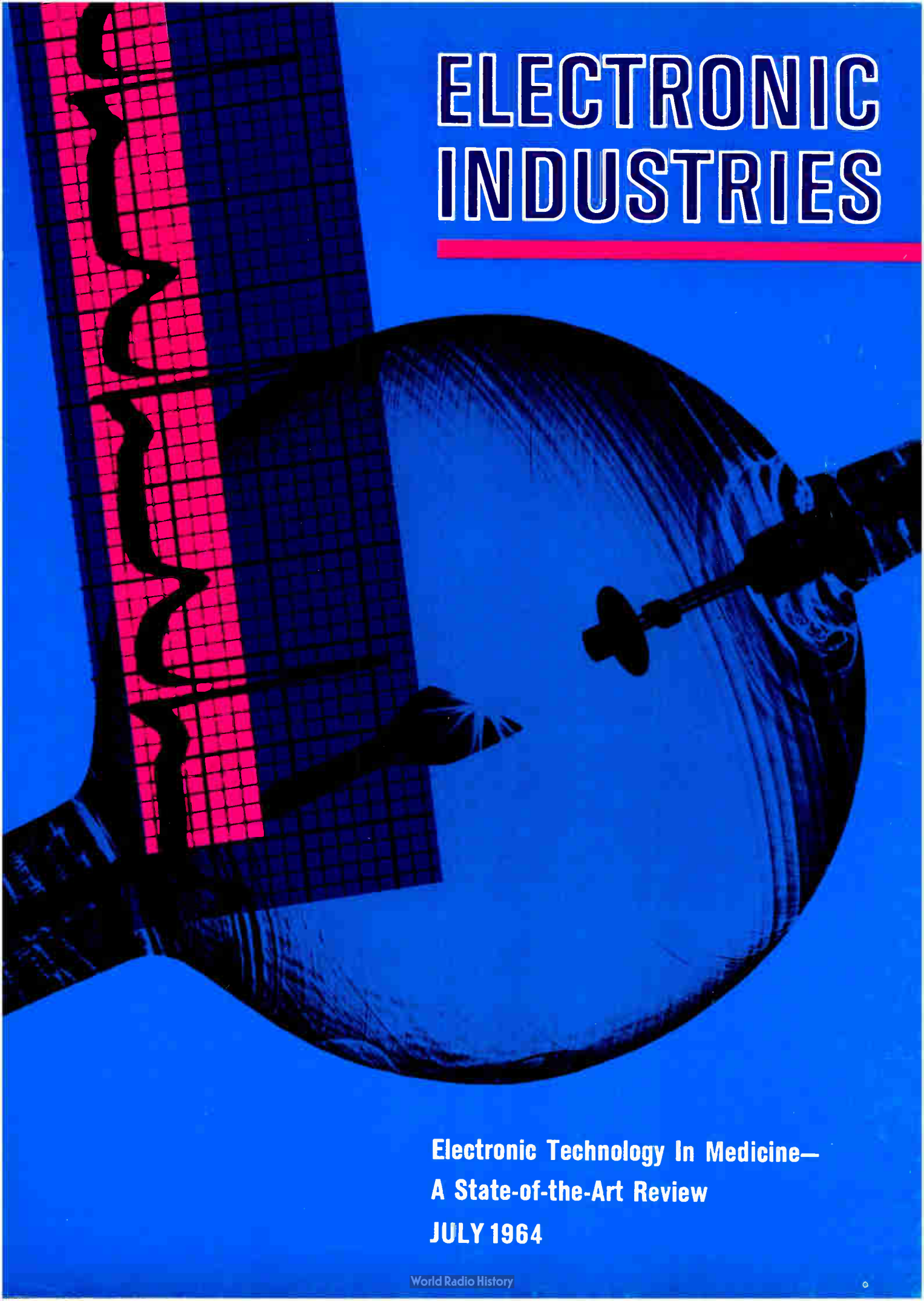


ELECTRONIC INDUSTRIES



**Electronic Technology In Medicine—
A State-of-the-Art Review
JULY 1964**



**QUALITY...
RELIABILITY...
DEPENDABILITY...**

**For MEDICAL ELECTRONIC
EQUIPMENT APPLICATIONS**

**TRANSFORMERS
INDUCTORS
TOROIDS
ELECTRIC WAVE FILTERS
HIGH Q COILS
MAGNETIC AMPLIFIERS
SATURABLE REACTORS
REFERENCE UNITS
PULSE TRANSFORMERS**

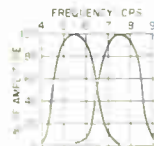
SOME TYPICAL UNITS ILLUSTRATED BELOW

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Used in heart pacer as pulse coupling transformer. 5 to 1 ratio. Pulse width of 1½ to 2½ milliseconds. PRF 1 per second. Approximate peak voltage 8 V. Size: 15/16 Dia X 13/32" h. Wt: 1/10 oz.



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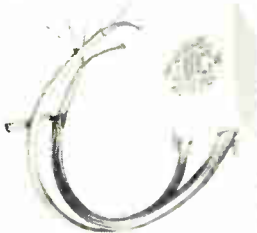
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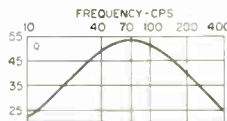
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Circle 1 on Inquiry Card

World Radio History

NEW MARKETS AND NEW JOBS IN BIO-MEDICAL ELECTRONICS

BIO-MEDICAL ELECTRONICS is unquestionably a prime new growth area for the electronic industries. By 1970 it could reach \$1 billion in annual sales.

Development of this market would produce substantial new growth and profits to our industry--expand engineering employment.

We believe significant expansion of the bio-medical electronics market is possible because of built-in growth factors in our society and economy. Sales to the medical market in 1963 were about \$300 million. This was less than 1% of the estimated \$33 billion spent for all medical purposes by our 191 million people.

Our population will be over 200 million by 1970 and those in our society who most need medical care are constantly increasing in number. These include the very young (sensitive newly born) and the (ailing) elderly. Government-sponsored preventive medicine programs will most assuredly increase because of population growth and political pressure.

The Federal government is now supporting extensive bio-scientific man-in-space programs. These activities will yield a vast new reservoir of technology. Components, equipment and systems developed for bio-medical aerospace programs can be transformed into a host of industrial, commercial and consumer products.

How can we convert this bio-medical growth potential into reality? There are some real hurdles, principally in the area of communications. Doctors and engineers don't speak the same language. Some engineers already have obtained medical degrees and there are doctors who have engineering degrees. We need much more of this dual training if medical electronics is to progress rapidly.

Private industry must do its own development work to translate technology obtained from aerospace, defense and public health research into industrial and consumer medical electronic products.

Equipment must be engineered for lowest possible cost with a maximum of reliability and performance to assure a mass market.

Present marketing programs for medical electronic equipment need to be defined, developed, and financed better.

ELECTRONIC INDUSTRIES' special report on Bio-Medical Electronics in this issue provides guidelines for entering this vast new market. Here are some suggested approaches for developing the bio-medical electronic market:

- Joint ventures might well be formed between electronic firms and medical equipment manufacturers having established marketing programs and distribution channels.

- Electronic companies could coordinate their development work with Federal and regional government agency projects for monitoring pollution and radiation in air, food and water supplies.

- Laboratories which conduct tests on animals could well utilize electronic test, measurement and clinical equipment. Veterinarians also should be able to use electronic apparatus, if priced right.

- Greater cooperation of electronic trade organizations and professional societies with their counterparts in the bio-medical profession could advance the understanding and further electronic applications in bio-medicine.

- Assign a staff member to specialize in investigating and monitoring electronic application possibilities in bio-medicine; or

- Engage an experienced and recognized bio-medical electronics consultant.

- Establish an advanced development group to work in conjunction with bio-medical research centers.

- Consider acquiring small companies specializing in bio-medical electronics to utilize and build on an existing capability.

Expansion of the bio-medical electronic market is a most desirable objective. It promises greater industry profits as well as new jobs for engineering and technical personnel.

Bernard F. Osburn

Did you know Sprague makes...?

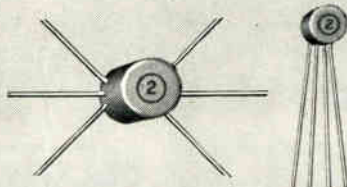
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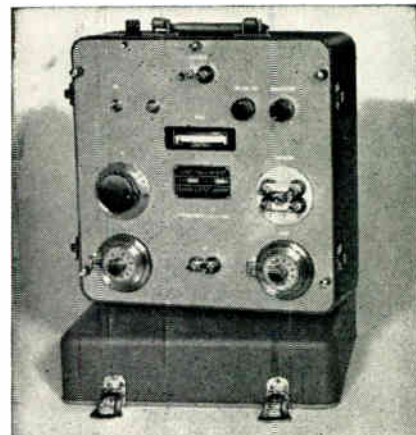
ELECTRONIC MODULES TO CUSTOMER REQUIREMENTS



Custom packaging is no novelty at Sprague's Special Products Division, where "specials" are continually being developed and produced with countless variations in electrical characteristics and mechanical configurations.

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New Bridge Design For Safe, Accurate, Easy Measurement of 'Lytic Capacitors



The Sprague Model 1W2A Capacitance Bridge introduces new, improved technical refinements as well as restyling for added attractiveness and ease of operation. Built by capacitor engineers for capacitor users, it incorporates the best features of bridges used for many years in Sprague laboratories and production facilities.

Precision Measurements over Entire Range from 0 to 120,000 μ F

The internal generator of the 1W2A Bridge is a line-driven frequency converter, and detection is obtained from an internal tuned transistor amplifier-null detector, whose sensitivity increases as the balance point is approached. It has provision for 2-terminal, 3-terminal, and 4-terminal capacitance measurements, which are essential for accurate measurement... $\pm 1\%$ of reading + $10\mu\text{F}$... of medium, low, and high capacitance values, respectively.

No Damage to Capacitors

The model 1W2A Capacitance Bridge will not cause degradation or failure in electrolytic or low-voltage ceramic capacitors during test, as is the case in many conventional bridges and test circuits. The 120 cycle A-C voltage, applied to capacitors under test from a built-in source, never exceeds 0.5 volt! It is usually unnecessary to apply d-c polarizing voltage to electrolytic capacitors because of this safe, low voltage.

Complete Specifications Available

For complete technical data on this precision instrument, write for Engineering Bulletin 90,010A to Technical Literature Service, Sprague Electric Company, 233 Marshall Street, North Adams, Massachusetts.

489P-128-63

Circle 138 on Inquiry Card

For application engineering assistance (without obligation, of course) on any of the above products, write or call the Special Products Division, Sprague Electric Company, 233 Union Street, North Adams, Massachusetts.

489P-131-63 93



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The STATE-OF-THE-ART* Magazine for Electronic Engineers

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COVER

From a dollars-and-cents point, EKG's and X-rays are still the major electronic products being used by the medical profession. But electronic techniques are making advances in a number of other medical areas. They are described in the two articles beginning on pages 28 and 42 of this issue.

*STATE-OF-THE-ART: up-to-the-moment capability in each area of electronic technology



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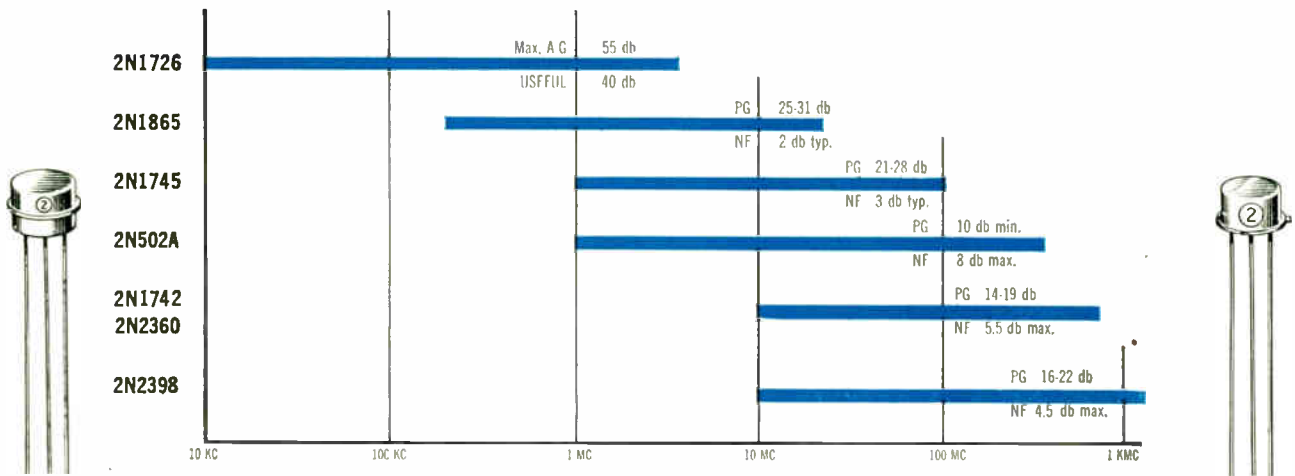
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INTEGRATING THE HEALING ARTS WITH ELECTRONIC SCIENCE 28

Research labs are turning out many prototypes of medical instruments and systems but few are finding acceptance in the presently limited bio-medical market. Many die either on the lab bench or in hospitals where they are tested. Reason? Mostly lack of understanding, little medical/engineering inter-education and rising medical costs.



Healing With Electronics

ADVANCED TECHNIQUES IN MEDICAL ELECTRONICS 42

Many of the medical procedures in use today are possible only because of electronic advances made over the last decade. These advances have made possible such life saving procedures as the extracorporeal heart pump, the cardiac pacemaker and the brain implant. This article discusses the latest progress in this field.



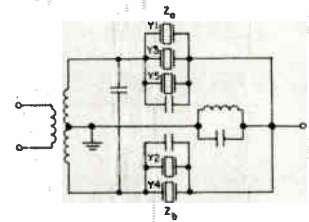
Advanced Medical Electronics

USING THE COMPUTER FOR INTEGRATED CIRCUIT ANALYSIS 52

A major restriction on integrated circuits is the high cost of fabrication. Thousands of dollars may be spent on a set of masks only to find that a mistake has been made. The technique described here uses a computer to predict circuit performance before large amounts of money are spent on the fabrication process.

CRYSTAL FILTER DESIGN CONSIDERATIONS 58

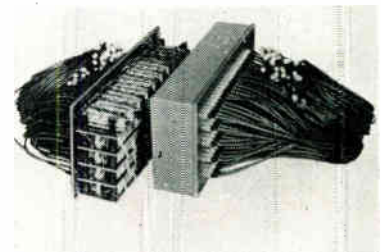
Crystal filters provide good discrimination and stability and are the practical solution to many systems problems. This article provides a basic understanding of the theory of operation of designs ranging from simple to complex. The "sections" discussed here can be designed to meet most band-pass, band-reject or single sideband specifications as needed.



Crystal Filter Design

ELECTROMAGNETIC DELAY LINE PROGRESS 64

This state-of-the-art article discusses the progress that has been made in electromagnetic delay lines since World War II. It covers the construction, features, applications and future of the various types of delay lines. Also discussed are the latest EIA specifications for delay lines.



Electromagnetic Delay Line

NEW GENERATOR TESTS DATA HANDLING SYSTEMS 108

As the demands on communication systems grow, the need for more realistic system evaluation techniques becomes imperative. The system and equipment described here is one approach to this problem.



Testing Data Handling

EVALUATING AND USING PROGRAMMED INSTRUCTION 123

Self-instruction training techniques are catching on in the electronic industry as technology demands employee retraining. Programmed Instruction has been used efficiently and economically. But, management must know how to select and evaluate the program and the materials to fit needs and objectives.

victoreen resistors

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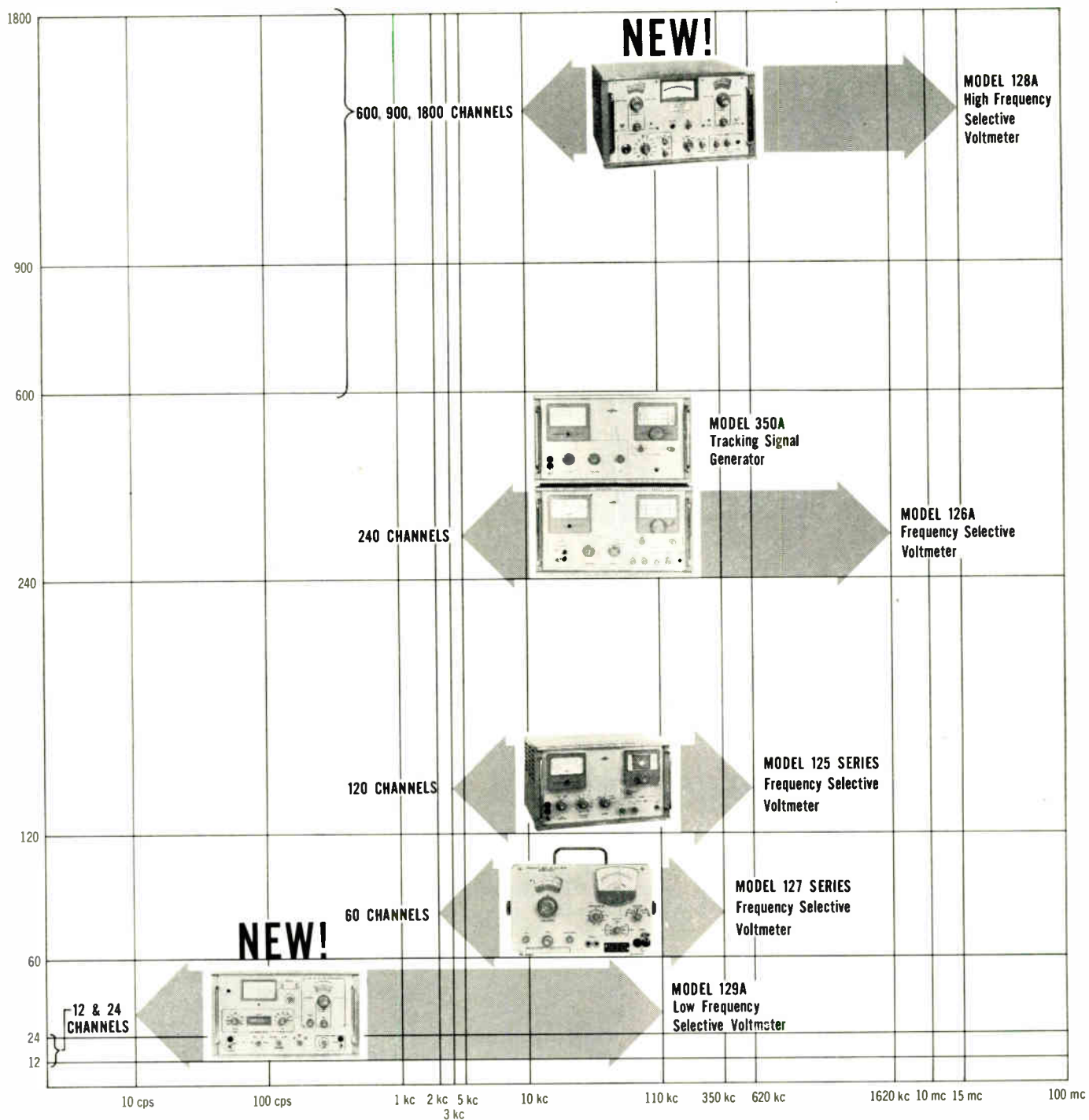
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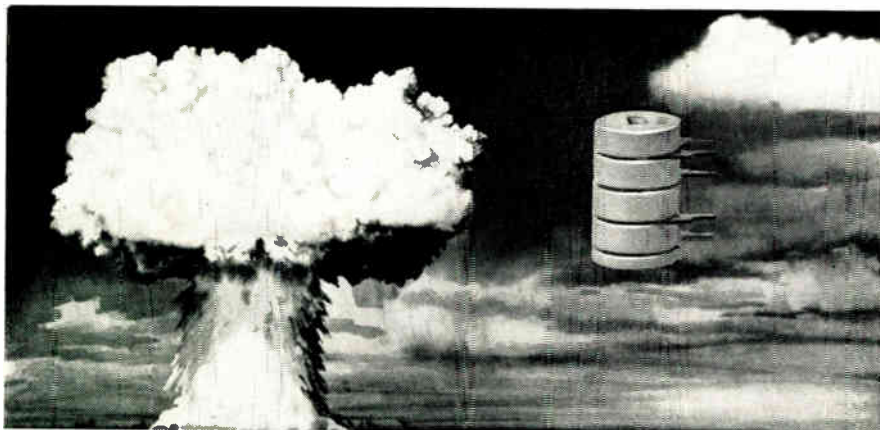
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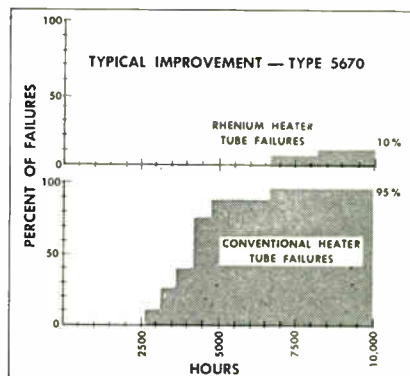
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FIVE NEW DEVELOPMENTS



38 G-E Tubes Now Have Long-Life Rhenium Heaters



Life tests of 10,000 hours under difficult conditions—in high ambient temperature and with the heaters negative with respect to the cathodes—gave the typical results shown above. The first open heater occurred in the tubes with conventional heaters at 2700 hours, and in the tubes with rhenium-tungsten heaters at 6300 hours. At 10,000 hours this grueling test had destroyed 95 percent of the conventional tubes, but only 10 percent of the rhenium-tungsten heater tubes.

Another test showed that rhenium-tungsten heaters in the type 5696-A small thyratron, used in a difficult, computer switching-circuit, more than tripled tube life.

The reason behind these outstanding test results is that rhenium-tungsten wire has less tendency to break or twist over a period of time under stresses of alternate expansion and contraction from thermal cycling as power is turned on and off. The alloy wire also has a higher electrical resistivity than the wire customarily used in tubes. Its use permits either a larger filament wire size or a shorter filament length—whichever may be the most advantageous.

In addition to the types mentioned above, rhenium now is used in the 1B3-GT, 1AD2, 1AL2, 1G3-GT, 1J3, 1K3, 2DF4, 6AK5, 6AK5WB, 6D10, 6DT8, 6EZ8, 6GY8, 12AT7, 12AT-7WA, 12DT8, 19EZ8, 30AG11, 5654, 5725, 5751, 5814A, 6072-A, 6111, 6112, 6201, 6386, 6679 12AT7, 6829, 7077, 7462, 7486, 7720, 7910, 8082, and 8083.

Circle 6 on Inquiry Card

CERAMIC TUBES OPERATE AT 3×10^{18} NVT; UPPER TOLERANCE LIMIT STILL UNKNOWN

Ceramic tubes have a demonstrated capability of withstanding at least 3×10^{18} nvt, and the upper limit of this capability is still not known.

Ceramic tubes' high tolerance to nuclear radiation makes them highly attractive to the aerospace system designer. Electronic portions of these systems are susceptible to damage both from high ambient temperature associated with the vehicle mission profile and from radiation effects associated with the space environment, on-board reactors, or weapons effects. In a nuclear explosion, the transient—pulse—effect of gamma rays or neutrons is troublesome to many electronic systems.

The ability of ceramic tubes to withstand the high nuclear radiation levels to which aerospace systems will be subjected has been demonstrated with factual data taken during the many radiation tests to which these tubes have been subjected. For example, General Electric 7296 triodes were irradiated during May of 1961 and subjected to 140 hours of nuclear radiation exposure with the reactor operating at 2 megawatts. The General Electric ceramic tube circuits were functioning properly at the termination of the test. The average thermal neutron flux during the run was 6.4×10^{12} neutrons/cm²/sec. and the integrated

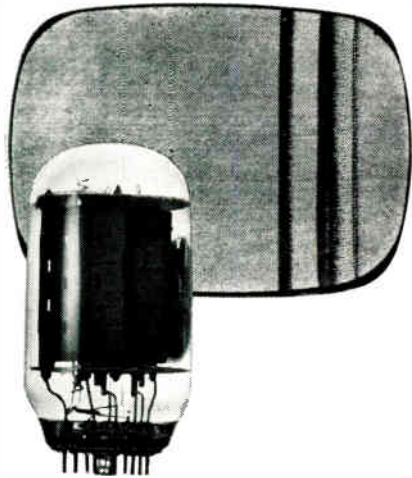
flux was 3.2×10^{18} neutrons/cm². The integrated fast neutron flux ($E > 2.5$ Mev) was 2.0×10^{18} neutrons/cm².

In October, 1962, fifteen General Electric ceramic triodes were irradiated in the Air Force Ground Test Reactor. The ceramic tubes showed no measurable changes in operation or characteristics during and after receiving a total integrated flux of more than 1×10^{17} nvt. The reactor was operated for 128 hours, achieving a 3-megawatt level at 20 hours. TIMM (Thermionic Integrated Micromodule) tubes, constructed from the same basic materials used in G-E ceramic tubes, were irradiated under a joint GE-USAF program. During the 190 hours of operation the tubes were subjected to a total integrated dose in excess of 3×10^{18} nvt and the tube characteristics showed no appreciable change.

We believe that G-E ceramic tubes are capable of operation to 10^{20} nvt or more, and know from past experience that they need not be shielded from either fast or thermal neutrons nor do they deteriorate when high-level gamma heating is present, provided that cathode temperature is held within reasonable ratings. These tubes are the most radiation-tolerant electronic devices known to the electronic components field.

IN ELECTRONIC TUBE APPLICATION

G.E. Conquers UHF Snivets With 38HE7



The wobbling, blurry, vertical trail of a snivet on the face of a picture tube usually indicates Barkhausen oscillation in the horizontal output tube. It results from a certain combination of voltage relationships within the tube.

UHF snivets reared their ugly heads "en masse" when two things came to pass in the last year: (1) the low B+ in television sets—140 volts instead of 270—and (2) the rule that all television sets must include UHF tuners, thus offering a "doorway" to Barkhausen oscillations.

With the older, higher B+ sets, a circuit designer could get all of the performance he needed without driving down into the voltage conditions conducive to snivets. However, with only 140 volts, the tube must be driven lower in anode voltage for comparable performance.

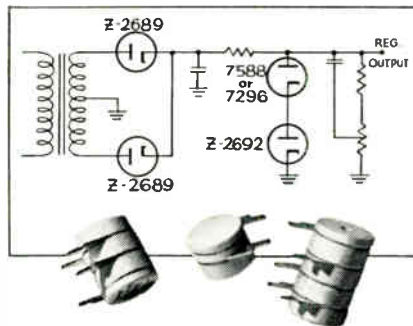
The General Electric Tube Department designed the 38HE7 specifically to minimize UHF snivets without the expense of providing unusual voltages to the beam plates. You'll be seeing a lot of these tubes in the new all-UHF television receivers.

An added value in the 38HE7 is that it includes the damper diode as well as the horizontal output pentode—thus combining two tough functions in one envelope, saving space and reducing costs.

Circle 7 on Inquiry Card

ELECTRONIC INDUSTRIES • July 1964

Versatile Ceramic Tubes Offer High Performance In Small, Regulated Power Supplies



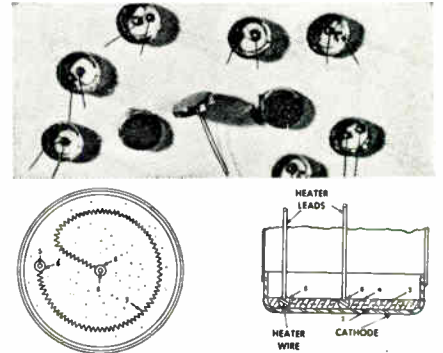
Small, versatile, ceramic receiving tubes offer unique characteristics not only at C and X bands, but also for direct current and audio applications. With transconductances up to 50,000 micromhos, these tubes are excellently suited for regulated power supplies.

Small ceramic tubes can handle voltages in the area up to 1000 volts or so. They're ideal for difficult environments and for applications such as traveling wave tubes, backward wave oscillators, klystrons and voltage tunable magnetrons. High transconductance and high voltage make the small planar triodes particularly useful where DC drift and ripple can cause serious frequency drift and/or modulation. Developmental samples have been operated satisfactorily up to about 600°C., with suitable reductions in heater power.

Types are available for every regulated power supply function (including a ceramic voltage reference tube). At 250 and 350 volt levels, high-level regulation has been obtained with high current loads. Ceramic tubes offer exceptional advantages in regulated power supplies for the higher voltage applications requiring only a few milliamperes of current. Small size of the tubes and their tolerance to heat contribute to permitting extremely small, ruggedized, lightweight power supplies as contrasted with the bulkiness of most supplies now in use for such purposes.

Circle 8 on Inquiry Card

Conduction Heated Cathodes Show Many Advantages



The cathodes of most receiving tubes are heated by radiation from a red-hot heater. General Electric tube engineers have done considerable development work on a new approach to the problem of heating cathodes. They are trying out "conduction heated cathodes" in the small ceramic tubes—wherein the heater wire is bonded directly to the cathode with a ceramic coating.

Apparent advantages:

1. Fast warm-up—as low as 2.1 seconds has been achieved.
2. High current density attained in the cathode.
3. Less power used to heat the cathode—thus greater efficiency in overall tube operation.
4. Less chance for contamination which could lead to heater failure—because heater and cathode are sealed together in the ceramic coating.
5. Heater and tube operate at a lower temperature (approx. 800°C. vs. 1400°C., for the heater).
6. Higher tolerance to vibration because the heater wire is sealed tightly and cannot vibrate by itself.

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GENERAL  ELECTRIC

For more information, write G-E Tube Department, TIPS, Room 7008, Owensboro, Ky. Be sure to specify product(s).

Circle 9 on Inquiry Card

Analyzing current developments and trends affecting the State-of-the-Art of technologies throughout the electronic industries



MOLECULAR IR TRACKING SYSTEM

New infrared tracking system uses molecular electronic components and is smaller, lighter and more reliable than conventional system. Built for the Air Force by Westinghouse, the system contains 543 molecular electronic components, the electronic equivalent to 6300 conventional parts. System has 100 molecular preamplifiers.

LASER-FOCUSED SPECTROGRAPH has been used for instant qualitative and semi-quantitative analyses of trace contaminants by Jarrell-Ash Co. Instrument can do non-destructive spectral analyses of pre-selected, 50- μ dia. spots without regard for electrical conductivity, sample size, or shape. Called a Laser Microprobe, the device has had success in analyses of micro-inclusions in metal matrices; inclusions in glass; photo emulsions; and trace metals in biological specimens.

PLASMA DIAGNOSTIC PROBE developed by General Electric, Syracuse, for OAR's Air Force Cambridge Research Laboratories. The ruby-laser-operated probe, highly precise, shows promise for measuring electron density in the flow field of a re-entering spacecraft. It also measures electron temperature of plasma at the same time. With a half-inch laser beam, spectrometer and photomultiplier tube detect doppler-broadened, scattered energy. Probe can measure electron density to a resolution of 1 cm³ or less. The probe uses a 0.30 joule, Q-spoiled laser with a pulse rate of 30 nsec.

INCREASED PEAK POWER by several hundred times is the result of a "laser lever" introduced by Raytheon's Laser Advanced Development Center. The lever is a switch that shortens output of pulsed laser to 100nsec. from normal range of 0.5 to 3.0 msec. Peak power is thus increased by two orders of magnitude. Pulse length reductions and peak power increases are accomplished with a prism rotating at speeds up to 24,000 rpm.

107-KG SUPERCONDUCTING MAGNET has been produced by RCA research engineers. The magnet uses less than 400 w. to produce a field of about 107,000 gauss. The coils of the solenoid are immersed in liquid helium, at temperatures close to 270°K. The coils are made from several miles of thin stainless steel ribbon on which niobium and tin are deposited. The entire magnet is the size of a half-gallon paint can and weighs 26 lbs. RCA is now thinking about a 150,000 gauss magnet.

TELECOMMUNICATIONS FACILITIES worldwide can be expanded and revenues will be increased because of an FCC ruling, reports Thompson H. Mitchell, President of RCA Communications, Inc., FCC ruled that alternate voice and non-voice commercial service should be furnished only by the nation's international record (telegraphic) carriers. Demands on carrier facilities will increase sharply, especially in electronic data processing, according to Mr. Mitchell.

ALPHA SPECTROMETER with high sensitivity has been developed by EON Corp. for identifying alpha radioactivity in biological tissues and environmental materials. EON's spokesmen say it may give clues to the relationship between smoking and lung cancer. The device can single out radioactive elements. The spectrometer includes a pre-amplifier and a power supply for its ionization chamber as well as the pre-amp. It uses an external linear amplifier and multi-channel pulse height analyzer.

NON-DESTRUCTIVE READOUT MEMORY, electrically alterable, developed at Bell Telephone Laboratories. Called Piggyback Twistor, the memory is being studied for use in phone switching systems. It operates in microseconds and can store more than 200,000 bits. It uses two magnetic materials: one to store data, the other to sense them. Materials are thin narrow tapes spirally wrapped around a fine copper conductor. They are wrapped one on top of the other in "piggyback" manner. Memory has 4,096 words, each stores 54 bits. One word takes about 20 μ sec; the 4,096-word memory can be loaded in less than 0.1 sec.

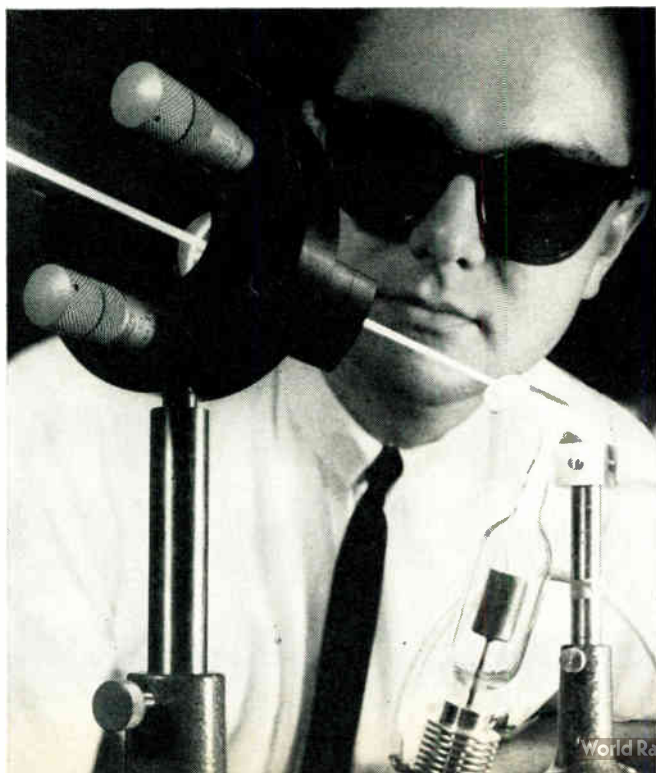
POWER-PULSED MAGNETIC FORCE is being used by Sangamo Electric to attach connectors to coaxial cables carrying high voltage, high current, oscillatory pulses. Firm uses Magneform metal-forming machine, made by General Dynamics, to do swaging. Machine forms metals with electromagnetic pulses of 20 to 50 μ sec. Pulses can exert up to 50,000 psi.

RUGGED MAGNETIC TAPE SYSTEM developed at Sylvania Electric Products, Inc., for Army use in battlefield conditions. Compact, the system has two magnetic tape handlers, each about one third the size of standard units. The new units use tape cartridges for faster tape loading. The system will have two data-processing functions: it will send and receive digital data at high speed; it will also be a bulk memory for Army computers.

PRECISION LASER FOR MICROSCOPES has been developed by Optics Technology, Inc. Precision laser device transforms passive scope into tool capable of concentrating light energy during laser pulse to millions of watts per sq. mm. Called Model 190 Microscope Laser, its optical head will fit any scope in place of normal ocular. Head will hold ruby crystal for visible spectrum or doped glass crystal for infrared. At full power, metals are vaporized and biological specimens destroyed.

NEW LASER FREQUENCIES

Laser action at more than 60 new wavelengths has been observed in a new class of gas ion laser by scientists at Hughes Aircraft Co. Gases used were argon, krypton, xenon and neon. Oscillations were both pulsed and continuous-wave. Action ranged up to ultraviolet, opening visible spectrum to the laser. Peak pulse power was 10w.



VISUAL TELEPHONY

Picturephone system by Bell Telephone Labs is still experimental. Calls can be dialed between any two of eight phones at the New York World's Fair and three at Disneyland in California. Herbert Hoover, bottom, Secretary of Commerce in 1927, took part in the first public showing of AT&T's inter-city television broadcasting.

3-WATT BRUSHLESS MOTOR developed by NASA uses photo-optical detectors and transistorized switching. Performance matches conventional ac motors and it has dc characteristics. It has a response time of less than 0.01 sec. Control at the milliwatt level will be of value in servo uses. Prototypes have starting torque of 2.7 oz.-in. and reach 50% efficiency of .67 oz.-in. at 3000 rpm.

THIN FILM ANALYSIS METHOD using xenon flash lamp has been developed by Bell Telephone researchers. The lamp removes thin metallic films quickly and easily from inorganic substrates and surfaces. Films are placed in a vacuum and are "flashed." Temperature rise—5000 to 8000°C—is enough to vaporize film from the substrate. Gases or vapors are analyzed by gas chromatograph.

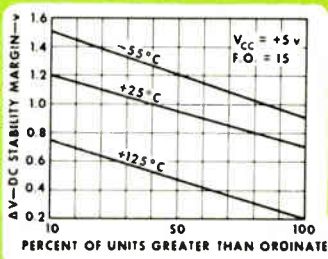
HYPERSONIC FREQUENCIES and highly intense "sounds" have been produced at Massachusetts Institute of Technology by bombarding a sapphire crystal for 30nsec. with an intense pulse (50-megw) from a ruby laser. The intense burst of red light (6940 Å) struck the sapphire virtually turning it into a hypersonic gong. Frequency was about 60gc. The waves had an intensity of about 1 kw. Laser was focused inside crystal. Power density at focal point was about 1,000,000 megw/sq. cm. Quartz gave similar results.

(More RADARSCOPE on Page 13)

IF YOU'RE DOING SERIOUS WORK WITH * INTEGRATED CIRCUITS * YOU'LL NEED AT LEAST THIS MUCH INFORMATION TO HELP YOU COMPARE BEFORE YOU'RE COMMITTED.

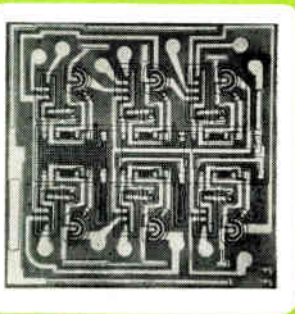
PERFORMANCE

is what you ultimately pay for, and d-c stability margin is one major requirement. To arrive at worst case d-c stability margin alone, Siliconix specifies 8 different parameters. Performance is proven through 18 different tests on each gate and at three temperatures . . . fifty-four tests in all. Distribution of d-c stability margin for worst case input and output loading is shown for all three ambients.



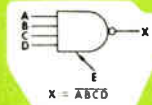
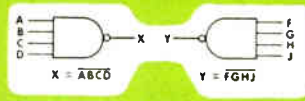
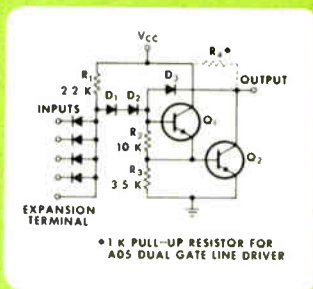
CONSTRUCTION

is a significant contributor to performance. For instance, each circuit uses epitaxial transistors and an N+ diffusion to minimize isolation capacitance, to control output resistance, and to improve switching times and yield. For circuit uniformity and cost economy, only one set of deposition and diffusion processes is used for the entire line of circuits.

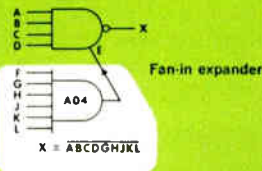
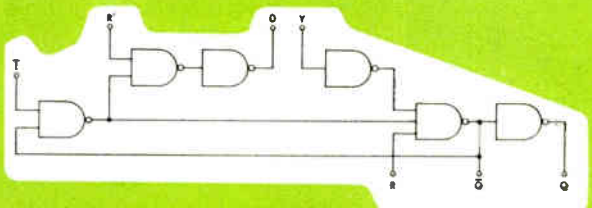
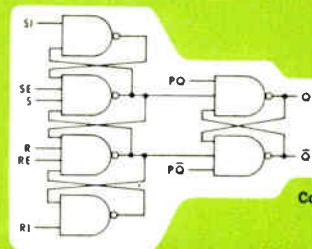


CIRCUITS

are the increasingly popular diode transistor logic (DTL), with the best balance of propagation delay (18 nsec), d-c stability (see curve), and power drain (7 mw) when operated from a single power supply (5v nom). The high-gain circuit removes critical gain-speed tradeoff at temperature extremes on the inverter transistor, providing higher yield while improving performance.



Single and dual NAND gates, power NAND gates, and NAND gate line drivers



AVAILABILITY

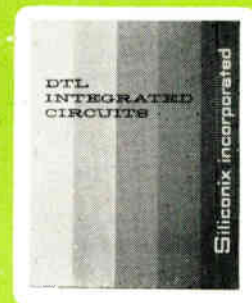
means now, from stocking distributors in the U.S. and Europe. The five circuits shown, plus three others, are all available in quantity (up to 1,000) with two weeks delivery. Evaluation kits are airmailed within 4 hours of receipt of order. Specials quoted on request.

PRICING

is geared to the evaluation order as well as the large one. For instance, if you order just one diode array, you get the 1-999 unit price of \$7. The counter, shift register is only \$29.

BROCHURE

tells all. Write or call collect for detailed specifications on Siliconix integrated circuits. That is, if you're serious.



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HIGH POWER FERRITE gives circuit designers more latitude as it combines high initial permeability with low loss, reports Indiana General Corp. Called Ferramic 0-5, the material has characteristics that make it effective for high power, low loss uses—such as color TV flyback transformers, and other fixed and adjustable inductors. Indiana reports 0-5 allows increase in operating voltage of transformers without changing core shape and size.

NEW RADIAL RESOLUTION CRT, of "unique" design, can be used as a multiplexer for coded transmission, report Raytheon Co. scientists. It can also be used as a frequency multiplier from 60c to 30kc, analog-to-digital converter, or in other applications where signals must be separated into narrowly defined angular sectors. In present design, the tube can segregate signals into 36 ten-degree sectors. Each sector has own output lead.

NEW COMPUTER TECHNIQUE has been developed by Air Force research engineers. The technique, large-scale digital, permits multiple user researchers to query or use a central computer through an executive supervisory multi-processing program. Each works at a console with CRT display. Capable of 20,000 operations per second, the system operates at its normal working capacity and no appreciable delays result.

MACHINES THAT LEARN TUNES described by scientists of ITT Federal Laboratories and of the Air Force. Dr. L. M. Vallese and Mr. A. Stefanis, of ITT, and Mr. C. W. Gwinn, of Wright-Patterson Air Force Base, disclosed a machine, based on computer technologies, that can repeat music tunes once it has "heard" and "learned" them. The device has built-in notes that it learns to control in the proper time sequence to play a tune. When "listening," the device analyzes tones and matches its own notes to the unknown tune.

MACROSCOPIC QUANTUM SYSTEM, formed by electrons in current flow between superconductors, has been observed by Ford scientists. A current amplifier based on the system has been prototyped at Ford's Laboratories in Dearborn, Mich. Dr. James E. Mercereau, of Ford, reports that the system obeys the laws of the quantum theory, but it extends over a distance of $3\frac{1}{2}$ mm, large for a quantum effect. Dr. Mercereau says this is the first time that one of such giant size has been detected. Discovery strengthens theory of superconductivity. A new solid-state family may result.

OPTICAL HETERODYNE RADAR developed by Sperry Rand's Electro-Optics Group may be "the first practical optical radar to exploit full potential of the laser." Aim is to combine power, narrow band width, phase stability, and narrow beam angle in a three-laser, optical system to work at 1.06 μ . This combination may enable laser radars to obtain unusual sensitivities and ranges.

RARE EARTH ALUMINUM GARNETS developed at Bell Telephone Laboratories permit a new solid-state optical maser to operate continuously at room temperature. The new maser needs only a fraction of the pumping power needed before. Dr. J. E. Geusic, Mr. H. M. Marcos, and Dr. L. G. Van Uitert, Bell's research team on the project, report that garnet crystals used in tests were neodymium-doped yttrium aluminum, yttrium gallium, and gadolinium gallium. Researchers believe pumping threshold can be dropped to as low as 100 watts; they believe that higher pumping levels will permit continuous outputs greater than 0.5 w.

(More RADARSCOPE on Page 15)

EXTRA-RUGGED SEMICONDUCTORS

Developed for use in microwave and millimeter wave communications by General Telephone & Electronics Laboratories, Inc., new, rugged class of wafer-thin semiconductors can operate between -195°C and 180°C . Dr. Richard I. Harrison is about to immerse test device in liquid nitrogen; device is fixed in faucet-like arm over vapor.





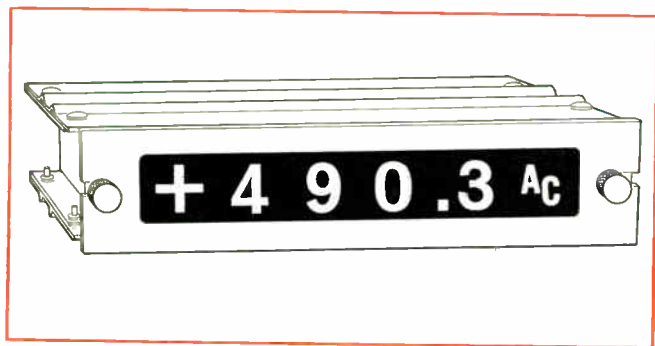
ANYTHING YOU CAN PUT ON FILM...YOU CAN DISPLAY ON THIS IEE READOUT (EVEN COLORS)

NUMBERS, LETTERS, WORDS, SYMBOLS, COLORS • There is literally no limitation to the display versatility of IEE readouts. As miniature rear-projectors, they operate by back-lighting display symbols arranged on film and projecting the selected message on a non-glare viewing screen. Each IEE readout contains 12 lamps for 12 separate messages which may be displayed individually or in combination. You may specify virtually any type or combination of messages that are photographically reproducible: numerals, letters, digits with polarity or decimal points, words and multi-digits, mode/word indications, multiple words, colors for emphasis, and any symbols.

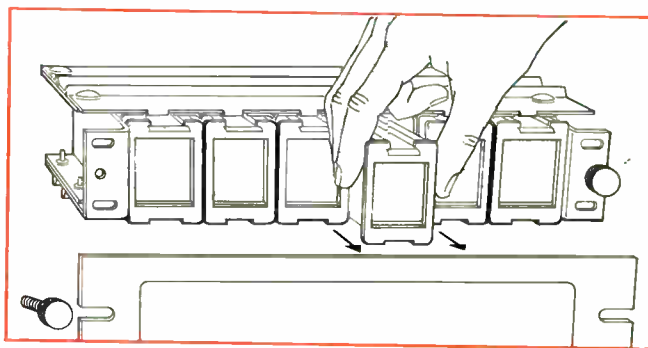
SINGLE-PLANE PRESENTATION FOR VISUAL CRISPNESS • IEE readouts combine the advantages of a new high-brightness lens system and the all-important single-plane presentation for visual clarity. The result is unmistakable readability—at wide angles, long distances, in bright light—without filters, screens, or shades of any kind.

UNLIMITED UNIT LIFE • IEE readouts contain no moving parts; hence, cannot wear out. The conventional MS or commercial lamps used in these readouts provide up to 30,000 hours of operation per lamp and are as easily replaceable as a flashlight bulb.

CLICK, IT'S IN; CLICK, IT'S OUT For quick, easy lamp replacement or complete message exchange, specify IEE Series 220 front plug-in readouts. These miniature rear-projection readouts ($\frac{5}{8}$ " maximum character height) plug in and out to provide front panel accessibility, permit permanent wiring and eliminate flexible cables.



Typical assembly shows six Series 220 readouts with common viewing screen. Display inserts with individual screens or with bezels also available.



Individual Series 220 readout insert clicks out for lamp replacement or exchange of insert for new message displays. Permanently wired base remains in assembly.

IEE one-plane rear-projection readouts are available in several sizes offering maximum character heights from $\frac{5}{8}$ " to $3\frac{3}{8}$ ". Your inquiry will bring the comprehensive new "Readout Display Selector Guide" which includes specifications and other technical information on the entire IEE line of readout devices.



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RADARSCOPE

SOLAR LIGHT BY CARBON ARC has been made with a non-consumable negative electrode. Main advantage of new tungsten cathode, operating in argon, is an estimated life of 1000 hours. Light-emitting positive carbon has diameter smaller than a dime, yet puts out light equal to 3200 100-watt bulbs. Arc duplicates sun's radiation beyond earth atmosphere more closely than any other man-made device. Arc developed by Carbon Products and Linde Division of Union Carbide Corp. The new light is expected to have many uses where a highly brilliant, continuously operating light source is needed. More data from Union Carbide Corp., Carbon Products Division, 270 Park Ave., New York, N. Y. (10017).

ELECTRONIC TYPE-WRITER, digitally-driven electronic display system, that will permit communication with computer system at extremely high speeds, is reported by Philco Corp. Called READ (Real-Time Electronic Access and Display System), it can send data at 36,000 lines per min. Read out is seen on CRT. Information can include, at one time, 4000 alphanumeric or 2000 characters and line segments. In command control operation, READ can keep track of every object in space. It can project data onto large screen for immediate decisions. Data can be alphanumeric, symbols, graphics.

IMAGE INTENSIFIERS made from solid state materials are in research and progress is reported. Aim is to fabricate low resolution photoconductive electroluminescent image intensifier panels. The main search is for intensifiers with wide use in optical systems but mostly for military training devices. Researchers have developed a sandwich-type panel but there are some deficiencies in speed and gain. OTS, Department of Commerce, Washington, D. C. 20230; (AD 431 545 \$3.00).

International Rectifier

SEMICONDUCTOR DESIGN DATA IOR®

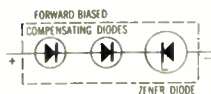
Guidelines to Voltage Stability with Standard Cell Accuracy . . .

IR Klip-Sels—the New Way to Spend Pennies to Save Dollars . . .

Super-Power Rectifiers for Jobs Too Big for Tubes to Handle . . .

Check Our References . . .

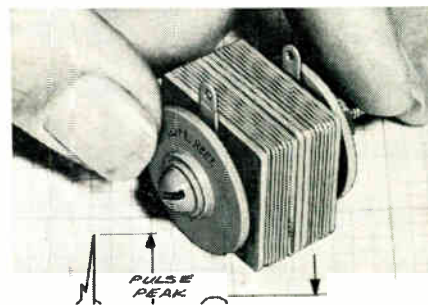
Ways to use temperature-compensated glass voltage reference diodes are discussed in the new Application Data Sheet #509 by IR's Julian Temple. Highly useful to designers of ultra-stable power supplies, computers, digital voltmeters and other equipment requiring standard cell voltage accuracy, these miniature devices are constructed by series connecting one zener diode and one or more forward-biased compensating diodes, as shown below. The resulting devices provide a stable voltage lying in the range of 5.9 volts to 6.5 volts at a current of 7.5 ma. Voltage stability better than 0.001% per degree centigrade over a temperature range of -55°C to $+100^{\circ}\text{C}$ can be achieved with the 1N827A. Julian's article exploits this characteristic in words and schematics.



Actual Size

The data covers series compensation, design of current sources and specific circuits for differential amplifiers, digital-to-analog converters, etc., with answers that may solve a wretched problem for you. Write for the data sheet, and we'll include Bulletin SR-269 listing Jedec types 1N821-1N827A and 1N3154-1N3157.

