an automatic gain control feature for permitting accurate rectangular to polar conversion over wide ranges of input variables.

Electronic Multipliers — These components are useful for multiplication of high frequency variables. The Model 7.006 Time Division Multiplier is capable of producing static accuracies to .01% and operates accurately to frequencies in excess of 100 cycles. For more demanding high frequency applications, the Model 7.007 or 7.036 Quarter-Square type electronic multipliers are recommended since these units will operate accurately into the kilocycle range.

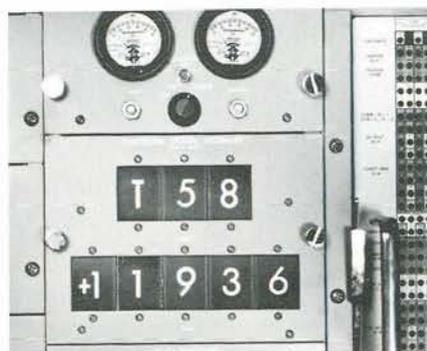
Electronic Resolvers — A new model sine-cosine generator provides a sine or cosine function with static accuracies of better than .02% and is usable at frequencies of several hundred cps. Resolution and coordinate transformation may be accomplished by combining these with our electronic multipliers.

Diode Function Generator — Several models of electronic diode function generators are available for simulating arbitrary non-linear functions with an approximation of 20 straight line segments. In addition, several types of fixed-function diode function generators are available for the simulation of commonly used algebraic functions such as X^2 , X^4 , $\text{Log } X$.

Potentiometer Padding Equipment — Unique "voltage padding" technique permits servo multipliers to generate arbitrary non-linear functions as well as to multiply variables. This unique system of function generation has been widely accepted throughout the analog computing field, with the result that thousands of such channels are presently in use today.

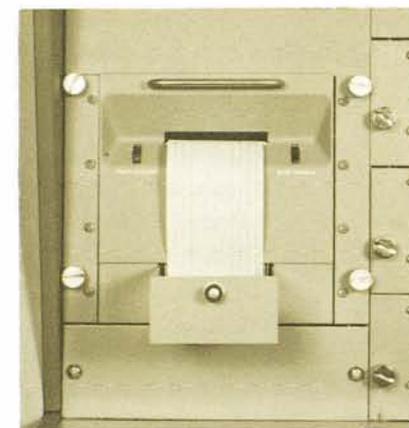
Repetitive Operation — The new Model 2.131 High Speed Repetitive Operation feature and its associated Type 4.051 single bay display group may be incorporated within any 231R Computer. It facilitates automatic time scale change by a factor of 100 and permits the operator to automatically recycle his problem at a rate of from 10 cycles per second to 50 cycles per second. A unique 8 channel electronic display console is used for readout and may be purchased as a separate accessory. This new technique facilitates the solution of statistical type problems, optimization and other techniques heretofore impossible or at best cumbersome on a real-time analog computer.

Accessory Equipment — Bi-variant function generators, variable time delay equipment, limiters, comparators, and a variety of other accessory equipment are available from Electronic Associates to meet specific requirements.



Electronic Digital Voltmeter

EDVM 2.001 conversion rate of 100 per second provides visually continuous readings for rapid manual pot setting (estimated 50% reduction in pot setting time.) With printer it permits making a permanent record of readings at approximately three lines per second. Also reduces typewriter readout time. Displays five-digit readout and sign over ± 120 volt range, to .01% accuracy. Includes component address and wide range angle viewing. Features solid-state design for added reliability.



High Speed Printer

Companion piece to EDVM 2.001. Prints voltage reading of computing component as sampled by EDVM on 3 inch paper tape for permanent record. Printed entry includes three-digit component identification plus five-digit signal read-out including decimal point and sign. Fan-fold paper facilitates reference to previously recorded data. Can be controlled manually from control panel or automatically from the Extended Read-Out System. Prints at the rate of three lines per second.

EAI readout equipment



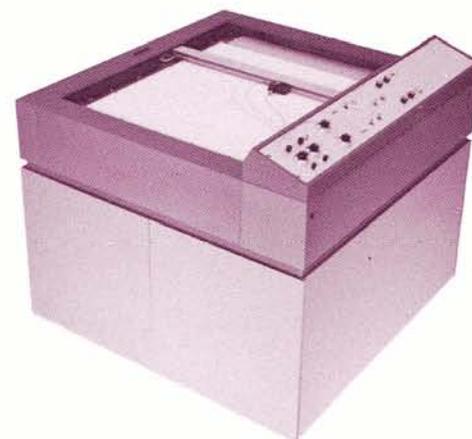
Table-Top Variplotter

An automatic X-Y plotter which plots one d-c voltage signal as a function of a second d-c voltage signal on an 11" x 17" plotting surface. Provides fast, accurate recording of coordinate data. Operates on completely self-balancing potentiometer principle. Features high static and dynamic accuracy and a wide range of input sensitivities. Superior acceleration and phase shift characteristics. Negligible drift. Outstanding repeatability.