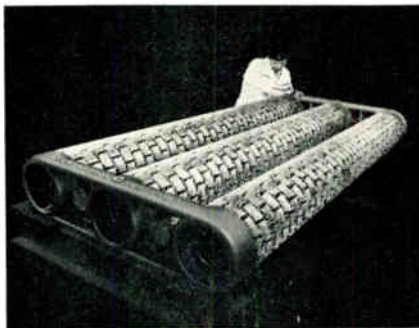
P.S. Rumor has it that temperature-compensated glass reference diodes are scarce . . . especially the 1N827A. Some say everybody offers them but few can actually deliver. It isn't so at IR. We have them in stock, in quantity, at the factory and on the shelves of our key distributors. If you've been disappointed elsewhere, try us. We specialize in meeting customer needs.



An Ounce of Prevention . . .

You know the rest . . . but do you know the story of IR selenium transient voltage suppressors, the "ounce of prevention" that can save pounds of high cost semiconductors? These remarkable, low cost assemblies of selected selenium cells, known as "Klip-Sels," clamp destructively high voltage transients to a level low enough to prevent damage to expensive silicon rectifiers, controlled rectifiers and transistors. As a result, you can use devices with a much lower PRV rating, thus save dollars in rather imposing groups.

Better yet, Klip-Sels eliminate the problems associated with resistance-capacitance networks or thyrite voltage sensitive resistors rigged up to do the same job. They even provide a faster response to transients with a steep voltage wave front than zener diodes can muster. Klip-Sels come in a variety of stacks and cartridge styles in polarized and non-polarized configurations, with operating voltage ratings from 26 to 364 volts and peak current ratings up to 15 amps. We'll send a 20-page manual on voltage surge protection and Klip-Sels absolutely free if you ask for it. See? . . . you're already saving money!



Anyone for 4.4 Megawatts?

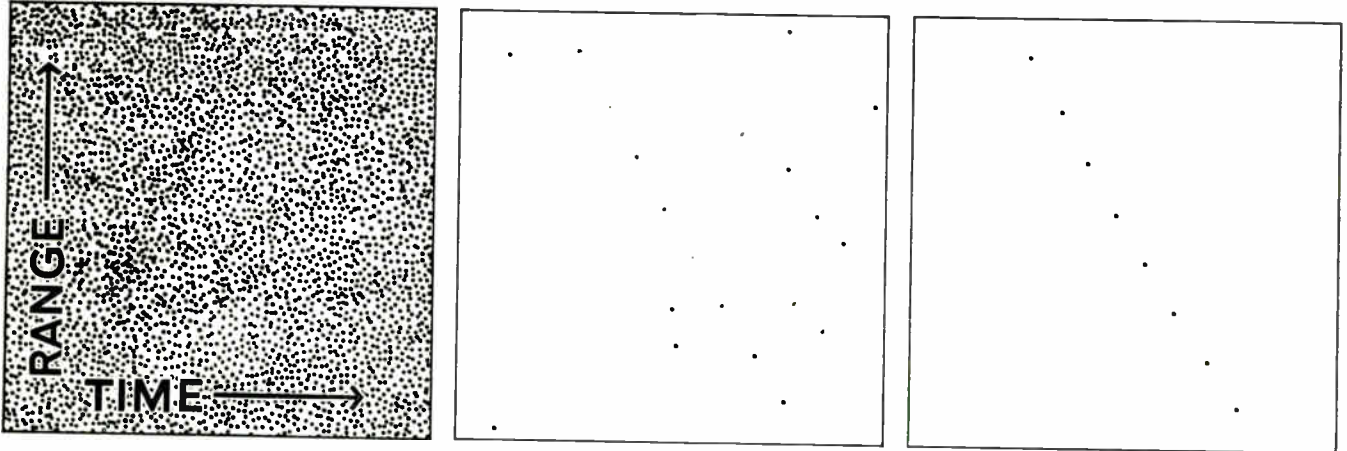
If you have use for standard rectifier columns for continuous dc power anywhere up to 4.4 megawatts, write for the report on IR modular, macro-power high voltage/high current assemblies. They are the new way to power conversion in magnitudes far beyond the capabilities of tubes. Their design is impressive . . . and so is their performance! Write to: Product Information Department, International Rectifier Corporation, El Segundo, California, or . . .

INTERNATIONAL RECTIFIER CORPORATION EXECUTIVE OFFICES: 233 Kansas Street, El Segundo, California

A 30-second
Report from

**BELL
LABORATORIES**

Charts show 30-second real-time elimination by computers of noise from radar range data: left, raw data; middle, first stage of filtering; right, noise-free space target trajectory.



(**NOISE** & space target) (noise & **SPACE TARGET**) (**SPACE TARGET**)

Space objects can be tracked by sending radar pulses and observing reflections. But such reflections are accompanied by thousands of “noise” signals from the sky and from the radar receiver itself—especially when the threshold of detection is set low enough to pick up very small or very distant objects. For accurate tracking it is essential, of course, to distinguish reliability between the target signals and the noise.

A new data processing system developed at Bell Laboratories performs this separation of “real” signals from “noise” signals, and does it in two steps.

In the first step, a computer compares the received pulses following each transmitted pulse with those following the next succeeding transmitted pulse. Those received pulses of the first train are then retained which have corresponding pulses in the succeeding train; the others are rejected. Such correlated data result in the information shown in the middle chart.

In the second step, another computer compares the correlated data resulting from the transmitted pulses constituting one “look” at a given section of the sky with the correlated data on subsequent “looks” for the same section of the sky (although enlarged somewhat to allow for motion of the space object), again checking for correlation and when none is found rejecting the data. The third chart shows the resultant noise-free data of a space target moving through the sky.

The data processing system operates continuously and in “real time”—i.e., it processes the data immediately as they arrive from the radar. A human being performing the calculations carried out during the 30 seconds depicted above would require three weeks.

For this military project, engineers at Bell Laboratories, working closely with engineers of the Univac Division of Sperry Rand Corporation, designed and programmed the computers. Because of the demanding requirements of reliability and speed, they developed for it new high-performance semiconductor and magnetic memory components. The two groups combined talents with engineers of the Western Electric Co., the manufacturing unit of the Bell System, to build prototype computers. **BELL TELEPHONE LABORATORIES**. World center of communications research and development.



COMING EVENTS

JULY

July 13-15: Rochester Conf. on Data Acquis. & Proc. in Biology & Medicine, IEEE, U. of Rochester; U. of Rochester, Rochester, N.Y.

July 20-24: Special Tech. Conf. on Nuclear Radiation, PTG-NS IEEE, U. of Wash.; U. of Wash., Seattle, Wash.

AUGUST

Aug. 24-26: Petroleum Industry Conf., IEEE; St. Francis Hotel, San Francisco, Calif.

Aug. 25-28: WESCON Show & IEEE Summer General Mtg., IEEE, WEMA, All PTG's; Los Angeles, Calif.

SEPTEMBER

Sept. 7-11: Int'l Conf. on Microwaves, Circuit Theory, and Inf. Theory, IEEE of Japan; Akasaka Prince Hotel, Tokyo, Japan.

Sept. 14-16: Int'l Conf. on Military Electronics (MIL-E-CON 8), PTG-MIL IEEE; Shoreham Hotel, Washington, D.C.

Sept. 17-18: 12th Annual Eng. Mgt. Conf., IEEE, ASME; Pick-Carter Hotel, Cleveland, Ohio.

Sept. 22-24: PTG on Antennas & Propagation Int'l Symp., PTG-AP IEEE; Int'l Hotel, Kennedy Int'l Airport, L.I., N.Y.

Sept. 24-26: 14th Annual Symp. on Broadcasting, PTG-B IEEE; Washington, D.C.

'64-'65 Highlights

WESCON, Western Electronic Show and Conv., Aug. 25-28, IEEE WEMA; Sports Arena, Los Angeles, Calif.

Nat'l Electronics Conf., Oct. 19-21, IEEE, et al; McCormick Place, Chicago, Ill.

NEREM, Northeast Research & Eng. Mtg., Nov. 4-6, IEEE; Boston, Mass. IEEE Int'l Conv., Mar. 22-25; Coliseum, New York Hilton, New York, N.Y.

Sept. 25-26: 3rd Canadian Symp. on Communications, Montreal Sec. & Region 7 IEEE; Queen Elizabeth Hotel, Montreal, Canada.

Sept. 27-Oct. 1: Nat'l Power Conf., IEEE, ASME; Mayo Hotel, Tulsa, Okla.

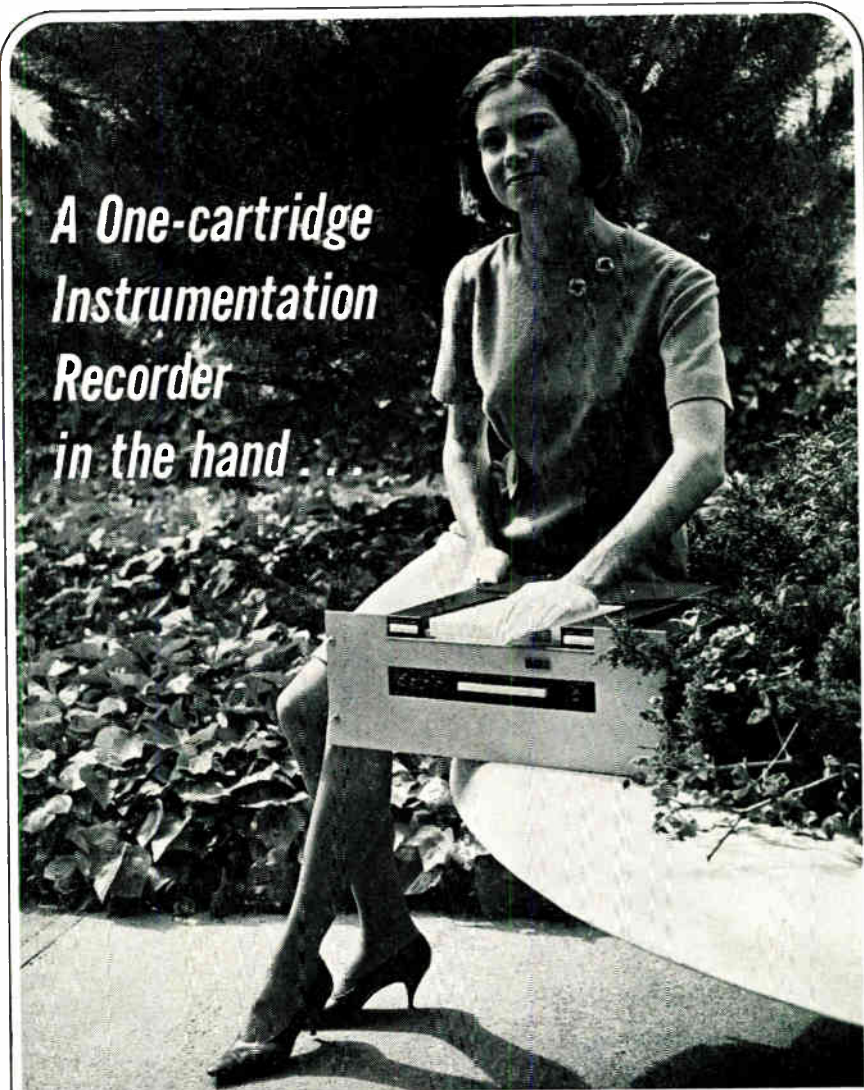
OCTOBER

Oct. 4-9: Nat'l Symp. on Space Electronics, PTG-SET; Dunes Hotel, Las Vegas, Nev.

Oct. 5-7: 10th Nat'l Communications Symp., PTG-CS; Utica, N. Y.

Oct. 6-8: 1st Annual Conf. on Indus. & Comm. Power Systems, IEEE; Marriott Motor Hotel, Philadelphia, Pa.

Oct. 6-9: Int'l Space Electronic Symp., PTG IEEE; Dunes Hotel, Las Vegas, Nev.



A One-cartridge Instrumentation Recorder in the hand

... is worth up to four straight hours of data logging in the bush—on a geological survey. In a laboratory—on a biomedical research project. Anywhere! The remarkable new KRS DATA-STACT™ MD-2 fits any need for a portable recorder with big tape capacity. This trim 20-pounder covers a range of DC to 100 kc, handles up to four channels, and gives you bigger performance features in a smaller package than any other portable tape recorder available today.

1200 FEET OF CONTINUOUS-LOOP TAPE! The handy size MD-2 recorder uses one KRS STACTape™ Cartridge—the precision magnetic tape cartridge that holds up to 1200 feet of 1/4" tape in an endless-loop roll, and incorporates unique reversing and fast-forward features. Models are available in all standard tape speeds from 15/16 to 30 ips.

WOW? FLUTTER? Extremely low, even at low tape speeds. Classically simple design eliminates all mechanical adjustments—you concentrate on your work, not the machine. Complete with solid-state standard instrumentation electronics (FM or Direct), MD-2 recorders sell in the price range of \$850 to \$2500.

™ Trademarks of KRS Electronics

For complete data on the new KRS DATA-STACT MD-2 Cartridge Instrumentation Recorder, send for Instrumentation Division Bulletin MD-2.



KRS Electronics, 4035 Transport Street, Palo Alto 1, California 94303

KLEIN PLIERS *Speed up electronic wiring*

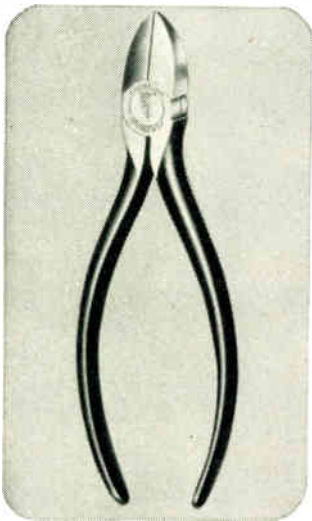
When the crystal set was a seven-day wonder, Klein long nose pliers were used to adjust the cat's whisker. Through the era of B and C battery sets, Klein kept pace by providing pliers specially adapted for electronic wiring.

Today, more than 100 different styles and sizes of Klein pliers are available to provide the exact tools needed for any job. Klein engineers have developed a special plier for wiring printed circuits; a high hardness

plier for cutting nickel ribbon wire; a transverse end cutting plier for cutting closely in confined spaces; extremely small pliers for wiring midget assemblies—and many others.

Klein has also developed special pliers to do special jobs requested by electronic manufacturers.

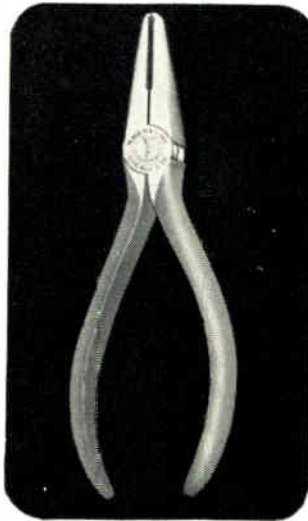
For better work done more quickly and at lower cost, be sure the pliers you use are exactly suited to the job . . . made by Klein, of course, "Since 1857."



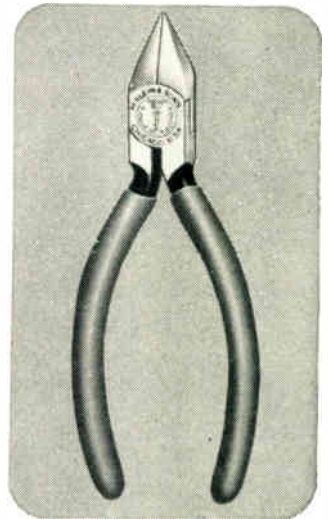
202-5C Oblique Cutting Plier with narrow nose. Available with coil spring. 5 1/2-, and 6-in. sizes.



203-5C Long Nose Side Cutting Plier. Available in 5 1/2-, 6 1/2- and 7-in. sizes. Supplied with coil spring.



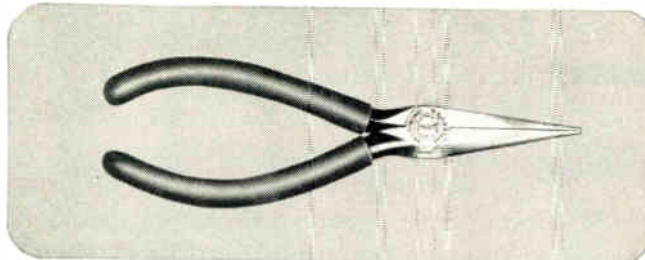
204-6C Transverse End Cutting Plier, 6-in. long. Supplied with coil spring to hold jaws open.



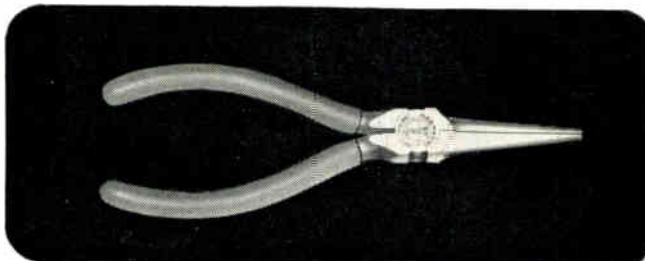
D209-5C Lightweight, Pointed Nose, Flush Cutting Plier. Supplied with coil spring to hold jaws open.



301-5C Long Nose Plier. Available in 5 1/2-, 6 1/2- and 7-in. lengths. Coil spring.



D307-5 1/2 C Slim Long Nose Plier for reaching into confined spaces. Yellow plastisol handles. Supplied with coil spring to hold jaws open.



D310-6C Slim Long Nose Plier. Handles are yellow plastisol covered. Supplied with coil spring to keep jaws open.



314-8 8-in. Long Nose Plier. Jaws have knurl.



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 Established 1857 Chicago, Ill., U.S.A.
 INCORPORATED
 7200 McCORMICK ROAD, CHICAGO 45, ILL.

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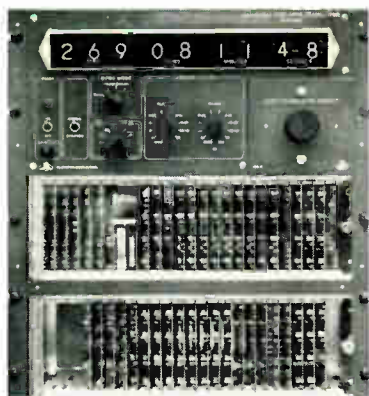
ASTRODATA

ADVANCED TIME CODE TRANSLATORS FOR YOUR TIMING SYSTEMS APPLICATIONS

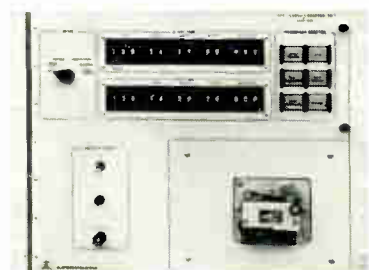
Astrodata Time Code Translators have been designed with advanced solid state circuitry to translate all known time codes...and to complement new data reduction facilities as they are developed.

Plug-in circuit cards are available for all commonly used codes. New modules are developed as new code requirements become known. To update Astrodata timing systems

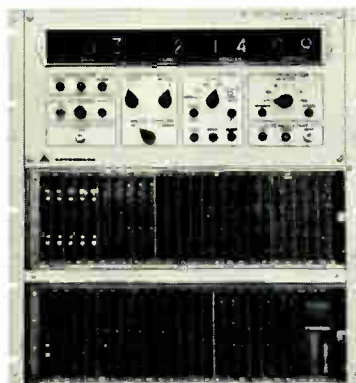
already in use, it is necessary only to add the desired plug-in code cards. To assure satisfactory performance for your time code translator requirements, consider the basic translators shown below. Many standard options are available such as logic level outputs, code conversion, serial code outputs, automatic tape search, manual tape search, fail-safe operation, remote display, computer interface.



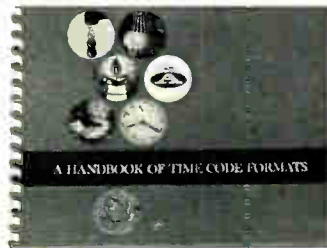
Model 6220 Universal Time Code Translator translates all serial time codes to decimal display . . . parallel BCD output . . . front panel code modules . . . adapts easily to fully automatic tape search . . . more than 30 standard options for greater systems applications.



Model 6225 Tape Search and Control Unit operates with Model 6220 time code translator . . . can be programmed from computer or punched tape to permit reduction of multiple data intervals or channels without manual set-ups.



Model 6420 Time Code Translator/Generator functions as a sub-central timing system . . . generates multiple serial time codes, parallel logic signals, pulse rates all synchronized within 1 μ sec to input timing signal . . . operates as a translator with input signal from magnetic tape. Jitter free and fail-safe outputs make the unit especially applicable for data acquisition where central time correlation is desired.



A new 48-page handbook of the most commonly used time code formats has been compiled as a handy reference for instrumentation engineers. Write for your free copy.



Model 6204 Time Code Translator typically used as time code reader or timing terminal unit where input code is limited to one format . . . translates serial time code . . . provides decimal output and display consistent with input code format . . . 30 standard options available for logic level outputs, code conversion, serial code outputs, fail-safe operations, remote display, computer interface.



Model 6201 Time Code Translator . . . most economical translator . . . translates time-of-day serial code to parallel logic level outputs and pulse rates . . . binary-coded display.

Write for more complete technical specifications and also an 8-page brochure "Design for Reliability".



ASTRODATA INC.

P. O. Box 3003 • 240 E. Palais Road, Anaheim, California • 92803

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A NEW PLUS FACTOR IN RELAYS

PHILLIPS-ADVANCE = Phillips Control Company + Elgin Advance (two names long synonymous with the highest standards of relay reliability). The recent consolidation of PHILLIPS and ADVANCE adds up to numerous plus-factors of real importance to all relay users—broader range of relay types and sizes + expanded research and development + increased plant facilities + new production economies + greater number of skilled personnel + faster service thru broader distribution. For prompt attention to every relay requirement, contact the PHILLIPS-ADVANCE representative in your area.



phillips
advance
control co.
Joliet · Illinois

SMALL FIRMS MAKING OUT—Small businessman's share of space contracts has grown considerably in six months. NASA says a higher percentage of small firms shared in a bigger proportion of total dollar value of subcontracts. Of \$345 million in contracts among 1,071 subcontractors, small businesses got \$81 million, or 24% of total. Of 1,071 subcontractors, 770 were small firms.

NEW FISCAL YEAR FOR MILITARY—Armed services begin year with definite trends in sight. All end of year statements by service communications chiefs stress more competition in electronic bidding, closer attention to project definition in major projects, and more fixed price contracts.

SERVICES EMPHASIZE RELIABILITY—Military radio and electronic equipment is getting smaller and lighter; durability will be measured in years, not hours. Interchangeable, interconnecting parts, reduced power have priority. Microelectronics are getting close attention. Navy is drifting toward functional solid-state modular concept.

MORE IN-HOUSE ELECTRONIC OUTPUT—As military and government buying of electronic products slows down, prime contractors face more and more the prospect of stepping up in-house electronic R&D and production. Leveling off of defense expenses has also meant loss of some contracts by prime firms. Industry in general hopes in-house increases will absorb the slack from other departments of prime contractors.

DEFENSE SUPPLY GOES AUTOMATED—A number of federal electronic supply classes will be phased into DOI's new uniform automated procurement system this summer. Included will be electron tubes, connectors, relays, antennas and wave guides, capacitors, coils and transformers. By August the Defense Electronic Supply Center hopes to have all 15 supply classes phased in.

CENTRALIZE TO ECONOMIZE—The idea long has been a favorite phrase of Defense Secretary McNamara. The idea is embodied somewhat in "Project 60," two-year DOD study of varied military buying methods and contract handling; objective is a uniform system for all branches. The some 60 district procurement and contract offices now serving DOD and NASA may soon be lumped together and remolded into just 13 U. S. regional offices.

HOW'S BUSINESS? GOOD—IN GENERAL—Despite nagging unemployment and pains of shifting to non-government production, the U. S. economy is riding high. It should keep up the pace through 1964. New government data show production registering solid gains. New orders surged ahead in the April-June quarter. Expansion and replacement plans suggest brisk order-taking by equipment sellers. Consumer spending lags. Government experts still think tax cuts will soon turn into more retail buying.

TV TAX CUT; HOME TV DRIVE—Congress is talking about cutting or removing the 10% excise tax on all-channel sets. FCC urges such a step; buyers now pay up to \$30 more than for VHF sets. Removing the tax could equalize retail prices of UHF-VHF sets with pre-April 30th models . . . A campaign to push home entertainment may be launched by the TV industry this fall. Washington sources hint that advantages of home entertainment via TV will be a prime sales tool.

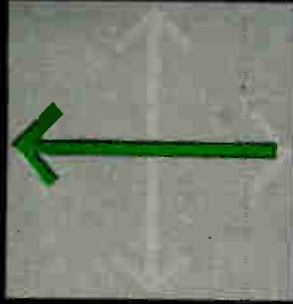
CONVERSION ADVICE STEPS UP—Government agencies are broadening their counseling services for firms learning how to get along on less government business. Former contractors and subcontractors are finding that, by necessity or choice, transition to civilian-type output is now the thing. Many firms saw this coming, and they were smart enough to lay groundwork. Others, who thought the government bandwagon would roll on and on, are having trouble as the Johnson-McNamara leveling-off of defense procurement takes hold.

COMPUTER CONFERENCE

Senate Majority leader Hubert Humphrey (D.-Minn.) checks output of 922 line-per-minute printer in UNIVAC 1050 System operating at the Spring Joint Computer Conference of 1964 held in Washington, D. C.

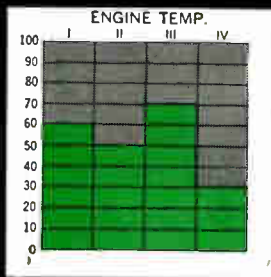


versatile



AIR SPEED KNOTS		457		WIND	DIR.	NE
					SPEED	25
FUEL	OK	R.P.M.	OK	RUNWAY CLEAR		
	LOW		LOW	WHEELS DOWN		
TEMP.	HIGH	SPEED	INCREASE	NAV. LIGHTS ON		
	OK		HOLD			
	LOW		DECREASE			

Super Market	TIME	WEATHER
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EL lets you create your own readout language...and at low cost!

The versatility of Sylvania EL makes it adaptable to so many uses. In combination with gauges and measuring devices, its high visibility is ideal for indicating readings in process instrumentation, telemetering, timing, programming, flows, pressures, levels, and so on. You name it.

Once we know your requirement, the rest is in the hands of Sylvania engineers who custom-design EL to suit the problem. The readout can be designed to fit many forms—often letters or numbers, or even bar graphs, pie charts, direc-

tional arrows or STOP-GO indicators.

Remember, too, that it's easy to add static symbols of any type or shape to your EL display, whatever its application. And because no costly tooling is involved, it's also relatively inexpensive. Using either photographic or special printing processes, the symbols of your choice are transferred to EL quickly, expertly and accurately.

The many features of EL are ideal for display requirements that call for reliability, minimum power consumption, light weight and compactness. Always

clearly readable, the modern-looking numbers and letters have no lines or gaps separating them. EL's long life is directly traceable to its basic solid state design and construction using phosphors instead of filaments. And unlike other readouts, EL is not subject to catastrophic failure, nor is it adversely affected by turning the display on and off.

Consider versatile EL for your next display application. Call in your Sylvania sales engineer, or write to Electronic Components Group, Sylvania Electric Products Inc., Box 87, Buffalo, N. Y.

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SUBSIDIARY OF
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NEW CAPABILITIES IN: ELECTRONIC TUBES • SEMICONDUCTORS • MICROWAVE DEVICES • SPECIAL COMPONENTS • DISPLAY DEVICES

CONSUMER TV SALES RISE; COLOR, UHF TAKE 33%

Sales of monochrome television receivers in the consumer market rose from about 6.3 million sets in 1962 to about 6.8 in 1963. Such sales may top 7 million sets in 1964. Color TV market tallied about 600,000 sets in 1963 and may total between a million and a million-and-a-half this year.

All-channel sales are off to a bumpy, spury start, following federal law and the April 30th deadline. There are not many UHF stations at present. Some 17 educational television (ETV) sta-

tions, funded with \$3.1 million of U.S. money, is the nucleus of UHF growth. Another 42 applicants, seeking \$8.1 million, are waiting for action from the Office of Education, U.S. Department of Health, Education and Welfare.

Currently, TV set makers are on the fence between making monochrome receivers to sell for as much as \$30 more with UHF tuners, and making highly profitable color sets. A number of firms, including RCA, GE and Admiral, reportedly, will advertise the UHF story in sales promotion, while Motorola and Magnavox will apparently avoid the issue.

Meanwhile, makers of UHF tuners are enjoying improved business in the U.S., Western Europe and Japan.

From another part of the TV market, Electronic Industries Association reports that monochrome TV distributor sales and production both were up substantially in March, 1964, compared to March, 1963. Distributor sales in March totaled 687,746 units, compared to 601,797 units in March, 1963.

BIO-MEDICAL MARKET RISING WITH LONG-RANGE POTENTIAL

Current estimates by market analysts place the total bio-medical electronic market for 1964 at \$250 million in annual sales. This does not include sales and rentals of computers and EDP equipment now being used experimentally in some medical fields. The market is expected to grow, though slowly, with gradual rises as the medical and engineering worlds become more familiar with each other.

By far the largest cut of yearly sales in medical electronic instruments goes for x-ray equipment, which is estimated at about \$150 million. Electron microscopes may be anywhere from \$15 to \$20 million a year.

Estimates for instruments for specialized medical uses—to monitor, measure and diagnose—may run as high as \$50 million annually. Such instruments include patient monitors, mobile bedside recorders of physiological data, complex polygraphic instruments for operating rooms, and the familiar though newer electrocardiographs and electroencephalographs.

Outlays for medical research in 1963, as estimated by the National Institutes of Health, were about \$1.5 billion, about double the cost for 1960. This estimate is aside from NASA's space bio-medical research.

Most of the annual sales dollars for medical electronic instruments are earned by some 300 firms somewhat deeply in the bio-medical field.

CONSUMER MARKETING AIMED AT DESIGN ENGINEERS

Consumer product-marketing approach is being given a try to help sell electronic goods.

General Electric urges design engineers to write in for "FREE: photoconductive cells for breadboarding and evaluation testing." Engineers are asked to specify name, title, samples desired, plus intended applications, all on a company letterhead.

RAYTHEON OFFICER SEES EXPANDING NATO MARKETS

As U.S. defense/aerospace market levels off, greater growth is forecast in markets among NATO nations.

Lawrence Levy, vice president of corporate development for Raytheon Co., estimates that by 1975 NATO nations (other than U.S. and Canada) will have a gross national product of \$650 billion—double today's total.

MICROWAVE COMPONENTS HIT NEW HIGH IN 1963 SALES

Survey of sales of selected microwave components last year totaled \$73.1 million, a 6.43% rise over 1962. Billings for R&D (in microwave) accounted for \$6.43 million more, according to the Electronic Industries Association, Microwave Components Section.

Sales totals for 1963 were reported in these major product categories: Ferrite parts, and semiconductor and solid-state duplexer assemblies sold for \$21,915,000, while non-ferrite, non-semiconductor components tallied \$51,174,000.

EIA estimates the total value of microwave products and components sold last year at \$238,400,000. This includes components mentioned above, plus tubes and semiconductor diodes.

Point-to-point systems sold for \$85.4 million for just the electronic content of such systems. About 25% of the systems were bought by domestic and foreign common carrier firms.

\$65 MILLION SALES PREDICTED FOR AUTO SEMICONDUCTORS

Study of marketing and transportation at Michigan State University predicts that by 1970 the automobile industry will be buying about \$65 million in semiconductor devices.

Dr. L. J. Giacoletto and T. A. Faulkner, of Michigan State, co-authors of a paper on the subject with graduate student D. I. Van Blois, report that the auto world spent \$15 million on semiconductors in 1963. Forecast for 1965 is \$20 million.

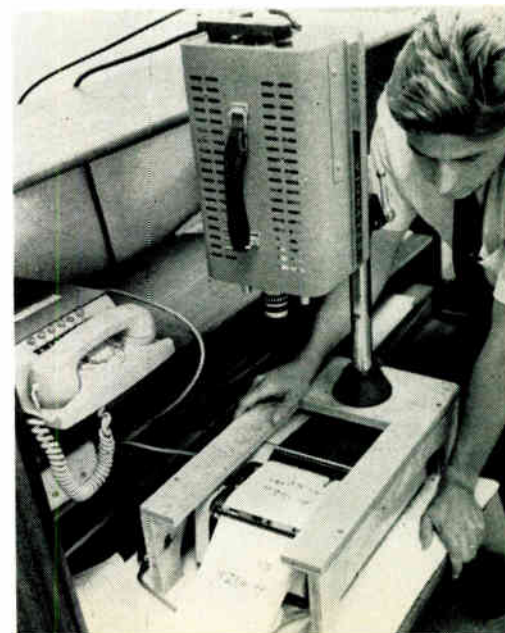
The authors say that if there should be a larger demand than now anticipated for FM radios in cars, the market will be still greater. Among growing uses seen for semiconductors in autos are in alternators, voltage regulators, ignition systems, and temperature controls for air conditioners. Minor uses include headlight dimmers, horns, fuel pumps, and clocks.

GE CHAIRMAN FORECASTS BUSINESS MACHINE MARKET

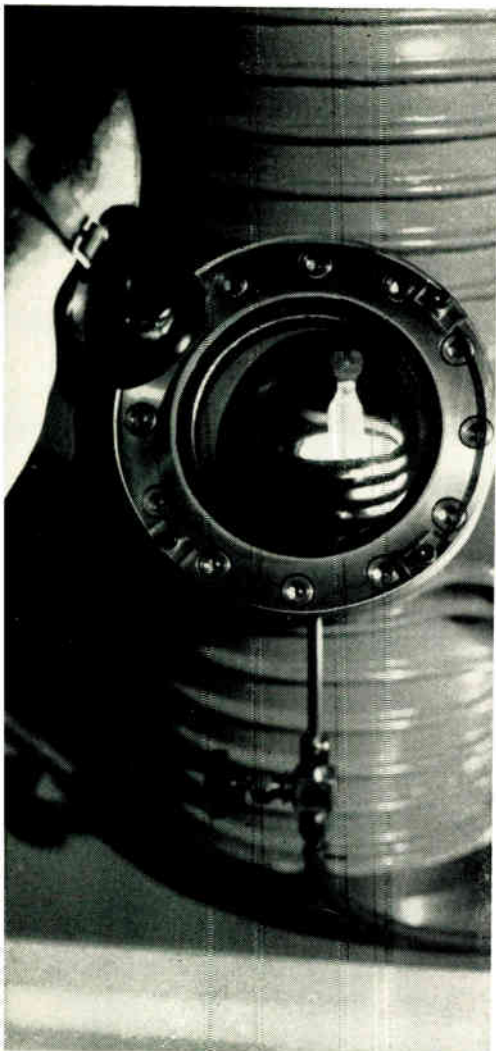
Some \$375 billion may be invested by American industry and business in new business machinery and equipment, predicts Gerald L. Philippe, chairman of the Board of General Electric Co. A portion of this total market offers growth potentials for electronic instruments, computers and industrial process controls and systems.

TEACHING BY ELECTROWRITER

Electronic writing machine has replaced the traditional blackboard for nuclear engineering classes at Georgia Tech. Equations from a teacher in Oak Ridge, Tenn., travel 200 miles by telephone lines and are instantly reproduced at the tech. institute. There is a Victor Comptometer Corp. Electrowriter at each end. Dr. C. J. Roberts focuses closed circuit TV camera to relay equations to class.



ELECTRONIC SNAPSHOTS



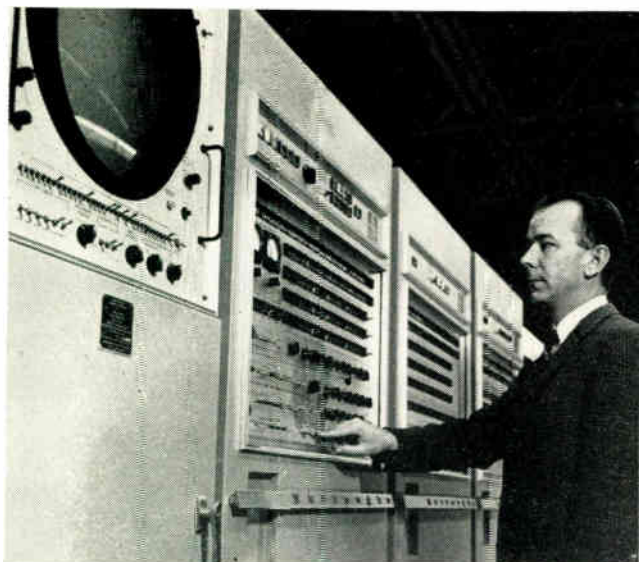
GROWING CRYSTALS

Single crystal of calcium fluoride is drawn from a "melt" contained in ADL Model-MP Crystal Growing Furnace made by Div. 500 of Arthur D. Little, Inc., Cambridge, Mass.



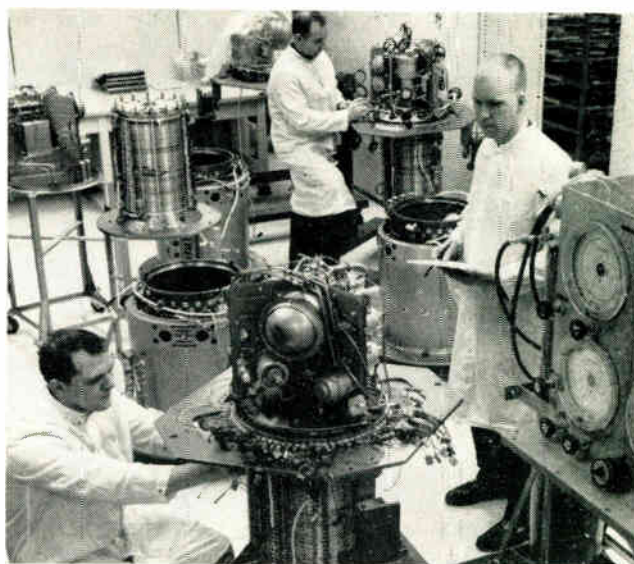
"TALKING TYPEWRITER"

Six-year-old Billy Moore listens to words that are spelled and pronounced by a learning machine developed at Westinghouse Research Laboratories. Named SLATE (Stimulated Learning by Automated Typewriter Environment), it is a streamlined version of a "talking typewriter"—a device which has demonstrated an ability to teach children to read and write.



AIRCRAFT CONTROL

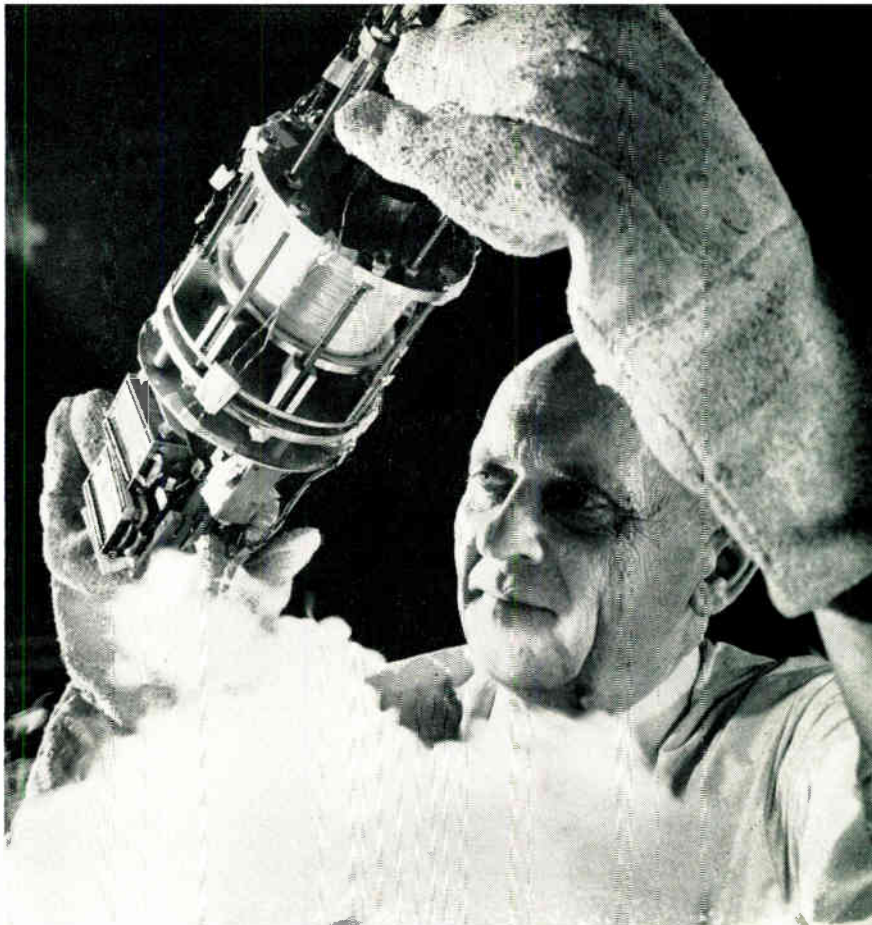
Engineer at Burroughs Corp., Paoli, Pa., conducts tests on radar video data processor for the FAA's National Aviation Facilities Experimental Center near Atlantic City, N. J. Units will enable air traffic controllers to have a clear radar picture of the position, altitude and identity of all aircraft under their control.



FUEL CELL POWER

Fuel cell powerplants being developed for Apollo lunar mission are shown in various stages of assembly at one of Pratt & Whitney Aircraft's East Hartford, Conn., facilities. These powerplants will provide on-board electricity for command and service modules. Their by-product is drinkable water to be used by the astronauts.

**The Changing
STATE-OF-THE-ART
in the electronic industries**



SUPERCONDUCTING COIL

Dr. Theodor Buchhold, Senior Engineer at G. E.'s Laboratory in Schenectady, N. Y., raises electric flux pump and superconducting magnetic coil from container of liquid helium. Flux pump has no moving parts and can convert a small input of ac into a large output of dc at temperatures near absolute zero. It has overcome a major obstacle to the construction of "super magnets" with fields of a hundred thousand gauss and above.



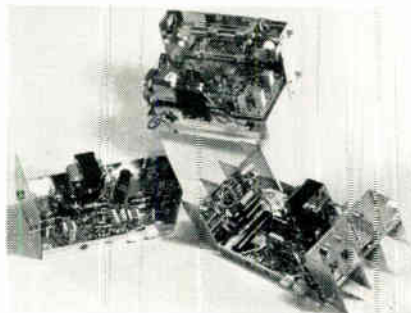
COMMUNICATIONS SYSTEM

V. Rodek of Stromberg-Carlson, a division of General Dynamics, Rochester, N. Y., inserts card in 711 multiplex equipment to be used as part of communications system for the five state Colorado River Storage Project.



MISSION CONTROL

Technicians check out consoles in mission control area of NASA's Space Flight Operations Facility at Caltech JPL in Pasadena, Calif. SFOF can control two simultaneous unmanned spacecraft missions. A third mission can be monitored at the same time. Facility uses almost noiseless electronic printers developed by General Dynamics Electronics, San Diego, Calif., to help create more efficient working conditions for scientists and engineers.



SOLID STATE PHONOGRAPHS

An increasing number of phono amplifier manufacturers are introducing "solid state" in FM/AM radio tuners and amplifiers. This is illustrated by the above—two amplifiers and a tuner from 1965 RCA phono line.

With either of two new Sel-Rex processes
you can plate **this many parts**



with just as much gold as you've been
using for **this many**



and still plate **to the same thickness.**

Interested?

Now, two new Sel-Rex processes permit you to plate electronic parts with an alloy containing 75-85% gold. The result: coverage per gram of gold is increased by as much as 66% over ordinary processes. Yet both of the new processes maintain gold's important characteristics for many applications and even increase them for others. Both can replace the conventional hot cyanide processes now being used for many manufacturing needs. This means money saved. But that's not all.

Autronex® W, an acid process, produces a bright, extremely hard plate with excellent solderability and

superior resistance to galling, corrosion and etching materials. Its hardness value extends to 450 Knoop.

The new alkaline process, **Alautronex™ 18**, has a high deposition rate of 100 mg. per ampere minute. It provides a bright plate with more than twice the hardness of conventional hot cyanide gold deposits, yet it has comparably low contact resistivity.

Find out today how you might lower your plating costs. For more information, or to learn how you may have samples of your product plated for evaluation, write:

SEL-REX CORPORATION, Dept. EI-7, Nutley, New Jersey 07110

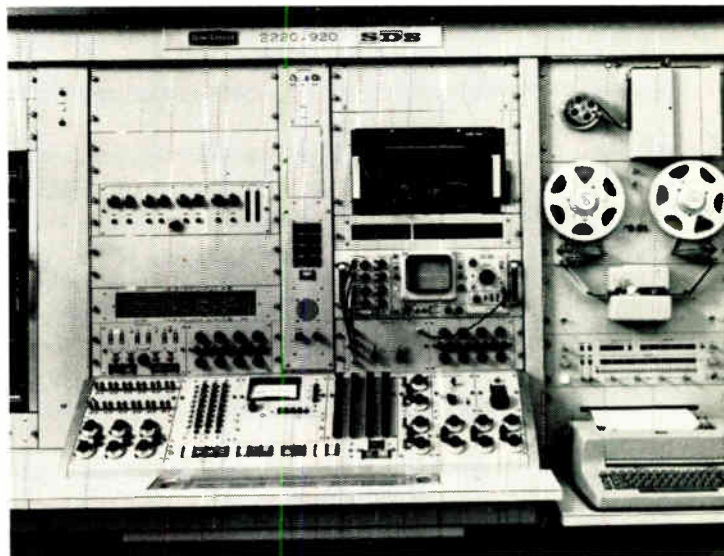


ANALOG/DIGITAL COMPUTER

THE FIRST COMMERCIAL SOLID-STATE COMPUTER to combine standard analog and digital techniques into a single unit is represented by the Beckman/SDS Integrated Computer System. Developed by Beckman Instruments, Inc., and Scientific Data Systems, Inc., the computer can solve separately and in combination the advanced analog and digital problems formerly requiring 2 computers.

The system is offered in a series of 8 standard models, using one of 2 Beckman analog computers and any of 4 SDS digital computers.

The computer will enable scientists and engineers to solve a growing class of design and simulation problems beyond the scope of conventional separate analog and digital equipment. It is particularly suited to real-time problem solving and simulation in major aerospace and industrial process control uses.



Digital function emphasizes accuracy, storage, arithmetic and control capabilities. Analog function emphasizes parallel operation speed and modeling and parameter variation.

SILICON CONTROLLED SWITCHES

DEVELOPMENT OF A NEW FAMILY OF 4-LEAD, integrated circuit silicon controlled switches (SCS's) which are voltage-transient-proof, has been announced by General Electric Co., Semiconductor Products Dept., Syracuse, N. Y.

The additional lead gives the SCS a built-in immunity to voltage transients because it increases the dv/dt —the ability to withstand high rates of rise of forward blocking voltage. The device is capable of withstanding dv/dt of more than 1 million $v./\mu\text{sec}$.

The extra lead also adds design flexibility. Each of the leads is connected to a separate semiconductor layer. In effect, the new SCS becomes an integrated circuit consisting of a complementary pnp and npn transistor in a positive feedback arrangement. It also behaves much like a silicon controlled rectifier.

The new device functions as a latching-type digital switch for both ac and dc uses up to 100v. and 200ma.

The new SCS's are highly reliable because all 4 layers are completely oxide passivated. Another major feature is their high sensitivity—e.g., types 3N81 and 3N82 have a gate trigger current rating of μa .

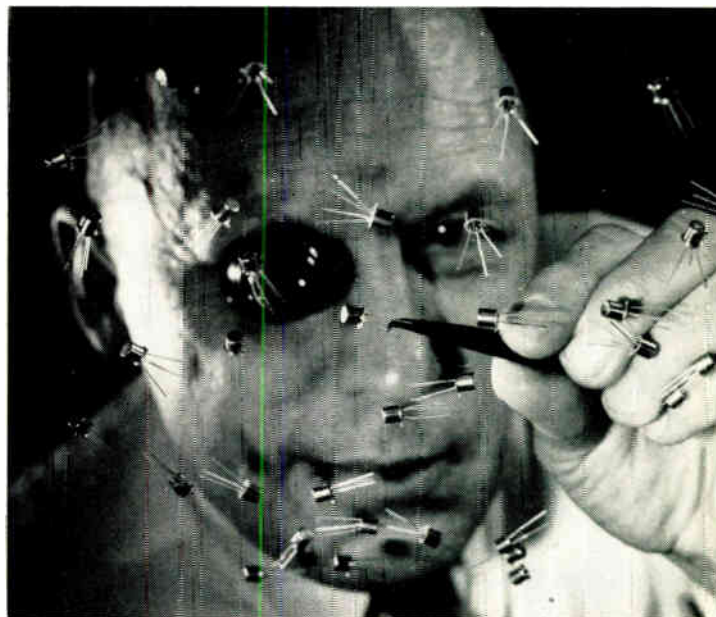
The SCS's are designed to be used as Alpha and numeric display drivers for gas tubes, neon tubes and incandescent lamps. As drivers for a broad variety of relays and solenoids, they offer an inexpensive way to latch, higher sensitivity and a greater variety of uses. Separate control over both center junctions of these 4-level pnpn devices permits such

flexibility as eliminating the turn-on caused by rate effects inherent in other semiconductor switches.

Other uses include low-speed logic, delays, gates, counters, machine-tool controls, process controls, computers, calculators, test equipment, low-level SCR and complementary SCR circuits.

The type 3N81 and 3N82 are designed to be used in temperatures from -65° to $+150^{\circ}\text{C}$. JEDEC-registered types from 3N81-3N86 are available.

New family of four-lead silicon controlled switches (SCS's) are highly resistant to voltage transients. Switch can withstand dv/dt of more than one million volts per microsecond.



INTEGRATING ELECTRONIC SCIENCE

WITH THE HEALING ARTS

Research labs are turning out many prototypes of medical instruments and systems but few are finding acceptance in the presently limited bio-medical market. Many die either on the lab bench or in hospitals where they are tested. Reason? Mostly lack of understanding, little medical/engineering inter-education, and rising medical costs.

By **SIDNEY FELDMAN**
Associate Editor
ELECTRONIC INDUSTRIES

VAST POTENTIAL, GRADUAL ACHIEVEMENT, SLOW GROWTH sum up bio-medical electronic activities in the U. S. thus far.

Yet, there is a tremendous built-in market of some 191,800,000 Americans who need medical and health services. There is a great and growing urgency to serve the sick, the diseased, and the injured. This urgency is the same for the handicapped lame, blind, deaf or speechless, and the increasing numbers of ailing elderly as well as the newly born.

By 1980 we may tally a national census of 245,000,000 citizens needing still more care or correction of mental and/or physical ills, as well as periodic diagnostic and preventive check-ups. Meanwhile, the cost of bio-medical-mental-dental-health care keeps rising, along with higher population, higher hospital costs, and rising use of instrumentation.

Before this "bio-medical electronic market" can be determined, it first must be defined. Despite its seemingly spanking newness, modern electrical-electronic activities started in 1895 when the German physicist Wilhelm Conrad Roentgen (Röntgen) accidentally discovered X-rays. Such developments now are racing ahead with the upcoming Gemini space flight when physiological conditions of twin astronauts will be telemetered electronically to earth.

Organized, yet hesitant markets for bio-medical electronic equipment and systems generally comprise about 7,000 hospitals, some 160,000 private practicing physicians and 83,000 dentists, about 6,500 bio-medical research laboratories, and, ultimately, more than 50,000,000 U. S. families. Exports offer additional world markets.

Longest Are Biggest

The longest-established markets are still the biggest: X-rays, hearing aids, diathermy and ultrasonic devices, generally. The next market represents equip-

ments, chiefly electrocardiographs (EKG's) and electroencephalographs (EEG's). The newest market represents an array of individual instruments and complex scientific instruments. These range all the way from custom aerospace research, telemetering and monitoring systems to the use of electronic computers to help analyze various diseases as well as perinatal events.

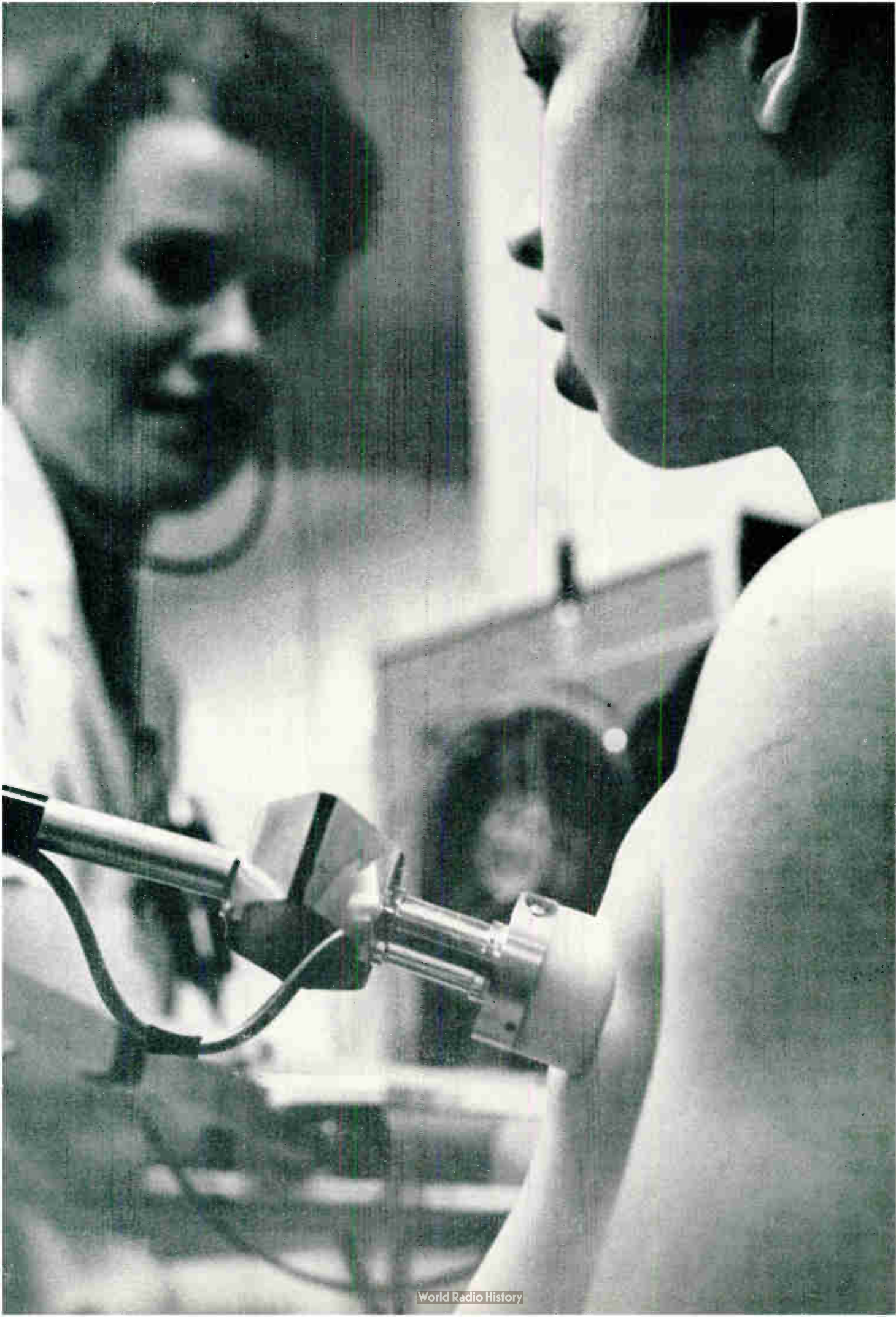
Basically, the life sciences concern birth, health and activities of men as individuals and in society. Man is particularly vulnerable at birth and during old age. These electronic equipments and systems help serve the sick and aid their healers:

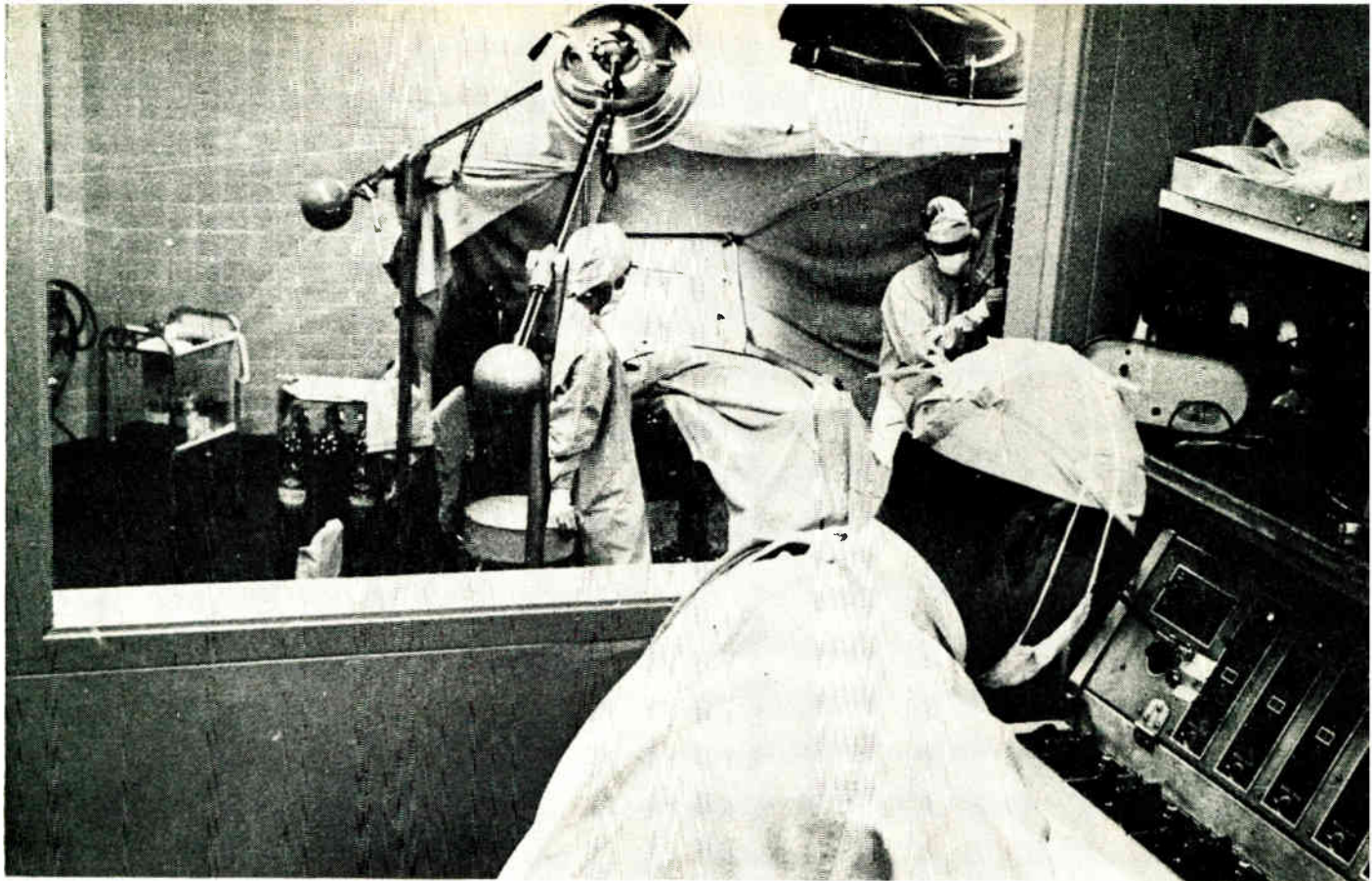
a) *Diagnostic*: to examine the nature and circumstances of illness and disease. Equipment here ranges from X-rays to infrared devices to EKG's which record heart activity, to EEG's which objectively present the brain's general functioning. Endoscopic instruments, to peer into body cavities and openings, include broadcasting FM radio pellets swallowed by patients. The relatively new fiber optic devices are used in conjunction with electronic instrumentation. An electronic stethoscope was patented recently.

b) *Treatment*: to relieve or to cure. Varied equipments here include short wave to ultrasonic diathermy units that produce high current heat in body tissues for thermotherapy. X-rays may be used here. Newest device is an electronic sleep-inducer.

c) *Surgery*: to operate to treat an ailment or disease. Various electronic instruments are used to monitor the patient's heart, respiratory and other bodily functions during an operation. Latest development is use of laser rays for eye, brain, cancer and other surgery. (Continued on page 30)

In tape recording heart beats of 50,000 Chicago children, researchers of Children's Memorial Hospital and Chicago Heart Association hope to pick out defective hearts by electronic means. Detection will be based on bad hearts' richer grouping of high frequencies.





MEDICAL ELECTRONICS (Continued)

d) *Prasthetics*: to use an artificial electronic part to aid body functions. Hearing aids are most common. Newest and most controversial is the electronic heart pacer which stimulates a faltering heart to maintain proper beats in an emergency. Other electronic devices help the blind to "see," the crippled to walk, and some speechless to talk.

Overlooked Market

A big, broad, commonplace electronic market is often overlooked. It concerns well-established electronic products which have found additional uses in hospitals, laboratories and offices of doctors, dentists and psychiatrists. Such items range from radio and TV sets listened to by patients all the way to high fidelity music used in therapy. The rest of this quasi-bio-medical market includes: electronic tape recorders; inter-communications and two-way radio systems; closed circuit TV; electronic facsimile; even office dictation machines and computers for hospital payrolls and billing. There are also special radio-TV broadcasts for medical personnel, specially transcribed records and tapes to keep doctors abreast of medical developments, and countless variations on these themes.

Another broad activity here involves ecology, concerning man and other organisms in relation to their environment. Electronic instruments are used to monitor radiation, pollutants, and pesticides in the air we breathe, the water we drink, and the food we

eat. Experiments even seek to substitute ultrasonics for insecticides. Electro-acoustic devices also are used to monitor "invisible pollution," meaning noises harmful to people at work, at home or at play.

Bionics represents another aspect of the broad, yet interdisciplinary panorama of life activities. Man here seeks to understand and translate life processes into mathematical terms to be duplicated or simulated with systems involving electronic and other equipments. This field relates to bio-cybernetics, involving control and communication methods common to living organisms and machines.

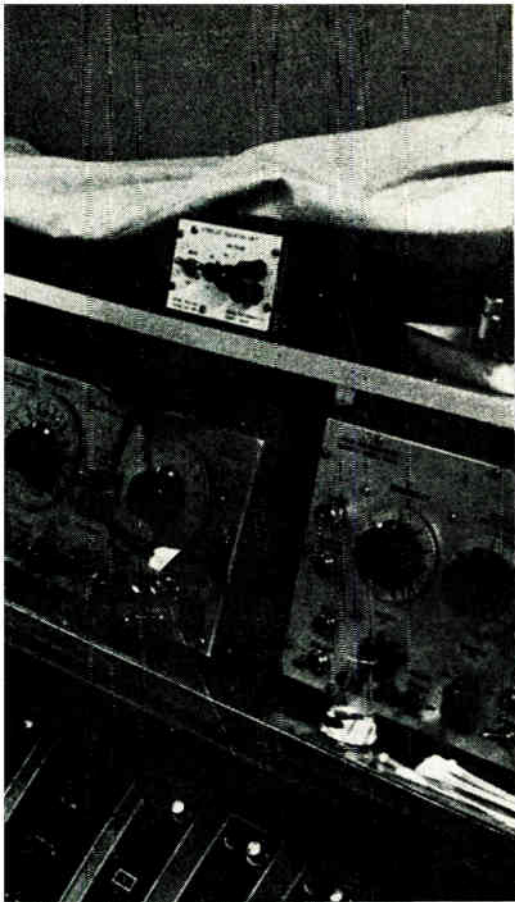
Activity here also concerns the man-machine relationship. Another aspect is bio-electricity which uses tiny electric currents, such as brain and heart waves, to help monitor and maintain life. Underlying these fields is the relationship and balance between body and mind of man as a thinking and talking social animal.

Interdisciplinary activities involve programs, projects and experiments in schools, laboratories, hospitals, government and industry laboratories. Here is one network of such inter-related activities.

Electrocardiograms are made on an electrocardiograph which records weak electrical impulses made by a beating heart. A transmitter converts heart impulses into audible FM signals, broadcast by telephone over wire and/or microwaves. A receiver reconverts FM signals into electrical impulses fed to an electrocardiograph.

1st EKG Auto-System

Next, the Public Health Service Heart Disease Control program showed the first fully automated



Technique developed at Northwestern University aids in brain operation to alleviate Parkinson's disease. Tiny accelerometer on patient's finger permits surgeons to tell Parkinsonism tremor from the normal, and so operate more precisely. Physician at console monitors tremor traces.

from the electron microscope that opens hitherto unseen new worlds all the way to an electronic device that counts red and white blood cells. Ultrasonic machines do cleaning. Microwave linear accelerators electronically sterilize surgical sutures and other bio-medical items.

True Extent Unknown

Despite the complex bio-electronic equipment and systems that have been developed, it is most difficult to determine the true extent of these markets. One estimate suggests that about \$150 million for bio-medical apparatus is annually spent thus: \$65 million by large hospitals, mainly; \$45 million by research laboratories, and \$40 million by medical specialists. In turn, such apparatus was used: 60% for research, 25% for diagnosis, 15% for treatment.

Another marketing school of thought suggests the market chiefly comprises \$100 to \$150 million for well-established electronic items, such as X-ray, hearing aids, ultrasonic and diathermy machines, EKG and EEG instruments. More precisely, major producers did sell about \$100 millions worth of X-ray gear in 1963. Closer analysis shows about \$78 million worth of medical X-ray equipment, about \$4 million worth of industrial equipment (chiefly for

(Continued on page 36)

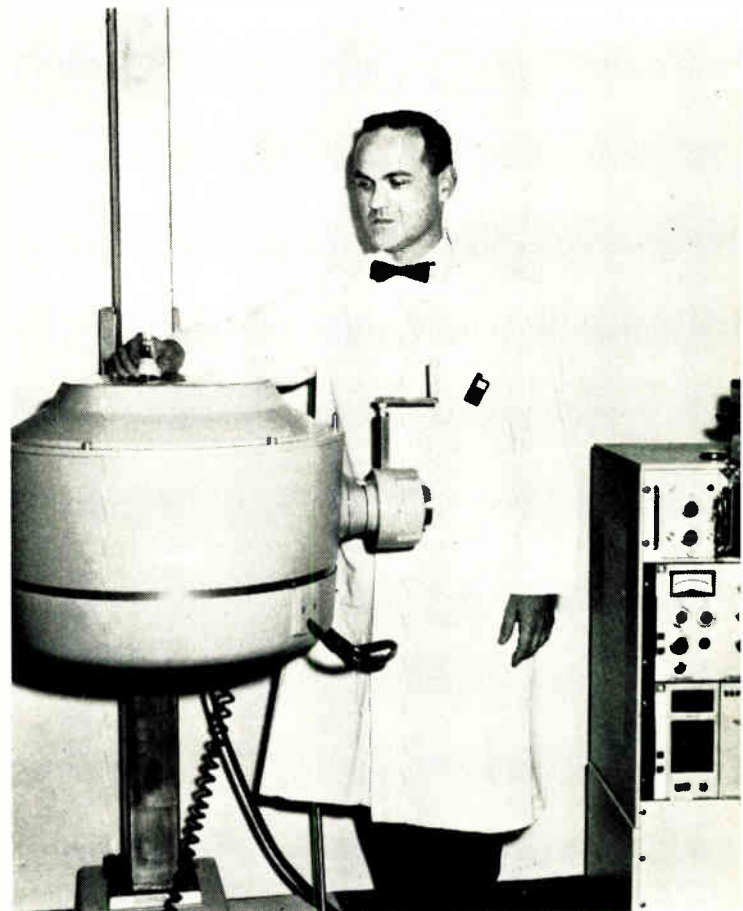
system to analyze electrocardiograms. Electrocardiographic signals were relayed from Cleveland by telephone to be processed and analyzed in Washington, D. C. The electrocardiographic signals, in turn, were converted to numbers and fed into a computer memory which is accumulating a library of many thousands of EKG's.

More recently, the Veterans Administration showed how a computer with a massive electrocardiographic memory could be tapped by hospitals, or by physicians at remote telephones. One test required 7.2 minutes from the patient's arrival in the EKG room in a Massachusetts V.A. hospital to receive an analysis from the computer memory at the National Bureau of Standards in Washington, D. C.

This central computer stores electrocardiograms of several thousand healthy and abnormal heart patients. Among other goals, medical men seek to learn more about the meaning of heart signals, how to determine normal heart activity at various ages, and how to diagnose heart ailments. Now "heartprints," to help diagnose a heart's health, are being recorded experimentally at Bell Telephone Laboratories.

Electronic items also are sold to analytical, test and research laboratories of hospitals, clinics, pharmaceutical houses, chemical plants, universities, among others. Radioactive and stable isotopes, with appropriate electronic safety and control equipment, are used in bio-medical activities. One test system uses compounds with radioisotope traces monitored by a Geiger counter tube, with mobile readout and data recording equipment.

Other functions performed electronically range



Physician at VA Research Hospital in Chicago displays one of only four existing scintillation cameras to detect tumors and visualize internal organs. Device uses Polaroid film to produce photos of internal abnormalities once unobtainable.

bulletin

MAGNETICS inc.

How Cold Water Solves a Hot Core Problem

Problem: Cores of high powered pulse transformers, such as those used in radar equipment, generate a tremendous amount of heat. High operating frequencies cause high core loss since the heat cannot be transferred through the windings without damaging both windings and core. This restricts the use of high permeability materials using standard constructions.

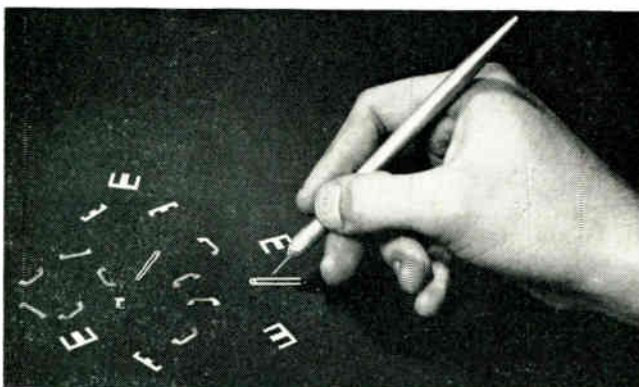
Solution: Magnetics developed a unique encased core within a case that allows water to circulate around—but not through a core of $\frac{1}{2}$ mil material. Constant core temperature is maintained with very little shift in the core's magnetic properties. Do you have similar problems of overheating cores? We would like to help.



Core assembly with water cooling jacket.

Photoetching of Intricate Parts Reduces Prototype Costs

Quite often we photoetch small shapes in prototype quantities, then tool for punching when they reach the production stage. Saves not only money but valuable time. Magnetics Inc. can photoetch precision flat components from almost any magnetic or specialty alloy used in the electronics industry. This process is especially effective when difficult configurations are needed in thicknesses less than .001". Materials ranging from .020" to .00025" can be processed and tolerances held from .005" to .0005". Should you require precision flat components, Magnetics can help.



A variety of precision flat components photoetched from strip less than .001" thick. Tolerances can be held to .0005".

New Two-Material Cores Extended Linear Operating Range of Transformers

How do you extend the linear operating range of a transformer—especially a current transformer—and still hold down its cost and size?

By making cores from combinations of materials—such as Permalloy 80 and Alloy 48, or Permalloy 80 and Magnesil—Magnetics Inc. extended the linear operating range. Fig. A shows this type construction. By using different constructions, unique characteristics can be developed due to the multiple saturation points in a single core. Fig. B shows a core which would saturate at different input levels giving unique output characteristics. If you need a combination core, Magnetics can help.



Fig. A



Fig. B

"Race Track" Core Becomes a Winner

A manufacturer of transformers needed cores with exceptionally precise high voltage windings. Conventional windings on toroidal cores would not withstand the high voltages without breakdown between turns. Standard laminations would not provide high permeability, low core loss at high frequencies, or low leakage flux which could be obtained from a toroidal structure. Magnetics Inc. solved this problem by designing a rectangular "race track" core. This special shape provided a uniform flat surface area on which high voltage windings could be applied, provided high permeability at high frequencies with low core loss, and prevented leakage flux. If you have a similar problem, Magnetics can help.



Rectangular core provided flat surface area needed for high voltage transformer coil.

Need More Versatile Magnetic Components?

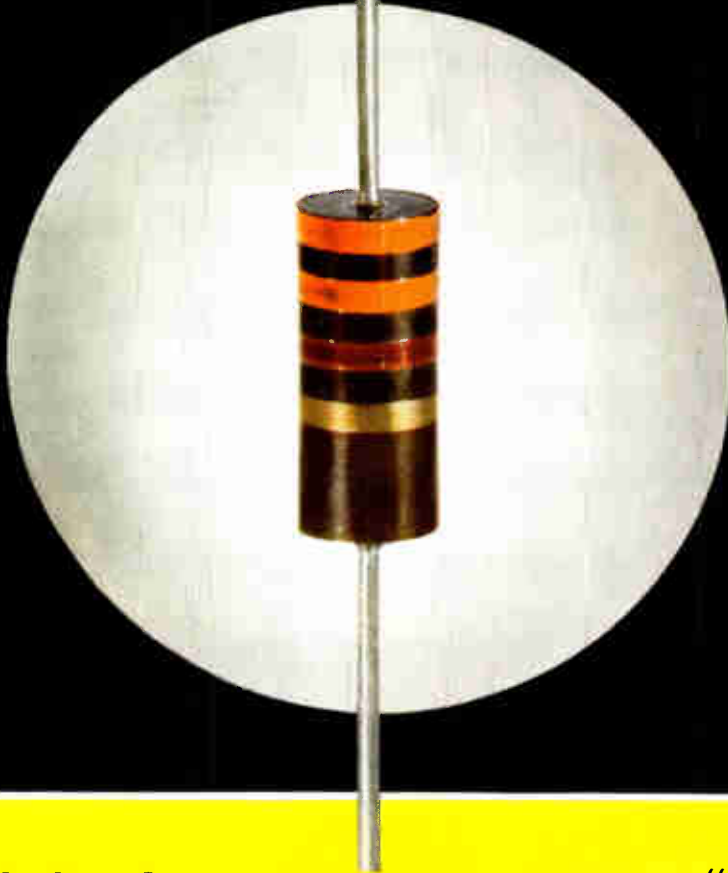
When your products won't operate with standard magnetic components, you need the help of a specialist. Magnetics Inc. will manufacture unusual components by strip winding, photoetching, punching, and hydrostatic pressing of intricate shapes . . . and we make our own materials which are quality checked at every stage.

You specify the size, shape, temperature values, cases, materials, windings and other characteristics . . . we'll do the rest and give you the part you need to put your product on the market.

Tell us what you require by writing Dept. EI-4, Magnetics Inc., Butler, Pennsylvania.

**failure-free
performance**

*over 10 billion Allen-Bradley
hot molded resistors in service,
and—this number is growing
daily by leaps and bounds!*



Can you think of any better proof of "reliability"?

■ No laboratory test program could possibly approach—either in quantity or duration—this field performance record of Allen-Bradley hot molded resistors. The more than 10 billion A-B resistors now in service are an established measure of their dependability.

The fundamental reason for this truly remarkable performance is to be found in the unique hot molding process—developed and used exclusively by Allen-Bradley. Being machine controlled, the remarkable uniformity is maintained from resistor to resistor—year in and year out—so that long term performance can be accurately predicted. In addition, the conservative ratings and stable properties of the material used guarantee superior performance wherever circuitry is critical.

By using Allen-Bradley hot molded resistors, the manufacturer automatically puts the stamp of "quality" on his product. So "standardize" on Allen-Bradley hot molded resistors—it's a decision you'll never have reason to regret. For more detailed information on these and other Allen-Bradley quality electronic components, please write for Publication 6024: Allen-Bradley Co., 222 W. Greenfield Avenue, Milwaukee, Wisconsin 53204. In Canada: Allen-Bradley Canada Ltd., Galt, Ontario.

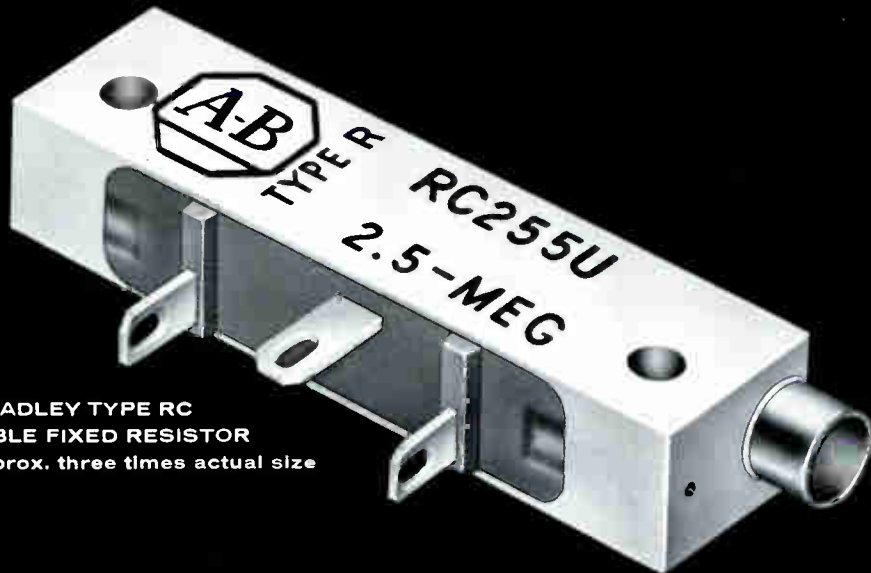


HOT MOLDED FIXED RESISTORS available in all standard EIA and MIL-R-11 resistance values and tolerances, plus values above and below standard limits.

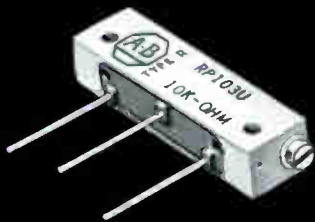


ALLEN-BRADLEY
QUALITY ELECTRONIC COMPONENTS

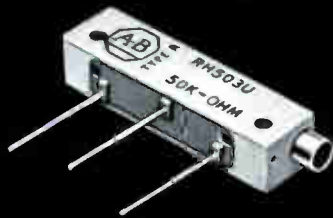
Allen-Bradley hot molding gives precise, stable control in severe environments



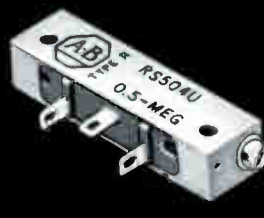
ALLEN-BRADLEY TYPE RC
ADJUSTABLE FIXED RESISTOR
Shown Approx. three times actual size



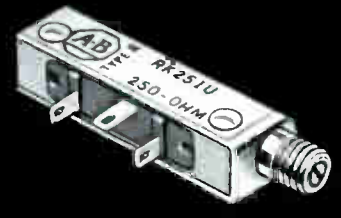
TYPE RP



TYPE RH



TYPE RS



TYPE RK

■ You can be certain of "Quality" in performance when you use Allen-Bradley hot molded, adjustable resistors. Their solid resistance and collector tracks—made by A-B's exclusive hot molding process—provide such smooth control that it approaches infinite resolution. The discrete steps from turn to turn of wire-wound units, as well as transients during operation are eliminated. Settings remain fixed under severe shock and vibration. You'll find Type R controls ideal for use at high frequencies—where conventional wire-wound controls are entirely unsatisfactory—they have low distributed capacity and are relatively noninductive. The molded enclosure of the Type R unit is both dustproof and watertight, permitting encapsulation.

Allen-Bradley Type R resistors are suitable for use from -55°C to $+125^{\circ}\text{C}$ and are rated $\frac{1}{4}$ watt at 70°C , 300 volts max. RMS. Available in total resistance values from 100 ohms to 2.5 megohms with tolerances of $\pm 10\%$ or $\pm 20\%$. For more complete details on the Type R control, please send for Technical Bulletin B5205: Allen-Bradley Co., 222 West Greenfield Avenue, Milwaukee, Wisconsin 53204.

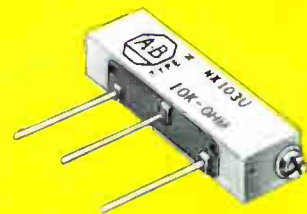
In Canada: Allen-Bradley Canada Ltd., Galt, Ontario.

NEW TYPE N HOT MOLDED PERFORMANCE FOR LESS CRITICAL ENVIRONMENTS

Here's an addition to the Allen-Bradley line of quality adjustable fixed resistors. It features the same solid hot molded resistance and collector tracks . . . the same stepless adjustment . . . stability . . . and high frequency characteristics.

The molded enclosure is splashproof and dust-tight, and using proper measures, it can be encapsulated. The adjusting screw has a handy new cross slot. It accepts conventional flat blade or Phillips type screwdriver which eliminates screwdriver dropout during adjustment.

The new Type N control is rated $\frac{1}{3}$ watt at 50°C , 300 volts max., and derates to zero power at 100°C . Available in total resistance values from 100 ohms to 2.5 megohms. Please write for complete specifications.



ALLEN-BRADLEY

QUALITY ELECTRONIC COMPONENTS

World Radio History

Ohmite Pee-Wee Rheostats solve knotty problems



MODEL C
7½ Watts
(0.515" dia.)

MODEL E
12½ Watts
(0.875" dia.)

both are wire-wound...ceramic and metal construction

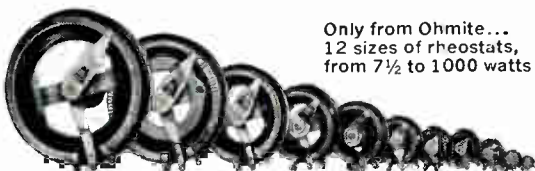
■ Here's the answer to such puzzlers as how to boost power levels without increasing equipment size . . . what to use when temperatures will run high . . . how to miniaturize without sacrificing reliability . . . and what to substitute for low-temperature, low-power pots in high ambients.

Both the Model C and Model E retain the same principles of rheostat construction that have proved so reliable in Ohmite's 10 larger sizes. They dissipate their full ratings of 7½ and 12½ watts respectively at 40°C ambient on a metal panel, and operate to 340°C maximum hotspot temperature *without charring, shrinkage, or deterioration.*

Stocked for Fast Delivery

Model C (7½ watts) is stocked in 18 resistance values from 10 to 5000 ohms as an enclosed model with either a standard or locking shaft. Three-pin transistor sockets can be supplied for plug-in mounting.

Model E (12½ watts) is stocked in 31 resistance values from 1 to 15,000 ohms as open models or in metal enclosures. Tandem assemblies, special shafts, and other variations can be engineered for you. *Write for Bulletins 201 and 203.*



Only from Ohmite...
12 sizes of rheostats,
from 7½ to 1000 watts



OHMITE

MANUFACTURING COMPANY
3662 Howard Street, Skokie, Illinois 60076
Phone (312) ORchard 5-2600

RHEOSTATS • POWER RESISTORS • PRECISION RESISTORS • VARIABLE TRANSFORMERS • TANTALUM CAPACITORS • TAP SWITCHES • RELAYS • R.F. CHOKES • SEMICONDUCTOR DIODES

ELECTRONIC INDUSTRIES • July 1964

Circle 20 on Inquiry Card

35

← Circle 19 on Inquiry Card

MEDICAL ELECTRONICS (Continued)

non-destructive testing) and about \$18 million worth of accessories and spare parts.

Perhaps another \$50 million or more is spent annually for hearing aids, and acoustic test equipment. The most easily accountable items are several electron microscopes averaging about \$35,000 each. Most difficult to count are the many oscilloscopes bought by bio-medical electronic equipment users.

Until bio-medical electronic components, equipment or systems are sold to a sufficiently broad market, they remain costly curiosities. Many die aborting as prototypes. They suffer from having been conceived in electronic plants, but with little or no consideration of the marketplace.

Successful marketing in the bio-medical field involves: 1) A design, based upon proper interdisciplinary understanding of needs between bio-medical people and electronic engineers; 2) A feasible, useful, highly reliable product that helps promote life and limb; 3) Thorough field-testing in clinics, hospitals and/or doctors' or dentists' offices; 4) Test and verification by public health, safety, welfare and/or other state and/or federal agencies including the Food and Drug Administration and Federal Trade Commission; 5) A sufficiently broad market, properly served by distributor, sales representatives and maintenance organizations; 6) A market to begin with.

Distribution a Weak Link

Distribution remains a weak link in marketing bio-medical electronic products. The Birtcher Corp. of Los Angeles, which calls itself the "world's largest volume producer of electro-medical-surgical devices," has direct sales facilities on the West Coast, in Boston and Chicago, including a wholesale distributor in sales and service for New York and New Jersey.

Trends to direct distribution are strengthened because: 1) Intimate product knowledge is vital; 2) Electronically-trained and knowledgeable sales reps are rare, or 3) Reps or hospital-medical-dental supply houses may be cluttered with hundreds to thousands of non-technical items, ranging from bandages to braces. Further, repair and service are essential because of the nature of bio-medical products which must be kept in good working order.

Competition is already tough from specialist companies. The X-ray business is chiefly in the hands of GE, Westinghouse and Picker. GE and Westinghouse also sell lines of other hospital and bio-medical electronic products. Among other giants in this relatively small market are Beckman Instruments and Sanborn, an acquired subsidiary of Hewlett-Packard.

Minor competition comes from foreign firms, especially the Japanese and English, plus the Swedish and Danish, Philips of Eindhoven (Holland) and Siemens & Halske of West Germany. Siemens pioneered in X-rays with Dr. Roentgen and today offers a broad line of X-ray, radiation measuring, high frequency thermotherapy, electrosurgery, hearing

Public and Private Expenditures for Health in the U.S.			
Sources: U.S. Department of Health, Education and Welfare National Industrial Conference Board			
	(Estimates in Millions)		
Program or Activity	1953	1963	
PUBLIC EXPENDITURES:			
Civilian medical-hospital care	\$1,345	\$2,730	
Defense Dept. and Medicare	610	790	
Veterans' hospital-medical care	647	1,021	
Public Assistance (incl. aged)	154	1,036	
Work compensation and temporary disability insurance	270	495	
Medical vocational rehabilitation	9	26	
Maternal, child health services	40	179	
School health	50	122	
Medical research	88	938	
Other public health services	322	495	
Health and medical services	\$3,535	\$7,832	
Veterans Adm. and Defense Dept.	90	124	
Other	455	525	
Medical-facilities construction	545	649	
Total	\$4,080	\$8,481	
PRIVATE EXPENDITURES:			
Direct payments	\$8,385	\$15,285	
Insurance benefits	1,762	6,950	
Expenses for prepayment	438	1,180	
Industry in-plant services	185	295	
Philanthropy	500	790	
Health and medical services	\$11,270	\$24,500	
Medical-facilities construction	280	800	
Total	\$11,550	\$25,300	
TOTALS—Public and Private Expenditures	\$15,630	\$33,781	

NOTE: Distribution of medical expenditures in 1961: Here's where the dollars went: 27.6% for hospital care; 27.6% for physician's services; 9.8% for dentist's services; 19.0% for drugs and drug sundries; 5.9% for eyeglasses and appliances; 1.4% for nursing-home care; 4.6% for net cost of health insurance; 4.0% for other professional services.

aids and dental equipment through its Siemed Incorporated and other representatives in the U. S.

Foreign technology also is imported. The "Electro-Sleep" electronic sleep-inducer, developed in the U.S.S.R., was brought into the U. S. by National Patent Development Corp. A Japanese firm adapted this Russian idea into a "Good-Sleep" machine. While this suitcase-size sleep device gathered dust in NPD's offices in New York City, medical men in a Brooklyn hospital spent \$28,000 to have an electronic firm translate Russian specifications into a wall-size sleep device. The original Electro-Sleep inducer has since been transistorized into a small

"gray box" being tested in several hospitals.

May be Licensed in U. S.

If this device passes hospital tests, it may be licensed to a U. S. electronic manufacturer. Present plans consider selling Electro-Sleep inducers to hospitals, for under \$100 each, through hospital supply distributors. If the device is accepted generally, it may be sold to insomniacs and others by a physician's prescription at local drugstores—preferably instead of barbiturates or tranquilizers. This electronic device would compete directly with drugs. Electro-Sleep is said to be as effective as phenobarbital, without any side effects.

INTERDISCIPLINARY NATURE OF BIO-MEDICAL ELECTRONICS

BIO - MEDICAL ELECTRONIC discipline problems must be understood before they can be resolved into useful equipment and systems.

"The more expert a scientist is, the less transferable he is to a different discipline," observes John R. Moore, president, Autonetics Division, North American Aviation, Inc.

Accordingly, bio-medical specialists had to learn to communicate with engineers. Mathematics, for example, facilitates communication between disciplines. It also enables computers to be programmed for bio-medical work.

Some years ago the New England Institute for Medical Research pioneered in studying fundamental research in medicine. It was staffed with nuclear, theoretical and solid-state physicists as well as medical specialists.

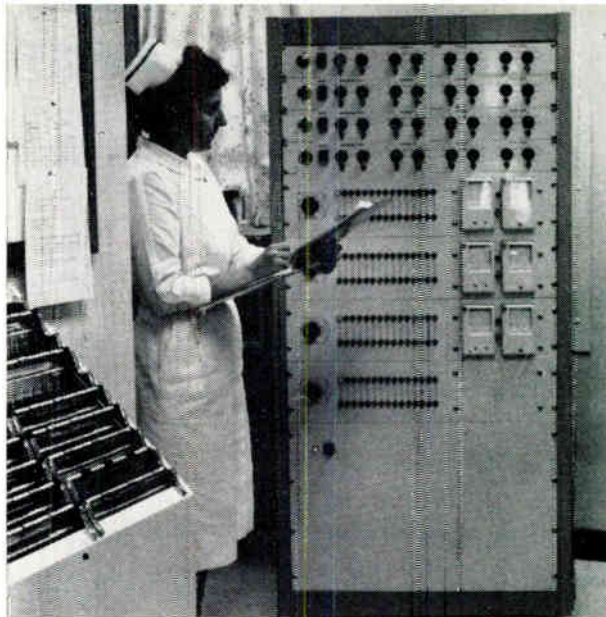
"These men do not simply work together," wrote Dr. John H. Heller, the Institute's executive director. "For when an engineer works with a physician without an understanding of medicine, he becomes merely a technician. It is incumbent upon all of us to learn the other's discipline."

In an interdisciplinary environment "the physician will understand principles and uses of nuclear magnetic resonance, and the physicist will understand the problems of peptic ulcers."

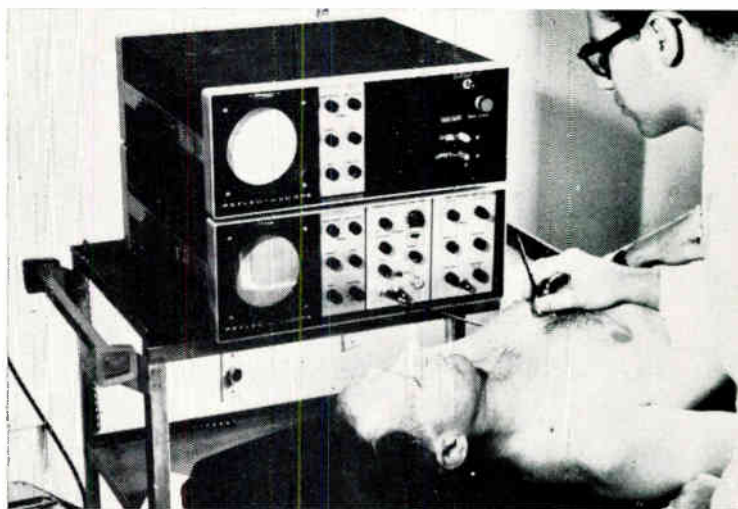
A living example of an interdisciplinary hybrid man is Major Jack Steele, U. S. Air Force, who apparently initiated military "bionics." He quit engineering to get a medical degree, became a psychiatrist, then a flight surgeon. To duplicate a brain-like device, he studied the nervous and information processing systems in animals.

(Moreover, NASA may adapt Electro-Sleep to help put astronauts to sleep during space flights. Possibly such a machine may have been used by Russian cosmonauts in aerospace.)

Even after overcoming basic marketing hurdles, a small firm or division of a big firm just entering the bio-medical electronic field has other problems. It requires good management and adequate finances to buy experience and educate the bio-medical professions. Such a firm also must survive the double jeopardy of: a) Learning to develop a new product in a relatively new field, and b) Learning how to serve a newly-developing market. (Continued)



Executone - Gulton Physiological Monitor provides readings of all measurements of patient's body functions, and warns medical staff of emergency conditions. Central console is located in nurse control area. If readings go beyond allowable medical limit, an audible alarm and red signal are activated. Readings are recorded.



Monitoring device, Viso-Scope by Sanborn Co., records patient's venous pressure, arterial pressure and electro-cardiogram during heart surgery at Lankenau Hospital, Philadelphia. Similar devices monitor blood pressure, esophageal and rectal temperatures, and temperature of blood in the heart-lung machine used in operation.

Echo-cardiograph developed by Sperry Products, division of Automation Industries, uses ultrasonic beam to monitor motion of body organs, including the heart. Standard EKG device measures electric impulses. Echo-cardiograph transmits sound waves reflected as echos on oscilloscope. Device is useful in evaluating need for surgery.



MEDICAL ELECTRONICS (Concluded)

A major factor in the bio-medical environment is the U. S. Public Health Service. It seeks to protect and improve the health of U. S. citizen-taxpayers and collaborates with foreign governments and international groups such as the World Health Organization. Individual electronic market interests must be sorted out of the Service: Office of the Surgeon General, Bureau of Medical Services, Bureau of State Services, National Library of Medicine, and particularly the National Institutes of Health. (NIH).

NIH works to extend basic knowledge about health problems of man and how to cope with them. Electronic technologies are being furthered by NIH as a whole and by each of its seven Institutes: Cancer, Heart, Allergy and Infectious Diseases, Arthritis and Metabolic Diseases, Dental Research, Mental Health, and Neurological Diseases and Blindness.

Traditionally, the basic source of health and medical care and research has been the military. Even the U. S. Public Health Service originated in an act of 1798 authorizing marine hospitals to care for merchant seamen. The U. S. Armed Forces also are major factors in bio-medical activities. Army, Navy and Air Force studies include obstetrics, battlefield surgery, life in underwater compartments, and aviation and aerospace life researches.

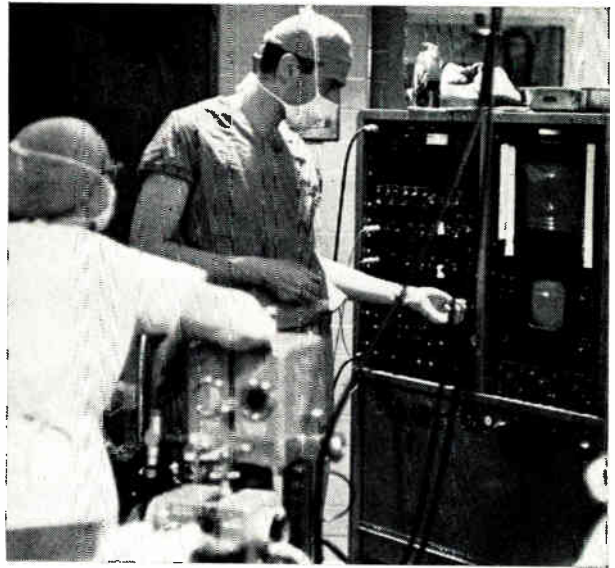
NASA Backs Biosciences

Programs in biosciences and human factor systems involving man-machine relationships are sponsored by the National Aeronautics and Space Administration. NASA's programs involve the origin of life, environmental effects on living cells, the influence of unaccustomed rhythms and various degrees of gravity, and possible life on other planets.

Other Federal agencies active in bio-medical activities include the Office of Aging in the Welfare Administration; the Civil Air Surgeon of the Federal Aviation Agency, and the Veterans Administration. Here, too, the Labor Department is interested in working conditions, including health and safety aspects of automation and technological change.

Public and private expenditures for health in the U. S. have more than doubled from \$15.6 billion in FY 1953 to \$33.8 billion in FY 1963. However, while private expenditures are about three times public expenditures here, most bio-medical research is financed by Federal agencies. Private industry and the already financially overburdened bio-medical community cannot afford to invest heavily to develop knowledge, not products, whose nature cannot be ascertained until after costly experimentation.

NIH spent about \$918.5 millions in FY and requested about \$957.4 million for FY 1965. NIH projects using bio-medical electronic equipment are listed in the Research Grants Index, weighing nearly five pounds. Activities cited include: electron—ac-



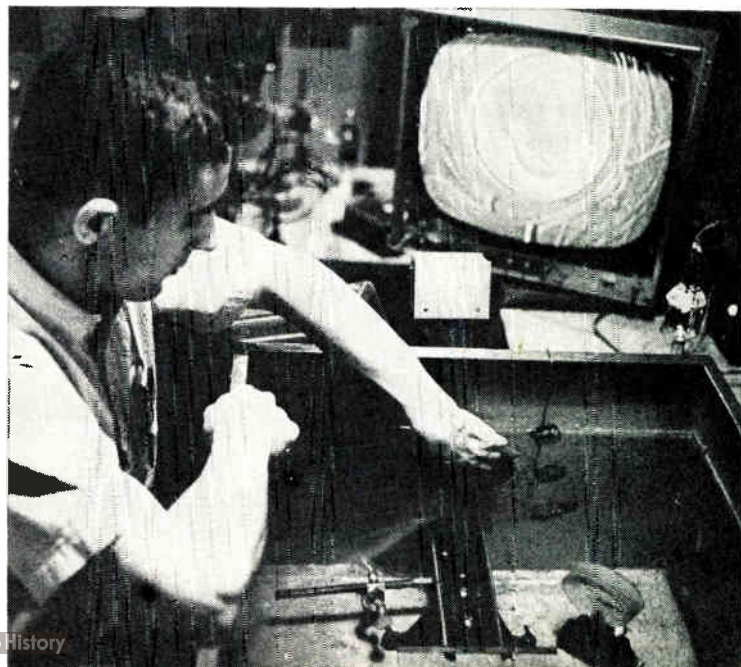
Doctor checks body functions on complex multi-monitor during open heart surgery at Temple University Medical Center, Philadelphia

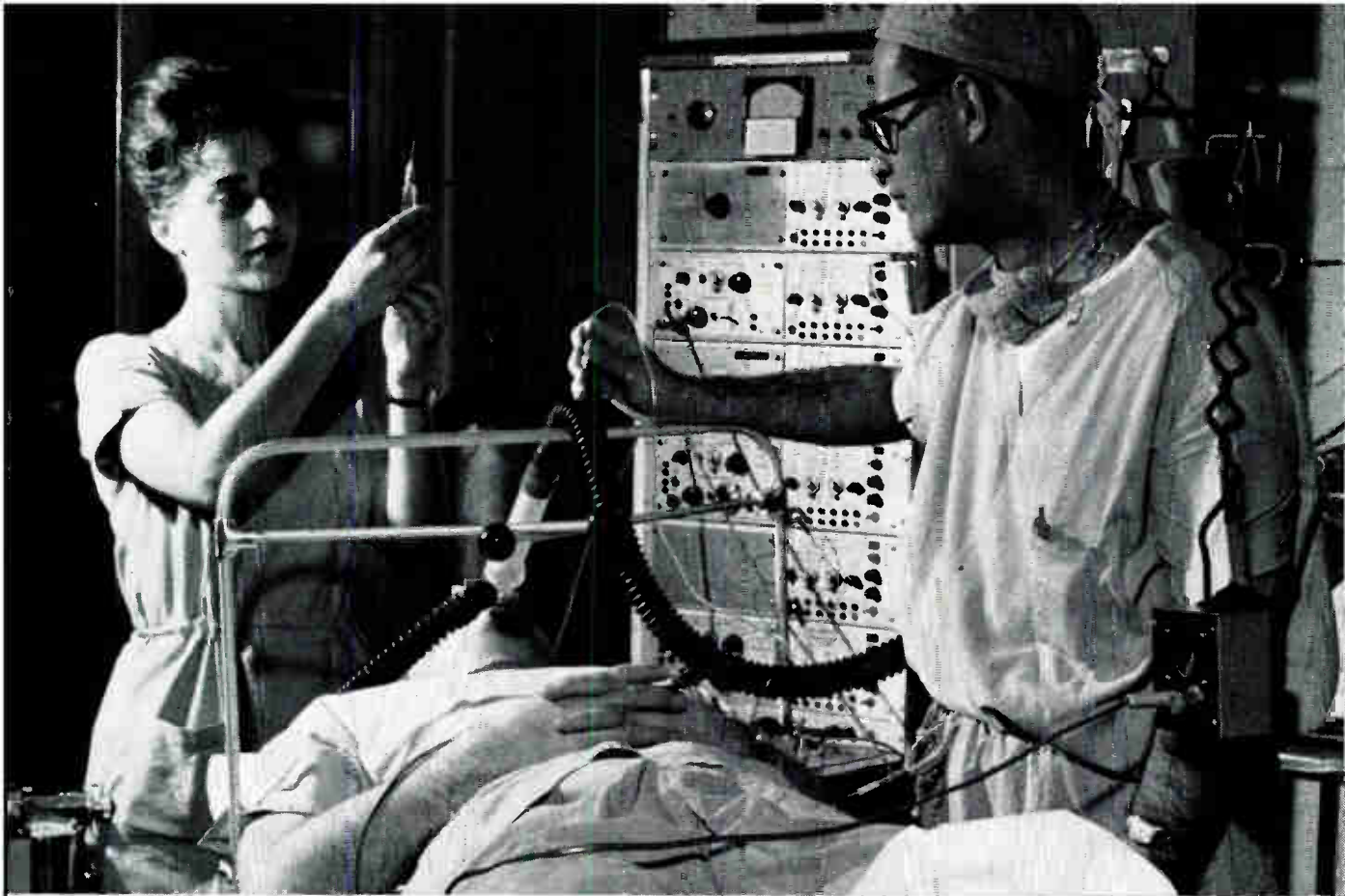
Complex electronic polygraphic instrument, by Grass Instrument Co., of Quincy, Mass., measures airway and arterial pressures, anesthetic gases and heart rate in cardiac division of University of Pennsylvania Hospital, Philadelphia

celeration; charge distribution; correlation; density; diffraction; donors; microscopy; paramagnetic resonance; probe X-ray microanalyzing; spin resonance spectroscopy; transport; electronarcosis (electroshock); electronic—cystometry; heart stimulation; recording; respiratory augmenting; electronystagmography; electrophilic substitution; electrophoresis; electrophysiology; and electroretinography. There are other projects involving electronic computers; instrumentation; radiation; and radioautography.

Costs Are Great

Obviously, bio-medical needs and costs are great. Paradoxically, there is an even greater backlog of





technology which remains to be tested and ultimately applied to help mankind. Yet hospital and private patients already are burdened with increasing costs of medical, dental, hospital and other voluntary group health plans.

Hospitals particularly endure increasing costs because doctors spare no expense to help conserve human life. Improved medical service, greater use of hospitals, broader use of electronic and other technical apparatus and services also account for higher hospital costs and higher rates for hospitalization insurance.