Rectilinear Recorder

Up to 8 sets of output data can be recorded simultaneously on the Model 99.003 Eight-Channel Recorder. Provides instant rectilinear recording of outputs. Automatic calibration feature indicates scale settings for every recorder run. Push button sensitivity and speed control provides for remote control of 231R computer. Chopper-stabilized output amplifiers assure stability and minimize drift. Heated stylus recording produces permanent traces without bother of refilling ink reservoirs.



Transistorized Variplotter

Provides full 30" x 30" plotting area. Vacuum paper hold-down system assures non-slip plotting surface in either horizontal or vertical positions. Features fast plotting speed, instantaneous warmup, compact size, low power consumption and greater accuracy and reliability. It is available in single or dual arm models and can be operated either vertically or horizontally. Outside dimensions 46" x 46" x 12". Pen interchange circuit is provided on the dual arm models.

PACE® 231R features *plug-in components, printed circuitry for*



All components are plug-in, drawer type units which feature miniaturization and printed circuitry to keep maintenance to a minimum.

When maintenance does become necessary, you'll find everything has been designed to make it easy and inexpensive. All major computing components are removable from the front. They require no unsoldering—simply pull out. This speeds servicing, reduces computer down-time. Bus-bar power distribution reduces complex power cabling, simplifies trouble-shooting and facilitates later system expansion.

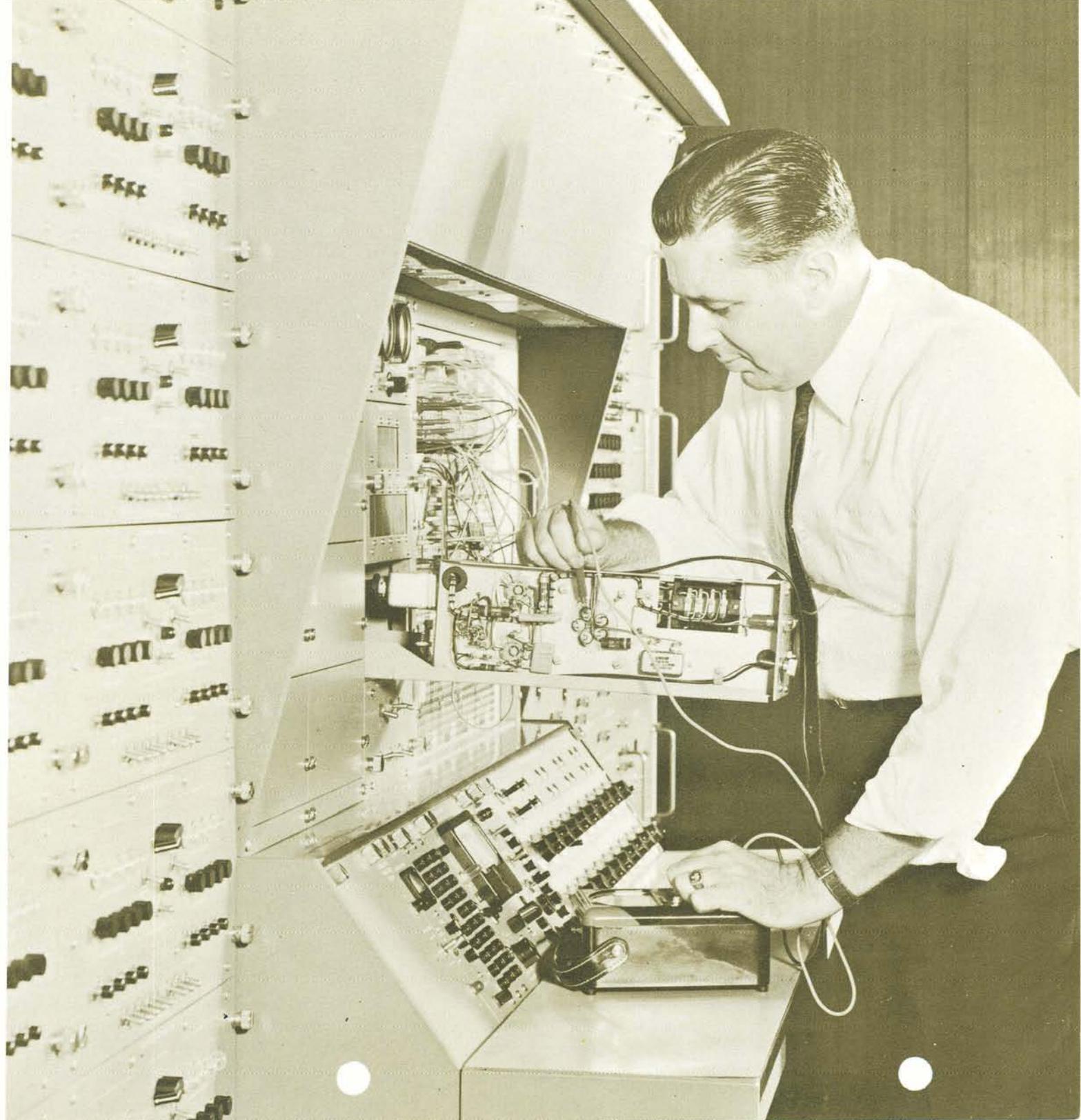
Computer console and expansion racks are constructed of the finest material. Hardware and finishes used are the best available. All racks are constructed of heavy-gauge steel. Modular, drawer-type computing components are U or T shaped for more efficient cooling.