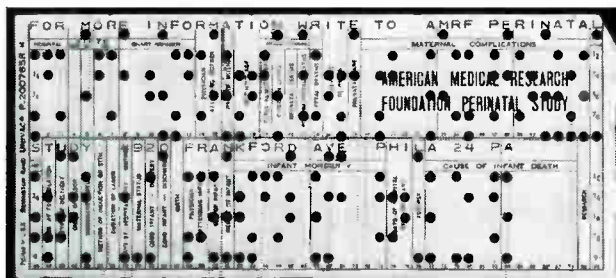
Thus the dual challenge to bio-medical electronic equipment is to help cure and heal, yet help cut

overhead costs. Economies may be achieved in actual diagnosis and treatment of patients. Other savings may come through use of devices such as "electronic nurse" sensors which report changes in a patient's condition to a central monitor.

However, some critics say electronic companies are "trying to rush the bio-medical market before understanding or even educating it." One observer notes, "You just can't get valid market research data until bio-medical men know enough about electronic equipment to make up their own minds." Others are overcautious or callous about "new-fangled electronic gadgets" that risk losing life as well as saving it. Another critic cautions, "Don't substitute technology for painstaking observation and thoughtful listening and talking to the patient."

Parenthetically, bio-medical electronic devices may offer new hope to dumb animals who cannot tell their symptoms to veterinarians. Animals, such as the monkey, also are being used by doctor-engineer teams conducting bio-medical researches.

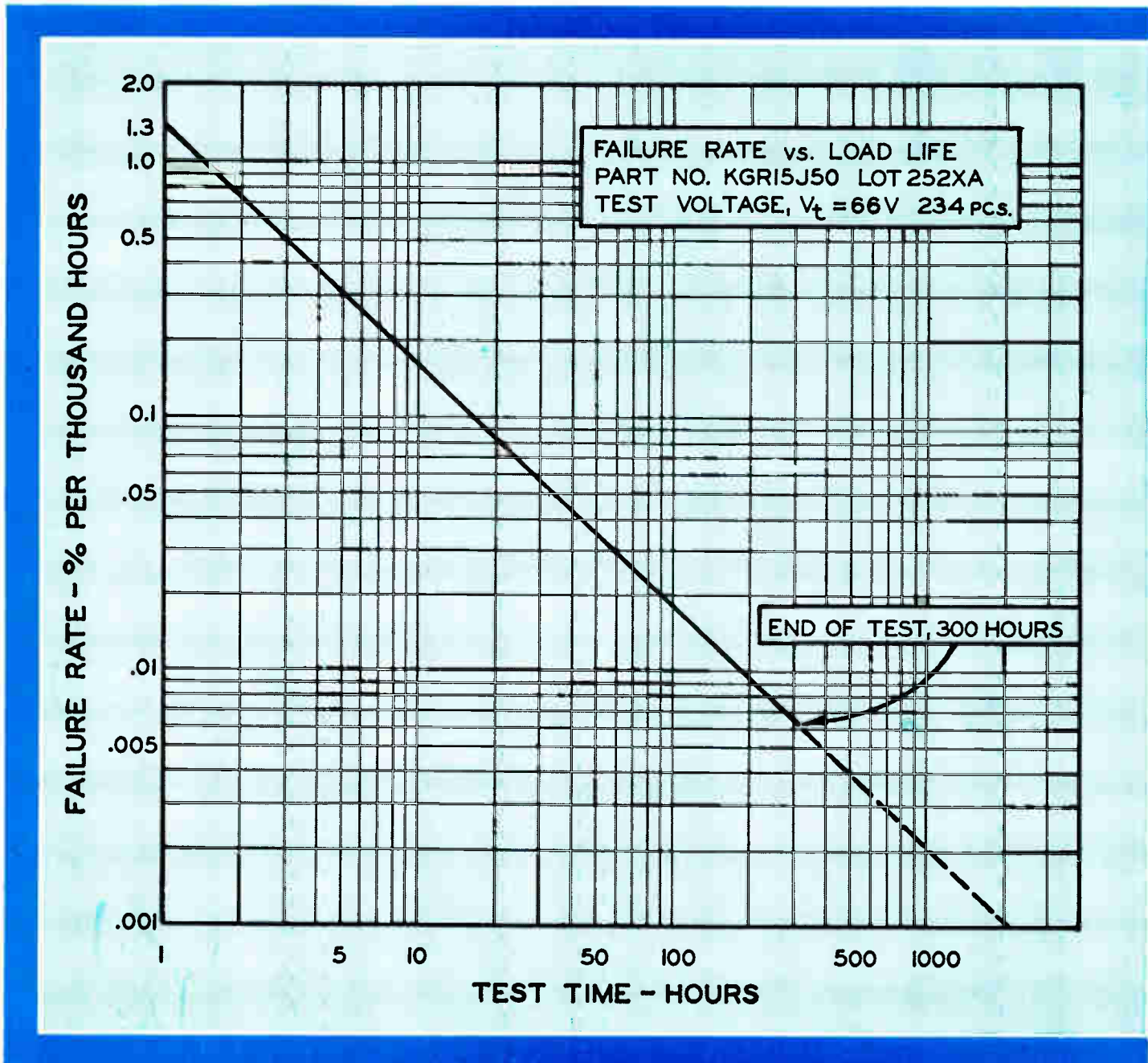
Bio-medical electronic problems will be resolved by integrating the healing arts with the electronic sciences. So far, many bio-medical electronic equipment manufacturers have reaped much publicity, but little profits—apart from the established X-ray and hearing aid businesses. It remains to be seen whether greater numbers of electronic firms will survive and start making money in this field. To some extent, it also depends upon whether use of certain bio-medical electronic equipment humanely may be equated with saving lives—at the expense of losing money.



EDP equipment used for medical purposes is largely for storing medical data. Card above is part of project to collect and analyze perinatal data.

Ultra-sonic visualization system may one day rival the X-ray. Graduate student at Northwestern University's Bio-Medical Engineering Center sees outline of his finger, bone detail and finger nail in TV monitor.

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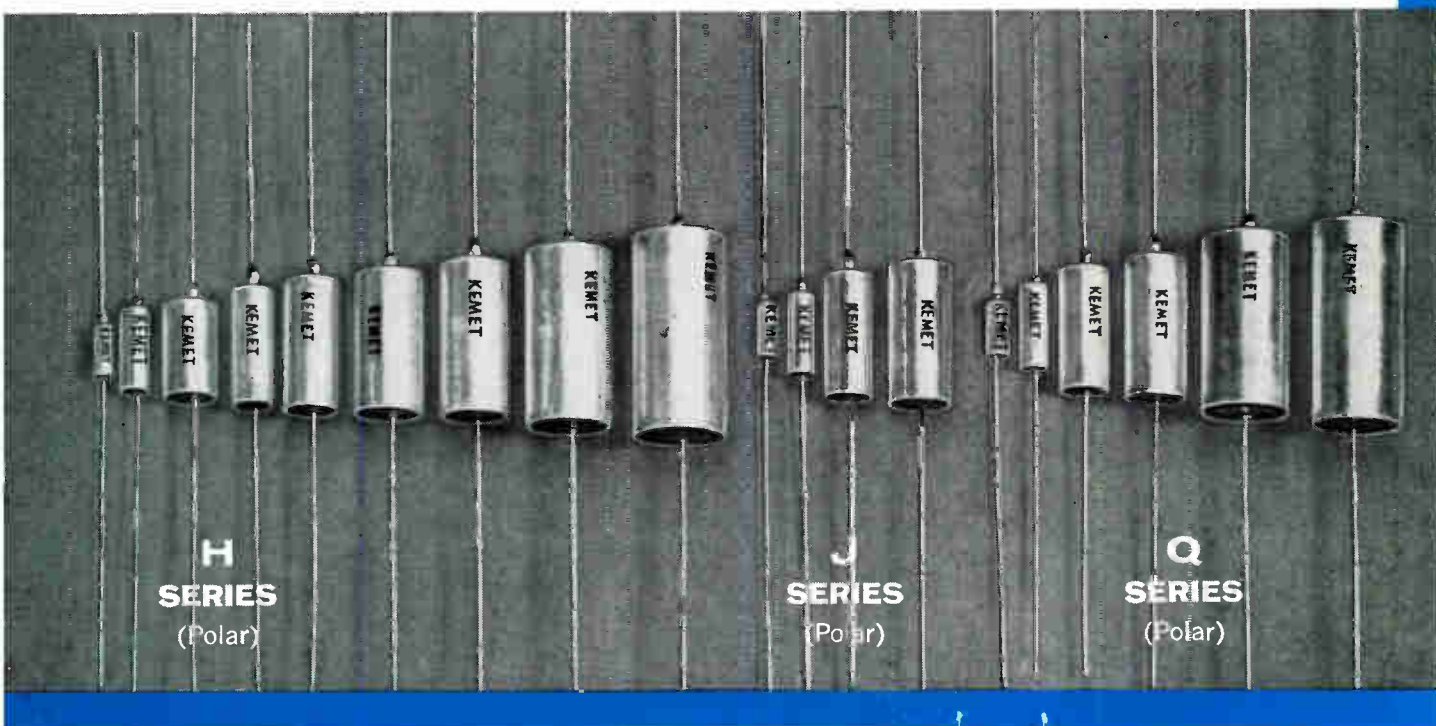
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ELECTRONICS

ADVANCED TECHNIQUES IN MEDICAL ELECTRONICS

By **A. H. URMER, Ph D**

Chief, Life System—Defense Systems Operations,
Lear Siegler, Inc.,
3171 S. Bundy Drive, Santa Monica, Calif.

**ELECTRONIC
INDUSTRIES**

**STATE-OF-THE-ART
FEATURE**

The influence of electronics on medicine is subtle and somewhat overshadowed by medical procedures made possible by electronic advances over the last decade.

This subtle influence is due to team efforts associated with these developments so that advances in electronics make possible the research with the resulting clinical procedures getting most of the publicity. With the rapid advances in microminiaturization and electronic methods one would expect to find many new methods available for general monitoring and evaluation of the human organism. Yet, few novel methods have been developed over the last decade. So medical electronics has not advanced as rapidly as the general field of electronics.

Data Processing

In the area of data handling large contributions have been made to medicine, both for clinical practice and research efforts. These procedures have resulted in semi-automatic patient monitoring systems. Thus, nurses can provide better services to patients. And, they can reduce their workload. Standard clinical parameters, such as respiration rate, body temperature, blood pressure, and cardiac output are monitored semi-automatically. They are only displayed to the nurse or physician when limiting parameters are either being exceeded or the trend is toward them being exceeded.

In research areas, data processing methods have resulted in the ability to derive much more information regarding standard physiological parameters. Also, the miniaturized electronic methods have resulted in some instruments, i.e., ingested transmitting sensor for monitoring stomach motility, brain implant systems which have contributed significantly to better understanding of brain function, and the implanted Pacemaker or cardiac control.

Aerospace Medicine

Except for the Pacemaker, these sensor advances

Many of the medical procedures in use today are possible only because of electronic advances made over the last decade.

These advances have made possible such life saving procedures as the extracorporeal heart pump, the cardiac pacemaker and the brain implant.

This article discusses the latest progress in this field.

are generally in the research areas. One has to look to the aerospace field for the determination of the present state-of-the-art of electronics in medicine. It is in the area of aerospace flight that great demands are made to advance the state-of-the-art in medical electronics. The need to acquire physiological information from the astronaut is being satisfied by improving miniaturizing methods and developing new hardware systems, although the parameters being monitored on man are not altered greatly. On Mercury flights, four parameters were monitored. They were oral temperature, electrocardiograph, respiration rate, and blood pressure. The initial Gemini flights will not have any additional parameters although others are being planned for later flights. While these parameters yield information as to the astronaut's present status, the lead time needed to permit a man to re-enter safely from a long mission makes it important that other methods be developed. These methods should permit information to be acquired from the human body which will allow prediction of man's status some time into the future.

Problems

The slow progress in achieving these goals is due to the basic problems associated with the unique electrophysiological parameters of man. Essentially, the parameters of interest are very paradoxical in that one attempts to monitor low energy signals ranging from between a few millivolts for cardiac potentials to about 50 μv for electroencephalography. Along with these low potentials, noise artifacts are present which have output magnitudes several times greater than the potential of the signal. In addition to the signal-to-noise ratio problems, body potentials and impedance variations occur which are fairly rapid and unpredictable.

Many of the noise problems are due to different parts of the body producing similar potentials and waveform outputs. One method of minimizing the extraneous noise problem is to reduce the area of interface between the body and the sensor. While this reduces the extraneous signal problems, it in-

creases the problem of acquiring a signal of enough magnitude.

Two additional problems present themselves in the interface between the human organism and the electronic hardware. One is the problem associated with the electrode in contact with the skin which often results in polarization. The other is that impedance changes occur with time in the electrode, electrode gel, and the skin interface.

These problems are not unique to the aerospace industry, but are also present in clinical practice. Aerospace uses add the additional need for minimum power, size and weight. Major difference is that in clinical practice they can be resolved by keeping the patient still and by having relatively unlimited power and space available so that large amplifying equipment can be used to compensate for low signal levels. Miniaturization of signal conditioners has compensated many of the above noise sources by permitting close contiguity between electrodes and amplifiers.

Advanced Method

These are problems primarily associated with any use of surface electrodes for monitoring electrophysiological functions of man. A typical example of an attempt to avoid some of these problems is the advanced method developed at Lear Siegler, Inc. (LSi) for monitoring cardiac function without electrodes.

With present methods, *external* determination of cardiac blood flow phenomena can only be achieved by using radioactive isotopes and X-ray methods. These methods have at least one intrinsic limitation in that they do not permit continuous monitoring of the blood flow phenomena. Others, such as the use of dye dilutions, flowmeters, and plethysmography, are all established methods but none of these allow for easy, continuous, and atraumatic monitoring of cardiac function.

The system developed by LSi (called CARDIA) operates on the principle of a free electromagnetic (EM) wave transmitted through the thorax and influenced (reflected and attenuated) by the heart emptying and filling with blood.

More specifically, in the case of an EM wave traversing a conducting medium, this absorption of energy is a function of the mediums' dielectric constant, ϵ ; permeability, μ ; and conductivity, σ . The basic relationship for equating these factors to the propagation of a plane wave polarized in the y direction traveling in a positive x direction is:

$$E_y = E_m e^{\alpha x} e^{j(\omega t - \beta x)} \quad (1)$$

where

E_y = electric field vector,
 E_m = constant (actually E_{oy} at the origin),
 $\omega = 2\pi f$ (f = frequency), and
 α and β are constants related as

$$\Gamma = \alpha + j\beta = j\omega \sqrt{\epsilon \left(1 + \frac{\sigma}{j\omega\epsilon}\right)} \quad (2)$$

where

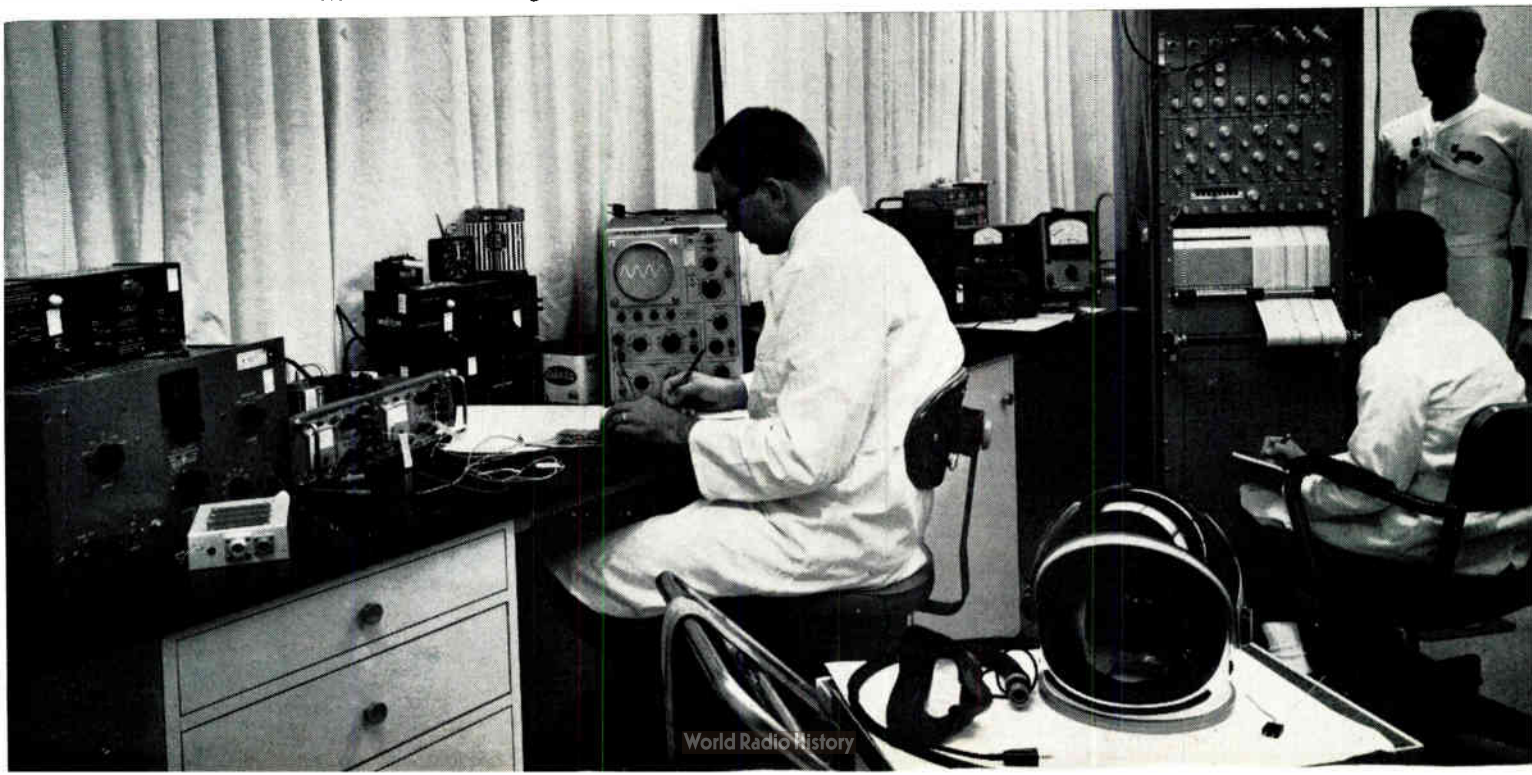
ϵ = dielectric constant μ = permeability, and
 σ = conductivity $j = \sqrt{-1}$.

The factor $e^{\alpha x}$ in Eq. 1 indicates the attenuation. If the conductivity of a dielectric is small, the wave travels with little attenuation for σ is small. In biologic material, the attenuation factor is large, for the conductivity of such hydrated tissue empirically has been found to be large.

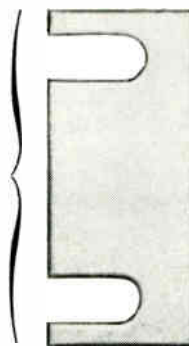
The impedance and wave attenuation of any segment or organ of the human body is a function of the composite ϵ and σ of that segment or organ. The marked alteration in blood volume with each cardiac cycle causes variation in the electrical impedance.

Continuous monitoring of the heart impedance
(Continued on page 45)

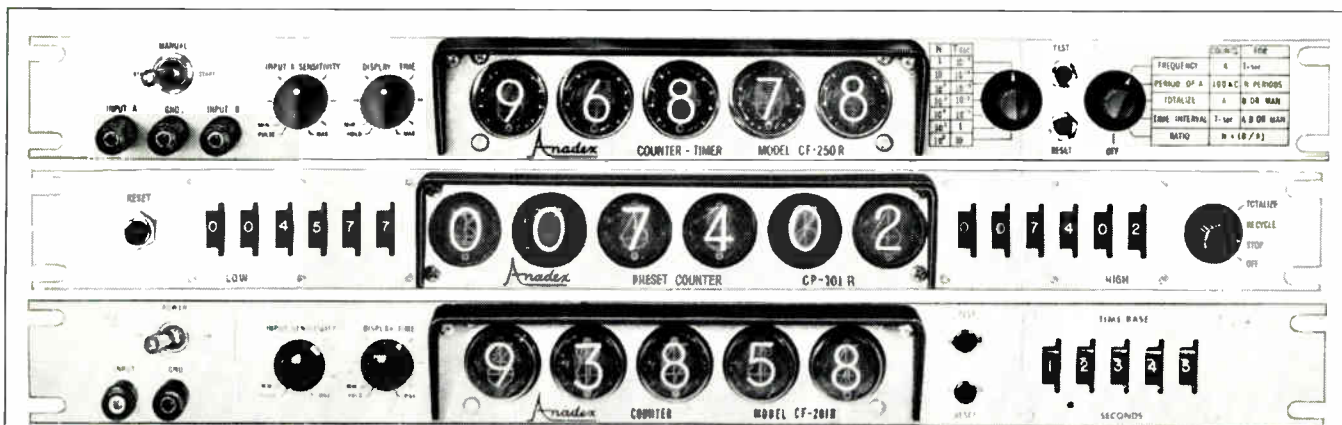
Researchers at Lear Siegler's Bio-Medical Laboratory test equipment attached to dummy at right.



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variations, i.e., the blood volume alterations is done with antenna radiating EM energy into a load η_t and a receiving device or antenna situated as shown in Fig. 1. Alterations in η_t leads to an alteration in the transmitted signal, a quantity which is detectable by the sensing device D , and displayed appropriately at R .

In practice, a 900 mc signal is combined with a 19.6 cm by 9.8 cm radiating and receiving aperture. This aperture is placed in juxtaposition to the chest.

For aerospace use, the relatively high gain of the horn antenna can be traded for size reduction, especially in thickness.

Of major importance is the selection of an optimum wave length. Frequency or wave length dependent factors are energy attenuation, surface reflection, and molecular resonance phenomena. The ideal frequency should demonstrate resonance absorption for the blood only and not for the other body tissues. Such a condition, of course, cannot be practically realized because of the molecular and electrical similarity of most of the body tissues and the complex nature of blood; but, experimental data show that certain wave lengths (i.e., 900 mc) give the maximum difference in electrical parameters between blood and fat, muscle, and body organ tissues. Also, experiments indicate that only a select range of wave lengths are useful because of reflection and absorption characteristics through deep tissue (muscle) and subcutaneous tissue (fat).

Use of CARDIA for remote screening, much like X-ray for cardiac function, obviously has potential as a mass screening device for monitoring individual astronauts without having anything attached to their body.

Respiratory Flow

Another area of direct contribution of the electronic industry to aerospace medicine and indirectly to general medicine has been in the monitoring of respiratory flow. A problem that has plagued the astronaut monitoring system is the determination of the volume of gas inhaled and exhaled. This problem was complex enough to result in three different systems being tried in the Mercury program. Those tried were a linear potentiometer, a heater thermistor, and an impedance method. The last method, while yielding reliable respiratory rate data, did not yield reliable quantitative data.

While many complex methods are available in a closed system for determining the oxygen intake and CO₂ output (best known of these by Beckman Industries), the actual determination of respiration factors depends upon an accurate determination of the actual volume of air inhaled and exhaled. Flowmeters in the intake oxygen lines and exhaust lines are not adequate due to the leakage problems associated with space suits.

This problem led to a research program to clarify the critical parameters associated with respiratory air flow determinations. Result of this research is an impedance method for determining respiratory air flow. Accuracy of the system is exemplified by the comparison of respiratory air flow on the LSi impedance pneumograph and a spirometer.

This system illustrates the problem posed by the random impedance changes of the human body. Impedance pneumographs, in the past, have been designed according to the following basic circuit-design approaches: bridge, modulated oscillator, and Thevenin equivalent sources (voltage divider, constant voltage, and constant current). Most of these either need continuous adjustment or are influenced by the total body impedance. The Thevenin equivalent pneumograph with constant current avoids these problems in that a constant ac current is passed through the subject so that the peak-to-peak carrier voltage amplitude at the subject is proportional to the subject impedance. Any variation in the impedance causes modulation of the carrier amplitude. A demodulator recovers the ΔZ information.

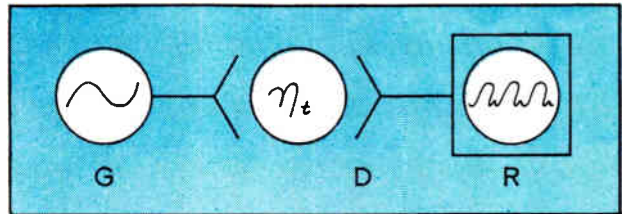
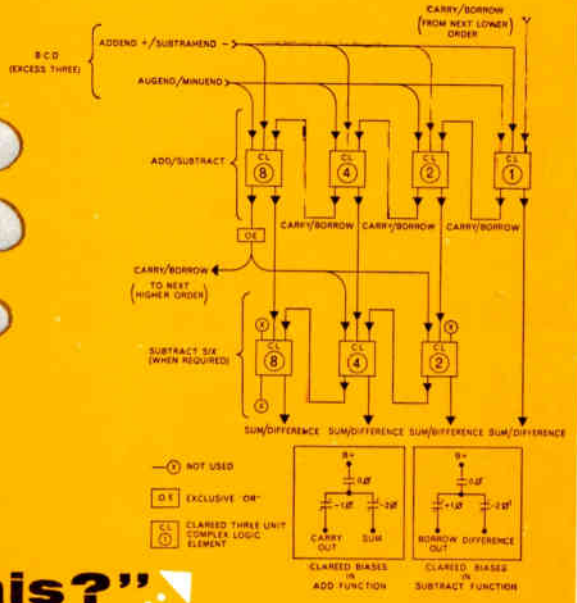
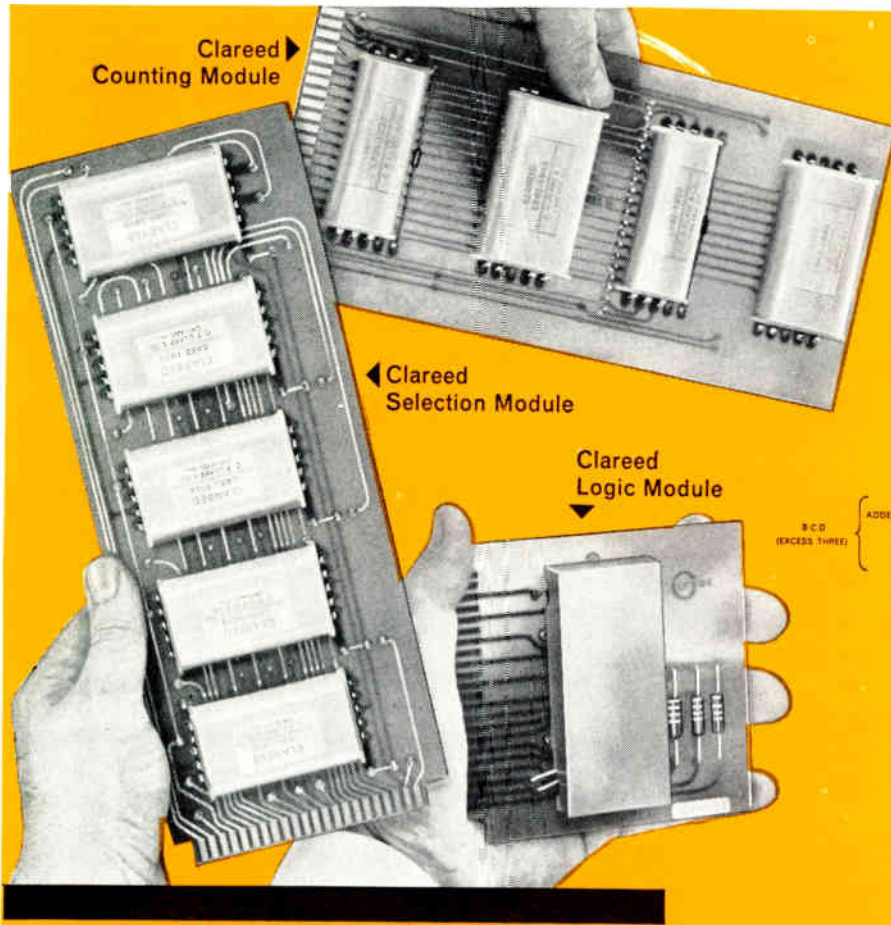


Fig. 1: Continuous monitoring of the heart impedance variations.

In the constant-current design there is a minimum and a maximum value of allowed subject impedance. The minimum value is set by the threshold of the pneumograph detector, the gain of the carrier amplifier (if used), and the subject stimulus level. This value can easily be well below the expected minimum subject impedance. The maximum value of subject impedance is determined by either the dynamic range limit of the carrier amplifier (if used), or the source impedance of the current source. The system may be used simultaneously with other equipment without multiple or conflicting subject grounds. Simultaneous use of ECG, REC, EMG, GSR, etc., is thus possible.

In the case of simultaneous ECG operation, with common electrodes, there are several additional considerations:

- (1) The pneumograph must have an exceptionally high input impedance at ECG frequencies, (perhaps 100 cps and below) in order not to load the ECG signal.
 - (2) The carrier voltage drop at the subject should be as small as possible to prevent over-driving the ECG amplifier.
 - (3) The ECG amplifier should have a very high input impedance at the pneumograph carrier frequency, to prevent loading the pneumograph.
- (Continued on page 49)



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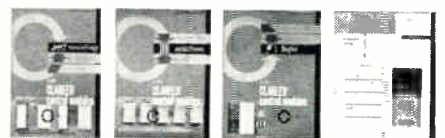
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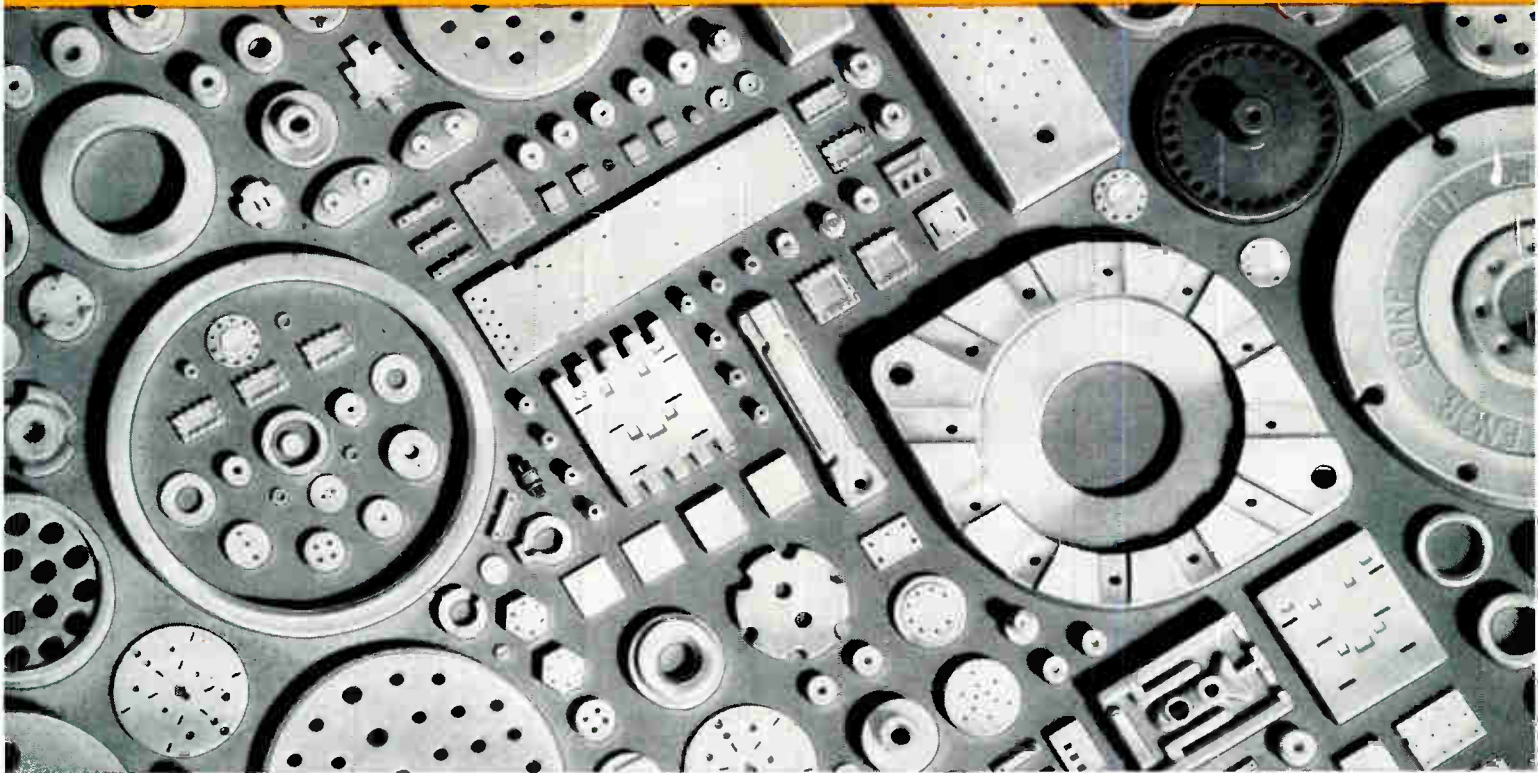


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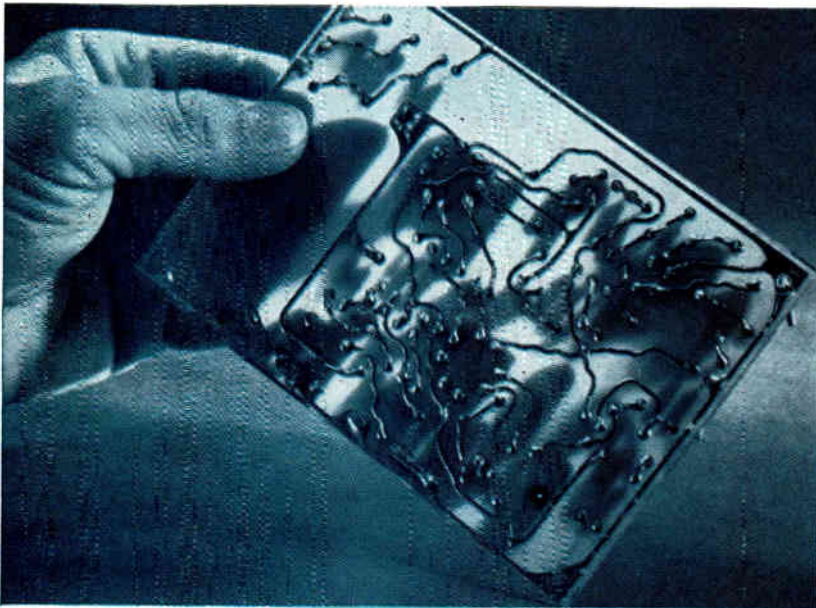
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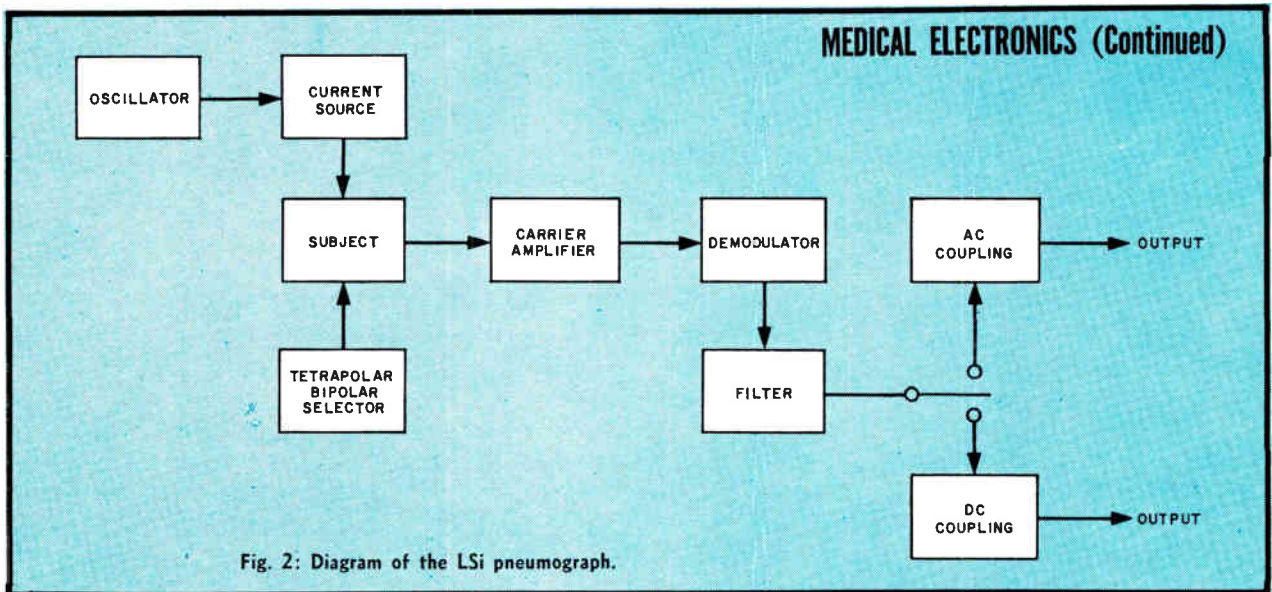


Fig. 2: Diagram of the LSi pneumograph.

Lear Siegler research efforts have developed an advanced laboratory model impedance pneumograph. This pneumograph is of the constant current type and uses advanced design concepts. It can operate in either a bipolar or a tetrapolar mode. Stimulus level and frequency may be varied, and output coupling may be either ac or dc.

The research results were obtained with the laboratory model pneumograph. Good correlation has been obtained between the pneumograph and spirometer recordings.

Fig. 2 presents a block diagram of the LSi pneumograph designed and built for a space flight. This circuit uses a passive close-coupled network for subject coupling making it possible to:

- (1) Allow parallel ECG operation.
- (2) Reduce subject-ground artifacts.
- (3) Operate with a low prime-power input.
- (4) Eliminate balancing adjustment.
- (5) Present operation of total subject impedance.

The Future

The example of advanced developments in medical electronics cited are only representative of many similar efforts where electronic methods are rapidly

advancing the capabilities of medicine.

In the near future the miniaturization of signal conditioners for aerospace use will make possible a portable monitoring system. This system will permit the physician to acquire diagnostic data from the patient in a dynamic situation rather than in the artificial environment of the office. Such a system will have the sensors, signal conditioners, power supply, and recorder on the patient as he pursues his daily tasks. Although relatively costly, such a system is with the state-of-the-art today.

Use of any of the instruments discussed is unlimited, ranging from complex for space flight monitoring to routine clinical diagnosis. The greatest use of the greatest demand will be for such instruments as CARDIA, which may result in mass population screening for early detection of cardiac insufficiencies and microminiaturized standard clinical diagnostic instruments (i.e., ECG, blood pressure, temperature) for continuous monitoring of patients in routine daily living.

It is apparent that the electronic industry may be on the verge of initiating a dynamic form of medicine. This will enable the physician to predict human malfunctions before clinical symptoms occur.

EDITOR'S SUPPLEMENT

Lear-Siegler is actively developing a Psychophysical Information Acquisition Processing and Control System (PIAPACS) originally under a greater than \$1 million contract to NASA's Flight Research Center at Edwards AFB, running for 18 months from July, 1963. The closed loop man-machine control system is part of a long range development program conducted by NASA's Office of Advanced Re-

search and Technology. PIAPACS is needed as a research tool and for operational use in long duration manned space flights, with possible use in supersonic flight and in submarines. The contract was hotly contested as a foot-in-the-door to great expectations in medical electronics.

The following comments were abstracted from a statement by Dr. Michael G. Del Duca, chief, Biotechnology, and Mr. Lowell O. Anderson, Chief, Man-Machine Con-

trol, Div., NASA's Division of Biotechnology and Human Research, before the National Space Electronics Symposium, I.E.E.E. at the end of 1963. It is believed that the program has been somewhat modified since that time.

"To fulfill its function, a PIAPACS must include a group of sensors to sense the appropriate physiological, environmental and performance parameters. It may include signal conditioners to amplify
(Continued on page 50)

MEDICAL ELECTRONICS (Continued)

and perhaps transduce the outputs of the sensors. It must include a computer which will accept the outputs of the signal conditioners and from them, and from stored information, determine the user's functional state, predict the trend, and counter any undesirable trend by providing control signals to the vehicle's environmental control system and perhaps the flight control system. The computer must also provide outputs to generate displays which will keep the user informed of his current state, the predicted trend, the action of the automatic portion of the system and the need, if any, for action by the user. The system must include the displays and the necessary controls.

"To meet reliability requirements a PIAPACS should sense only those parameters which are essential to measuring and predicting the user's functional state. Ideally, the sensors used would be such that their outputs could be fed directly to the computer with no need for signal conditioning; if signal conditioners are necessary, they should be solid state microcircuit devices mounted directly on the sensors. The computation requirements must be carefully established to insure that only the absolutely minimum necessary amount of data processing is carried out. The computer itself should utilize solid state microcircuitry.

"The displays are also highly important in considerations of system reliability. Displays which contain needed information but which present it in such a form that its significance is not readily understood may be worse than useless. It must be kept in mind that most users of PIAPACS will be medically naive. Showing them, for example, an electroencephalogram would convey little usable information. Whatever displays are used must present the required information; they must be readily understood by medically untrained personnel; they should be few in number, preferably one; and, they should call attention to them-

selves if an unfavorable trend is encountered. A final consideration in regard to PIAPACS reliability is that of the controls to be available to the user. Even though one provides simplified displays which enable the user to understand that a situation requires action on his part, system reliability is degraded if he must then ponder what to do with the controls. Display design and control design must be carried out coincidentally so that the displays convey not only the need for action but precisely what action is required. In other words, display-compatible controls must be included.

"The need for gaining PIAPACS user acceptance by keeping him informed of what is happening has been mentioned; so has the need for minimizing the number of sensors to increase reliability. Minimizing and simplifying the physiological sensors is also important to user acceptance. Humans are generally averse to having sensor probes inserted in various orifices, to having portions of their heads and torsos shaved for attachment of electrodes, etc. For these reasons, it is considered highly desirable that the sensors and their signal conditioners be built into an easily donned and comfortable undergarment.

"In an ultimate PIAPACS for use in space, no outputs to nor inputs from earth would be required. It is recognized, however, that for the next several years it will probably be necessary to telemeter back to earth some of the data from PIAPACS. This will allow means for ground monitors to exercise some control over the system if needed. This should be provided

until the system reliability is proven.

"Up to this point, this paper has described a system which is desirable but which does not exist. One may well ask why it does not exist. It can be argued, and quite convincingly, that most, if not all, of the electronic techniques required for such a system are already known. Even presuming that this is true, we still cannot build a PIAPACS today. The problem is that we simply do not know enough about the interrelationships of the many physiological parameters and their relation to performance and to environmental conditions. Even after some centuries of work in the medical arts and some decades of studies in medical sciences, these relationships are still not well understood. It is important, therefore, that we get on with the work of trying to understand them and of designing a system based on such understanding. Before we describe the program which is presently under way, let it be noted that we are not so naive as to believe that this program will be a panacea. It will not substitute for, but will greatly benefit from, prior work and other current efforts in this field. We do believe, however, that it is sufficiently well focused on specific facets of the problem that significant results may be expected.

"The contract cited (Lear Siegler's PIAPACS, Ed. note) is for an eighteen-month period starting July 1, 1963, and consists of three overlapping phases. Phase I is for the design, development, fabrication, test and delivery of an integrated sensing and recording system to sense and record selected physiological environmental and performance parameters. The performance measures are not firm nor are the specific sensors, with the notable exception of the mass spectrometer. This will be modified Consolidated Systems Corporation's Type MSDF-BA-1201. The Phase I system consists of four packages. The first package includes the mass spectrometer, arterial pressure and electrocardiogram sensors plus a complete PCM telemetry system. The second package consists of wave velocity,

(Continued on page 56)

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USING THE COMPUTER FOR INTEGRATED CIRCUIT ANALYSIS

A major restriction on integrated circuits is the high cost of fabrication. Thousands of dollars may be spent on a set of masks only to find that a mistake has been made. The technique described here uses a computer to predict circuit performance before large amounts of money are spent on the fabrication process.

INTEGRATED CIRCUIT DESIGN has caused a new and costly problem for designers, namely an excessive time lag from conception to device. As a result, the designer should avail himself of new tools to insure an accurate and correct design on the first try. This article describes a mathematical approach, using a computer, for predicting the behavior of an active linear circuit after it has been integrated.

The simple but powerful computer analysis method described here is based upon the nodal equations of a complete amplifier. Method provides a unified approach to linear circuit analysis. It replaces the normal piece-meal approach needing three separate equivalent circuits—one each for low, mid-band, and high frequencies. Further, this method is applicable to any system which can be described by a set of linear simultaneous complex equations.

A 3-stage differential amplifier using 2N918 transistors was selected to show the method's feasibility.

* * *

The procedure followed was first to write circuit equations for, and to calculate frequency response of, three stages of the discrete circuit of Fig. 1. An integrated version of this circuit was then simulated by including parasitic capacitances and resistances characteristic of such circuits. Next, equations for the latter case were written, values of all parasitic components set near zero, and response again calculated. The two responses were found to be in excellent agreement. Satisfied that the equations for the circuit including the parasitic components did degenerate to the discrete case, the response was calculated with the parasitics taking on actual values—obtained from RCA, Somerville. The high frequency 3 db point was found to drop from 20 mc for the discrete case to about 10 mc for the simulated integrated circuit. This calculated 50% reduction in

bandwidth agreed very well with the change in bandwidth observed in the lab between a general purpose integrated amplifier, and its discrete equivalent.

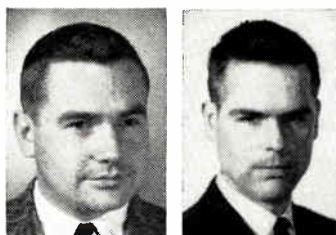
Discrete Circuit Analysis

A single stage of the circuit under examination is shown in Fig. 1. Using the transistor "y" parameter equivalent circuit of Fig. 2, the single stage equivalent circuit of Fig. 3 was built. Corresponding nodes of Figs. 1 and 3 are labeled. An overall equivalent circuit comprising three stages of the setup of Fig. 3 was then built and analyzed on the basis of nodal equations.

This approach was enhanced because the complex "y" parameters of the 2N918 were available over the frequency range of interest. These parameters, published for only the common emitter setup, were converted, where necessary, to the common collector and common base parameters as follows:

$$\begin{array}{ll}
 y_{ic} = y_{ie} & y_{ib} = (y_{ie} + y_{re} + y_{fe} + y_{oe}) \\
 y_{rc} = -(y_{ic} + y_{re}) & y_{rb} = -(y_{re} + y_{oe}) \\
 y_{fc} = -(y_{ic} - y_{fe}) & y_{fb} = -(y_{fe} + y_{oe}) \\
 y_{oc} = y_{ie} + y_{re} + y_{fe} + y_{oe} & y_{ob} = y_{oe}
 \end{array}$$

Seven simultaneous complex nodal equations describing circuit operation were next written. The coefficients were then arranged in matrix form, Fig. 4.



By LAURENCE C. DREW and ALAN G. ATWOOD

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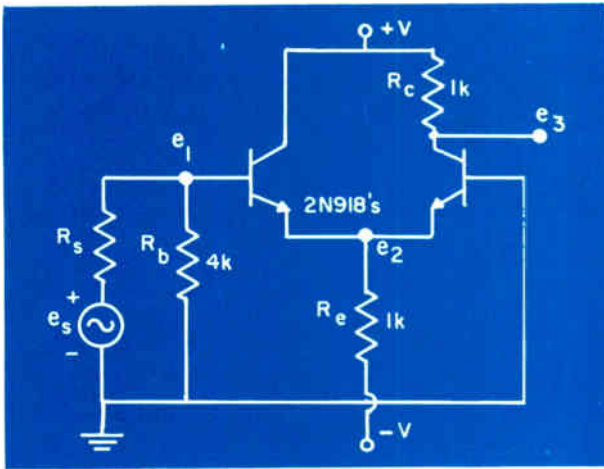


Fig. 1: Single stage differential amplifier.

Fig. 2: Transistor "y" equivalent circuit.

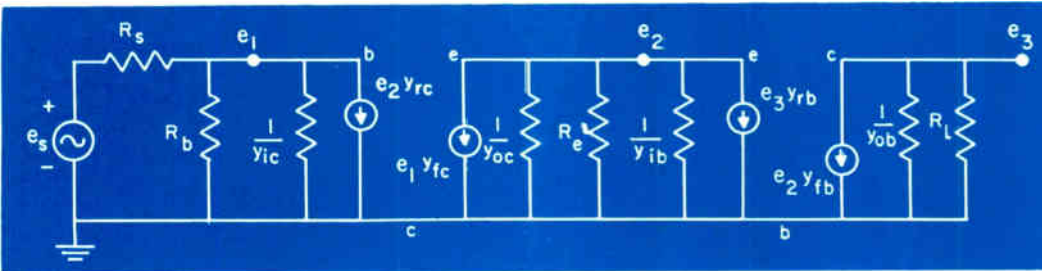
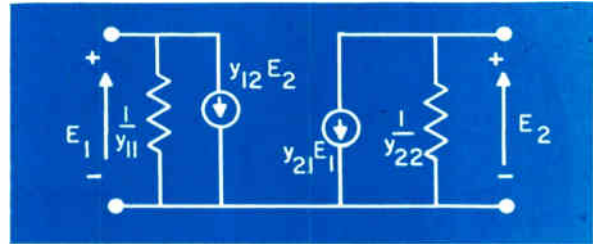


Fig. 3: Single stage equivalent circuit.

e_1	e_2	e_3	e_4	e_5	e_6	e_7	e_8
$A_{1,1}$	$A_{1,2}$	0	0	0	0	0	$A_{1,8}$
$A_{2,1}$	$A_{2,2}$	$A_{2,3}$	0	0	0	0	0
0	$A_{3,2}$	0	$A_{3,3}$	0	0	0	0
0	0	$A_{4,3}$	$A_{4,4}$	$A_{4,5}$	0	0	0
0	0	0	$A_{5,4}$	$A_{5,5}$	$A_{5,6}$	0	0
0	0	0	0	$A_{6,5}$	0	$A_{6,7}$	0
0	0	0	0	0	$A_{7,6}$	$A_{7,7}$	0

Fig. 4: Matrix (7x7) of nodal coefficients.

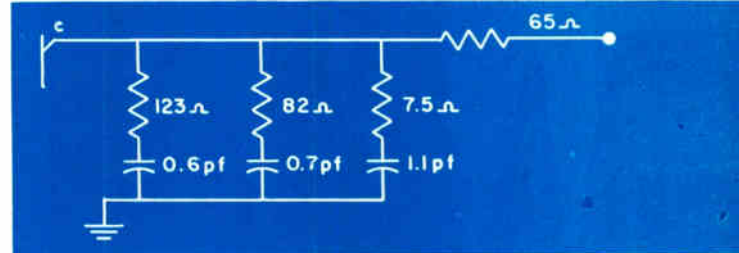


Fig. 5: Collector parasitics.

$$e_1 \left[\frac{1}{R_s} + \frac{1}{R_b} + y_{ic} \right] + e_2 [y_{rc}] = e_s \left[\frac{1}{R_s} \right] \quad (1)$$

$$e_1 [y_{fc}] + e_2 \left[y_{oc} + y_{ib} + \frac{1}{R_c} \right] + e_3 [y_{rb}] = 0 \quad (2)$$

$$e_2 [y_{fb}] + e_3 \left[y_{ob} + y_{ic} + \frac{1}{R_c} + \frac{1}{R_b} \right] + e_4 [y_{rc}] = 0 \quad (3)$$

$$e_3 [y_{fc}] + e_4 \left[y_{oc} + y_{ib} + \frac{1}{R_c} \right] + e_5 [y_{rc}] = 0 \quad (4)$$

$$e_4 [y_{fb}] + e_5 \left[y_{ob} + y_{ic} + \frac{1}{R_c} + \frac{1}{R_b} \right] + e_6 [y_{rc}] = 0 \quad (5)$$

$$e_5 [y_{fc}] + e_6 \left[y_{oc} + y_{ib} + \frac{1}{R_c} \right] + e_7 [y_{rb}] = 0 \quad (6)$$

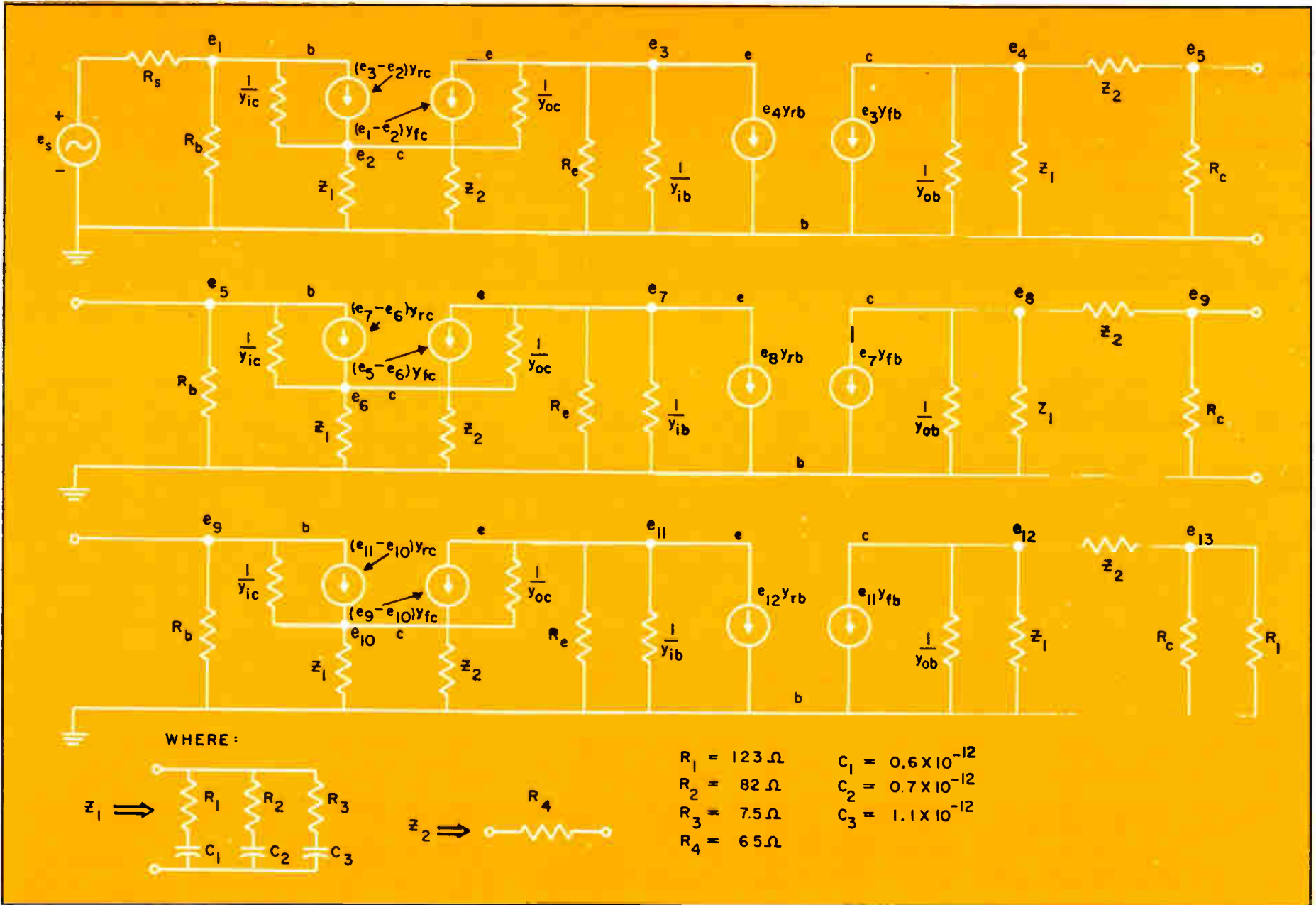
$$e_6 [y_{fb}] + e_7 \left[y_{ob} + \frac{1}{R_c} + \frac{1}{R_L} \right] = 0 \quad (7)$$

Finally, the computer was programmed to pick up the transistor "y" parameters and solve for the complex elements of the matrix at each frequency, as well as to invert the matrix for the complex node voltages. Amplifier gain was made numerically identical to the voltage of the output node, e_o , by taking the input voltage, e_s , equal to unity. Further, the computer was instructed to take $20 \log_{10} |e_o|$ thereby giving the gain directly in db. A plot of this computer-calculated response is shown in Fig. 7, Discrete Circuit Response.

Simulated Integrated Circuit Analysis

As a first approximation toward simulating integrated circuit behavior of the discrete circuit of Figs. 1 and 3, the collector parasitics of Fig. 5 were introduced into the collector circuit of each transistor.

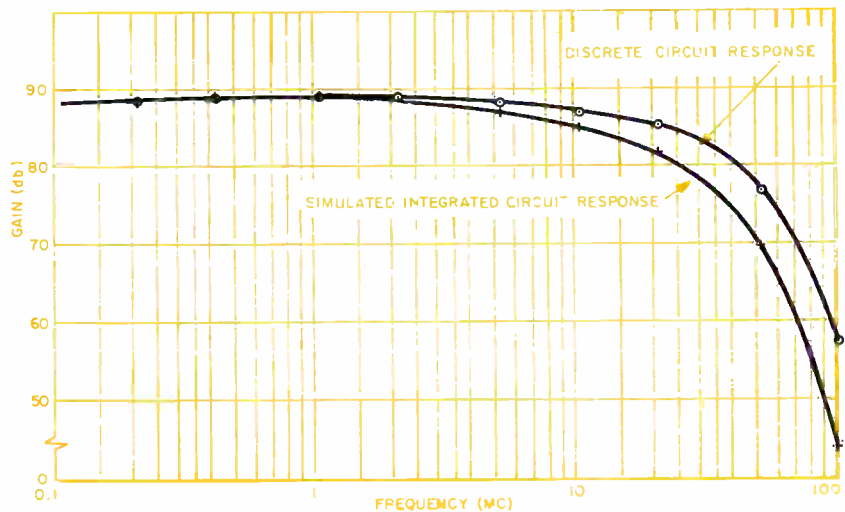
A new overall 3-stage equivalent circuit was then drawn and an analysis identical to the one just described, performed. This circuit is shown in Fig. 6.



CIRCUIT ANALYSIS (Continued)

Fig. 6: (left)
Simulated integrated circuit—
three stage equivalent.

Fig. 7: (right)
Computer calculated
frequency responses.



Its 13 nodal equations are shown below. A new Fortran computer program was then written to solve the resulting 13×13 matrix.

To insure that this new circuit and computer program truly represented a more generalized description of the original discrete circuit, and did in fact degenerate to that case, all the collector parasitics were initially given values close to zero. (To actually set them equal to zero would have caused difficulties in the computer program.) The resulting computer-calculated response differed from that of the discrete case in only the third significant digit.

Satisfied that this circuit and computer program were valid, the parasitics were then given the values shown in Figs. 5 and 6, and the response again calculated. Results are plotted in Fig. 7. The 3 db point dropped from 20 Mc for the discrete case to about 10 Mc for the simulated integrated case. These results confirmed observations in the lab.

The Nodal Equations

$$e_1 \left[\frac{1}{R_s} + \frac{1}{R_b} + y_{ic} \right] - e_2 [y_{ic} + y_{rc}] + e_3 y_{rc} = e_s \left[\frac{1}{R_s} \right] \quad (1)$$

$$e_1 [y_{ic} + y_{fc}] - e_2 \left[y_{ic} + y_{rc} + y_{fc} + y_{oc} + \frac{1}{Z_1} + \frac{1}{Z_2} \right] + e_3 [y_{rc} + y_{oc}] = 0 \quad (2)$$

$$e_1 [y_{fc}] - e_2 [y_{fc} + y_{oc}] + e_3 \left[y_{oc} + y_{ib} + \frac{1}{R_c} \right] + e_4 [y_{rb}] = 0 \quad (3)$$

$$e_3 [y_{fb}] + e_4 \left[y_{ob} + \frac{1}{Z_1} + \frac{1}{Z_2} \right] - e_5 \left[\frac{1}{Z_2} \right] = 0 \quad (4)$$

$$e_4 \left[\frac{1}{Z_2} \right] - e_5 \left[\frac{1}{Z_2} + \frac{1}{R_c} + \frac{1}{R_b} + y_{ic} \right] + e_6 [y_{ic} + y_{rc}] - e_7 [y_{rc}] = 0 \quad (5)$$

$$e_5 [y_{ic} + y_{fc}] - e_6 \left[y_{ic} + y_{rc} + y_{fc} + y_{oc} + \frac{1}{Z_1} + \frac{1}{Z_2} \right] + e_7 [y_{rc} + y_{oc}] = 0 \quad (6)$$

$$e_5 [y_{fc}] - e_6 [y_{fc} + y_{oc}] + e_7 \left[y_{oc} + y_{ib} + \frac{1}{R_c} \right] + e_8 [y_{rb}] = 0 \quad (7)$$

$$e_7 [y_{fb}] + e_8 \left[y_{ob} + \frac{1}{Z_1} + \frac{1}{Z_2} \right] - e_9 \left[\frac{1}{Z_2} \right] = 0 \quad (8)$$

$$e_8 \left[\frac{1}{Z_2} \right] - e_9 \left[\frac{1}{Z_2} + \frac{1}{R_c} + \frac{1}{R_b} + y_{ic} \right] + e_{10} [y_{ic} + y_{rc}] - e_{11} [y_{rc}] = 0 \quad (9)$$

$$e_9 [y_{ic} + y_{fc}] - e_{10} \left[y_{ic} + y_{rc} + y_{fc} + y_{oc} + \frac{1}{Z_1} + \frac{1}{Z_2} \right] + e_{11} [y_{rc} + y_{oc}] = 0 \quad (10)$$

$$e_9 [y_{fc}] - e_{10} [y_{fc} + y_{oc}] + e_{11} \left[y_{oc} + y_{ib} + \frac{1}{R_c} \right] + e_{12} [y_{rb}] = 0 \quad (11)$$

$$e_{11} [y_{fb}] + e_{12} \left[y_{ob} + \frac{1}{Z_1} + \frac{1}{Z_2} \right] - e_{13} \left[\frac{1}{Z_2} \right] = 0 \quad (12)$$

$$e_{12} \left[\frac{1}{Z_2} \right] - e_{13} \left[\frac{1}{Z_2} + \frac{1}{R_c} + \frac{1}{R_L} \right] = 0 \quad (13)$$

Additional Applications

This method has also been applied to a 5-stage high gain broadband amplifier (Fig. 8) to obtain its frequency response. The computer solution of the 21 simultaneous complex nodal equations describing the circuit is shown plotted, along with the laboratory measured response, in Fig. 9. Note how well the two curves agree, especially in the immediate region of h-f roll-off. A greater appreciation is had when it is realized that strictly "typical" values of transistor "y" parameters were used in the solution.

Although frequency has been the only parameter thus far varied, it seems equally certain that tabulated values of non-linear elements, such as integrated resistors and capacitors, could easily be handled. For example, tabulated values of expected variations in R_b (Fig. 1) from unit to unit, or as a function of temperature, could be individually introduced into the circuit equations in the same manner that the various transistor "y" parameter values were han-

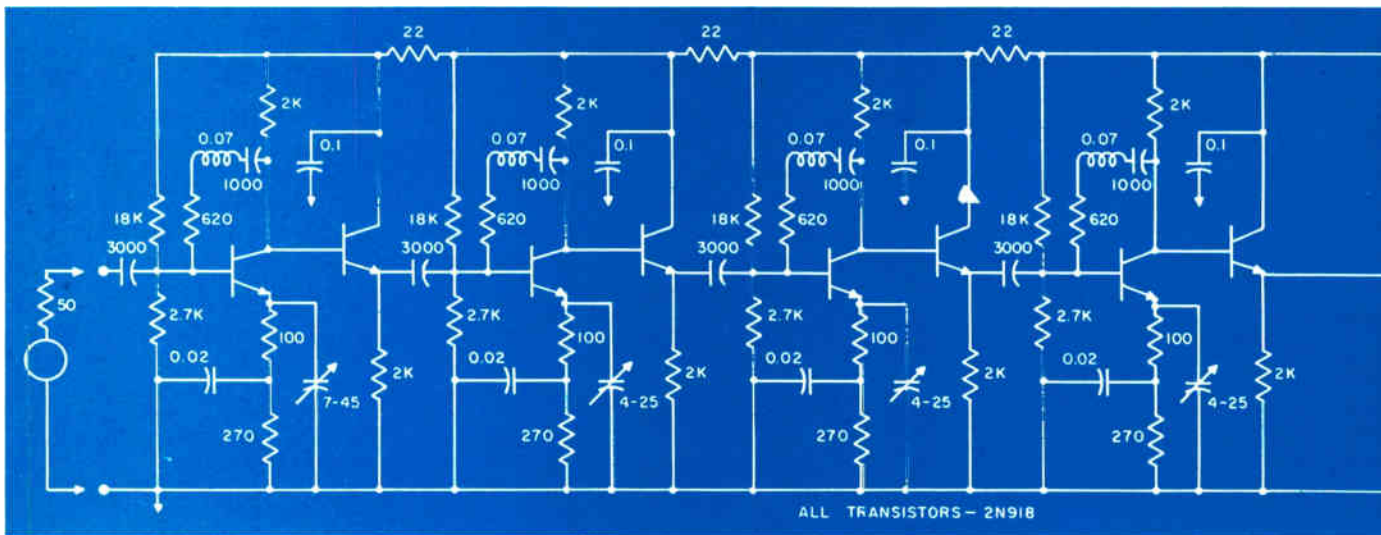


Fig. 8: High-gain broadband amplifier diagram.

CIRCUIT ANALYSIS (Concluded)

dled above. The matrix solution of node voltages could then be obtained with each different value. Sets of parametric curves could thus be generated for evaluation.

Further, since it isn't much work to write the circuit equations, it becomes mathematically simple to handle distributed circuit components as described

by discrete components nets. The discrete representation of an integrated resistor, as shown in Fig. 10, is a typical example. Component values are set by a specific value of reverse junction voltage.

Even though many more nodes have thereby been introduced into the overall circuit, the size of the matrix to be solved is not necessarily increased. This is true because we are not specifically interested in the voltages at these new "conceptual" nodes. A criterion for finding the number of voltages to be

MEDICAL ELECTRONICS (Concluded)

... from page 50

oxygen saturation of blood and heart sound sensors, and the third package the temperature sensors and EEG and the fourth an equipment package. The schedule allows somewhat more time for some of the more difficult sensor developments; more importantly, it allows time for personnel to become thoroughly familiar with the various components.

"The primary function of this Phase I system is to gather data. It will be used both in the laboratory and in flight to gather data on man's physiological condition and performance under normal and stressful environments. Although much physiological data has been recorded in the past, it is believed that this is the first time that all of these parameters have been measured on healthy subjects in operational environments.

"The Phase I system will require the use of signal conditioners. However, the sensors for this system are being selected or designed in such a way that the variety of signal condi-

tioning circuitry is held to a minimum. It is planned, in fact, that with the exception of the use of three different amplification levels, all of the signal conditioners will be identical. The signal conditioning circuitry is being constructed by Lear Siegler using thin film microelectronic techniques. The conditioned signals are compatible with both PCM and FM/FM telemetry systems.

"The Phase II portion of this Flight Research Center contract consists of an advanced statistical analysis effort using data acquired from the Phase I system and other pertinent data. Included in this will be data available at the Flight Research Center from in-flight measurements acquired during past X-15 operations. During this Phase, the Phase I system will be used at Flight Research Center, and if necessary at other locations, to provide a continuing flow of data for analysis. After extensive tests in the laboratory and in flight simulators the sensing system will be used to gather data in flight. It is planned that many flights will be made in F-104B air-

craft, that there will be flights in the Flight Research Center lifting bodies or paragliders, and finally, a series of flights in an X-15. A very tentative flight schedule has been established with flights beginning early next year and continuing well into 1965.

"The purpose of the Phase II analysis is to statistically examine the measured parameters and to identify their interrelationship for use in prediction and decision making. The static and dynamic physiological norms and limits will be determined for normal and stressful environments. The necessity for this is clear from the fact that, for example, pulse rates of 140 beats per minute are normal for pilots in certain phases of X-15 and Mercury flights, but the same rates would be cause for alarm in persons sitting in an audience listening to a dull paper.

"The real objective of the Phase II analysis is to determine the number of parameters which must be sensed and the minimum amount of data processing which must be carried out in the system to be concep-

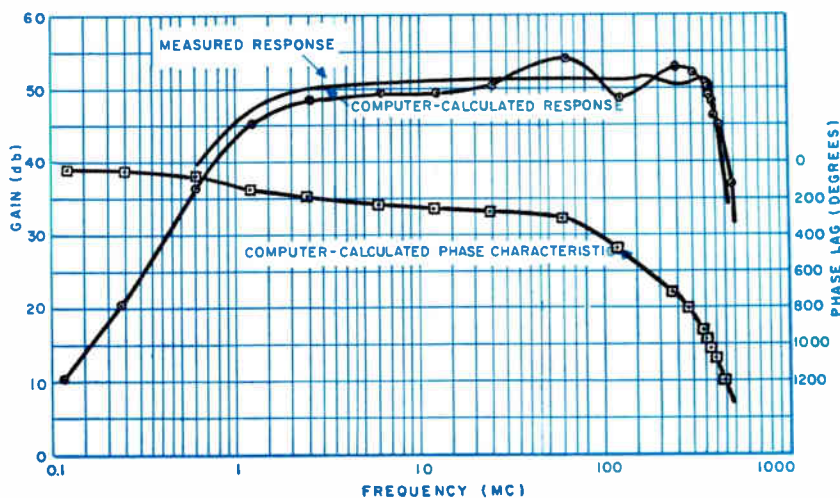
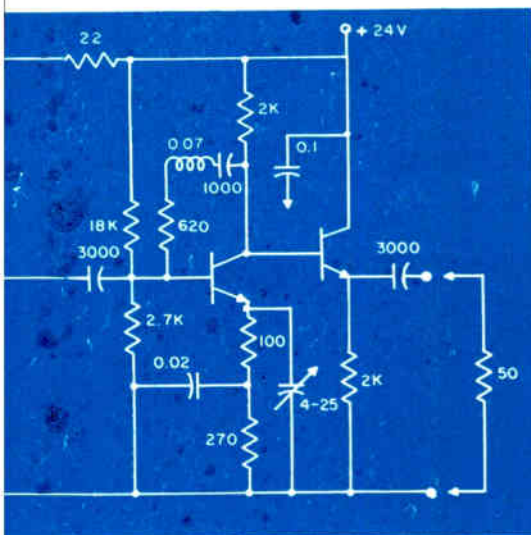


Fig. 9: Amplifier frequency response.

solved in a discrete circuit is to take the total number of separate circuit nodes at the transistor terminals themselves, exclusive of the transistor terminals tied to ground, plus one for the output node if that is a separate terminal.

Conclusions

Although the computer analysis described is fairly simple, the idea of using a computer as a ready made design tool is fairly new to most engineers. This

simple example shows the value of this method in helping integrated circuit designers to achieve the best possible circuit.

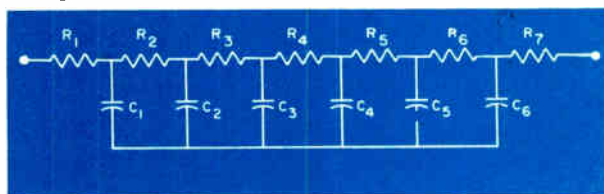


Fig. 10: Integrated resistor equivalent circuit.

tually designed in Phase III.

"It is difficult at this time to say much about the Phase III PIA-PACS since much work remains to be done before it can be defined. It may be assumed, however, that it will consist of several major subsystems, including:

"Sensor Subsystem: This will be a set of microminiaturized, ruggedized and flyable sensors. They will sense those physiological, environmental and performance parameters which were determined to be essential by the Phase I and Phase II efforts and other concurrent analyses.

"Undergarment Subsystem: The undergarment subsystem will be a garment and headgear which provides the means of applying the sensor subsystem to the human subject. The design will be dictated by several factors including the sensor subsystem, anthropometric considerations, and mission requirements.

"Signal Transfer Subsystem: This subsystem will condition the sensor signals to a suitable level and format for input to the computer. It will also transfer them to the computer.

The transfer will usually be accomplished by short range telemetry allowing the subjects to have freedom of movement. For some missions it may be desirable to use hard wiring. This should be an alternate capability of this subsystem.

"Computer Subsystem: This subsystem, which will be microminiaturized, will provide the computational capability for the system. The computer subsystem will incorporate the capability of determining and predicting the subject's psychophysiological state, establishing and performing required adjustments in the environmental control and flight control systems, and provide outputs to drive the display subsystem.

"Display Subsystem: This subsystem will be a selective integrated display which will give the subject access to the required quantitative and qualitative information. This information will include the status of important parameters, the trends in their status of important parameters, the trends in their status, control actions required and the results of control actions. The information will

be displayed in a manner easily comprehensible to and usable by the subject.

"Control Subsystem: This subsystem will accept commands from the computer and in a stable manner will provide signals to the flight control, life support, and environmental control systems. It will be capable of accepting over-riding commands from the subject or from ground stations."

In summary, it is appropriate to restate the purpose of PIAPACS: it is to insure that its user is maintained in a state of peak performance capability. To achieve such a system, we must first establish which are the basic parameters which must be sensed, what are their interrelationships, and how may their values and relationships be used in a control system. A prerequisite for determining these is the collection of adequate data for analysis. A program of research to work its way through this chain to the design of a Psychophysiological Information Acquisition, Processing and Control System has been started. P. G.

CRYSTAL FILTER DESIGN CONSIDERATIONS

Crystal filters provide good discrimination and stability and are the practical solution to many systems problems.

This article provides a basic understanding of the theory of operation of designs ranging from simple to complex.

The "sections" discussed here can be designed to meet most band-pass, band-reject or single sideband specifications as needed.

USERS OF CRYSTAL FILTERS are often not aware of the type of network contained in the filter "blackbox." An understanding of the makeup of these networks is thus necessary.

Crystal filter synthesis is based primarily upon the symmetrical lattice network, Fig. 1. The Z_a and Z_b series and shunt impedances are assumed to be pure reactances. The frequency range in which Z_a and Z_b have opposite signs defines the filter passband. And, the range in which Z_a and Z_b have like signs is the stopband region. Attenuation reaches infinity when $Z_a = Z_b$.

The balanced form of the Symmetrical Lattice Network is, in most cases, not desirable. Fig. 2 shows an equivalent network in the unbalanced form which has the same transfer features as the lattice. A high degree of coupling between transformer secondaries is needed to insure equivalence.

The degree of complexity of the Z_a and Z_b reactances is directly related to the filter frequency response needs. Passband width, stopband attenuation, skirt selectivity and stability are a few of the items needing consideration before the filter design is started.

A narrow band filter with high stopband attenuation may be realized by cascading many Hybrid Equivalent Networks, each having one crystal in each of the Z_a and Z_b impedances. Ultimate attenuation of the cascaded sections will be nearly the sum of the attenuations of the individual sections. It is generally more advantageous to increase complexity of the Z_a and Z_b arms to avoid the need for cascading many simple sections. This is due to interaction and mismatch between sections, along with increased tuning difficulty.

Referring to Fig. 3 as a two-pole network and assuming that a specific set of filter specs can be met by cascading four of these sections, it is obvious that a minimum of four transformers will be needed. Four sections would result in a total of eight poles. The quantity of transformers and sections would lead to tuning difficulty and may create production problems. The same ultimate attenuation and other desired frequency response features could be had by increasing the complexity of the Z_a and Z_b arms. By adding

another crystal in each of the equivalent-lattice branches, making a total of four crystals per section (Fig. 4), the same frequency response could be obtained with two sections. Where possible, it is desirable to hold the number of cascaded sections to two. Using more sections enhances mismatch possibilities and increases needed alignment time.

The Simple Section

Fig. 3 shows what is called the Simple Section. All discussions will be relative to its performance.

Looking at Fig. 3 on an impedance basis, it is possible to illustrate network operation. By referring to Fig 5, it is obvious that the start of the passband coincides with an impedance-zero and ends with an impedance-pole. Center of the passband is the point of coincidence for a pole and a zero.

Passband limits are defined by the frequencies f_1 and f_2 . The lower limit, f_1 , is defined by the crystal frequency of Z_a whereas the upper limit, f_2 , is defined by the pole frequency of Z_b . " f_1 " is thus fairly well defined after assigning a value to the series frequency of the crystal in the Z_a arm. " f_2 " depends upon the inductance values and other parameters associated with coils or transformers used as part of the network. In general, where an impedance pole defines a passband limit, there is some dependency upon other network elements for stability of that point.

Cascading a number of these sections results in alignment problems and strict needs for other network components. Frequency changes in the crystals have a direct affect on the filter frequency response. If the Z_a frequency were to increase, the bandwidth would be narrowed. If the Z_b frequency were to decrease, the bandwidth would again be narrowed. The converse is also true. The above cause-effect relations are not meant to cover every possible change that would result due to a change in either of the impedances.

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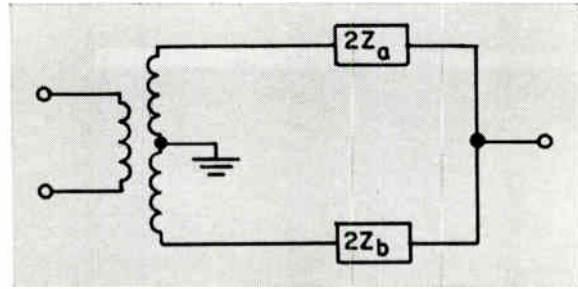
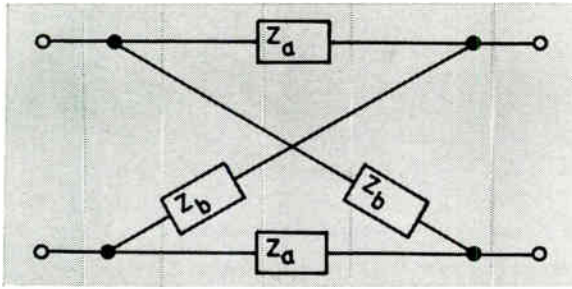


Fig. 1:
Symmetrical Lattice Network
(above left).

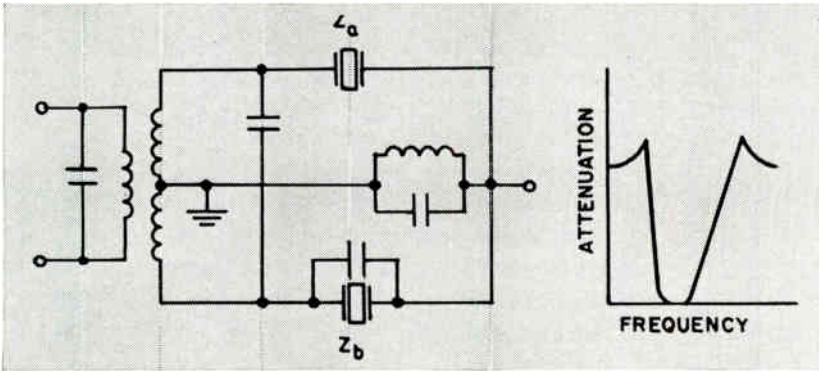
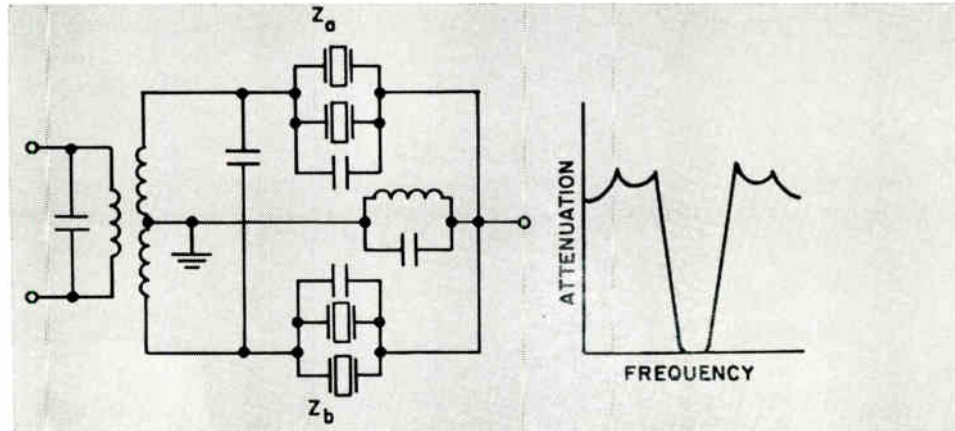


Fig. 2:
Hybrid Equivalent Network
(above).

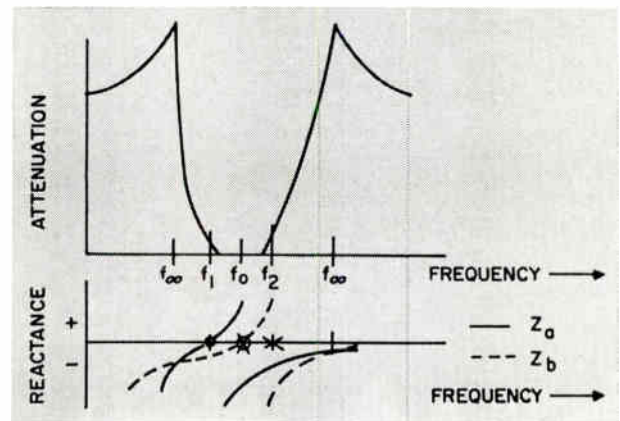
Fig. 3:
Far left is the schematic
for the Simple Section.
Frequency Response curve
is to the right of it.

Fig. 4:
Four Pole Network
schematic (right).
Frequency Response curve
is at the far right.



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Fig. 5: Crystal Reactances
relative to filter performance.



More-Complex Sections

By adding crystals to the Z_a - Z_b impedances, it is possible to more reliably define the passband limits and to obtain a greater ultimate attenuation per section plus a greater percentage bandwidth. Adding crystals also makes it possible to reduce the number of coils and/or transformers which may be needed due to cascading a number of simple sections. Although this may appear to result in a complicated network, the operation is about the same as the simple section.

Fig. 6 illustrates the network operation and the similarity of the schematic compared to the Simple Section. For this scheme, the impedance-zero located in the Z_b arm is critical relative to the shape of the skirts. Movement of this 'zero' upward or downward in frequency will give the response curve asymmetrical characteristics, i.e., one of the skirts will

become steeper than the other and result in a single side band characteristic. Frequency response on the "steepest-skirt" side will have a reduced stopband attenuation. This is due to the introduction of a transmission zero resulting from misplacement of the Z_b impedance-zero. This often undesirable effect could be caused by aging and/or drift in frequency of crystal Y2. *(Continued on following page)*

CRYSTAL FILTERS (Concluded)

The four-crystal section shown in Fig. 4 is slightly different in performance. Here there are also impedance-zeros at the passband limits, but none at the center of the band. This network has alignment advantages over the three-crystal section. The upper or lower skirt may be steepened individually through proper alignment and the circuit of Fig. 4 has better out of band discrimination than that of Fig. 6. The best discrimination is obtained when a plot of the frequency response yields a curve symmetrical about the center frequency (the same is true for the three-crystal section).

Adding still another crystal will provide more freedom in network synthesis and result in a circuit with many production advantages. Some of these advantages are: (1) skirt selectivity, (2) out-band rejection, (3) stability of rejection, and (4) high attenuation achieved with fewer cascaded sections resulting in the use of fewer coils and/or transformers.

Skirt selectivity, or steepness, is related to the location of the impedance zeroes in the passband. Shifting the frequencies of Y2 and Y4 will move the pole frequencies and alter the minimum stopband attenuation, Fig. 7. Maintenance of good rejection is dependent upon the out-of-band balance, impedance-wise, between Z_a and Z_b . In this setup a

crystal can shift in frequency and the resulting unbalance will not be extremely significant. This is because the balance is determined by the equivalent shunt capacitances in each of the impedance arms.

Frequencies of the Y2 and Y4 crystals affect the steepness of the skirts, as previously mentioned. To insure long term steepness and good stopband selectivity, these frequencies can be located in a manner such that drifts due to aging and temperature have little effect on the overall frequency response. For example, placing the peaks of attenuation at infinity in the synthesis stage locates these two zeroes of impedance such that the frequency response is stable and least affected by drift. Two sections of this type will more than satisfy 60db ultimate rejection features, have excellent selectivity and built-in insurance against the effects of frequency drifts.

Passband limits are well defined. There is only one requirement imposed on the network relative to meeting long term bandwidth needs. That requirement is that crystal aging be within the tolerance of the bandwidth tolerance. The greatest percentage of crystal aging takes place within the first 30-60 days of operation. By pre-aging the crystals at an elevated temperature, stabilization is improved and long term aging is reduced. Pre-aging of filters eliminates the shipment of questionable units. This is because adverse drift characteristics due to an unreliable unit are apparent after reviewing the data gathered during the inspection period.

Fig. 6: Three-Crystal Section scheme and Reactance vs. Filter Response.

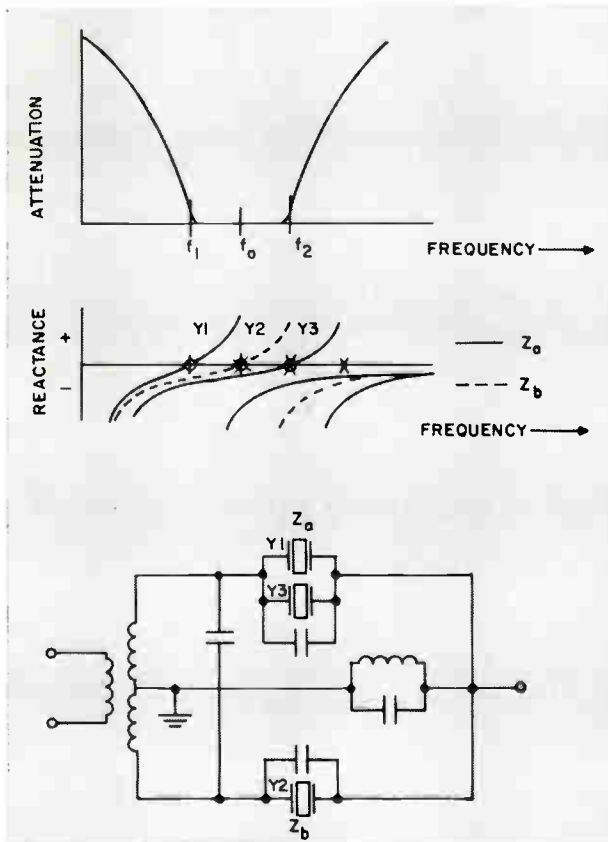
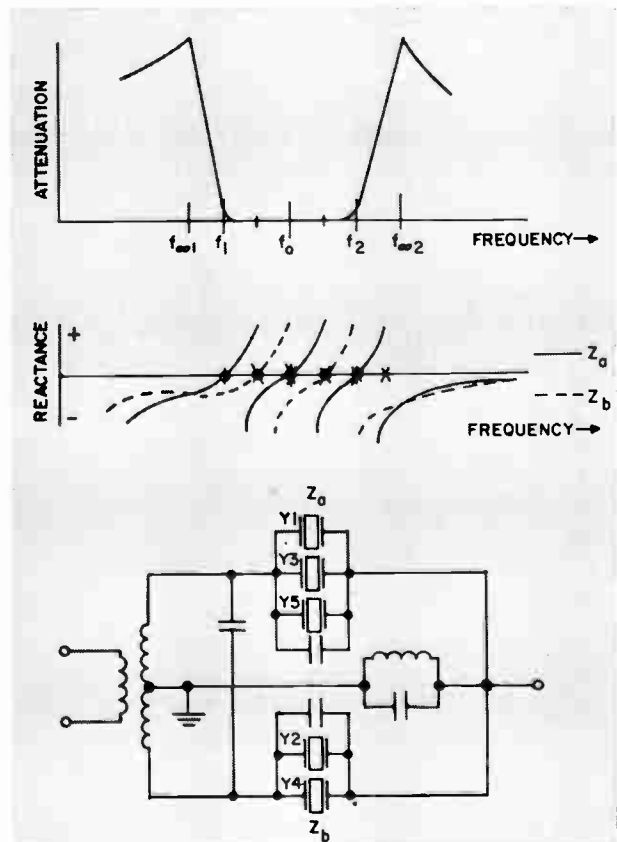


Fig. 7: Five-Crystal Section scheme and Reactance vs. Filter Response.



SOME APPLICATIONS FOR NEON-PHOTOCELL UNITS

Neon-Photocell combinations offer significant advantages in economy, long life and low noise. Because of these features they are finding increasing use in a variety of applications. Their use as switches and variable resistances is discussed here.

By **EDWARD BAUMAN** and **D. WHATELEY**

Vice President, Engineering
Signalite Inc.
Neptune, N. J.

Applications Engineering Laboratory
Raytheon Co.
Lexington, Mass.

MANY USES ARE BEING FOUND for electro-optical components which consist of a neon glow lamp and a photoconductive device in a light-tight casing. Because of the advantages of economy, long life, low maintenance and low noise, this type of unit is finding increasing use as a switch and as a variable resistance. These devices and some of their uses are discussed here.

* * *

The light output and spectral distribution of certain neon glow lamps are compatible with photosensitive polycrystalline semi-conductors such as cadmium selenide and cadmium sulphide. For many uses the low power consumption and speed of response of a neon glow lamp makes it the ideal light source for use with the photocell.

Basically, these devices operate on the principle that any variation of input current to the lamp alters the illumination incident on the photocell and changes its resistance. As a result the voltage across a fixed resistance in series with a signal voltage and the photocell can be changed by altering the input current to the light source.

Photocells have two response speeds which govern their use. These are their turn-on and turn-off responses. In neon lamp-photocell devices, the speed of response is limited to that of the photocell. This is because the glow lamps can react faster than the photocells.

Among the Raysistors (R), developed and produced by Raytheon Co., are neon glow lamp-photocell combinations which are designed to be used as a single component to perform a specific function. Working closely with Signalite, three primary requirements for performance of the glow lamps were established. Because the Raysistor is a closed, encapsulated unit, the lamp had to fire reliably in a dark

environment. For practical use, a high ratio of conversion of current to light was needed. And, because replacement of parts in the Raysistor was not compatible with its design purpose, the lamp had to have a long effective life.

A special lamp (type A240954) developed by Signalite, was based on use of some of the recent developments in the design of gas discharge devices. Among these are special radioactive elements, new gas mixtures, electrode design, and others. These developments have made it possible to establish new standards for neon glow lamps for use as electronic circuit components. These standards are not based on adapting indicator lamps to performances for which they are not suited.

(Continued on following page)

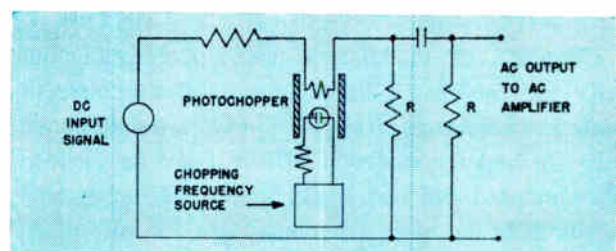


Fig. 1: Series modulator circuit.

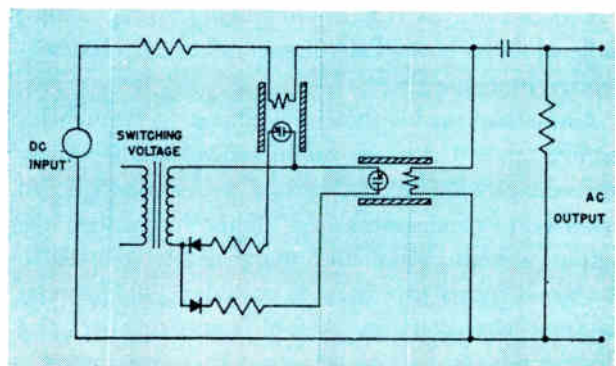
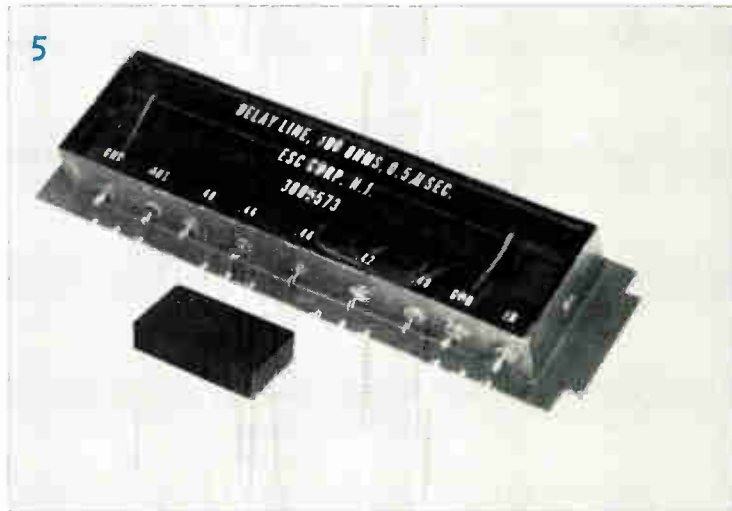
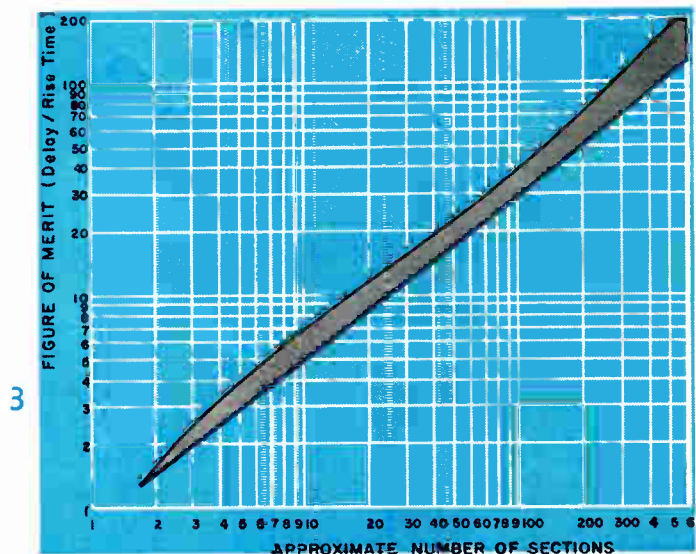
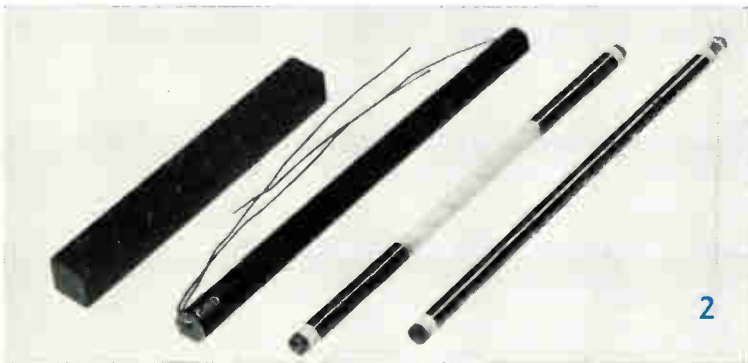
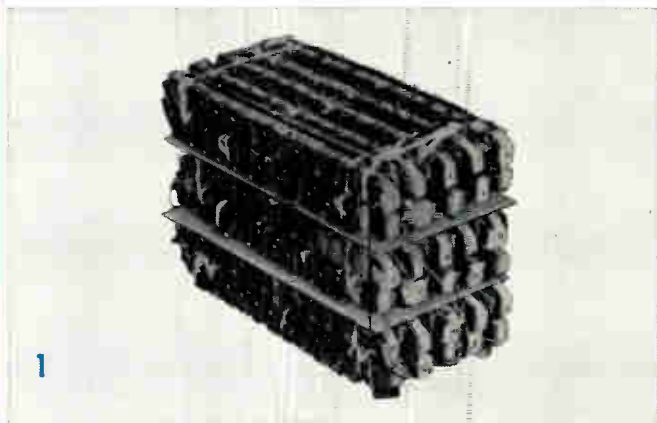


Fig. 2: Series shunt modulator circuit.

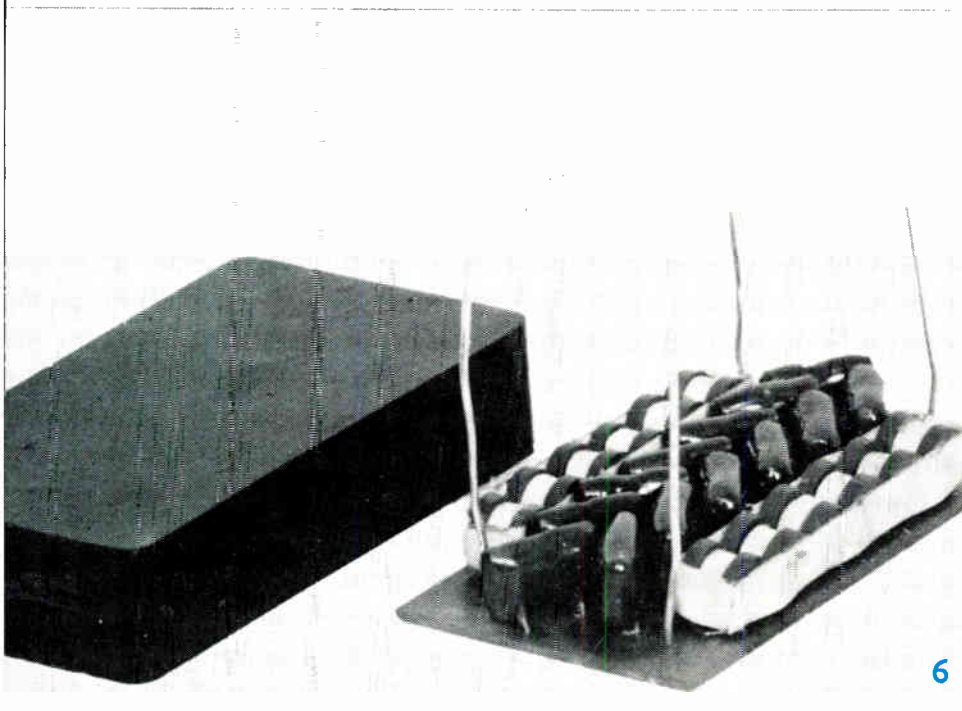
ELECTROMAGNETIC DELAY LINE PROGRESS

This state-of-the-art article discusses the progress that has been made in electromagnetic delay lines since World War II. It covers the construction, features, applications and future of the various types of delay lines. Also discussed are the latest EIA specifications for delay lines.

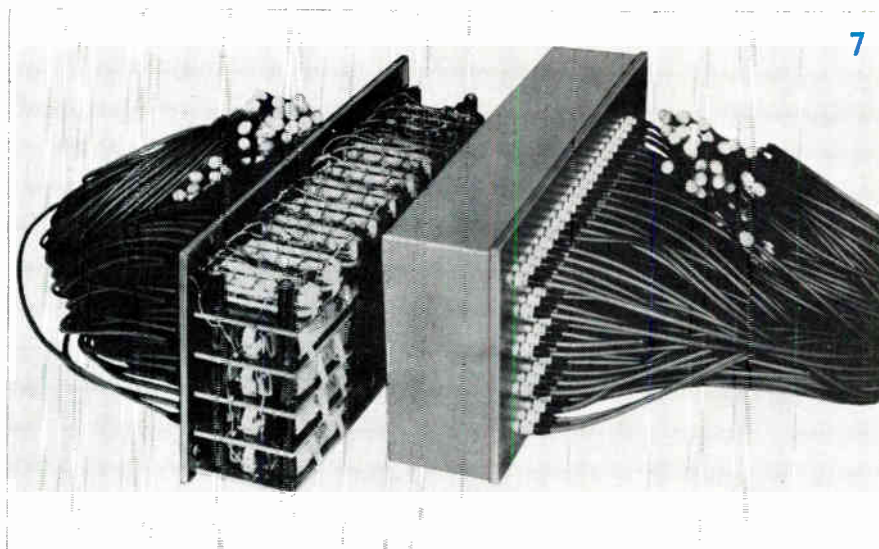


By **STANLEY S. PACKER**,
 Vice President,
 ESC Electronics Corp.,
 534 Bergen Boulevard,
 Palisades Park, N. J.





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- Fig. 1: Assembly of coils and capacitors for a relatively large delay net. To insure reliability, these assemblies are generally sealed into a case and potted in a foamed resin.
- Fig. 2: Two methods of packaging a distributed constant delay line. Cylindrical units are for clip or clamp mounting while the rectangular units lend themselves to PC board mounting.
- Fig. 3: Curve depicts delay line elements (one coil and one capacitor/section) needed to achieve a given figure of merit.
- Fig. 4: Two ATC transponder delay lines have about the same characteristics. Smaller one has helped reduce equipment size.
- Fig. 5: Two computer delay lines with about the same features.
- Fig. 6: Computer delay line before and after encapsulation.
- Fig. 7: Complex multi-tapped delay line for a special use.

ALTHOUGH PRIOR KNOWLEDGE EXISTED, it was not until World War II that the use of electromagnetic (EM) delay lines, as well as other types, expanded. The major use was in radar and associated instrumentation. Delay lines were thus widely used during the war. Following this period, the expansion of technology into the time domain concept in electronics greatly increased and the need for delay lines of all types grew proportionately. Basically, radar and computers have since comprised the greatest markets for EM delay lines. Complex combinations and extensions of these uses continue to comprise the most important segment of the market. Most uses involve pulse circuitry while others, which essentially constitute signal phasing devices, are of lesser importance in relation to the total market.

Types

There are essentially two types of EM delay lines; the lumped constant delay line which is usually a low pass m-derived filter consisting of discrete coils and capacitors and the distributed constant type which is actually a wound inductor with a shunt capacity distributed along its length. An extension of the latter concept is a coaxial cable, which, in some applications, is still being used for short delays where maximum bandwidth at minimum cost is most important. Since a coaxial cable will generally occupy a good deal of space, size must not be a major factor. Fig. 1 shows an assembly of coils and capacitors for a relatively large network. The use of magnetic cores to achieve high Q, and silvered mica capacitors, is evident. To insure reliability, assemblies of these types are generally sealed into a case and potted in a foamed resin. Fig. 2 shows two methods of packaging a distributed constant delay line. Cylindrical units are supplied for clip or clamp mounting. Rectangular units lend themselves to printed circuit (PC) board mounting. Unencapsulated delay line rods are also shown. Construction is simply a dielectric tape wound over a silver glass rod

EM DELAY LINES (Concluded)

(ground plane) followed by the magnetic winding. Leads are then added prior to encapsulation.

Development in the Art

The state-of-the-art in delay to rise time ratio that may be achieved under practical conditions is about 180. Most uses, however, are limited because of cost and size to less than 100. Efficiency in design is pursued constantly. Thus, a minimum number of components to achieve necessary bandwidth or delay to rise time ratio is sought. Fig. 3 is a curve depicting the needed delay line elements (one coil and one capacitor per section) to achieve a given figure of merit. The apparent range in sections for any one figure of merit is a function of the Q of the components.