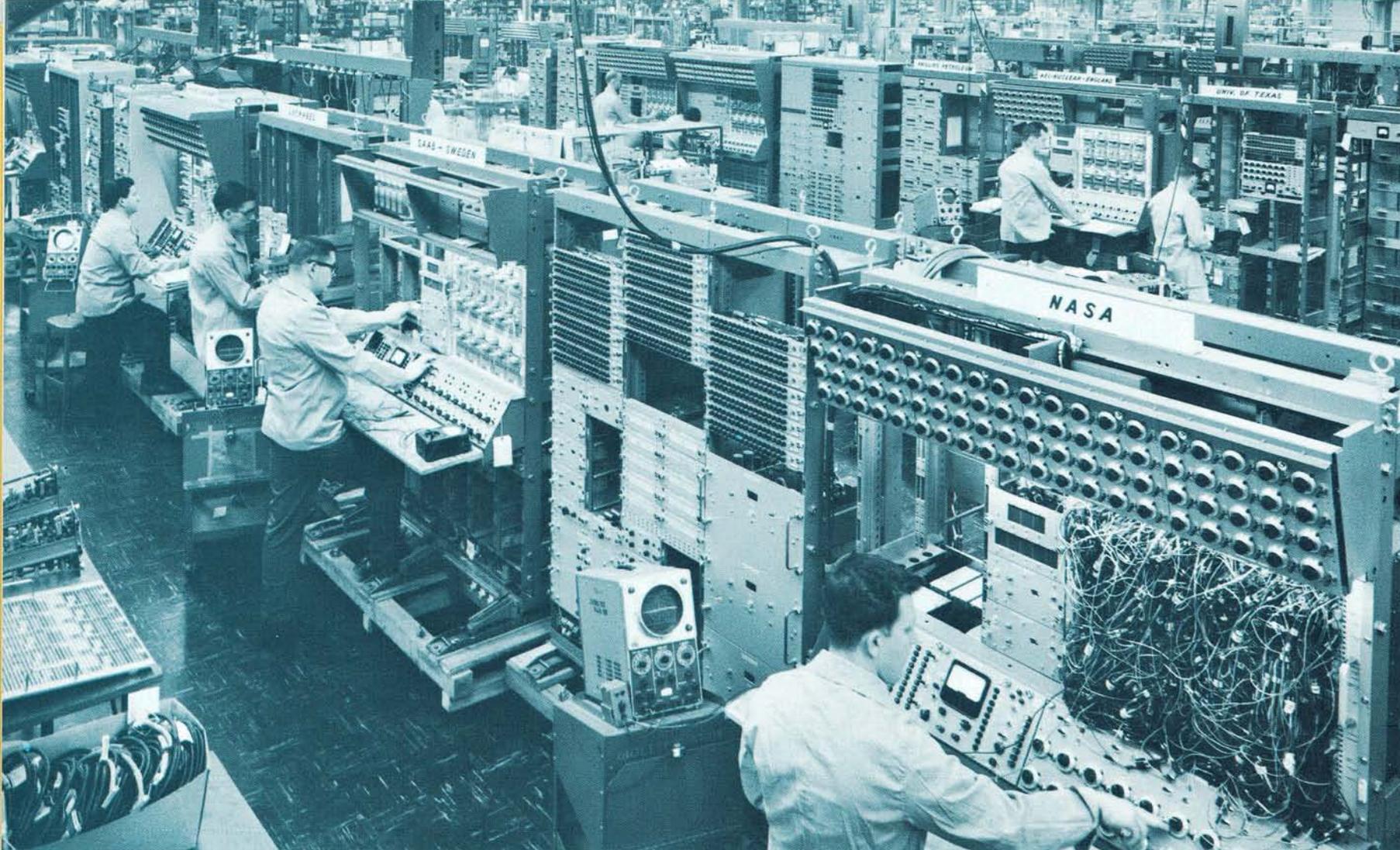
Maintenance Check Panels can be used to perform preventive maintenance checks on all computing components. Marginal components can be located quickly and removed.