Over the past decade, because of improvements in components and technology, volume has been reduced about 10 to 1. New magnetic materials and smaller capacitors were partly responsible for the reduction. Fig. 4 shows two ATC transponder delay lines with about the same features. The smaller one, developed within the last few years, has helped reduce airborne equipment size. Fig. 5 shows the progress in size reduction of two computer delay lines, each with about the same features. Fig. 6 shows the smaller unit before and after encapsulation. Other delay lines, commonly available, may be referred to as a miniature size but are generally characterized by relatively short delay. Delay lines in the nsec. region, by virtue of their requirements for small inductance and capacity, will, by this very nature, occupy little space. A tabulation of a typical series of nsec. delay lines provided for PC board mounting, is included in this article.

In spite of the reduction in size, the delay line today is characterized by its large size relative to other circuit components. Not unusual in present equipment is an assembly consisting of sub-miniature solid state components dominated by a

large "black box"—the delay line.

Nature of the Market

Air navigation and traffic control systems, missiles, computers and ASW projects and related equipments are the major end equipments using EM delay lines. Other than these, a continuous flow of special devices in limited quantities typifies many military and industrial electronics needs. Fig. 7 is a photograph of a typical one-of-a-kind requirement for a complex multi-tapped delay line.

Variable delay lines from miniature nsec. units to switched msec. devices comprise another segment of the EM delay line field. Changes in these devices have been limited by the nature of the components themselves. Some work has been done in electrically controlled variable delay lines, but these devices have had limited acceptance. This is due in part to the expense and the relatively small delay variation available. Other problems facing these devices involve a characteristic high residual delay, variable impedance and attenuation and high component cost. Fig. 8 shows a typical group of mechanical-variable delay lines.

Future of EM Delay Lines

With the improvements in reliability of solid state circuits, the inherently reliable passive delay line will find less application in circuits where delay in digital uses may be achieved electronically. This change is particularly noted in the nsec. delay regions.

Quartz, glass and magnetostrictive delay lines have also supplanted EM delay lines in some cases, but mainly in those areas where the state-of-the-art, already being pressed, precluded their use for reasons of size and cost. For example, for short time storage of many bits of digital information, magnetostrictive or glass delay lines are much smaller and cheaper than EM delay lines.

The search today places particular emphasis on economics. Strides are being made in the automation of assembly and packaging, to a greater

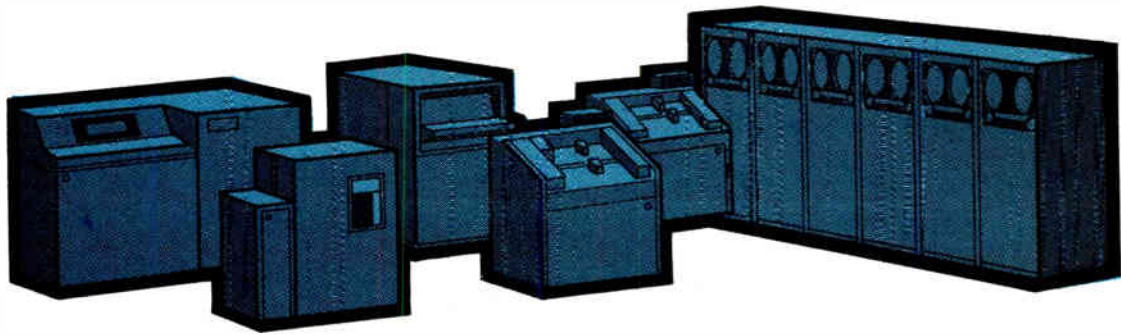
extent than in pushing forward the ability to achieve complex designs. Miniaturization, although important, is secondary to the needs of cost reduction. Developments are pursued in their order of considered importance in the following way:

- (1) Cost reduction (improved design and production methods).
- (2) Size reduction.
- (3) Improved packaging.
- (4) Miscellaneous devices.
- (5) Extension of delay to rise time ratio or delay-bandwidth products.

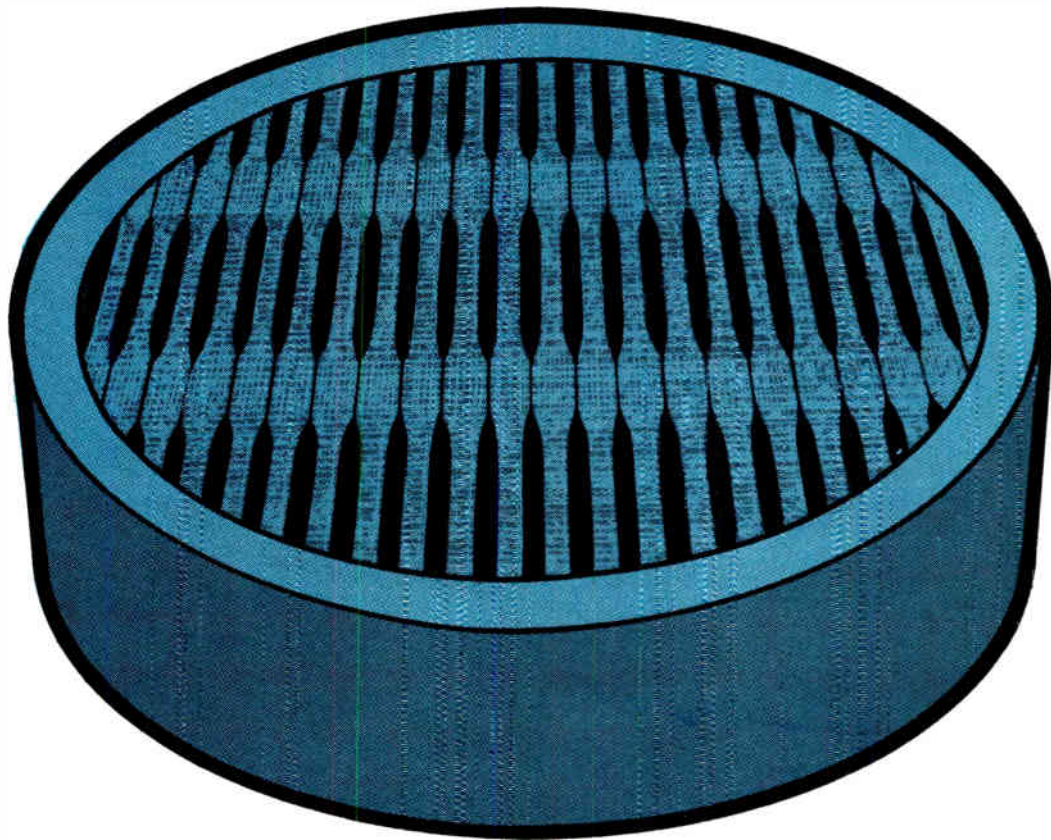
Other Developments

About two years ago, Electronics Industries Association released its Standard RS242, Definitions for Electromagnetic Delay Lines. The four page document, at long last, sets down terminology to be used in specifying pulse delay lines. The standards, which include pulse diagrams, are of interest in that they assist the engineer in his preparation of a complete specification, avoiding the pitfalls involved in omission or misinterpretation.

The EIA committee which prepared these standards, in conjunction with the military went on to prepare a complete spec which has recently been released as MIL-D-23859 and is entitled "Delay, Lines, Pulse, Electromagnetic, Fixed, General Specifications For." The document extends the usefulness of the EIA RS242 Standards by adding standards for environmental needs and other features relating to pulse delay lines. A system of type designation has been formed. A series of standard case sizes identifying delay line style will soon be added. Some detail sheets are now in preparation and are expected to be included in the future. A future task of the committee now being considered as an addendum to the MIL Spec, is a group of test procedures which will assist the engineer in the preparation of his spec and will also provide helpful information to the designer and spec writer. Copies of MIL-D-23859 are available from Naval Supply Depot, 5801 Tabor Ave., Phila. 22, Pa.



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Magnetic Definitions

Bulletin 110, contains 12 pages of magnetic definitions, including mathematical derivations, of the most commonly used terms applied in the design of magnetic devices. In the general sections of this bulletin, terms relating to flux, induction, magnetic field, permeability, inductance, and losses are defined. A memory-core section is also included in which terms particular to pulsed, sq. loop application of magnetic materials are defined. Ferroxcube Corp. of America, Saugerties, N. Y.

Circle 210 on Inquiry Card

High-Power Varactor

A varactor-diode, Model 1N4387 is capable of supplying up to 15w. output at freqs. as high as 600mc. It will triple 40w. of 150mc input power to 450mc with a typical efficiency of about 60% and maintain this efficiency at input power below 10w. Additional data available from Motorola Semiconductor Products, Inc., P. O. Box 955, Phoenix 1, Ariz.

Circle 211 on Inquiry Card

Research Reports

"EPR at Work" consists of 33 research reports in a 16-page booklet. The reports represent significant original contributions to the art of applying electron paramagnetic resonance phenomena to basic and applied research in physics, chemistry, biology and medicine. Analytical Instruments Div., Varian Associates, 611 Hansen Way, Palo Alto, Calif.

Circle 212 on Inquiry Card

Panel Boards

GEA-6737A is a 2-color bulletin describing Types NL7Q, NLAB, and DB panel boards. This publication describes in detail selection information, dimensions, features, and application data for these three panelboard types rated 240vac with max. 600a. mains and 15a. through 100a. branch circuit breakers. Distribution Unit, General Electric Co., 41 Woodford Ave., Plainville, Conn.

Circle 213 on Inquiry Card

Cable Assemblies

This comprehensive brochure, "How to Design and Specify Cable Assemblies and Coaxial Delay Lines for Interconnecting Systems," systematically breaks down all the parameters in a step-by-step form. It is divided into 2 sections: the first deals with specs. and design of cable assemblies; the second, with specs. and design of coaxial delay lines. The brochure not only spells out the specs. but details all of the design possibilities. This is followed with evaluation and production procedure information. Times Wire & Cable, div. of International Silver Co., Hall Ave., Wallingford, Conn.

Circle 214 on Inquiry Card

Low-Voltage Supply

This compact low-voltage power source is designed for use with microscope and projection illuminators and accessories. Two models are available, each of which provides a source of low-voltage ac power from a standard 115v. 60-cycle outlet. Model 9099 supplies a fixed 8.5v., 4a. ac output. Model 9094 provides stepped output of 5v., 6v., and 6.5v. ac at 2.75a. Stocker & Yale Inc., 28 Green St., Marblehead, Mass.

Circle 215 on Inquiry Card

Trimmer Resistor

Data is available on a new low-cost miniature knob-operated carbon-trimmer variable resistor. Series 201 has a wide resistance range and is intended for PC preset trimmer applications. Resistance range is from 250Ω through 2.5 megohms linear taper; power rating is 1/8w. @ 85°C; and voltage rating is 350vdc across end terminals. CTS Corp., Elkhart, Ind.

Circle 216 on Inquiry Card

Blank Plug-in Cards

These circuit cards can be used to fabricate circuits in development of production work. The 15 or 22-pin cards, whether epoxy-glass or paper phenolic, have hundreds of soldering pads for component leads and interconnecting wire jumpers. Transistor pads are located over the entire card to simplify circuit fabrication. For complete data write for Bulletin 10000. Plug-in Instruments, Inc., 1416 Lebanon Rd., Nashville, Tenn.

Circle 217 on Inquiry Card

Relay Fact File

"Can a current-type relay be used on dual-voltage motor applications?" and "Is it possible to apply a current relay to any motor?" are among 10 questions discussed in a new fact file. Besides answering such questions, the file, CP-9, provides detailed descriptions of Klixon® motor starting relays. These include relays for split-phase and capacitor-start motors in single-phase ac applications with starting circuit loads up to 25a. The data is being offered by Metals & Controls Inc., div. of Texas Instruments Incorporated, 34 Forest St., Attleboro, Mass.

Circle 218 on Inquiry Card

Infrared Scanning Radiometer

The Thermoscan is an infrared scanning camera using an indium antimonide detector thermoelectrically cooled. Its high-speed scanning time of less than 1 min. makes it suitable for research and production control. The unit detects a 0.2°C differential on an object that is at 30°C. At higher temp., smaller differential temp. can be detected. Additional data available from Infrared Industries, Inc., Santa Barbara, Calif.

Circle 219 on Inquiry Card

Support Systems

A new brochure, "Support Systems," encompasses technologies, applications and functional examples of support equipment. Text and illustrations cover support equipment involving hydraulic, pneumatic and electromechanical technologies as applied in aircraft, space and oceanographic programs. Aerospace Div., Walter Kidde & Co., Inc., Belleville, N. J.

Circle 220 on Inquiry Card

Modulation Chart

A modulation chart, which shows the Percentage Modulation vs Switching Ratio, is available from Somerset Radiation Laboratory, Inc., Box 201, Edison, Pa. Values from 0-60 db are given.

Circle 221 on Inquiry Card

Memory Device

Data is available on a new wide-temp.-range transfluxor, believed to be the first device of its kind to make possible non-destructive-readout memory systems with complete cycle times of 2μsec. The RCA 0154M5 transfluxor is capable of operating without current compensation or peripheral temp. control over the full range of military environmental temp. needs. It is particularly suitable for use in high-speed, non-destructive-readout ferrite memories in missiles, supersonic aircraft and space vehicles. This device offers full memory-cycle times as low as 2μsec. in word-address systems. RCA, Receiving Tube & Semiconductor Div., Needham Heights, Mass.

Circle 222 on Inquiry Card

How Relays Operate

A new booklet entitled, "How Magnetic Latching Relays Operate" discusses the construction and vital parts of magnetic latching relays. It is illustrated and accompanied with a brief description of the assembly and the relation to magnetic flux developed in the relay. A step-by-step description and illustrations detail the movement of a magnetic latching relay from power-off, power-on to power-off condition. Sigma Instruments, Inc., Braintree, Mass.

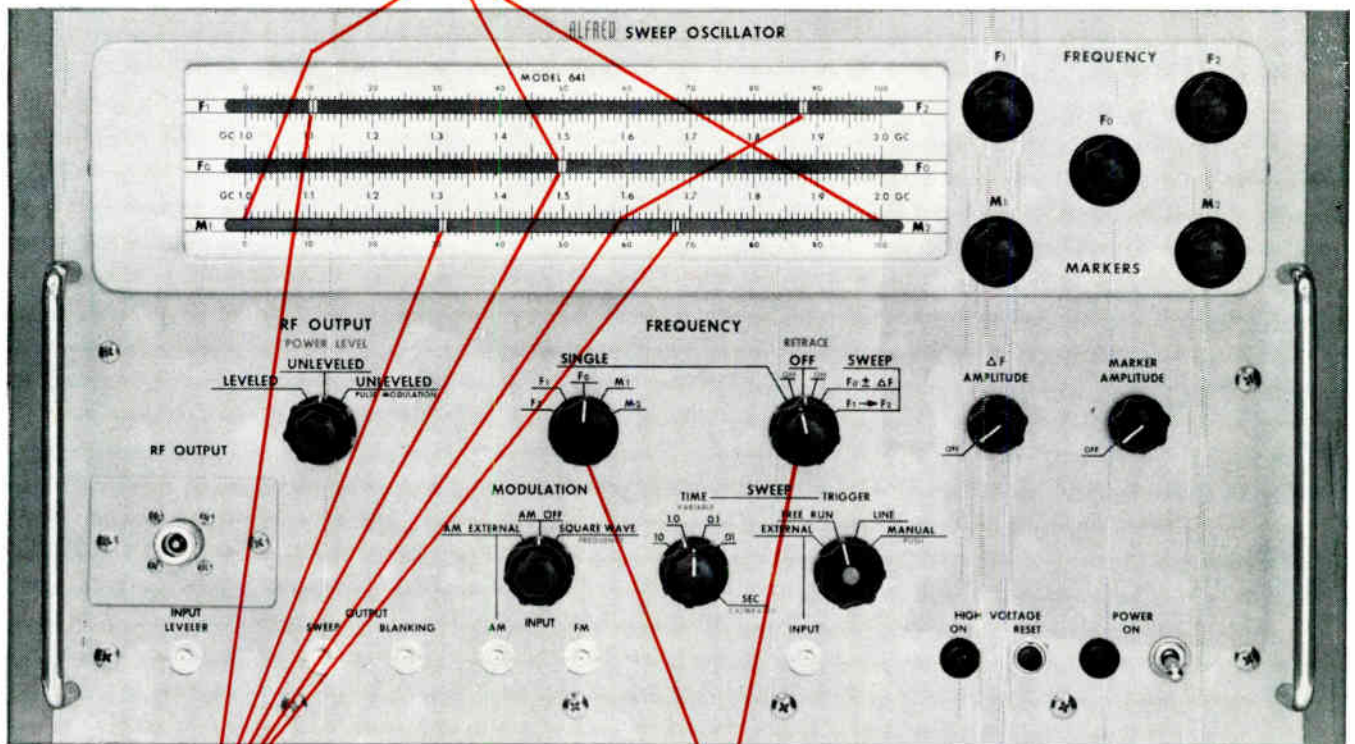
Circle 223 on Inquiry Card

Integrated Circuits

Data sheets describing an integrated circuit for volume commercial use have been issued. The circuit, RC-124, is a dual NOR-gate produced by the silicon planex process, and it is available off-the-shelf. For use in direct coupled transistor logic systems, this commercial integrated circuit comes in the standard TO-5 package or optionally in the flat package called the RC-144. Literature lists all specs. Raytheon Co., Semiconductor Div., 350 Ellis St., Mountain View, Calif.

Circle 224 on Inquiry Card

Multiple frequency markers allow frequency calibration with 3 markers during broadband sweep and 2 during symmetrical sweep.



Five single frequency settings simplify and speed component evaluation. Choose stable, clean CW or modulated single frequencies at F_1 , F_2 , F_0 , M_1 , and M_2 . Sweep for qualitative analysis and measure precisely at end frequencies (F_1 , F_2) and 3 intermediate frequencies (F_0 , M_1 , M_2).

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Separate F_0 control independent of $F_1 \rightarrow F_2$ allows switching from broadband sweep to symmetrical sweep without "disadjusting controls."

New Sweep Oscillators, 1 to 40 Gc

This is the face of the new Alfred 1 to 40 Gc sweep oscillator. Alfred 640 Series Sweepers offer the cost-conscious engineer the best price-performance ratio.

Features include: internal or external leveling with wide control range, retrace blanking at all sweep speeds for scope or recorder operation, accurate manual sweep, solid state design, 50 to 400 cps operation, ruggedized construction. Ask your Alfred representative for a demonstration.

	Frequency Range	Power Output	Leveled Power Variation	Residual FM	Price
641	1 - 2	100 mw	*	25 kc	\$3,050
641K	1 - 2	70 mw	± 0.5 db	50 kc	\$3,290
642	2 - 4	70 mw	*	25 kc	\$2,850
642K	2 - 4	50 mw	± 0.5 db	50 kc	\$3,090
643	4 - 8	20 mw	*	50 kc	\$2,850
643K	4 - 8	20 mw	± 0.5 db	75 kc	\$3,190
645	8 - 12.4	20 mw	*	75 kc	\$2,990
645K	8.2 - 12.4	10 mw	± 0.75 db	100 kc	\$3,390
647	12.4 - 18	10 mw	—	100 kc	\$3,350
648	18 - 26	5 mw	—	300 kc	on request
649	26 - 40	5 mw	—	350 kc	on request

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Used by more engineers than any other commercial laboratory oscilloscope, the Type 545A became the standard of the industry.

User suggestions and research innovations helped it grow and develop into the world's best known laboratory oscilloscope—through five years as the Type 545, another five years as the Type 545A.

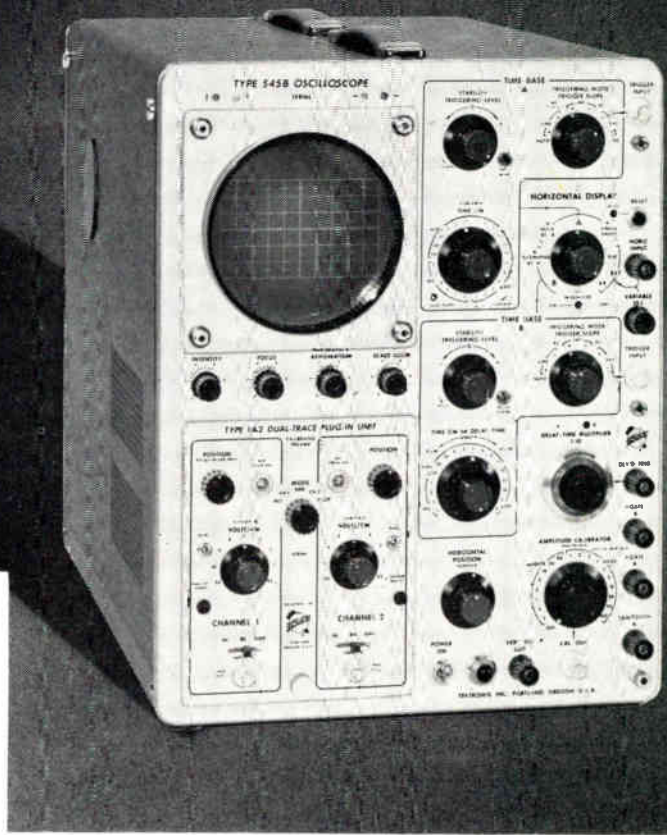
Over the years, better circuit components and design techniques led to simpler operation and application, greater accuracy and reliability, easier maintenance and calibration.

Seventeen amplifier plug-in units were developed to provide quick adaptability for particular applications. Other features were added or improved to update performance specifications.

With the dual-trace unit, the Type 545A provided 50 mv/cm sensitivity for a wide range of dc-to-24 Mc applications.

Further updating of the "A" Model to implement additional improvements has resulted in a new "B" Model—as the "A" Model was developed from the early Type 545.

So, now, the Type 545A is superseded by the Type 545B. Instrument support will continue to be available for the "A" Model, however, for at least 10 years.



Here is the improved Type 545B at \$1550.

Looks about like the Type 545A. But added capabilities and convenience further enhance its value.

New crt. Internal no-parallax illuminated graticule. Improved resolution, uniform focus over the full 6-cm by 10-cm (50% greater) display area. New hybrid vertical amplifier—greater stability and reliability. Fixed-tuned delay cable, prevents misadjustments. Triggering beyond 30 Mc. Sweep delay, single-sweep, other features and refinements that equal or excel those of the present "A" Model.

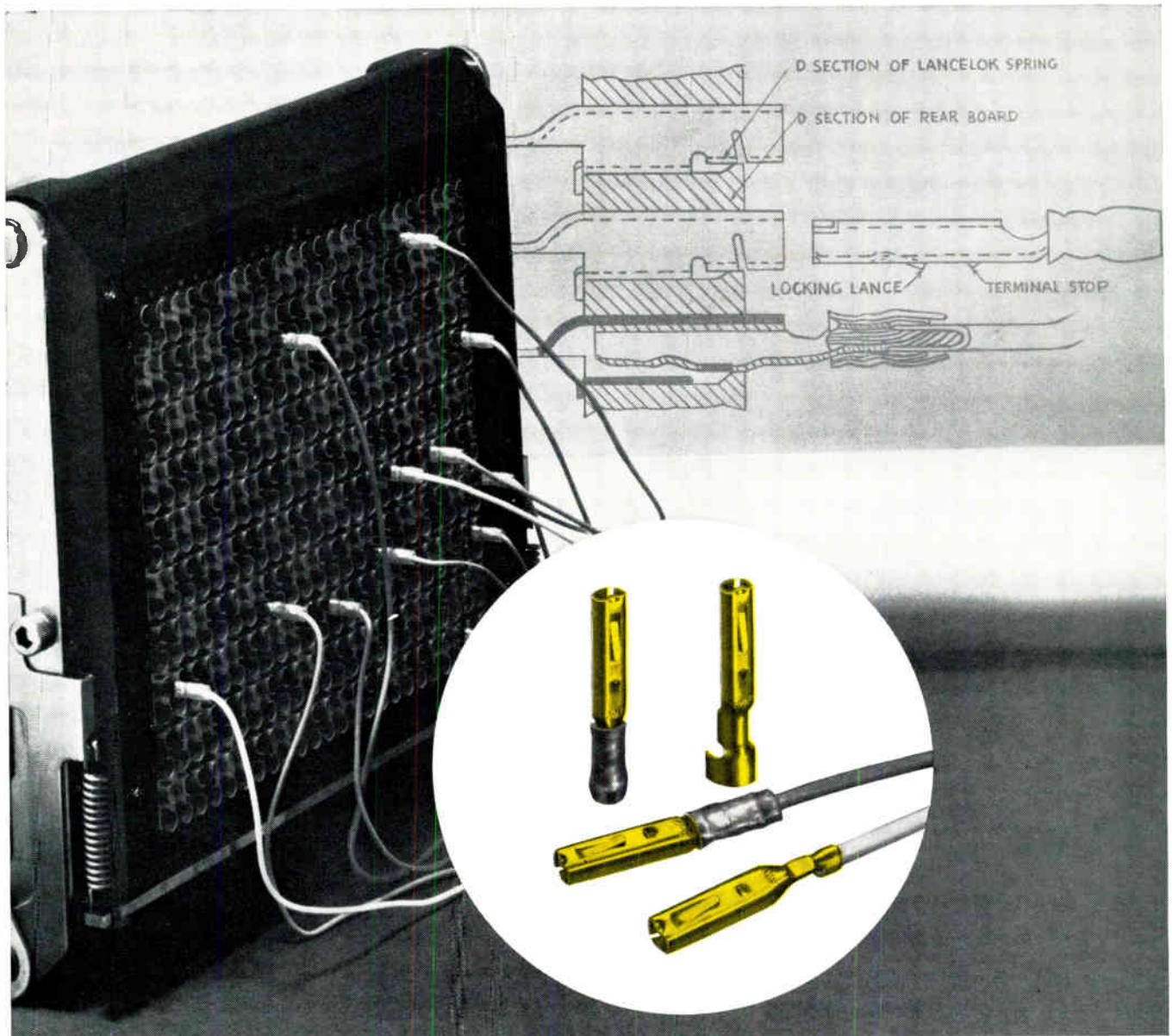
Use all your Tektronix Type A to Z Plug-In Units at equal or better frequency response, or the new Type 1A1 or 1A2 Dual-Trace Plug-In Units for 50 mv/cm at dc-to-33 Mc. The Type 1A1 also offers 5 mv/cm at dc-to-23 Mc dual-trace, and, by cascading the two amplifiers, approximately 500 μ v/cm at 2-cps-to-14 Mc.

Price at \$1550 is the same as the Type 545A and includes two probes. Full field-engineering services back up every instrument.

But to hear the complete story, call your Tektronix Field Engineer. He will know if a Type 545B offers the best solution to your measurement problem. If the Type 545B appears to be the answer, try it. Use it in your own application—with one of your 17 letter-series plug-ins or one of the new amplifier plug-in units.

Tektronix, Inc.

Available throughout the world



Better wire your back bay . . . this way

Our new LANCELOK★ terminal is the better way. It's designed to perform better with increased contact areas for maximum conductivity. An integral lance locks it in to stay. No calibrated tool is necessary for insertion. A simple extraction tool makes circuit changes and repairs easy. And insulated and uninsulated LANCELOK terminals are provided loose piece, or tape mounted for automatic application.

Because of its special design, there's no chance to over-insert a LANCELOK terminal. A positive stop in the terminal body takes care of that! And there's no chance at all for incorrect installation—positive "D" shaped polarization assures quick, correct assembly.

Once locked in, minimum retention force between terminal and programming spring is 20 pounds. That's more than enough to assure top reliability under maximum shock and vibration in missile launching, fast-flying aircraft, automated assembly lines and other advanced patchcord programming applications.

Other important features include:

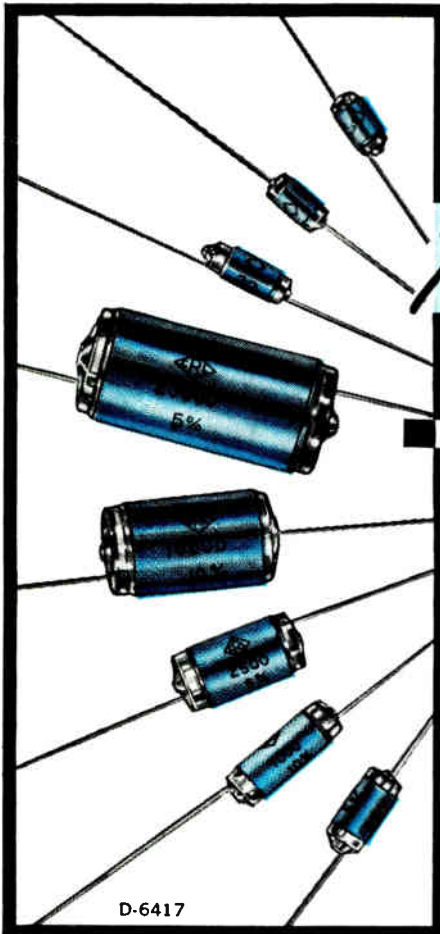
- Superior electrical performance
- Minimum of 15 insertions and extractions without electrical or mechanical changes
- Both insulated and uninsulated types available
- Pre-insulated type meets tensile and dielectric requirements of MIL-T-7928
- Gold over nickel plating

Get the facts on the *better* way for back-bay wiring. Write for complete details on the new LANCELOK terminal today.

★Trademark of AMP INCORPORATED



AMP★ products and engineering assistance are available through subsidiary companies in: Australia • Canada • England • France • Holland • Italy • Japan • Mexico • West Germany



*polystyrene capacitors
shipped same day*

FROM CENTRALAB'S 7,000,000 UNIT STOCK

Low cost, stable, reliable substitutes for micas and other plastic film capacitors. Centralab has over 300 types in stock, from 20 pf to .025 mfd, 125 and 500 VDCW, tolerances of 2.5, 5, 10, and 20%.

SPECIFICATIONS: Capacitance Drift: 0.3% or less after temperature cycling.

Temperature Range: -40°C . to $+85^{\circ}\text{C}$.

Q Factor: Over 2000 at 1 mc, 25°C .

Insulation Resistance: 5000 meg/mf or 500,000 megohms whichever is lower at 100 VDC, 25°C .

Write today for complete technical data, list of values in stock, and quotations to your requirements.

Centralab[®]

THE ELECTRONICS DIVISION OF GLOBE-UNION INC.

P.O. Box 591, Dept. 38G • Milwaukee, Wisconsin 53201

In Canada: Centralab Canada Ltd., P.O. Box 400, Ajax, Ont.

Circle 33 on Inquiry Card

NEW TECH DATA

Tape Recorder Brochure

Brochure HETR-364 covers a broad product line of miniature, high environmental tape recorders for myriad high environmental applications. It contains general operating characteristics and environmental and mechanical specs. on units ranging from a 26 oz. tape transport with a 75 ft. tape capacity to a 22 lb. recorder/reproducer having a 2250 ft. tape capacity. Leach Corp., 1123 Wilshire Blvd., Los Angeles 17, Calif.

Circle 191 on Inquiry Card

New Measurement Method

A 36-page booklet entitled, "Notes on the Julie Ratiometric Method of Measurement," describes a new technique for measuring voltage, current, resistance and ratio. It is illustrated with 20 charts and diagrams and includes a complete derivation for ratio correction. The new method of measurement described in the booklet offers accuracies in PPM and traceability to NBS units. In addition, it is said to make virtually all dc measurements faster, cheaper and more simply than classical techniques. Julie Research Laboratories, Inc., 603 W. 130th St., New York 27, N. Y.

Circle 192 on Inquiry Card

High-Speed Transistors

A series of 900mc ultra-high speed germanium switching transistors is the newest addition to the MADT line. Type 2N3320 has a breakdown voltage of 10v. and a gain of 50; 2N3321 has a 7v. breakdown and a min. beta of 100; 2N3322 has a 7v. breakdown and a min. gain of 30. Engineering bulletins available by writing on company letterhead to Technical Literature Service, Sprague Electric Co., 233 Marshall St., No. Adams, Mass.

Circle 193 on Inquiry Card

Pushbutton Switch

Data Sheet 218 describes an addition to the Series 2 system of modular lighted pushbuttons—Remote Control Series 2. It provides switching sequences never before available in a manual device. A powerful tractive magnetic coil pulls in the operating plunger, causing circuit transfer in the switching units. The contact position is held until current flow to the coil is interrupted. At 28vdc, these coils are rated at 2.2a. during actuation (time duration of about 20msec. or less) and 0.11a. during hold-in. Micro Switch, Freeport, Ill.

Power Oscillators

Bulletin PO-1B describes a line of VHF-UHF Power Oscillators. Five oscillator models, identical except for frequency, are offered to cover the spectrum from 10 to 1800mc. The oscillators are designed for use in antenna evaluation, calibration of power-measuring devices, driving amplifiers, and applications which require more power than can be obtained from mw signal generators. Complete specs. and photos are included. Microdot Inc., 220 Pasadena Ave., So. Pasadena, Calif.

Circle 194 on Inquiry Card

Reference Elements

The GREA series of low-current temp.-compensated reference elements are for low-power uses. Units in the new series are based on diffused-junction silicon diodes and operate at 4ma. They are designed to provide a reference voltage for potentiometric and comparison measurements which has as few as 5 ppm change in voltage/ $^{\circ}\text{C}$ change in temp. It meets or exceeds applicable military and/or industrial standards for reference elements. U. S. Semcor, 3540 W. Osborn Rd., Phoenix, Ariz.

Circle 195 on Inquiry Card

Packaged Blowers Catalog

This 24-page condensed catalog presents over 150 models of cooling equipment. They are offered in 24 different series to provide units that meet a wide cross-section of engineering requirements. Air deliveries range from 150 cfm to 1000 cfm. Mil-Spec. blowers, commercial blowers, and RFI-shielded blowers are included in all series. McLean Engineering Laboratories, P.O. Box 228, Princeton, N. J.

Circle 196 on Inquiry Card

Semiconductor Catalog

This 26-page condensed catalog covers a complete line of standard industrial and Mil-type semiconductor products. The catalog gives major electrical specs. for a full line of transistors, MECL, DTL, and linear integrated circuits, multiple devices, zener diodes, SCRs, gate-controlled switches, rectifiers and rectifier stacks. It provides mechanical characteristics and outline drawings. The catalog also includes new product lines such as high-current rectifiers up to 650a., varactor diodes, linear amplifier communication transistors, DTL integrated circuits, multiple devices, and multiple assemblies. Technical Information Ctr., Motorola Semiconductor Products Inc., P.O. Box 955, Phoenix, Ariz.

Circle 197 on Inquiry Card

Potentiometers

This 2-color brochure details a complete line of precision non-linear potentiometers. Tables describe standard resistance values and conformities of single and multi-turn units for all commonly used functions; availability of special units are also noted. Duncan Electronics, Inc., 2865 Fairview Rd., Costa Mesa, Calif.

Circle 198 on Inquiry Card

Rotary Converters

These compact dc to ac rotary converters are available in 12 models for operation on 12, 24, 32 or 115vdc. Not affected by transients, low input voltage or sudden overloads. Gives clean ac wave form. Voltage regulation and freq. regulation is approx. 20%, no load to full load. Catalog #163 available from Carter Motor Co., 2760A W. George St., Chicago, Ill.

Circle 199 on Inquiry Card

Relay Bulletin

Bulletin BR-635, 2 colors, outlines performance specs. of the BR-20 subminiature, latching dry-circuit to 10a. relays. The all-welded relays provide more than 100,000 trouble-free operations. Dimensions, mounting types, and terminal styles are detailed in addition to standard coil resistances and operating characteristics. Babcock Relays, div. of Babcock Electronics Corp., 3501 Harbor Blvd., Costa Mesa, Calif.

Circle 200 on Inquiry Card

Digital Voltmeter

The DT-305 integrating digital voltmeter is available in bipolar ranges: 100mv to 100v. It has a floating, guard-shield input for max. noise rejection. The unit has 5-digit display with storage —4 decimal positions and polarity indication. Linearity: $\pm 0.025\%$ of full scale; zero drift: 0.01% full scale/day. Complete specs. available from Data Technology Corp., P.O. Box 10935, Palo Alto, Calif.

Circle 201 on Inquiry Card

Terminal Blocks

This 2-color, 20-page catalog describes a complete line of more than 475 terminal blocks. Included are feed-thru, high current, control and power circuit, printed boards, track types and those for surface connections. Catalog includes specs., blueprints, and prices of both parts and complete blocks. Curtis Development & Mfg. Co., 3266 N. 33rd St., Milwaukee, Wis.

Circle 202 on Inquiry Card

Programming Aid

Powers of 2, from +72 to -72, are printed on 15 x 22 in. heavy-stock suitable for wall mounting. Produced primarily for use by programmers and digital designers, the computer-generated table is accurate to 72 significant figures. Technical Publications Dept., Digital Equipment Corp., 146 Main St., Maynard, Mass.

Circle 203 on Inquiry Card

for rotary switches

YOUR BEST SOURCE IS CENTRALAB

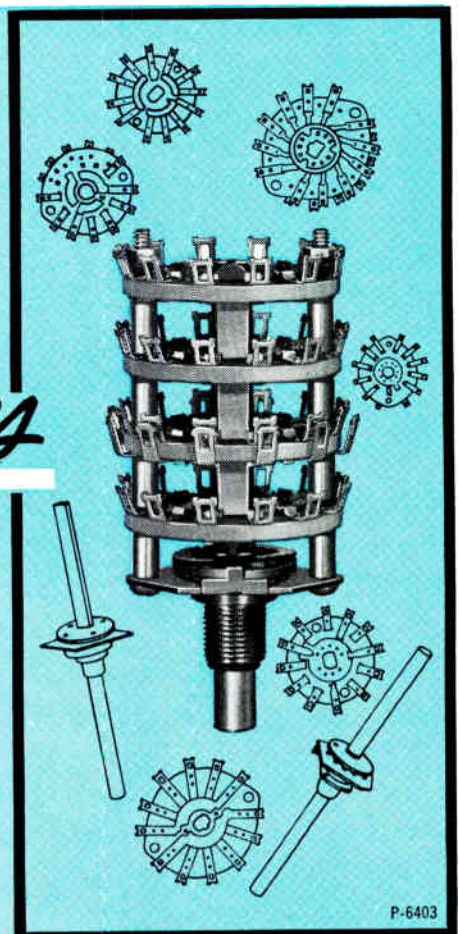
The industry's broadest range of sizes and materials, as well as custom-design switches for specialized applications—military, industrial and commercial.

For Immediate Delivery, over 250 Centralab switches are available from Centralab Industrial Distributors, in quantity, at factory prices.

Write for our 48 page switch design handbook and catalog.

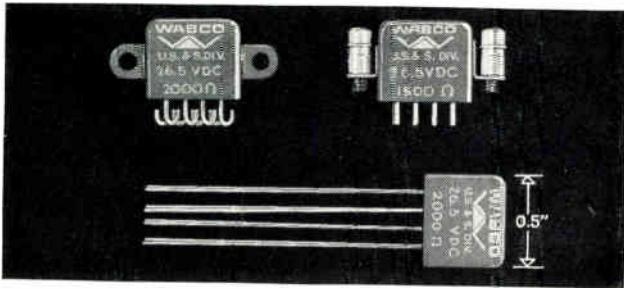
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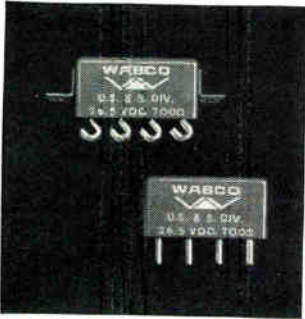
P-6403

MEET THE NEW WABCO RELAYS



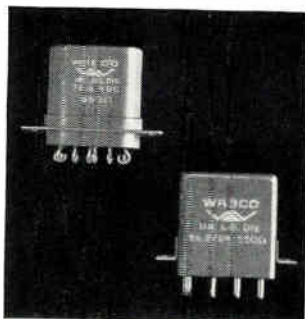
MODEL 901— $\frac{1}{8}$ -size crystal case DPDT relays

Meets or exceeds MIL-R5757D. Printed circuit board, brackets, and plug-in mountings available. 0.1" grid spaced terminals. Size: .500"L x .230"W x .430"H. Weight: 0.15 ounce. Coil Rating: 6, 12, 26.5, 48, 76 VDC (others available). Contact rated load: low level dry circuit to 1.0 amp resistive, 26.5 VDC. Terminals: 1½", solder hooks, or plug-in. Vibration: 0.1" D.A. or 20G peak, 10 to 2000 cps. Shock: 50G for 11 milliseconds. Temperature: -65°C to 125°C. Write for Bulletin 1077-A. Also available as SPDT—Model 900, write for Bulletin 1076.



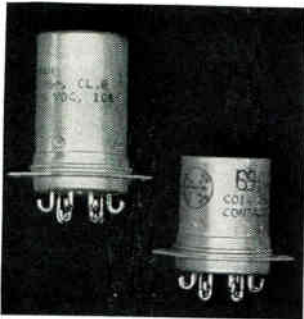
MODEL 902 $\frac{1}{2}$ -size crystal case relays

Meets or exceeds MIL-R5757/9. Size: .80" L x .40" H x .40" W. Write for Bulletin 1073.



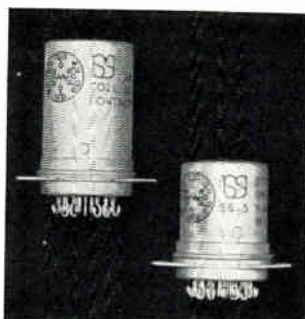
MODEL 903 "S"-type header MODEL 904 0.2" grid header crystal case relays

Meets or exceeds MIL-R5757/10. Size: .80" H x .80" L x .40" W. Write for Bulletin 1078.



MODEL H 4PDT 10-ampere relays

Meets or exceeds MIL-R5757D. Size: 1½"D x 1½" H (AC and sensitive versions available in 2" height). Write for Bulletin 1069.



MODEL J 6PDT 2-ampere relays

Meets or exceeds MIL-R5757/1. Size: 1½"D x 1½" H (AC sensitive versions available in 2" height). Write for Bulletin 1075.

These reliable relays are constructed of precision-made parts to exacting tolerances and assembled under "White Room Conditions" for uniformity of production and to provide consistent, dependable performance. They are available from stock in standard mountings and coil ratings. For technical information, call or write WABCO Aerospace Products. Telephone 242-5000, Area Code 412. TWX 412-642-4097, TELEX 086748.

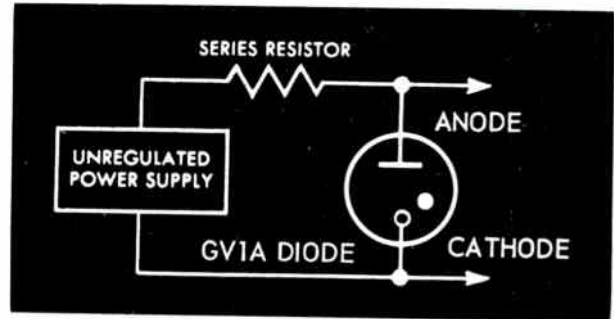
WABCO UNION SWITCH & SIGNAL DIVISION
PITTSBURGH, PA. 15218/Westinghouse Air Brake Company

Circle 90 on Inquiry Card

MICROMINIATURE HV DIODES

THE GV1A SERIES ARE MICROMINIATURE high-voltage regulating and reference diodes with voltage capability to 2 kv. The diodes, developed by Victoreen Instrument Co., Cleveland, Ohio, are ideal as shunt regulators, low-current applications, and for producing reference voltages in satellites and other high-voltage power supplies where miniaturization is vital.

In use, the unit is shown as a high-voltage regulator.



Current capabilities range to 100µa. Maximum temperature coefficient is 0.009%/°C from -55° to 125°C. The components are supplied in any desired nominal voltage from 300 to 2000v. (±2%) at the 10µa test point. Envelope size is maximum of 0.20 in., diameter by 1.0 in. long, with leads a minimum of 1.5 in. Weight is 0.8 gram.

HUNDREDS OF STOCK DIES

BUCKEYE ROUND CLOSURES

WIDE RANGE OF SIZES
AND MATERIALS



— Stock dies provide closures to 5" in diameter and heights to 6".

— Standard materials include Mu-Metal, Brass, Copper, Nickel-Silver, Steel, and Stainless Steel.

Modern equipment and the latest techniques, coupled with over sixty years of experience in deep drawing methods, qualify our engineering and production staff to fulfill today's most difficult drawing and stamping requirements at the lowest possible cost. Write today outlining your closure requirements. We will also gladly work with you on other shapes and materials.

THE BUCKEYE STAMPING CO.
555 Marion Road, Columbus, Ohio 43207
"Quality metal products since 1902"

Circle 94 on Inquiry Card

ELECTRONIC INDUSTRIES • July 1964

DALE**RELIABILITY**TOTAL CAPABILITY IN
PRECISION RESISTANCE*Here's
what the
excitement's
about...*

One watt at 70° makes Dale 2100 Series highest-rated commercial wirewound T-pot

Check the case dimensions of Dale's new 2100 Series — it's a direct, and competitively-priced replacement for several frequently specified wirewounds with lower power ratings. In both construction and performance, the 2100 is Dale-designed to be the commercial counterpart of RT-11, MIL-R-27208A. Normally an unsealed unit, it can be sealed for just a few cents more — giving you a humidity-proof trimmer equal to the Mil-Spec in all areas except temperature. Right now, you can simplify your design, standards and inventory problems by putting the 2100 Series to work on jobs which you may now be assigning to as many as three *different* trimmers. The price is right — and the delivery is fast.

Write for Catalog B

SERIES 2100 SPECIFICATIONS

Case Dimensions:	.31 high	.28 wide	1.25 long
Standard Models:	2187 — Printed Circuit Pins, 21 AWG Gold Plated 2188 — Stranded Vinyl Leads 2189 — Solder Lug, Gold Plated		
Power Rating:	1 watt at 70°C, derating to 0 at 125°C		
Oper. Temp. Range:	-65°C to 125°C		
Adjustment Turns:	25±2		
Standard Tolerance:	±10% standard (lower tolerances available)		

**DALE ELECTRONICS, INC.**

1304 28th Avenue, Columbus, Nebraska

A subsidiary of THE LIONEL CORPORATION

Also Sold by Dale Electronics Canada, Ltd., Toronto, Ontario, Canada



"... advancing the STATE-OF-THE-ART in Components & Equipment.

METAL FILM RESISTORS

The resistors are 1% tolerance units with TC of 100 ppm max.



The RL07 and RL20 type resistors have parameters appreciably exceeding requirements of Mil-R-22684. Designated M-07 and M-20, they have round end cap, welded lead terminations and brown epoxy enclosure. The 1/4w. M-07 is rated for 250v.; the 1/2w. M-20 at 350. Resistance values for the M-07 range from 50Ω to 150KΩ; the M-20 from 50Ω to 500KΩ. Clarostat Mfg. Co., Inc., Dover, N. H.

Circle 146 on Inquiry Card

POWER METER

Full scale readings from 0.01 to 10mw are covered in 7 steps.



The PRD 686 can be used with temp. compensated and uncompensated thermistor mounts having negative coefficient elements with operating resistances of 100 and 200Ω, without the use of additional accessories. With uncompensated thermistor mounts, the power range is limited to 0.1mw at the low end with an accuracy of ±5% full scale. Two self-balancing bridges in the transistorized unit render it drift-free. Continuous zero setting is not required, even on the most sensitive range. Bridge accuracy is ±3% full scale. The unit weighs 8 lb. A rechargeable battery pack is available. PRD Electronics, Inc., subs. of Harris-Inter-type Corp., 202 Tillary St., Brooklyn, N. Y.

Circle 147 on Inquiry Card

RUBBER POLYMER

For electrical potting; cures without heat or sulphur.

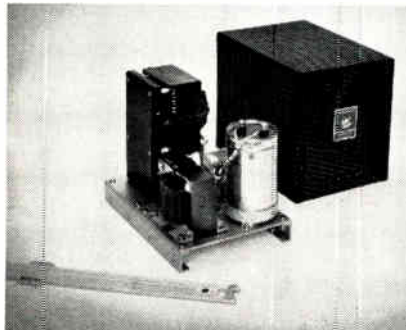


This pourable 100% solids compound cures to a flexible rubber at room temp. Applications include transformers, switches, relays, connectors and other components and assemblies. Usable temp. -40°F to 180°F; negligible exotherm and shrinkage; 85% cure in 24 hrs. @ 72°F; 100% cure after 48 hrs. DPR Inc., subs. of H. V. Hardman Co., Inc., 571 Cortlandt St., Belleville, N. J.

Circle 148 on Inquiry Card

STATIC FREQUENCY CHANGERS

Solid-state designs provide regulated and sinusoidal outputs.



These units convert ac of a given freq. to either a 60 or 400 cps output at power levels. The units eliminate the disadvantages of vacuum tube or mechanical converters and are ideally suited for powering gyro assemblies, motors, electronic equipment and all other types of ac operated apparatus. Three model series are available corresponding to unregulated models with sq. wave outputs, regulated sq. wave output types, and regulated models with sinusoidal outputs. All models operate from an input of 105-125vac, 50-1000 cps and provide ac outputs at 105, 115, 125vac RMS at 60 or 400 cps. Output power ratings vary from 25va up to 60 or 400 cps. Electronic Research Associates, Inc., 67 Factory Place, Cedar Grove, N. J.

Circle 149 on Inquiry Card

CLOSED-CIRCUIT VIDEO TAPE

Offered in widths of 1 in. in 5 different lengths to 3600 ft.

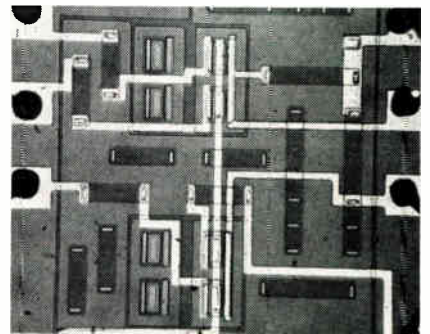


The 75P tape series has playing times of 32, 48, 64, and 96 min. It features good stop-motion wearability and low recording head wear. Additional features include high video output; low dropout incidence; high durability; superior audio performance; static-dissipating conductive coating; and packaging in dust-proof storage containers. Memorex Corp., 1180 Shulman Ave., Santa Clara, Calif.

Circle 150 on Inquiry Card

MICROCIRCUITS

Have pattern accuracy to 1 micron and perfect topological registration.



Series SD-2000 consists of 9 RTL silicon epitaxial integrated circuits. The units are standard 15mw/node, 10mc functional blocks. Special, proprietary photolithographic techniques provide precise dimensional control, with resultant high uniformity and quality. The elements provide full logic capability. Memory and counting functions are achieved by a half-register element designed for the very reliable double-rank clock system. Four different gates are available. Fan-ins from 2 to 6 are possible from combinations of dual 2-input and dual 3-input units. The basic node has a fan-out of 5, but it can be expanded to 25 with a buffer. Molex Corp., 2950 San Ysidro Way, Santa Clara, Calif.

Circle 151 on Inquiry Card



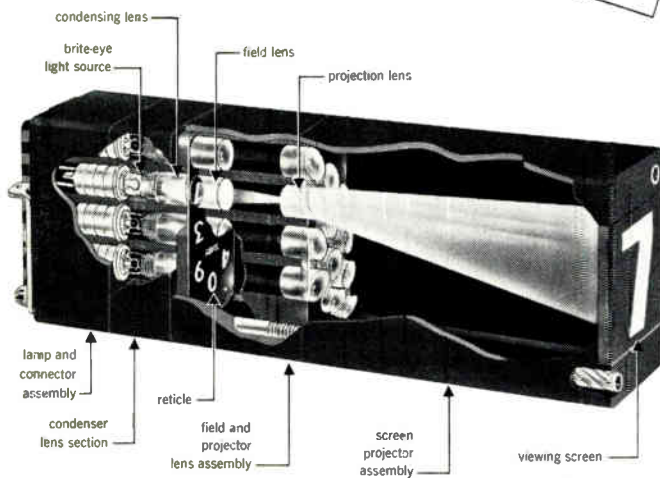
**This is Adlake's
new 100-amp. load
relay - it stands
100% overloads
for 1 min. - 15,000
amp. for pulse
durations - takes
up less than
57 cubic inches**

Type 2101 normally open load relay is rated 100 amperes, non-inductive, at 115 volts, 60 cycles. Operate and release time average 0.07 and 0.10 seconds respectively. Compression terminals are molded in place with flameproof epoxy resin. Relay can be used with panels and connectors, or fastened directly to point of application. Want more details? Ask your nearest Adlake representative or us direct. Adlake makes more kinds of mercury relays than anybody.