Test Shelf comes as integral part of computer. It provides convenient area for maintaining and servicing the components.

Test Rack is separate accessory which provides work area for off-the-computer repair of all components. Helps reduce computer down-time.

minimum maintenance



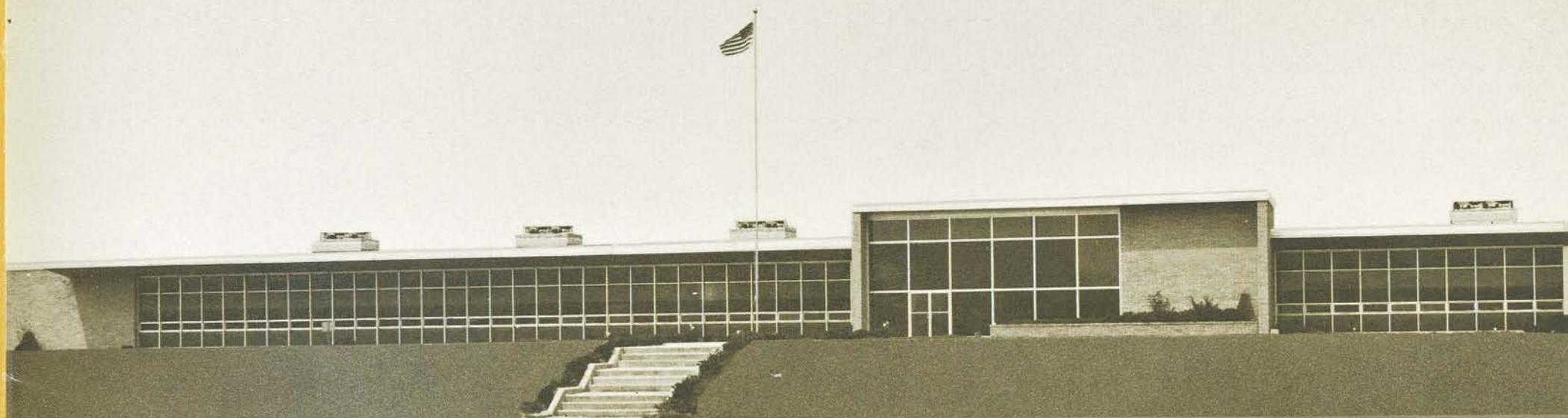


HIGHEST STANDARDS OF QUALITY CONTROL

At EAI, PACE manufacturing operations literally revolve around Quality Control.

At each step in production, inspection or test, operations have been established to assure that all components and manufacturing operations measure up to rigid EAI standards. This strict control continues as major computing components are completed and assembled into expansion racks and consoles. All critical items receive 100% inspection and test during incoming inspection. Non-critical items are inspected according to proven statistical methods. On-line-inspection and final inspection take place on every sub-assembly going into a computing system; each unit is tested electrically for all required operational character-

istics. After careful check-out of individual racks and consoles, the entire system is connected together just as it will be set up in the customer's computing laboratory. Not only are elaborate test procedures then carried out, but actual test problems are run which operate all computing components and check their actual operational characteristics as part of a complete system. Results are compared to a set of standards developed at EAI Computation Centers. Most systems remain in Final Test from 1 to 3 weeks depending on the size of the system in order to perform the elaborate test procedures required. Such painstaking evaluation assures PACE customers that their purchases will perform with outstanding accuracy and reliability.



MODERN MANUFACTURING FACILITIES

PACE 231R Analog Computers are manufactured in a modern 122,000 square foot plant in West Long Branch, New Jersey. Here under skilled direction the world's highest capacity general purpose analog computer production lines are engaged in the building of PACE equipment. In many cases, precision operations have been automated with machines, designed and developed at EAI. Such wide applications of production engineering know-

how would not be practical in small quantities and only the growing sales of PACE equipment throughout the United States, Canada and Europe have made it profitable here. High production rates and techniques naturally react to the benefit of PACE customers everywhere. By reducing production costs EAI is able to incorporate higher quality components into its products while marketing them at competitive prices.

EAI Computation Center Service

EAI Computation Centers make available, on a fee basis, latest analog equipment and experienced EAI personnel to aid in the solution of complex engineering problems. Centers are located in Princeton, New Jersey; Los Angeles, California; and Brussels, Belgium.

LOS ANGELES



PRINCETON



BRUSSELS