A⁺ Adlake 

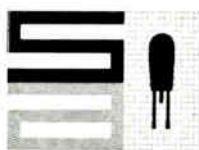
The Adams & Westlake Co.
Dept. P-8807, Elkhart, Ind.
Phone: Area 219 CO 4-1141

ACTUAL SIZE



SIMPLEST / SMALLEST * SHELLY READOUT

* Simplicity of design is the key to the new Shelly Readout Model SRO-100... the new Shelly Readout is a rear projection digital readout containing twelve "Brite-Eye" micro-miniature optical systems. It is the simplicity of this optical system which provides more brightness with one-third to one-half the light source than heretofore possible in readouts of this size. This same simplicity of design has opened the door to the smallest readout of this type to date. If your interest is communications, and not design bugs, you will appreciate the simplicity of design in the SRO-100. The Shelly Readouts are communication devices that display any symbol that can be reproduced on film, from algebraic terms to whole sentences and in color. Write for detailed engineering specification sheet.



CAL-GLO COMPANY

A DIVISION OF SHELLY ASSOCIATES, INC.

111 EUCALYPTUS DRIVE, EL SEGUNDO, CALIFORNIA

PHONE: 322-2374 • AREA CODE: 213

NEW PRODUCTS

SELF-MOUNTING CLAMP

Reduces installation time of cables and harnesses.



The Ty-Rap all-nylon clamp features an expanding post which locks the clamp securely and permanently in place. It is installed in a mounting hole in the cabinet or chassis without special tools. Designed to accommodate all sizes of Ty-Raps except the largest, the new clamp is available in 3 post sizes to fit #6, 8, and 10 clearance holes. Average pull-out strength ranges from 25.5 lbs. to 35 lbs. depending on the hole size. The Thomas & Betts Co., 36 Butler St., Elizabeth, N. J. Circle 152 on Inquiry Card

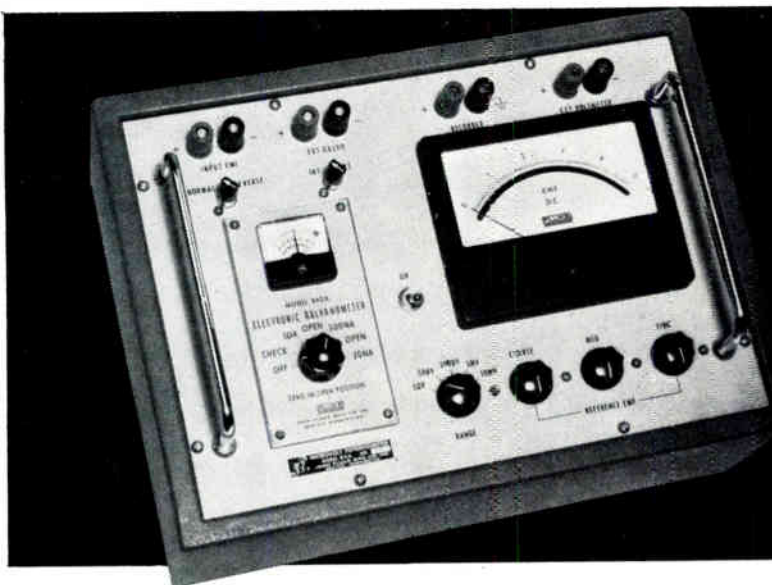
PORTABLE COMPUTER

It has a memory capacity of 4096 words and weighs 65 lbs.



The low-cost L-2010 is designed for rugged military and commercial uses. It incorporates a buffering capability that permits it to be used in real-time systems. A built-in capability to communicate with up to 128 input/output devices permits it to be used as either a self-contained computer or as a unit in a computer complex. A special input/output track on the memory disc provides a buffered communications link. No modifications are needed in the basic L-2010 to use this buffering capability. The capacity of the input/output track is 128 buffer words, each 30-bits in length. Librascope Group, General Precision, Inc., 808 Western Ave., Glendale, Calif.

Circle 153 on Inquiry Card



Another new and useful
Fluke instrument

MODEL 831A

MICROVOLT
POTENTIOMETER

1 New, compact solid-state microvoltmeter and source

Fluke Model 831A is an accurate, self-contained, fully portable Lindeck potentiometer for measurements from $0.2 \mu\text{v}$ to 50 mv. Input resistance is infinite at null. Input isolation from case is greater than 10^9 ohms. Input polarity is reversible via front panel switch.

Four terminal resistance configurations are used to match precisely the standard resistance IR drop to the input EMF. Fluke-manufactured precision wirewound resistors, low-thermal electrical design, and rugged construction insure accurate, reliable performance over wide environmental range.

Model 831A may also be used as a microvolt source, with the same accuracy and range as for microvolt measurements.

BRIEF 831A SPECIFICATIONS

VOLTAGE RANGE: 0.2 μv to 50 mv in ranges of 5 μv , 50 μv , 500 μv , 5 mv and 50 mv full scale.

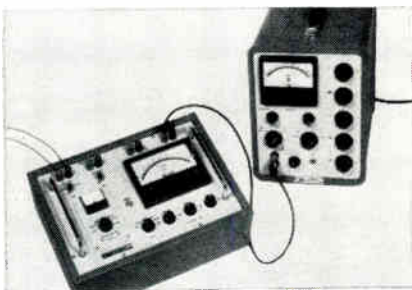
MEASUREMENT ACCURACY: $\pm(0.75\%$ of full scale + 0.2 μv). With external voltmeter $\pm(0.04\%$ + voltmeter accuracy + 0.2 μv). See chart below.

NULL DETECTOR: Fluke Model 840A electronic galvanometer. See separate description below. Switch and terminals provided for external galvanometer.

SIZE: Cabinet model, 10 $\frac{3}{4}$ " high x 14 $\frac{3}{4}$ " wide x 5 $\frac{1}{2}$ " deep. Rack model, 7" high x 19" wide x 5 $\frac{1}{2}$ " deep.

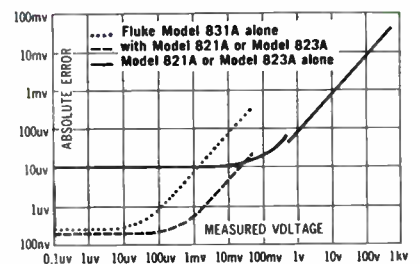
PRICE: f.o.b. factory, subject to change without notice.....\$595

2 Extends high accuracy of Fluke differential voltmeters to microvolts



A precision external standardizing resistor is located in series with the internal reference current so that the Model 831A may easily be used in combination with any Series 800 Fluke differential voltmeter. Accuracies of the 831A alone and in combination with Fluke Models 821A or 823A are shown on chart at right.

MEASUREMENT ACCURACIES



3 Incorporates new Fluke galvanometer with 2 na sensitivity



The Model 831A potentiometer employs a Fluke Model 840A electronic galvanometer for null detection. Using the same input terminals, the 840A may conveniently be used as a nanoammeter. Power sensitivity of the 840A is better than 8×10^{16} watt per division. Current overloads of more than 110 db on the most sensitive range cause no damage. The unit meets MIL-T-945A vibration and MIL-E-4970A shock tests. Recorder output is provided.

Send for full specification data on the Model 831A, plus new 64A Catalog Digest describing 40 models of Fluke differential voltmeters, power supplies and other precision instruments. Address JOHN FLUKE MFG. CO., INC., Box 7428, Seattle, Washington 98133.

BRIEF 840A SPECIFICATIONS

DC CURRENT SENSITIVITY:

30-0-30 nanoamperes, full scale (2 na/scale div.)

300-0-300 nanoamperes, full scale (20 na/scale div.)

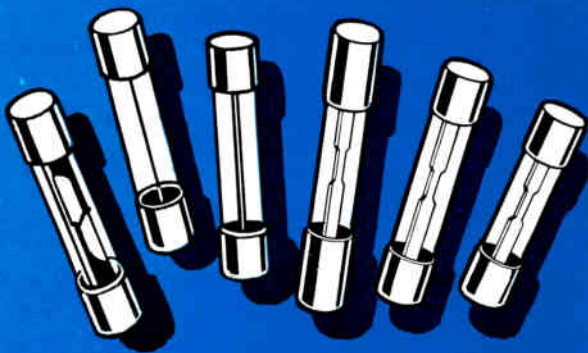
3-0-3 microamperes, full scale (200 na/scale div.)

INPUT IMPEDANCE: approx. 180 ohms

TEMPERATURE RANGE:
Operating, 0°C to 50°C
Storage, -40°C to 85°C

HUMIDITY: 0 to 90%





BUSS quick-acting Fuses

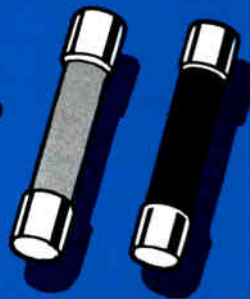
"Fast Acting" fuses for protection of sensitive instruments or delicate apparatus;—or normal acting fuses for protection where circuit is not subject to starting currents or surges.

BUSS

Write for BUSS
Bulletin SFB

BUSSMANN MFG. DIVISON, McGraw-Edison Co., St. Louis, Mo. 63107

BUSS MBO
1/4 x 1-1/4
inch



BUSS ABC
1/4 x 1-1/4
inch

BUSS high interrupting capacity Fuses

For the protection of circuits capable of delivering currents as high as 25,000 amps. at 125 volts or 10,000 amps. at 250 volts.

BUSS

Write for BUSS
Bulletin SFB

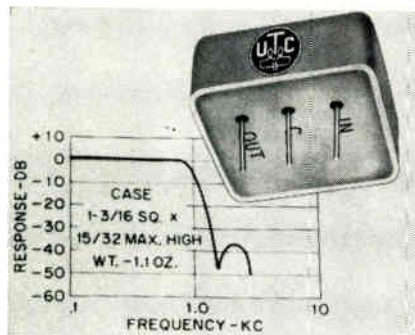
BUSSMANN MFG. DIVISON, McGraw-Edison Co., St. Louis, Mo. 63107

BUSS: 1914-1964, Fifty years of Pioneering....

NEW PRODUCTS

LOW-PASS FILTER

From dc to 800 cycles re-
sponse is flat within ± 0.3 db.

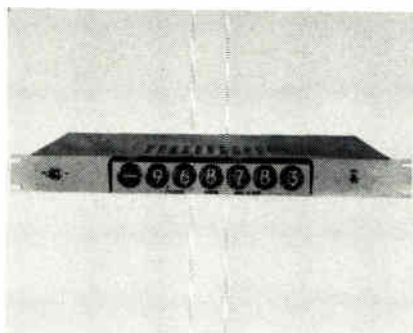


This low-pass filter is exceptionally flat constructed, metal cased, and hermetically sealed. Unit is ruggedized, manufactured and guaranteed to Mil-F-18327B, Mil Type FR4RX11YY. Attenuation at 940 cps is less than 3db, and at 1kc it is less than 6db. At 1450 cycles and above attenuation is more than 35db. Source and load is 47K Ω . Straight pin terminals and flat construction make unit ideal for PC uses. United Transformer, 150 Varick St., New York 13, N. Y.

Circle 225 on Inquiry Card

COUNTER

For position indication, flow-blend-
ing, speed synchronization, etc.

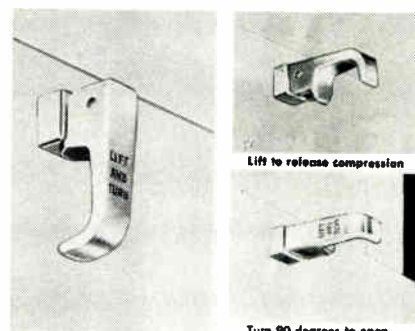


This solid-state, electronic counter accepts add-subtract data from 2 different sources; from the same source on separate lines; or from quadrature signals. Called the Bi-Directional Counter Model CF-400R, it is available with 4, 5, or 6 wide-angle Nixie displays plus polarity sign. Power required is 105 to 125v. RMS, 50 to 60 cps, 25w. Reset button is located on the front panel. Anadex Instruments Inc., 7833 Haskell Ave., Van Nuys, Calif.

Circle 226 on Inquiry Card

PAWL FASTENER

Applies instant selective compres-
sion on doors, panels, and drawers.

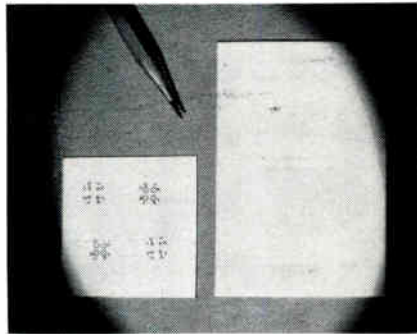


This No. 62 pawl fastener operates with a 90° motion to remove or apply pressure, and a quarter-turn to engage or disengage the panel. Cam action through the handle to the easily-adjustable pawl compresses gasketed doors. As the handle moves through a 90° arc, pressure of the pawl against the door is automatically set up or released. A quarter-turn of the handle in either direction permits the door to be opened or closed. Southco Div., South Chester Corp., Lester, Pa.

Circle 227 on Inquiry Card

CERAMIC SUBSTRATES

Has a high temp. thermally-matched glazed surface.



This substrate is intended especially for thin-film circuitry. It is useful in processes involving temps. from 700°C to 800°C. These substrates normally use AlSiMag® 614 alumina ceramic though other AlSiMag ceramic compositions can be used. Varied sizes can be produced in sample quantities up to the size limitations of many vacuum systems. These substrates can be made in various shapes with serrations, slots, holes, etc., as required. Metallized terminations are available. It normally has a smoothness of 1μ in. CLA. Finer finishes are also available. American Lava Corp., Manufacturers Rd., Chattanooga 5, Tenn.

Circle 228 on Inquiry Card

HEAT-SINK COMPOUND

Provides faster heat flow from electrical test specimen blocks to heat sinks.

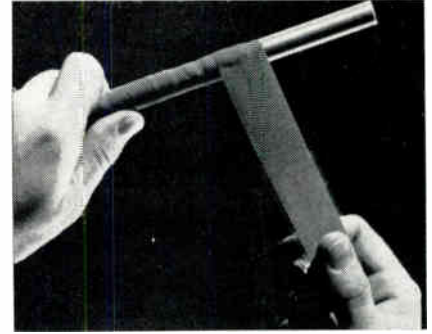


The Corning 340 silicone heat-sink compound speeds thermal conductivity testing of satellite components exposed to high vacuum and extreme temps. in space environment vacuum chambers. Applied between and around machined aluminum blocks and copper-base heat sinks, the paste provides intimate contact by wetting the surfaces and filling the voids caused by surface irregularities. The result has been the virtual elimination of time lag for heat transfer between test blocks and base plates. Compound will not harden or melt in temp. range from -50° to 500°F. Dow Corning Corp., Midland, Mich.

Circle 229 on Inquiry Card

SELF-BONDING TAPE

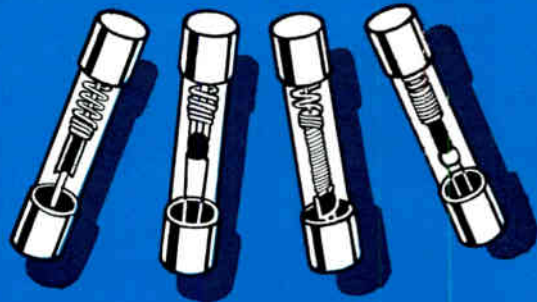
For compounding stocks used in making self-adhering insulating tapes.



The SE-104 gum produces finished stocks possessing a high-gloss and excellent physical and electrical properties. Due to the properties inherent in the gum, finished tapes are non-blooming. SE-104 based compounds are recommended for use in tapes for motor coils and bus bars, cables, cable-splicing, insulating wrap for wiring harnesses and general conformal sealing of electrical connections. The tapes exhibit improved touch tack, higher tensile strength, elongation, tear strength and lower compression set as well as longer processability life. Silicone Products Dept., General Electric Co., Waterford, N. Y.

Circle 230 on Inquiry Card

...New Developments in Electrical Protection



FUSETRON dual-element Fuses

time-delay type

"Slow blowing" fuses that prevent needless outages by not opening on motor starting currents or other harmless overloads—yet provide safe protection against short-circuits or dangerous overloads.

BUSS

Write for BUSS
Bulletin SFB

BUSSMANN MFG. DIVISION, McGraw-Edison Co., St. Louis, Mo. 63107

Circle 38 on Inquiry Card

New! BUSS SPACE SAVER PANEL MOUNTED FUSEHOLDER



Actual Size
Only 1 1/8 inches long . . .
Extends just 29/32 inch
behind front of panel

- Fuseholder takes 1/4 x 1 1/4 inch fuses. Converts to 9/32 x 1 1/4 inch fuses simply by changing screw type knob. Holder is rated at 30 ampere for any voltage up to 250.

- Also available in military type which meets all requirements of MIL-F-19207A.

BUSS

Write for BUSS
Bulletin SFH-10

BUSSMANN MFG. DIVISION, McGraw-Edison Co., St. Louis 7, Mo.

Circle 38 on Inquiry Card

HOW TO BUY POWER SUPPLIES AND SAVE MONEY

Over the years, Acme Electric has designed and supplied DC regulated power supplies in substantial quantities to some of the largest electronic equipment builders.

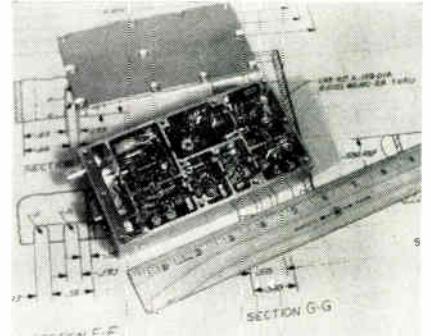
A number of these **Custom Designed** units have specifications and performance features that make them uniquely suited for **standard industrial and laboratory use.**

If you have an application in which one of these custom designed power supplies would be acceptable, the probability is that you can save money and at the same time obtain greater value represented by improved performance parameters.

NEW PRODUCTS

TELEMETRY TRANSMITTER

Solid state transmitter operates on telemetry band of 215-265Mc.

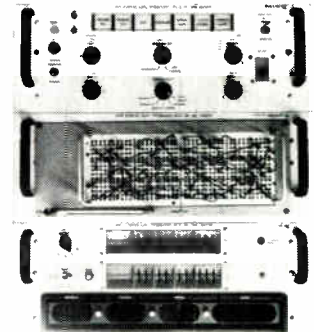


Model FM 200 maintains an r-f stability within 0.01% of the assigned center freq. under all specified environments throughout temp. variation of -20°C to $+85^{\circ}\text{C}$. Min. output power is 2w. The unit withstands shock and acceleration to 100Gs and vibration to 20Gs to 2kc. The FM 200 uses true freq. modulation. Unwanted or spurious freqs. are eliminated through filtering the desired signal. This transmitter requires 655ma of 28vdc power. Leach Corp., 1123 Wilshire Blvd., Los Angeles 17, Calif.

Circle 154 on Inquiry Card

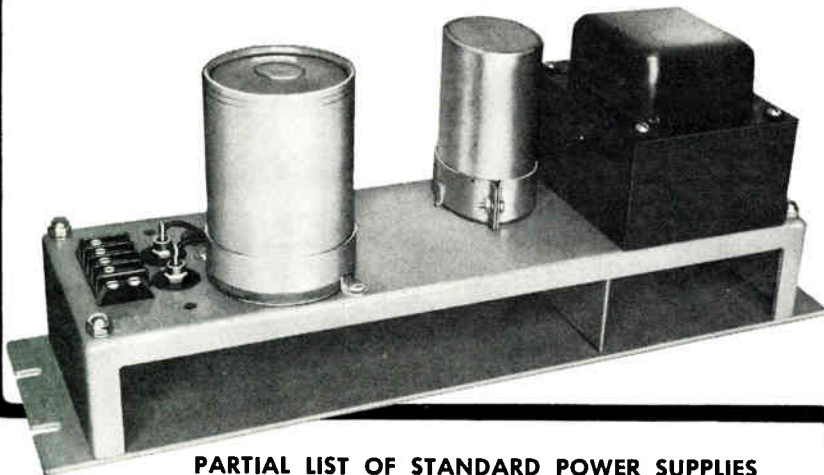
TAPE SEARCH SYSTEM

Demodulates time codes for translating to a visual tape time display.



The Model HI-215ABC Universal Magnetic Tape Search Unit accepts any of the standard modulated time codes. It controls a tape transport to search for desired blocks of data sequences on the basis of previously recorded time-code indices. Changing from one time code format to another is accomplished by changing a front panel-mounted, pre-wired, code patch plug. The unit controls the tape transport mechanism during search and playback operations. Its AGC compensates for over 40db in input time code format. Input carrier freq. of time code varies from 5 cps to 100kc. Hyperion Industries, Inc., 134 Coolidge Ave., Watertown, Mass.

Circle 155 on Inquiry Card



PARTIAL LIST OF STANDARD POWER SUPPLIES

INPUT: 110-130 Volt, 50/60 cycles

LINE REGULATION: $\pm 1\%$ for $\pm 13\%$ line voltage change

LOAD REGULATION: $\pm 2\%$ for load change between 50% and 100%

TYPE	DC VOLTS	DC AMPS	PANEL SIZE
PS-41922	24	2	19 x 3 $\frac{1}{2}$ x 7
PS-41423	24	6	19 x 5 $\frac{1}{4}$ x 9 $\frac{3}{4}$
PS-47173	24	25	19 x 7 x 9 $\frac{3}{4}$
PS-41424	48	4	19 x 5 $\frac{1}{4}$ x 9 $\frac{3}{4}$
PS-47519	48	10	19 x 7 x 9 $\frac{3}{4}$
PS-41425	125	2	19 x 5 $\frac{1}{4}$ x 9 $\frac{3}{4}$
PS-41428	250	1	19 x 5 $\frac{1}{4}$ x 7 $\frac{3}{4}$

RIPPLE: 1% RMS MAXIMUM

For full details covering component features, operating performance and price, write for Bulletin 175.

Acme Electric

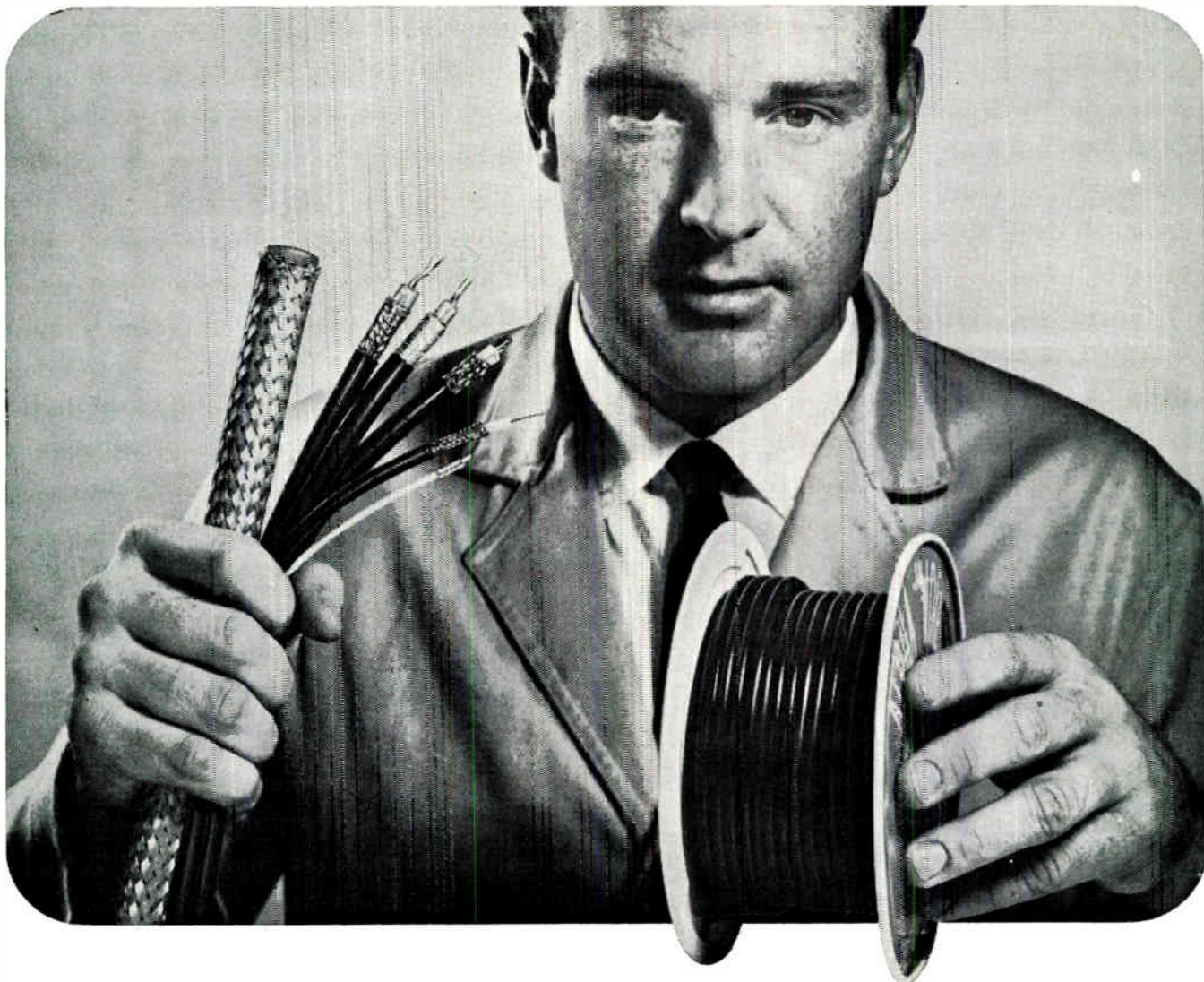
Engineers and Builders of...

897 WATER STREET, CUBA, NEW YORK

Canadian Representative: Polygon Services, Ltd.
50 Northline Rd., Toronto 16, Ont.

SAA-3767-3075

REGULATED POWER SUPPLIES
STATIC POWER RECTIFIERS
VOLTAGE STABILIZERS
VOLTAGE REGULATORS



Now ALPHA Manufactures Coaxial Cable

MAKING IT THE MOST COMPREHENSIVE SOURCE FOR ALL ELECTRONIC WIRE!

With the production of a wide range of coaxial cable types, Alpha is now truly your *one-stop prime source for all electronic wiring items*. Over 7,000 individual wire, cable and tubing products available immediately from stock . . . at competitive prices! From the drawing of the copper conductor to the extruding of the jacket, every step in

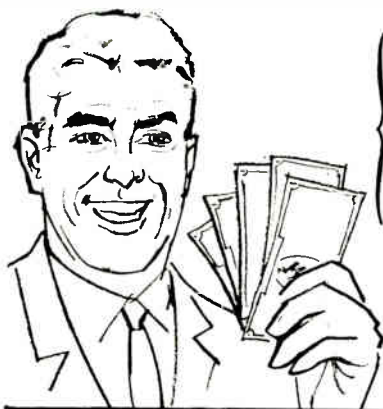
production is constantly controlled by Alpha engineers, to meet all applicable mil-specs.

For detailed specs and prices on the new coaxial cable, plus a complete catalog describing the industry's most comprehensive, most competitively-priced line, write or call Alpha Wire Corporation today!



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Subsidiary of LORAL Electronics Corporation
Executive Offices and New York Plant:
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New York 10014
(Area Code 212) AL 5-5400

PLANTS IN UNION, NEW JERSEY • LOS ANGELES, CALIFORNIA • HOLBROOK, NEW YORK



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When you specify EMCOR Modular Enclosures, you benefit from enclosure mass production prices. Your enclosure savings can be deducted from your product or systems market price to keep competitive. Take a cost evaluation of your present housings. Then investigate EMCOR Modular Enclosures quality construction, handsome appearance, depth of line and attractive pricing. The advantages of specifying EMCOR Enclosures will be self-evident. You be the judge. Request full details and literature—no obligation.

Seattle: 722-7800; Los Angeles: 938-2073; Palo Alto: 968-8304; La Jolla, Calif.: 454-2191; Dallas: 631-7450; Houston: 526-2959; Tulsa: 742-4657; Orlando: 425-5505; Washington, D. C.: 836-1800; Huntsville: 536-8393; Winston-Salem: 725-5384; Ft. Lauderdale: 564-8000; Boston: 944-3930; Bridgeport: 368-4582; Albany: 436-9649; Buffalo: 632-2727; Binghamton: 723-9661; Syracuse-Utica: 732-3775; New York City: 695-0082; Union City, N. J.: 867-3204; King of Prussia, Pa.: 265-3440; Detroit: 357-3700; Cleveland: 422-8080; Dayton: 298-7573; Pittsburgh: 884-5515; Chicago: 676-1100; Indianapolis: 356-4249; Minneapolis: 545-4481; St. Louis: 647-4350; Kansas City: 444-9494; Denver: 934-5505; Albuquerque: 265-7766; Centerville, Utah: 295-6521.

EMCOR Enclosures by...
INGERSOLL PRODUCTS

Division of Borg-Warner Corporation
1000 West 120th Street • Dept. 1245 CHICAGO, ILLINOIS 60643

electronic
equipment



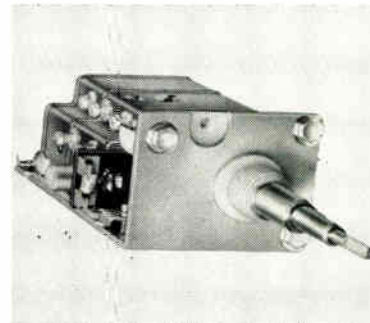
VISIT US IN BOOTHS 1838-39-40 AT WESCON

Circle 41 on Inquiry Card

NEW PRODUCTS

UHF TUNER

*Features automatic freq. control.
For color and black and white sets.*

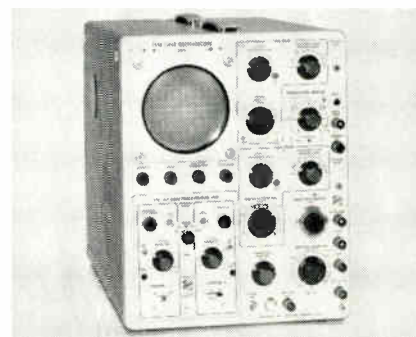


This tuner offers a detenting (indexing) feature which enables the TV viewer to snap in each of the 70 channels on the UHF band the same as VHF tuners click from channel to channel. The detented feature contrasts with continuous tuning, as on a radio dial, which is the method used on other UHF tuners. Oak Mfg. Co., Crystal Lake, Ill.

Circle 231 on Inquiry Card

OSCILLOSCOPE

Features dc to 33mc passband; 6cm vertical scan; broadband triggering.



The high-performance Type 545B replaces the Type 545A oscilloscope. Using a new CRT of unique design and a hybrid, solid-state/vacuum-tube vertical amplifier, it provides improved reliability and a bright, high definition trace with uniform focus over the full 6 x 10cm (50% greater) viewing area. Complete compatibility with all 15 Tektronix Type A to Z plug-in preamplifiers has been retained. New Types 1A1 and 1A2 plug-in units provide dual-trace displays at dc to 33mc passband. A push-pull, fixed-tuned 200-nsec. delay cable permits observation of the leading edge of triggering waveforms, and requires no tuning for smooth transient response. The illuminated internal graticule has a rise-time scale. This parallax-free unit permits easy and accurate measurements of rise-time and fall-time. Tektronix, Inc., P. O. Box 500, Beaverton, Ore.

Circle 232 on Inquiry Card

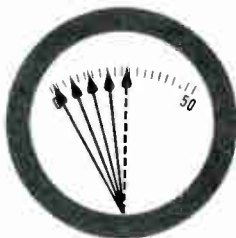
migraine
eight headaches
you can't
get
with a
Simpson Meter



Simpson

SIMPSON ELECTRIC COMPANY 5213 West Kinzie Street, Chicago 44, Ill.

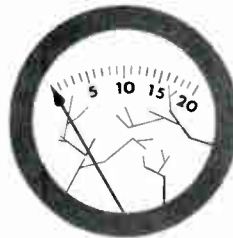
Phone: (312) ESTebrook 9-1121
 In Canada: Bach-Simpson Ltd.,
 London, Ontario



"STICKERS"



SHIFTY CALIBRATION



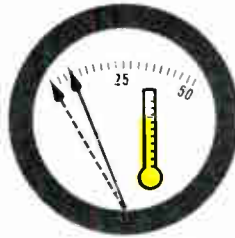
CRAZED CASES



YELLOWING CASES



LINT
 GRABBER



TEMP. DRIFT
 (Composition Resistors)



MIDDLE AGE
 DRIFT



TEMP. SENSITIVE
 (No Compensation)

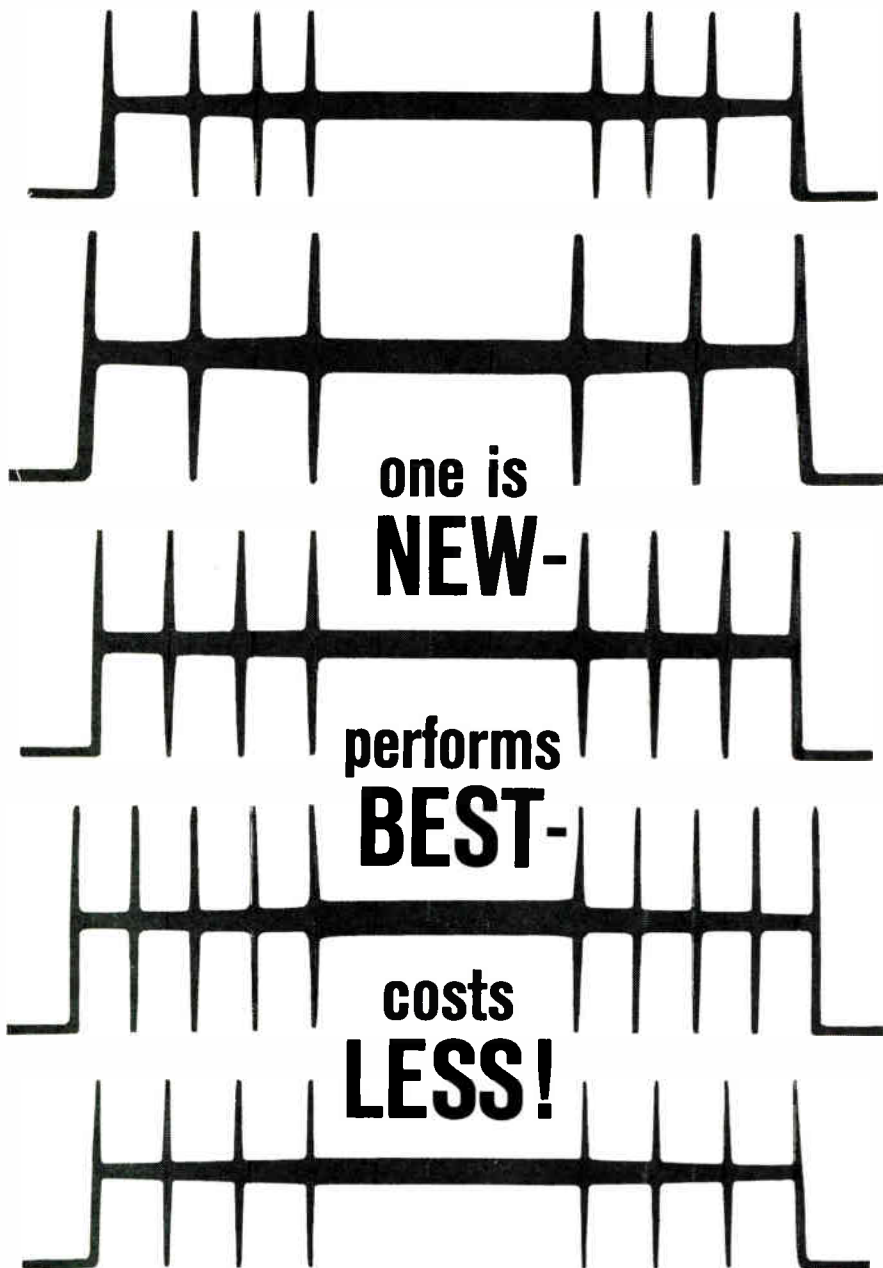
If you are an equipment builder, you yourself may not come down with the headaches shown above. But your customers can. The shortcuts in meter quality which cause such malfunctions don't always show up during incoming inspection . . . but just wait 'til the equipment is in use.

That's what makes "price meters" so treacherous. You try to cut costs on one end, but lose your shirt on service calls and returned merchandise at the other.

The remedy is Simpson meters. Through experienced engineering, and a policy of no shortcuts in design, Simpson eliminates these meter troubles . . . and the price for this quality insurance is surprisingly close to so-called "price meters."

You can get stock Simpson meters immediately from your distributor in 1300 sizes and types . . . or custom meters from the factory in almost infinite variety. Write for General Catalog No. 18.

Representatives In Principal Cities
 ... See Telephone Yellow Pages



one is
NEW-

performs
BEST-

costs
LESS!

Our new E-1 extruded heat sink (the one in the middle) is it... a 3" size has a thermal resistance, mounting surface to air of 2.05° C/W in natural convection!

Available complete with black anodize finish, mounting slots and mounting holes from IERC Technical Distributors at 70 to 90 cents each. 500 volt insulating finish, standoffs, and any lengths available.

Write today for technical and performance data on E-1 heat sinks and IERC's complete line of cooling/mounting hardware, accessories and new THER-MATE silicone heat sink compound.

IERC  **D I V I S I O N**

INTERNATIONAL ELECTRONIC RESEARCH CORPORATION

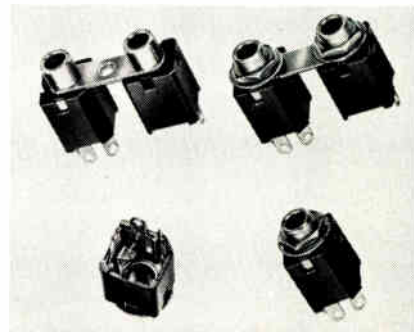
a subsidiary of Dynamics Corporation of America

135 WEST MAGNOLIA BOULEVARD • BURBANK, CALIFORNIA

NEW PRODUCTS

PHONE JACK

For high-density uses. Suitable for PC board mounting.

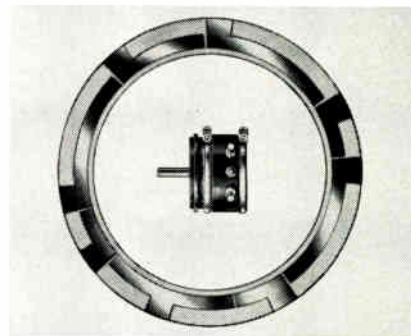


The HI-D JAX is an enclosed commercial-type ¼ in. phone jack. It is a small compact unit that takes minimum depth behind the panel. It uses molded thermosetting plastic housing which protects springs from being bent during mounting. The silver-plated springs provide long life and low resistance. Unitized insulation minimizes leakage. Extremely low electrical capacity between springs. The unit weighs 7⅛ grams. Mounts on ⅝ in. centers in either of 2 planes. Switchcraft, Inc., 5555 N. Elston Ave., Chicago, Ill.

Circle 204 on Inquiry Card

COMMUTATOR SWITCHES

For use singly or in ganged assemblies with potentiometers.

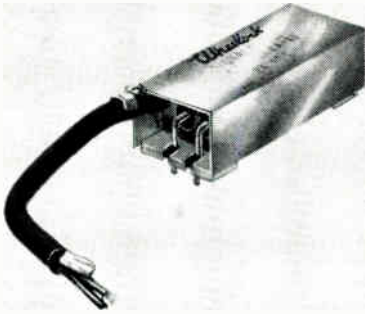


These PC units are designed with flush segments for break-before-make switching and high-speed operation. Standard switches are available in body dia. from ⅞ to 3 in. with a max. of 43 segments/section. Operating temp. range is from -55°C to +125°C, with accuracies to +0.5° and shaft speeds to 1000 RPM. Torque and inertia values to 0.1 oz. in. and 0.020 gm-cm² per cup, respectively, are claimed. Voltage rating is 100v. RMS (segments to gnd). Construction features include unitized rotor-slip ring-brush arm assembly, glass-filled diallyl phthalate parts, and circuit switch elements. Duncan Electronics, Inc., 2865 Fairview Rd., Costa Mesa, Calif.

Circle 205 on Inquiry Card

REED RELAY

Capacitance is 0.025pf. Contact life 20 million @ 1/4 rating.



The series 266-2A-X1 is a low-capacitance reed relay for use in medical digital computers. It switches signals from various sensors attached to the body. The signals are supplied to the computer for data analysis. Low capacitance is required to prevent false signals from entering the switch contacts, especially the inductive back EMF from the coil. Contacts are rated at 4w. resistive max., 0.125a. max. or 250v. max.; contact resistance is 200 milliohms max. initial. Operate time is 1.0msec. (max.) including bounce. Wheelock Signals Inc., Long Branch, N. J.

Circle 206 on Inquiry Card

PRINTED-CIRCUIT CONNECTOR

Multi-contact unit has wire-wrap terminals and external polarizing keys.



The CDS-618-W connector has bifurcated contacts fabricated from gold-plated beryllium copper. The contacts are on 0.150 in. centers. It is designed for telephone, computer, and communications uses. The connector accommodates 1/16 in. thick PC cards. Terminals are of the wire-wrap type. The terminals accept approx. 4 wraps each of four #20 wires. Easily changed polarizing keys of beryllium copper spring wire with epoxy insulation may be inserted between any 2 contacts to match notches in the PC board. This method provides polarity without losing any of the contacts. Methode Electronics, Inc., 7447 W. Wilson Ave., Chicago, Ill.

Circle 207 on Inquiry Card

1 10

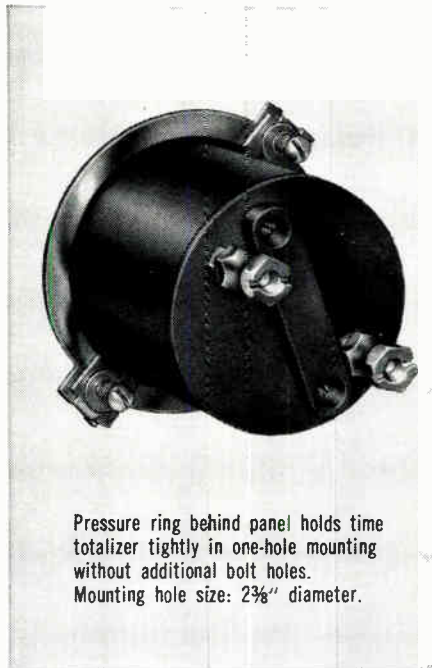
Eagle's new time totalizer tabulates minutes or hours down to tenths.

MINUTES

999999

1/10

Large, easy-to-read digits shown actual size. Knob on Model HK300 permits resetting to zero at any time.



Pressure ring behind panel holds time totalizer tightly in one-hole mounting without additional bolt holes. Mounting hole size: 2 3/8" diameter.



New time totalizer tells how long electronic gear operates, electric machinery has run, components are in operation or when maintenance checks are due. Face size: 2 5/8" x 3 1/8".

New Eagle time totalizer gives accurate time readout to six digits

Eagle's new time totalizers keep track of minutes or hours down to tenths. Heavy duty synchronous motor matches accuracy of a.c. power system. Reset model (HK300) permits re-zeroing as desired. Both non-reset model (HK200) and reset unit will measure either ON or OFF time of an electric circuit. Hooded metal bezel protects dial and contributes to easy reading of the large, 7/32-inch digits. Entire mechanism is housed in a high-impact, plastic case. Complete specifications upon request. Eagle Signal Division, E. W. Bliss Company, 736 Federal Street, Davenport, Iowa.



EAGLE SIGNAL

PROVEN

... DURING 70,000,000
MISS-FREE OPERATIONS

SERIES 3002 DATA SWITCH

- 100% Tested
- Coil Ratings: 60 to 1500 mw
- Contact Ratings to 50W Inductive
- Operating Time: —2ms (Typical)
- Coil Voltages: 6 to 120 VDC
- "Cradled Reed" Design

NEW CATALOG describes the complete line of Wheelock Proven Glass Reed Relays. Includes capabilities, limitations, application data, mechanical and electrical specifications.



Wheelock

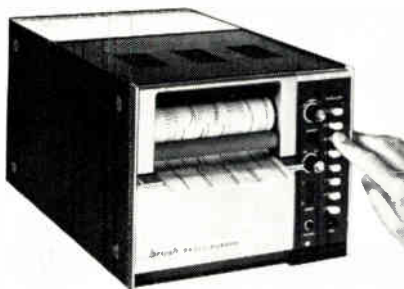
273 Branchport Ave.
Long Branch, N. J.
201-222-6880

Circle 45 on Inquiry Card

NEW PRODUCTS

LIGHT-BEAM OSCILLOGRAPHS

Obtains recordings without disturbing existing analog recording channels.

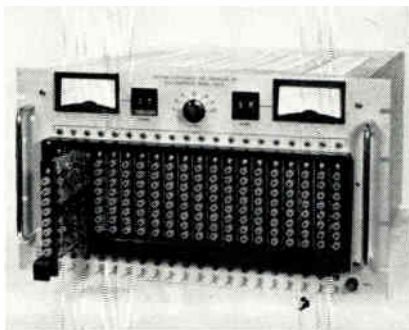


The 2300 Series oscillographs are available with either 8 or 16 channels for high-speed analog recording. Light sources for both analog and event recording are incandescent filament lamps. Conventional oscillographs use a galvanometer for obtaining event recording. This reduces the number of galvanometers available for analog recording. Recorder uses a 10-channel event lamp accessory which can be added to or removed from the basic oscillograph. Brush Instruments, div. of Clevite Corp., 37th & Perkins, Cleveland, Ohio.

Circle 208 on Inquiry Card

DIGITAL-ANALOG CONVERTER

Provides 20, 8-bit D-A converter channels with integral binary displays.



The DAL-2 converter occupies 10½ in. of standard panel space and features a self-contained calibrator and power supply. Two output meters are provided—one for actual output voltage and the other for percent-of-full-scale indication. Thumb-wheel switches are used to select the channel to be monitored on the respective meters. D-A converter modules accept data samples for conversion from time multiplexed data on 8 parallel input lines. Each channel contains an input buffer register which holds data samples until a transfer pulse clears register and loads a new data sample. Defense Electronics, Inc., Rockville, Md.

Circle 209 on Inquiry Card

ENCAPSULATED INDUCTORS FOR PRINTED CIRCUIT BOARD MOUNTING

CHECK THESE FEATURES:

- ✓ All inductors vacuum encapsulated in epoxy.
- ✓ Terminals on 0.10" grid with minimum 0.20" spacing.
- ✓ Header pads keep unit off mounting board, facilitating flux removal.
- ✓ Delivery—Any Inductance
ET's: Stock to 72 hours on prototypes.
EV's: Stock to 1 week on prototypes.



TYPE ET-1
(Miniature)
Frequency Range
to 500 KC.
Inductance from
1.0 mh to 2.5 h.

TYPE ET-2

Frequency Range
to 100 KC.
Inductance from
2.4 mh to 10.3 h.



TYPE ET-4

Frequency Range to 60 KC.
Inductance from 3.60 mh to 30.4 h.

ET-2 AND ET-4

are also available in center-tapped construction and with up to 8 terminals for multi-tap applications.

EV VARIABLE INDUCTORS

FREQUENCY RANGE to 200 KC. NOMINAL INDUCTANCES from 3.0 mh to 1.0 h. GUARANTEED ±10% tuning range.



NEW VARIABLE INDUCTOR KITS FOR BREADBOARD CIRCUIT DESIGN

Available for immediate delivery.

KIT No. 101A contains 31 Type EV variable inductors ranging from 3.3 mh to 1.0 h in 20% steps.

KIT No. 102 contains 62 Type EV variable inductors ranging from 3.0 mh to 1.0 h in 10% steps.

**SANGAMO
ELECTRIC
COMPANY**



P. O. Box 359 EC64-10

SPRINGFIELD, ILLINOIS 62705

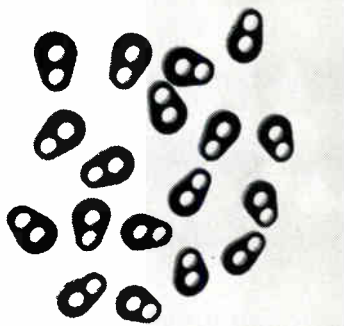
Phone: 217-544-6411

Circle 46 on Inquiry Card

NEW PRODUCTS

TEMPERATURE TRANSFLUXOR

Miniaturized, wide temp. device is for airborne applications.

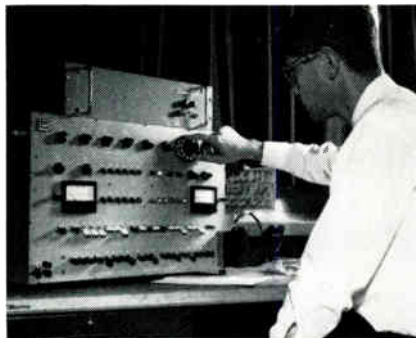


This transfluxor is a non-destructive readout device (NDRO) with switching characteristics that permit its use in stacks using coincident current selection. It is designed for NDRO memory systems that operate over a temp. range of -55°C to 125°C without stack heaters. It has two 20 mil. apertures and outside dimensions of 46 and 65 mils. The new device makes possible the miniaturizing of airborne memory systems. Electronic Memories, Inc., 12621 Chadron Ave., Hawthorne, Calif.

Circle 156 on Inquiry Card

DIGITAL TEST SET

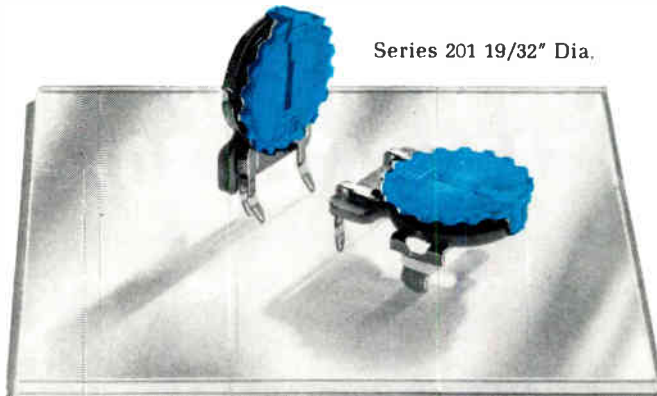
For checking PC boards used in digital telemetering equipment.



This device has cut individual testing time by 75% and gives a more accurate result compared to the apparatus used previously. It enables the operator to make a composite check of the overall logic of the board instead of the more time-consuming test of the individual logic modules. Testing time for an average PC board has been reduced from approx. 45 to 10 min. The test set gives a simplified readout indication on various colored lights in binary code values. The test set has a master plug to set up the correct combination of input circuits to match the logic of each type of circuit board under test. Leeds & Northrup Co., 4901 Stenton Ave., Phila., Pa.

Circle 157 on Inquiry Card

Series 201 19/32" Dia.



NEW MINIATURE LOW COST CARBON TRIMMER RESISTOR

is especially designed for P.C. applications. Instantly, firmly snaps into position with self-supporting bracket. Two versions for parallel or perpendicular mounting. Attached knob has arrow indicator for easy adjustment and convenient screwdriver slots on front and rear.

Uses the same highly reliable composition resistance element as the broad line of CTS commercial and industrial carbon controls. An unusually wide resistance range of 250 ohms through 2.5 megohms (linear taper), and power rating of 1/8 watt at 55°C derated to no load at 85°C (linear taper), make the 201 series particularly adaptable for instruments, communication equipment, electronic machine controls, micro-wave transmission, medical electronic equipment, electro-data processing equipment applications.

Priced under a dime in quantities of 3,000. Write for Data Sheet 1201.



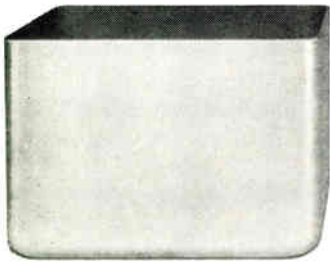
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Elkhart, Indiana

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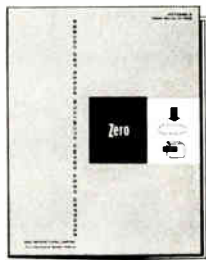
(Both made from .064" aluminum in lots of 1,000)

THIS PART is made by the Zero deep draw process. It costs less than the fabricated part and offers these additional advantages: Uniformity; close tolerances; straight side walls, excellent surface finish; work-hardened side walls. Because it was made from stock tooling, there was no tooling or set-up charge.

THIS PART was fabricated by the conventional notch-fold-weld method. In addition to a higher cost it has these disadvantages: Measurements vary; welds are subject to porosity and failure; warpage caused by weld heat must be straightened. Fixtures and tools must be charged for with a set-up charge for every order.

NEW 38 PAGE CATALOG LISTS 20,000 STOCK SIZES

Send today for the Zero Deep Drawn Aluminum catalog...lists more than 20,000 sizes and shapes available without tooling costs...quantities of 100 or less shipped in one week from stock!



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ZERO MANUFACTURING CO.

1121 Chestnut Street • Burbank, California 91503
Factories in Burbank, California and Monson, Massachusetts

NEW PRODUCTS

INTEGRATED CIRCUITS

For use in computers, missile and aircraft guidance systems.

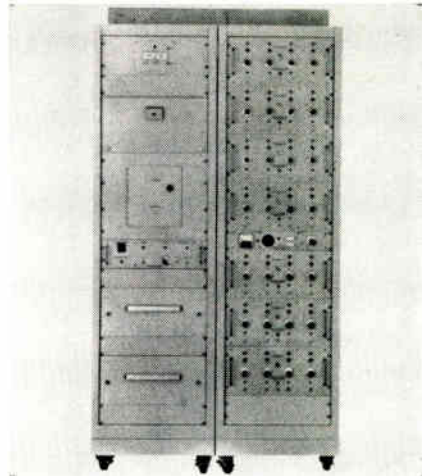


These integrated circuits contain the equivalent of 28 components, 6 resistors and 22 transistors. Each of the circuits are etched in a silicon wafer approx. 0.050 in. sq. and 0.006 in. thick. They can make decisions in 5nsec. Sylvania Electric Products Inc., 730 Third Avenue, New York, N. Y.

Circle 158 on Inquiry Card

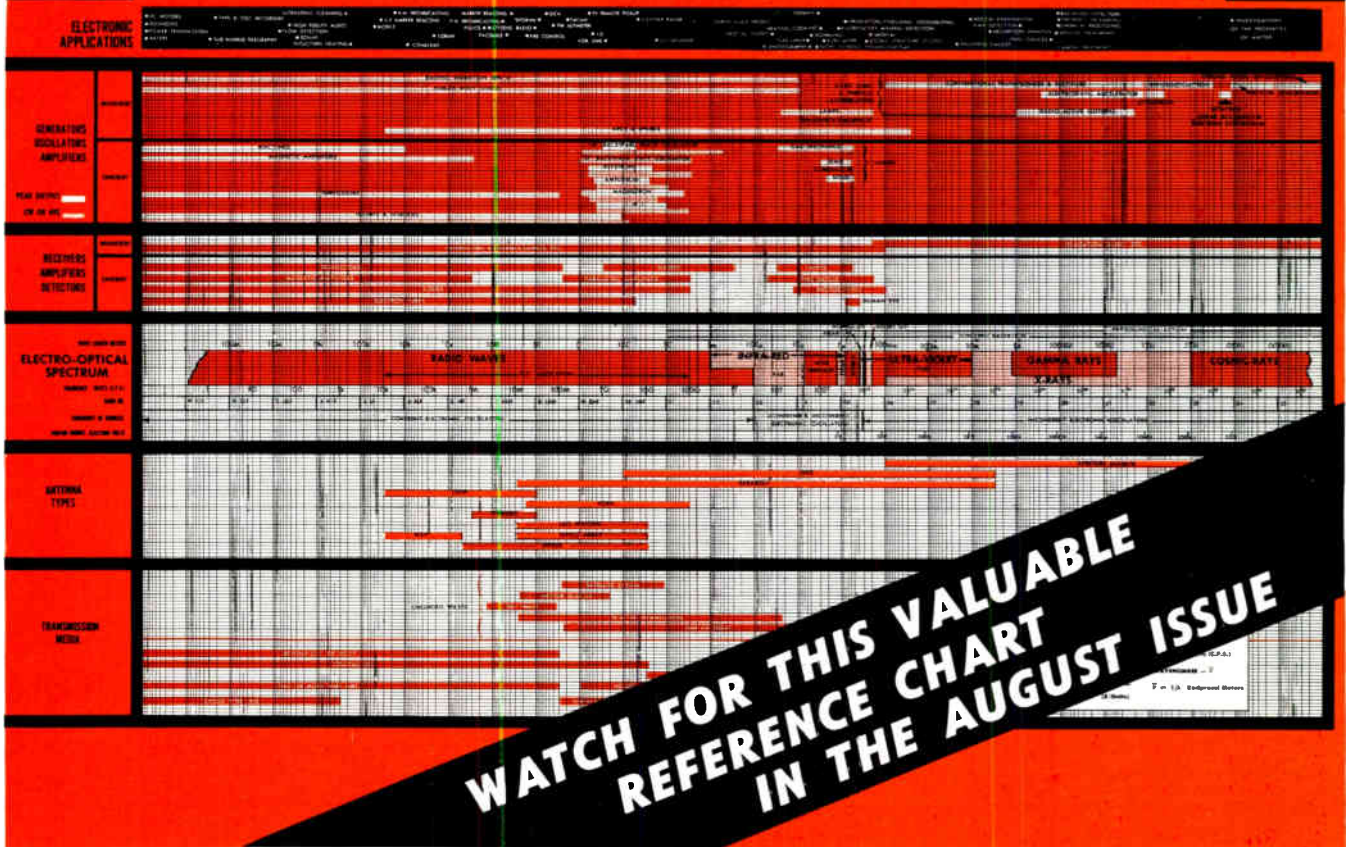
TRANSIENT MONITOR

Capable of monitoring and recording transients at 50 separate points.



The Model 2550 is comprised of 11, 4-channel transient detectors; 6, 1-channel transient detectors; 2 line voltage monitors; 2 calibration units; an indicator light panel; and a camera photocell assembly. Each detector is connected into the overall system in a way which allows the detector to be easily removed from the console for use as an independent piece of test equipment. Appropriate combinations of input probes permit measurement of positive or negative transients as short as 50nsec.; as low as 0.1v. peak, and as high as 5kv. peak. False transients detection is prevented by input power line filters. Huggins Laboratories, Inc., 999 E. Arques Ave., Sunnyvale, Calif.

Circle 159 on Inquiry Card



what makes ELECTRONIC INDUSTRIES SO different?

ELECTRONIC INDUSTRIES is the only magazine that keeps you abreast of the State-of-the-Art in every area of electronic technology. Most significant new developments have been reported first in the pages of E.I.

Whatever your job responsibility may be: management, design, research & development or manufacturing—you'll find E.I. brings the most timely and useful information for your work.

In the August issue, ELECTRONIC INDUSTRIES presents a four-color wall chart for your use:

Design Guide for Electronic-Optical Systems

The design information on this chart has never been available before. It was prepared by Dr. O. M. Salati, Moore School of Engineering, University of Pennsylvania.



to dial any attenuation — EVEN FRACTIONAL DB

Stoddart precision two- and three-turret attenuators offer any combination of db values from zero to 120, including fractional db.

Each turret in the attenuator consists of a group of 6, 10, or 12 quality Stoddart coaxial pads, mounted about a central shaft which permits dialing of the desired attenu-

ation by a simple "pull-turn-push" motion. Smooth, positive positioning at each step is ensured by a spring-loaded detent mechanism made to give years of trouble-free service.

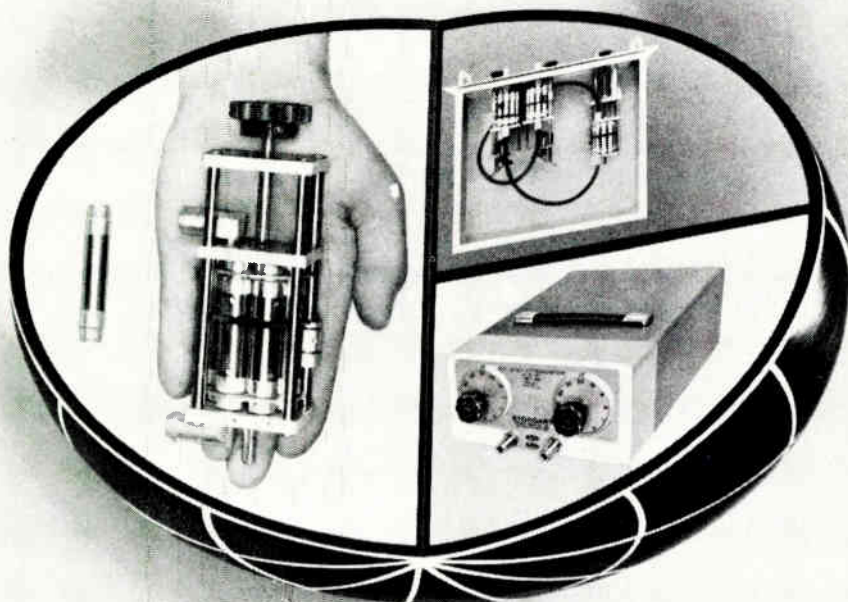
Individual Stoddart-developed attenuator pads are comprised of a thin, very stable resistive film fired to a special ceramic substrate. These outstanding units combine inherent high accuracy from DC to 3 GC with exceptionally low phase shift, minimal noise figures, and negligible skin effect. Other important characteristics are dimensional stability, excellent performance in shock and vibration environments, extreme resistance to moisture and chemical effects, and temperature stability in the range from 4°K (liquid helium) to 500°K.

If your application requires a two- or three-turret unit, a single turret, or only an individual coaxial attenuator, Stoddart's diversified line* can meet your needs. Write or phone for complete details to Stoddart Aircraft Radio Co., 6644 Santa Monica Boulevard, Hollywood 38, California. Phone: HOLLYWOOD 4-9292. A subsidiary of Tamar Electronics, Inc.

**Common db values available for immediate delivery. Some units now rated to 10 GC.*



STODDART



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Circle 50 on Inquiry Card

NEW PRODUCTS

CONTROL KNOB

Mil. spec. clutch spinner knob protects delicate equipment.

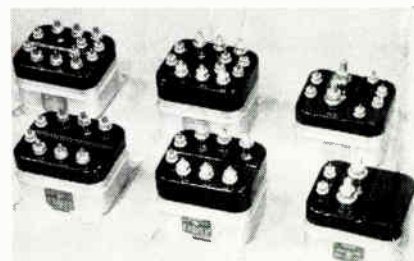


This KMS series clutch-spinner knob meets all the requirements of MS91528 Rev C/procurement spec. Mil-K-3926A. The clutch mechanism of this knob prevents damage to delicate tuning controls by allowing the spinner knob to slip at the end of its rotation when the torque exceeds a set limit. Each knob is factory adjusted for any of several specific torque limits. The clutch knob is available in 3 dia.: 1.250, 1.750, and 2.250 in. for 1/4 in. shafts. National Radio Co., Inc., Dept. C, 37 Washington St., Melrose, Mass.

Circle 160 on Inquiry Card

POWER RELAYS

Hermetically-sealed power relays are for aerospace uses.



These relays are available in 25a. (3-PST), 50a. (3PST) and 100a. (SPST) configurations with and without auxiliary contacts. The line features a pancake magnet that cuts weight and reduces size. A balanced armature enhances vibration and shock resistance—15Gs vibration at 750 cps; 12Gs at 750-1500 cps. They withstand 50Gs of impact shock. Hermetic sealing (glass-to-glass fusion and metal-to-metal welding) permits efficient and reliable performance in amb. temps. ranging from -65°C to 125°C. The line meets the requirements of Mil-R-6106D; the 25a. relays conform to MS-27997-D1 and D2. Cutler-Hammer Inc., 436 N. 12th St., Milwaukee, Wis.

Circle 161 on Inquiry Card



You can leave CEC's newest leak detector behind

Thanks to remote control

There are some places you just can't take a leak detector. That's when you need a Remote Control Unit—standard equipment for CEC's new 24-120B Leak Detector. This handy remote unit contains all the controls needed by the operator including an indicator meter, a dynamic range switch (with 9 steps of attenuation from X-1 to X-10,000), a filament indicator lamp, zero control and an optional audio alarm. If there's a remote possibility of leaks . . . you can find them with CEC's new 24-120B. Most versatile of all helium/mass spectrometer leak detectors, the compact 24-120B may be hand carried to places other instruments can't go. Or it may be mounted on a mobile workstand and equipped with a quick-disconnect inlet and bell jar base plate. Or it may be installed on top of an Automatic Test

Port and Roughing Station for total application flexibility. Or it even may be hooked up to a Test Port Station with large tabletop worksurface for check-out of mass-produced components. Whatever your application, a 24-120B can be supplied to fit it.

Exclusive features for which CEC's 24-120 series leak detectors are preferred include:

- High-conductance 2-inch manifold constructed entirely of stainless steel.
- A high-conductance roughing valve that permits use of 15 cfm pumps for the fastest pumpdown available.
- A vacuum-operated automatic protection valve that closes instantly if a pressure surge results from failure of a part being tested.

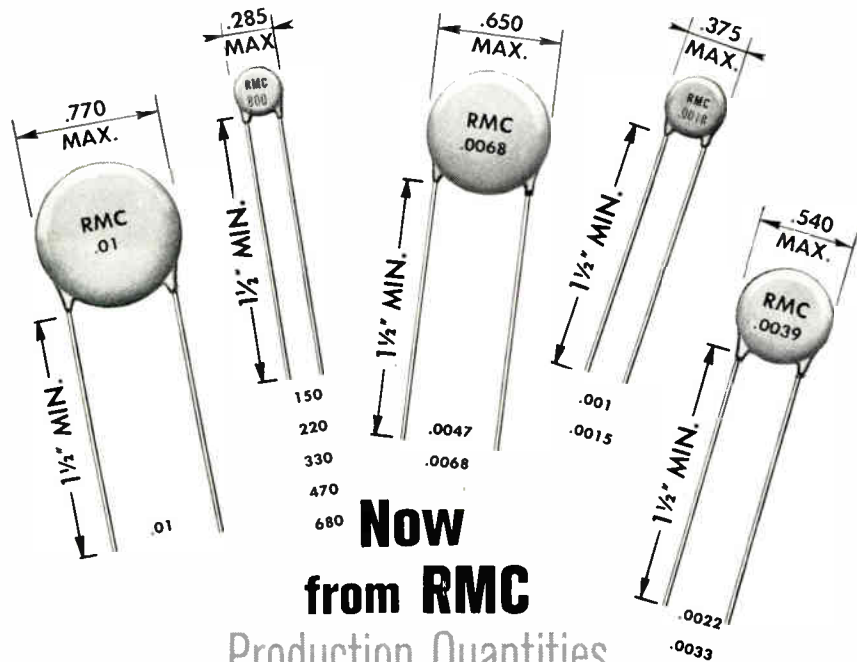
- Detection & location of leaks as small as 5×10^{-11} atm cc/sec/div of helium.

For the full story on CEC's latest leak detector, contact your nearby CEC Sales and Service office, or write for CEC Bulletin 24120-X16.



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Circle 51 on Inquiry Card



Now
from RMC
 Production Quantities
BY-PASS DISCAPS
 (TYPE BA)

engineered to X5U specifications

RMC type "BA" Discaps offer high capacitance over an extended temperature range while maintaining acceptable stability characteristics. These DISCAPS can be specified, with complete confidence, for coupling and by-pass applications operating in environmental extremes. Write on your letterhead for additional information on type BA and other high quality DISCAPS.

SPECIFICATIONS

CAPACITANCE: Within tolerance @ 1KC and 25°C

CAPACITANCE TOLERANCES: + - 20% or + 80 - 20%

WORKING VOLTAGE: 500 V.D.C.

POWER FACTOR: 1.5% maximum @ 1KC

INSULATION RESISTANCE: Greater than 7500 Megohms @ 500 V.D.C.

TEMPERATURE COEFFICIENT: Y5U, X5U

FLASH TEST: 1250 V.D.C. for 1 second

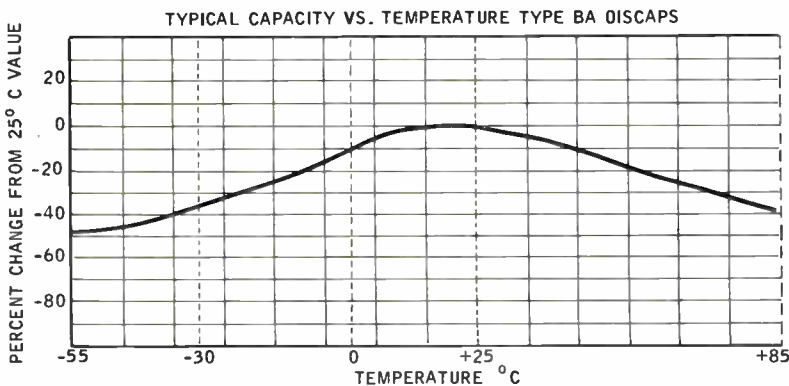
LIFE TEST: Per EIA RS-198 Class II

POWER FACTOR AFTER HUMIDITY: 2.5% maximum @ 1KC

INSULATION RESISTANCE AFTER HUMIDITY: Greater than 1000 Megohms @ 500 V.D.C.

BODY INSULATION: Durez phenolic - vacuum wax impregnated

LEAD STYLES AVAILABLE: Long lead - #22 AWG tinned copper-, fin-lock, kinked lead plug-in and pin type plug-in

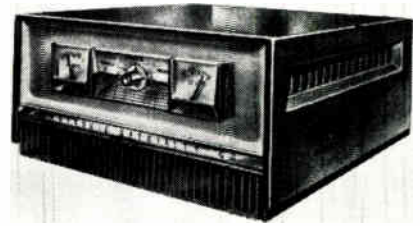


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 FACTORIES AT CHICAGO, ILL. AND ATTICA, IND.

NEW PRODUCTS

FREQUENCY CONVERTER

Input is 115/200vac, 3 phase, 50-60 cps. Output is 400 cps.

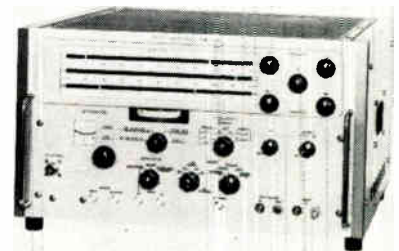


Type 32-53-02570 consists of 3-phase reference oscillator; a 3 phase discriminator PC card; and 3 basic 1kw inverters. All control circuitry are mounted on interchangeable PC cards, providing a high degree of flexibility. Because of the design, the unit achieves substantial reductions in space, weight and cost. It also eliminates the noise and maintenance problems of rotary equipment. Regulation to ±0.01% can be provided. Load balance is uncritical, and total harmonic distortion is less than 5%. Electronic Specialty Co., 5121 San Fernando Rd., Los Angeles, Calif.

Circle 162 on Inquiry Card

SWEEP GENERATORS

Designed for coverage of telemetry and microwave communication link bands.



Model 633A-S1 has a power output of 10dbm flat to better than ±0.5db. Model 633D-S1 has a power output range of 8dbm to -45dbm with power variation of ±0.5db. Both models offer a freq. range of 3.5 to 6.75gc. Freq. is continuously adjustable. Balanced bolometer assures constant power output over wide temp. range. Each unit has 2 time saving indicators of band limits and 2 freq. markers. Other specs.: Residual FM, less than 60kc unlevelled and 80kc levelled; drift, ±0.01%/°C; sweep width, continuously adjustable from 2% to any part of the entire freq. range; symmetrical sweep, 0 to ±5% of range about any center freq.; sweep time, CW operation, 100 to 0.01 sec. Internal AM squarewave 800 to 1200 cps. Alfred Electronics, 3176 Porter Dr., Palo Alto, Calif.

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Today, there's something new in electrical laminates—a more versatile, more rewarding material for the designer. It's Benelex 100A. This hard, dense, hardboard laminate has superior dielectric properties. Costs less than phenolic laminates, offers easier workability (cuts and shapes just like wood). And Benelex keeps its advantages through years of use. It will pay you to investigate Benelex 100A—send now for technical brochure.

BENELEX 100A

the electrical laminate



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What's better about Benelex 100A?

- Self-extinguishing with superior arc resistance compared to phenolic laminates
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- Benelex 100A is eligible for use up to 105° C as sole support of current-carrying electrical parts where the suitability of the application is determined by Underwriters' Laboratories, Inc.
- Approximately 50¢ per lb. in less than carload lots—much less than phenolic laminates
- Lightweight—high density electrical laminate
- Absolutely grainless, without defects, uniform in hardness
- Machines with ordinary woodworking equipment
- Masonite Fabricator Service delivers Benelex 100A components made to order in any size, shape or quantity.

Masonite Corporation, Dept. EI-7, Box 777, Chicago 90, Ill.
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Our high-precision resolvers will meet a wide range of requirements for accuracy, compactness, ruggedness and application.



10-SECOND DUAL SPEED RESOLVERS

Both 1- and 16-speed outputs from one resolver. ■ Direct two-speed operation. Simplified circuitry. Superior reliability. ■ Readily adaptable to digital systems. ■ 10-second accuracy, consistent in production units. ■ Integral bearings... direct mounting. ■ Beryllium housings... thermal stability.



10-SECOND SINGLE SPEED RESOLVERS

10-second accuracy with 2-second repeatability. ■ For data transmission, stable platform applications. ■ Integral bearing... direct mounting to gimbal structures. ■ Stable operation under extreme temperature variation... Beryllium housings.



MULTI-SPEED RESOLVERS

Available with speeds from 2^n to 64-speed for ready digital conversion. ■ Other speeds, such as 15, 25 and 36, also available. ■ Permit design of compact, simplified systems of superior reliability. ■ Furnished either as synchros or resolvers. ■ Reeves' multi-speed resolvers are readily adaptable to digital output when used in conjunction with the new Reeves' RDC 4162-1000 analog-to-digital converters.



TANDEM RESOLVERS

New mechanical design and configuration. ■ Stacking, up to 3 units in tandem on common shafts, provides multiple-output from a single mechanical input. ■ Each unit only $\frac{5}{8}$ " thick. ■ Available in transmitter and receiver models.

These are merely indicative of Reeves' unique and almost limitless capability in the field of resolvers, synchros, gyros and other components. If you have some "tough" problems, we may already have some answers.

Write for Data File 107 ... and use our advisory services without obligation.



REEVES INSTRUMENT COMPANY
Roosevelt Field, Garden City, N. Y.
Division of Dynamics Corporation of America

LETTERS

to the Editor

Metrologist Licensing

Editor, ELECTRONIC INDUSTRIES:

Your editorial titled "The Need for Better Measurements" in the April issue of *Electronic Industries* is a view of the matter of measurement capability which has been sorely needed for some time. I appreciate your concern for the effect of the lack of adequate measurement capabilities on improvements in state-of-the-art advancements.

I have been a Metrologist for about 10 years and we have had a very much uphill battle to fight with management people who have long considered this area of scientific effort to be an overhead problem to be ignored or stuffed into the most convenient dark corner. Recognition has been very slow in coming to the effort of Metrology in all areas of scientific effort.

You will find with a little research that more of the monetary funds of this nation exchange over some type of measurement than through any other method. It is not confined to the government efforts but is also very conspicuous in our everyday life. Stop and think for a moment of all the things you, yourself, do during the day which involve consideration of a measurement of some sort. I do not believe that the thinking person can deny that measurement is one of the most all encompassing and important features of this economy of ours today.

My background in Metrology extends a number of years back when I worked in a civil service position and was intimately involved in laying the groundwork for the present Navy Calibration and Measurement Standards Program. Subsequent to that effort I have been a consultant in the field of Metrology and am presently a staff Metrologist for Douglas Aircraft Company, Inc.

I have said all the above to indicate the background for that which I am about to request of you now. A Mr. Robert L. Galley and myself are working with the office of California State Senator Thomas M. Rees to establish a professional license for Metrologists in the State of California. Senator Rees is convinced that this is sufficiently important to warrant the effort required

(Continued on page 104)

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1-A EI-229 JULY 1964

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**D. I. S. C.
ANNOUNCES REVISION TO
MIL-K-3926 TO MEET CONTROL
KNOB STANDARD MS-91528-C**



**NATIONAL RADIO ANNOUNCES
IMMEDIATE AVAILABILITY
OF CONTROL KNOBS
TO MEET MS-91528-C.**



Just announced by the U. S. Government Defense Industrial Supply Center! New tougher tests included in Mil-K-3926 to guarantee the continued utility of control knobs under adverse conditions and after continued rugged use.

1. New flammability tests in K-3926 will require that all control knobs made to MS-91528 be subjected to a direct flame for a period of not less than 15 seconds after which time the knob material must not support combustion for any period greater than 30 seconds.

2. All control knobs which are manufactured by assembling and cementing together various parts must now be subjected to a torque test on the cemented parts such as dials and caps. These parts must withstand a minimum torque of 5 inch pounds, after being subjected to a grueling test, without showing signs of loosening or coming away from the main body of the knob.

3. Set screw torque test. After completion of environmental testing which also includes salt spray and radiation tests, set screws are subjected to a tightening torque test. The 4-40 UNC-3A set screw is subjected to 3 inch pounds of torque and the 8-32 UNC-3A set screw is subjected to 15 inch pounds of torque. Upon examination after the test, there must be no evidence that physical damage has occurred.

4. Knob identification. Each control knob must be clearly marked with the mil standard number and also the military type

number designation. These markings must remain clearly legible after completion of all environmental testing. During environmental testing control knobs must undergo exposure to intense salt spray, extremes of temperatures and humidity, ultra-violet radiation and vibration, after which they must be usable.

5. After environmental tests are completed knob inserts with a 1/8" shaft hole are torqued to 15 inch pounds, and for 1/4" shaft hole inserts, the torque is 30 inch pounds. After the test there shall be no movement of the insert within the knob, cracking, or other failures.

How is it possible for National to make knobs available to the revised specifications so fast? Because National Radio Company has complete facilities for "in-house" testing and can perform all of the tests in the presence of a resident naval inspector as soon as new production is accomplished.

NATIONAL RADIO COMPANY, INC. Dept. EI 1-64

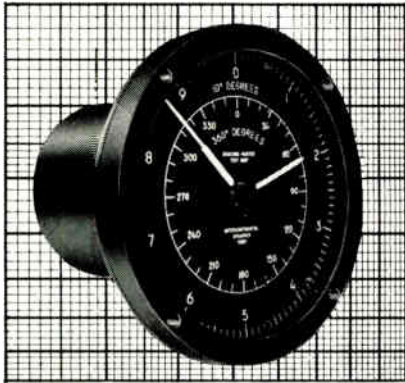


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Circle 55 on Inquiry Card

LETTERS

to the Editor

(Continued from page 98)

to present a bill to this effect before the California State Senate in the session beginning in January 1965.

Senator Rees has asked Mr. Galley and me to provide his office with all the material available from publications such as yours indicating further the importance of this matter of measurements and its effect on the lives of each person. I will greatly appreciate your providing his office with a copy of this editorial and with any other articles produced for your publication concerning measurement and its role in industry.

Thurlow M. Morrow

Apartment 8
Blue Horizon Motel
1201 South Atlantic Ave.
Cocoa Beach, Florida

Better Measurements

Editor, ELECTRONIC INDUSTRIES:

I noticed with great interest your editorial regarding the need for better measurements. Your comment regarding the lack of educational institutions providing Metrology courses is of particular interest. As you may or may not know, the Precision Measurement Society (PMS) is a group of Professional Metrologists, and peripheral people associated in some way with measuring equipment. This group was inaugurated about 5 years ago to provide a common organization for exchange of Metrology information and, if possible, to advance interest in the Metrology Sciences.

An early goal of the group was to interest universities and colleges in the San Francisco Bay Area in the importance of the field of Metrology and the need for trained measurement engineers. After a considerable period of negotiation, involving attempts to educate the local academic institutions to the fact that there really was such a field as Metrology Science, San Jose City College agreed to co-sponsor a metrology course. The course is actually a lecture series involving present state-of-the-art of Precision measurement on an introductory level. Each lecture is given by a PMS member working in a specific discipline of the

various Metrology Sciences. Copies of the lecture are reproduced by the City College and made available as handouts to the attendees. It was originally anticipated that the course would probably have about 50 students, however, initial attendance ran closer to 250. Even now, with only 3 lectures left the attendance is around 175. The guest lecturer was Dr. F. K. Harris of National Bureau of Standards which helped lend a prestigious figure to the proceedings.

The intent of my letter is to inform you that there is a scientific professional group in complete accord with your editorial statement and that possibly the first faltering step has been initiated in interesting the Colleges in supporting such a course.

J. A. Winchell
President

Precision Measurements Society
P. O. Box 1312
Los Altos, California

"State-of-the-Art"

Editor, ELECTRONIC INDUSTRIES:

Please send me reprints of your two excellent April articles, "Noise Behavior in Semiconductor Devices," and "The Government Electronics Market."

Although I think the expression "State-of-the-Art" has been beat to death, the quality of these two articles goes a long way in proving your point of up-to-date contributions.

Keith V. Warble

Avco Corporation
1808 Newton Drive
Norman, Oklahoma

Heartfelt Thanks . . .

Editor, ELECTRONIC INDUSTRIES:

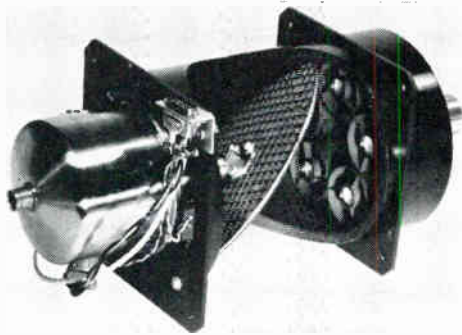
I acknowledge with pleasure and my heartfelt thanks your letter of April 27 and enclosed check, which we are crediting as a contribution to Boys Town from Mr. A. Demmerle, Mr. P. J. McCaney, and Mr. T. J. Karras, in accordance with the information you gave me. I deeply appreciate it that the money they received as an honorarium for the article they had written for your magazine was sent to Boys Town instead. A letter of thanks to each of them is going out today.

With kind personal regards, I am

Father Wegner

Father Flanagan's Boys' Home
Boys Town, Nebraska

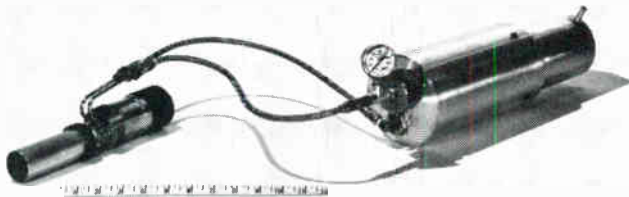
Ed.: These gentlemen wrote the article, "Time Decoding for Satellite Tracking Systems."



Radiometer for NIMBUS weather satellite



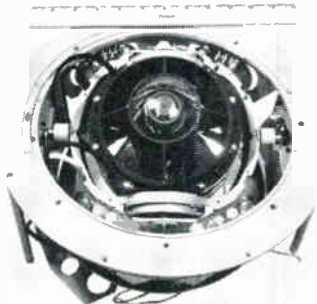
Interceptor IR installation



12°K closed-cycle cryostat



90C :R search/track set



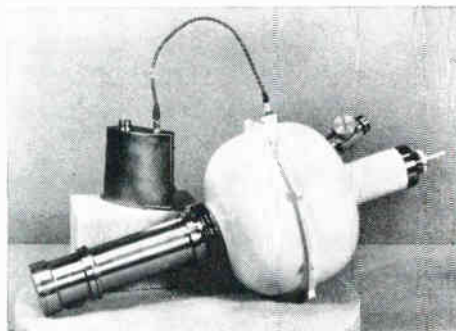
IR multi-channel tracking radiometer



Star tracker for SURVEYOR spacecraft



Modulated IR source



Liquid-helium-cooled IR detector



IR anti-tank missile controller

Expanding Infrared Programs

create new career assignments

Rapid growth of HUGHES Infrared activities in the Aerospace Divisions and the Santa Barbara Research Center has created many responsible positions for qualified engineers and scientists in all phases of IR systems development from conception through production engineering. Immediately available assignments include openings in such diverse technologies as semiconductor physics, optical design, cryogenics, mechanical

engineering, precision electro-mechanisms, electronic circuit design, servo systems . . . and many other areas. Current HUGHES IR contracts include advanced systems for space exploration, weather reconnaissance, anti-ballistic missile defense, anti-submarine warfare, interceptor weapon guidance & fire control, bomber defense and tactical weapon control. Professional experience, an accredited degree and U.S. Citizenship required.

For immediate consideration, please airmail your resume to:
MR. ROBERT A. MARTIN
Hughes Aerospace Divisions
11940 W. Jefferson Blvd.
Culver City 10, Calif.

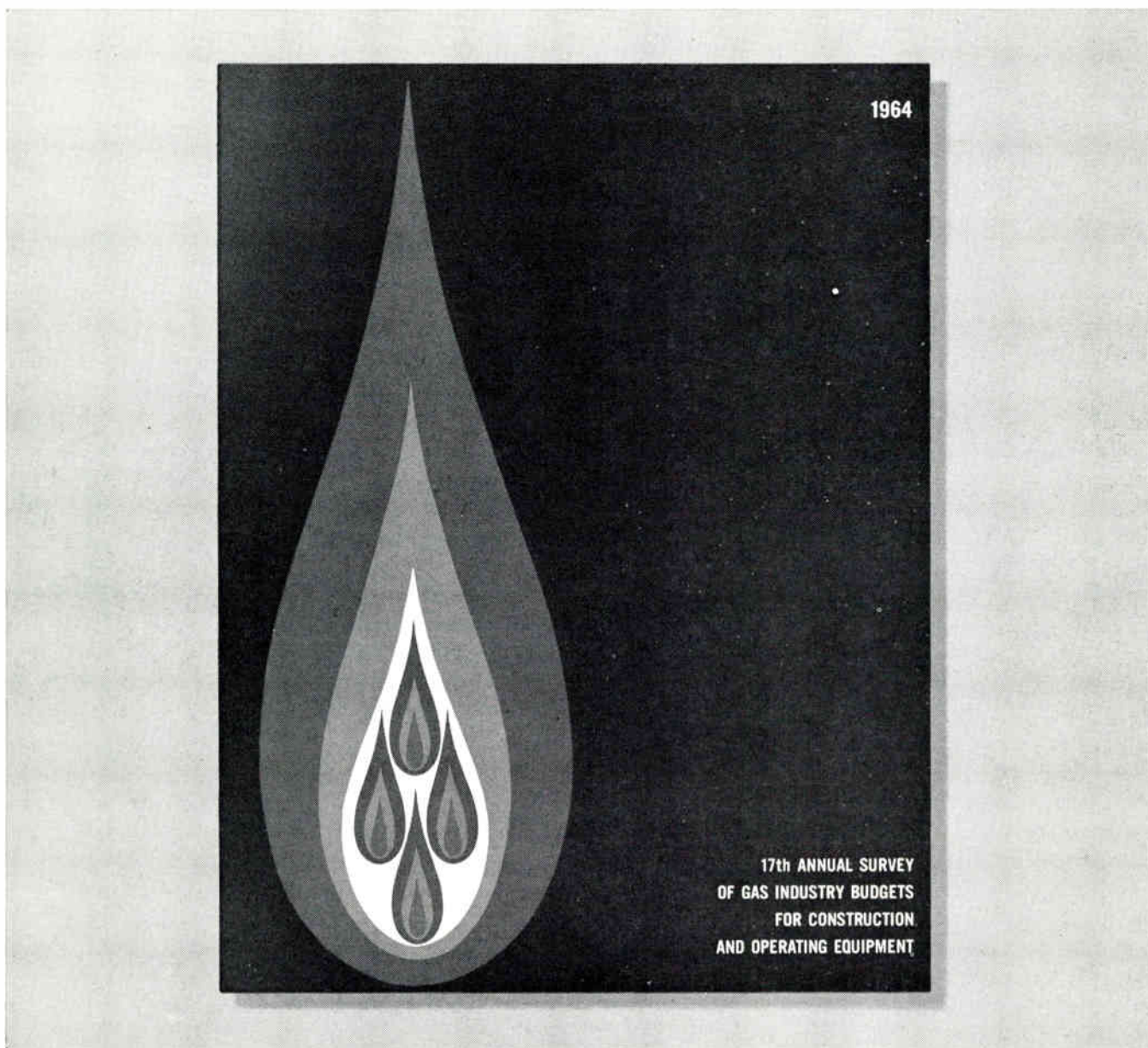
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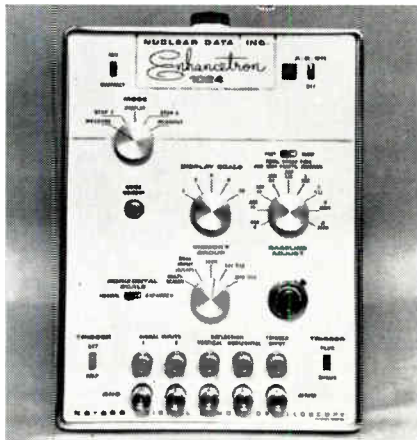
GAS

**THE MAGAZINE OF THE
NATURAL GAS INDUSTRY**



SIGNAL-AVERAGING DIGITAL COMPUTER

Enhancetron 1024 signal-averaging digital computer separates single brain impulses from other signals. It takes repeated samplings, translates them into numerical equivalents and stores them in a core memory. It is made by Nuclear Data Inc.



Simulators and other training devices for Project Gemini will be maintained and serviced under a \$100,000 contract signed recently by NASA and the Link Div. of General Precision, Inc. Initial phase of the contract covers maintenance, repair and updating of Gemini mission simulators located at Cape Kennedy.

The thermal conductivity of metals is easily measured by a new thermal conductivity instrument developed by Dynatech Corp. The axial rod of Model No. TCAG-R8-E tests a rod test specimen $\frac{3}{8}$ to $\frac{1}{2}$ in. sq. x 7 in. long over a conductivity range of 5 to 200 Btu-ft./hr.-ft².-°F. Accuracy over temp. range of 20°F to 800°F is $\pm 2\%$. Measurements are made of the heat flux through the sample and of temp. at seven equally-spaced stations along the length of the rod.

A measurement engineering short course will be held on July 20 to 25 at the Princeton Inn, Princeton, N. J. The theme of the program will be "How to Obtain Valid Data on Purpose." It will cover the basic data and the fundamentals of the science of measurement. Included will be the measurement of stress, strain, vibration, flow and temp., as well as transducer mechanical design principles and biological measurement. The course is sponsored by Training Services, Rutherford, N. J.

A portable, battery-powered test unit for determining the voltage and current characteristics of semiconductor devices is contained in Model 2115. Developed by Electronic Systems, Inc., it measures the forward conduction and reverse leakage of diodes and transistor junctions simultaneously. This unit also determines current at maximum Beta and permissible current range for linear amplification.

An r-f calibration system with accessory instruments, designated Model RFS-1, has accuracies from $1\mu\text{v}$ to 1125v. and 0.5 ma to 100a. at freqs. to 1gc. Developed by The Singer Co., Metrics Div., the module is designed for rapid, high resolution readout of true RMS, r-f sensing devices such as micro-potentiometers, A-T voltmeters, coaxial thermal converters, thermoelements and other transfer instruments.

A 2-arm pen X-Y plotter-recorder, featuring simultaneous plots with 2 completely independent curves, has been developed by Electronic Associates, Inc. It has a $100\mu\text{v}/\text{in.}$ sensitivity and unique dual-mode hydraulic damping. The 2-arm version uses 4 independent servo systems, and input data can be accepted from 4 physically independent sources. This instrument can also be modified to accept input data from 2 physically independent sources and will plot this data against a third independent source or as a function of time.

A plasma diagnostic probe, developed by General Electric's Radio Guidance Operation, on a contract with the AE Cambridge Research Laboratories, shows promise as an in-flight instrument to measure the electron density distribution in the flow field of a re-entering hypersonic vehicle. It also measures the electron temperature of the plasma at the same point. Salient features are: it provides measurements with high resolution in portions of the flow field of interest; does not disrupt or modify the flow field; has application to other plasma diagnostic requirements.

COMPUTER ASSISTS JET MAINTENANCE

In-flight jet engine and aircraft system monitoring equipment and electronic computers now make it possible for airlines to spot potential troubles and reduce non-scheduled corrective maintenance. Used during ground checkouts, it permits quick analysis to expedite the "fly—no fly" decision when trouble is suspected. Since detailed engine and component failure information is accumulated for analysis on a computer, economies in routine jet engine maintenance also can be effected. The system was developed by Lockheed Aircraft Service Co.





NEW GENERATOR TESTS DATA HANDLING SYSTEMS

By **LARRY MOBLEY**
Project Engineer
Industrial Products Group
Texas Instruments Incorporated
Houston, Texas

As the demand on communication systems grows, the need for more realistic system evaluation techniques becomes imperative.

The system and equipment described here is one approach to this problem.

A NEW PULSE GENERATOR is being used for digital memory exercising, data-handling tests, and other uses requiring repetitive pre-set or pseudo-random 10-bit NRZ (non return to zero) words at from 100 cps to 25 μ c bit rates. It achieves its high prf via high-speed transistors and meticulous circuit layout throughout, core gating of non-saturating load-isolated flip-flops, and current switching in "and" and "or" logic.

* * *

Two such generators have been used to test external transmission link bandwidth or data-handling capabilities up to 20 μ c bit rates. Fig. 1 shows the elements of the system.

Generator 1 supplies the input to the system under test. Waveforms received from the system output are compared against the output from Generator 2. This is an exact duplicate of the original input, except delayed in real time by the amount of delay inherent in the transmission system. Generator 2

clock pulses are derived from recovered signals. When using the generators' pseudo-random mode outputs (actually a series of binary words, each differing from the preceding by binary one), absolute synchronization can be achieved by using a simple integrator circuit to detect the unique "long pulse" occurring for words 1022 and 1023—19 "1's" in a row. Operation at prf's up to 25 μ c, continuously variable, allows quantitative measurement of system degradation vs. frequency.

A similar technique of "master-slave" operation has been considered for extreme-security message translation. Here the generators function as the encode-decode elements. They can be cascaded in 10-bit incremental modules for "century-long" periods.

The Generator

The generator is essentially a 10-bit shift register with a high-speed serial binary adder. Fig. 2 shows the principal elements. Non-saturating operation is
(Continued on page 110)

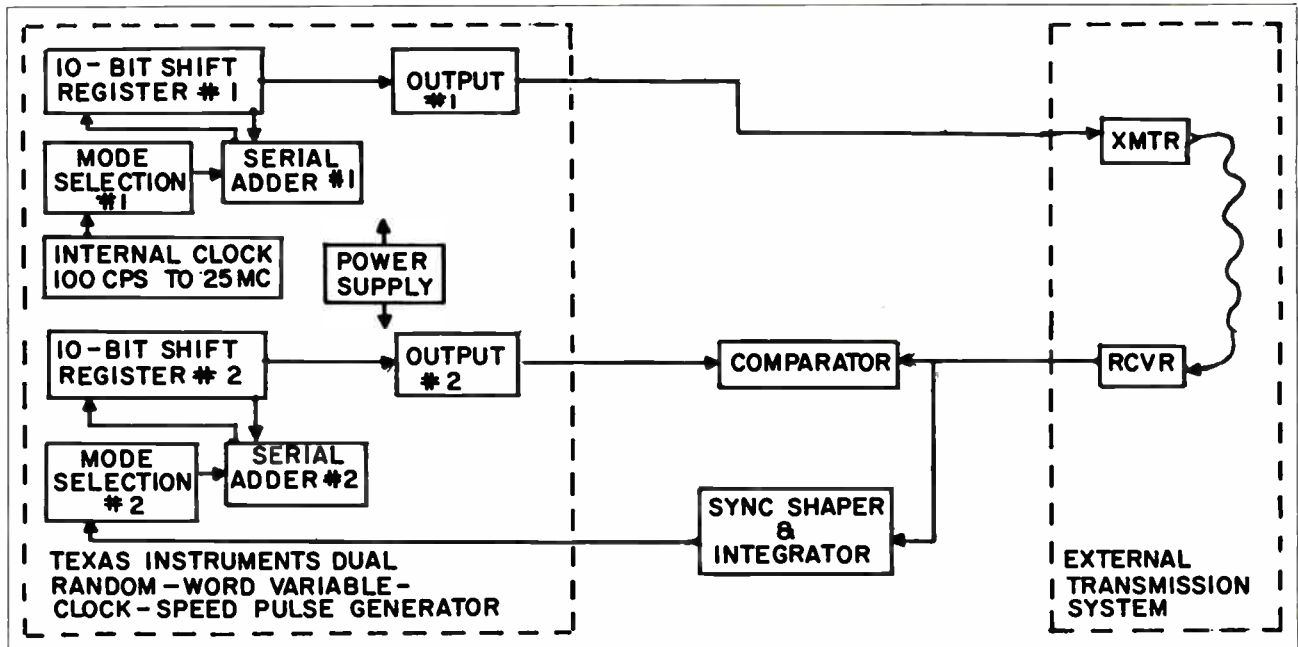


Fig. 1: Elements of a system data-handling test using dual pulse generator.

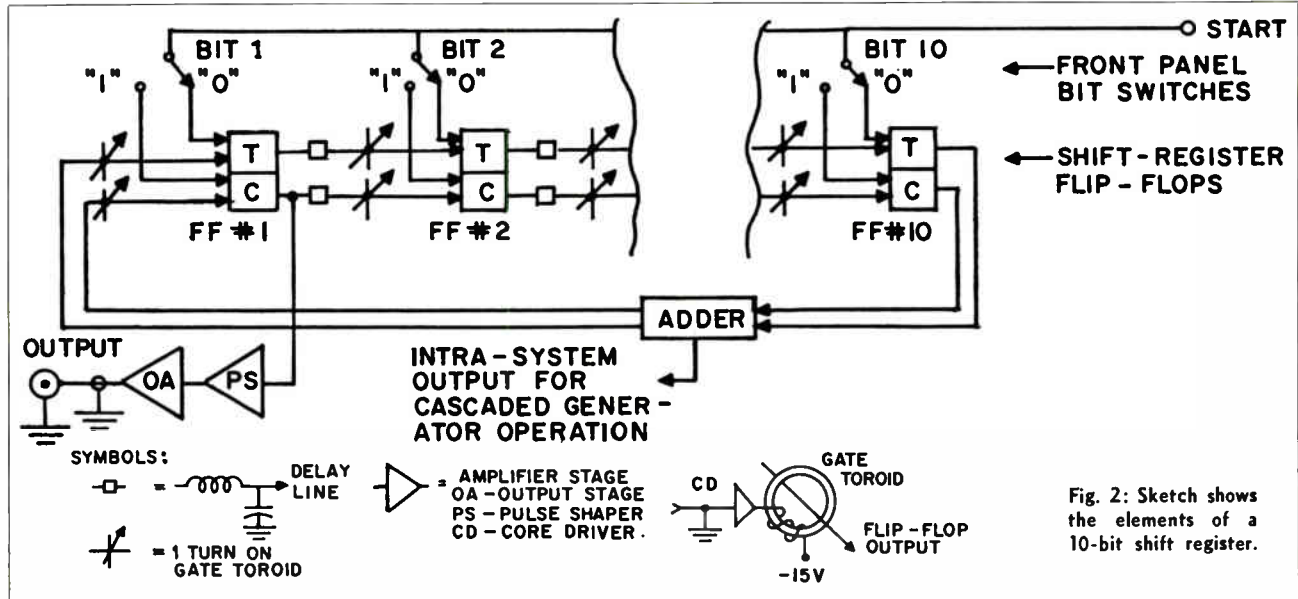


Fig. 2: Sketch shows the elements of a 10-bit shift register.

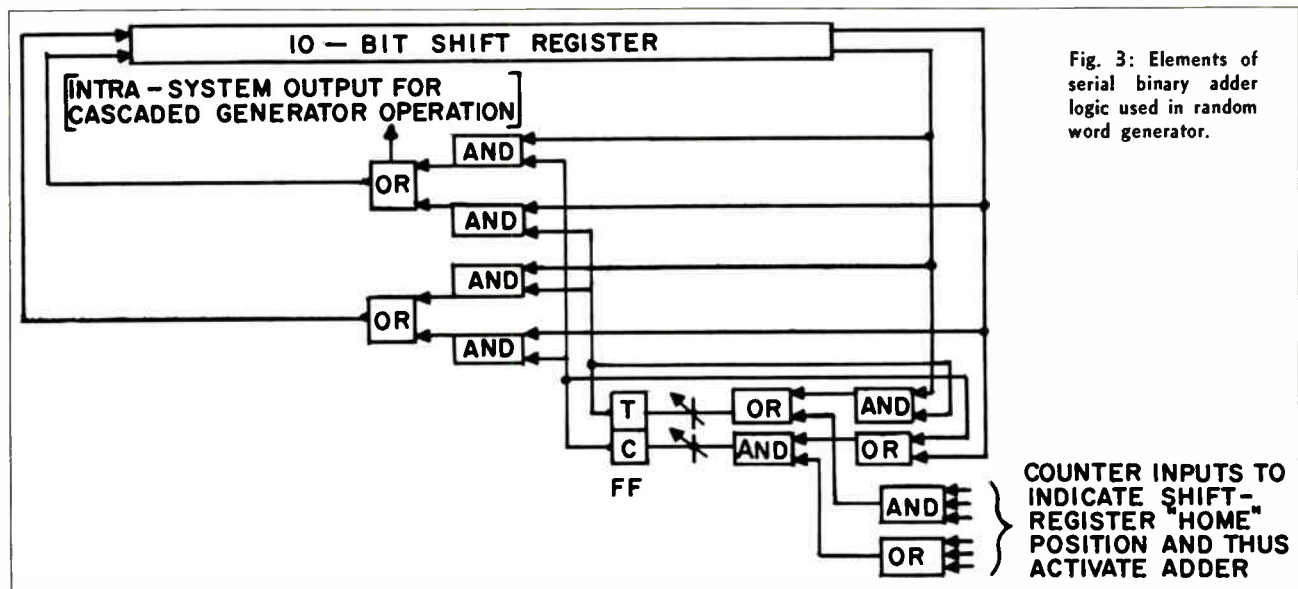


Fig. 3: Elements of serial binary adder logic used in random word generator.

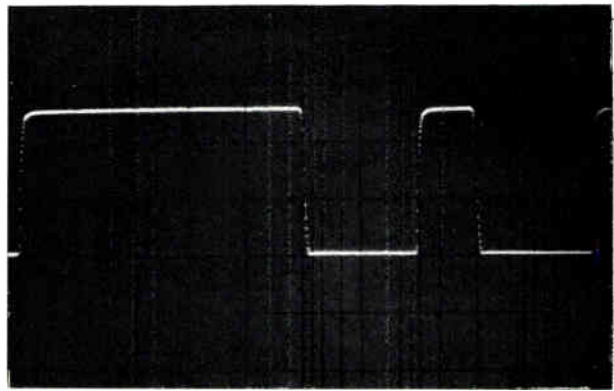
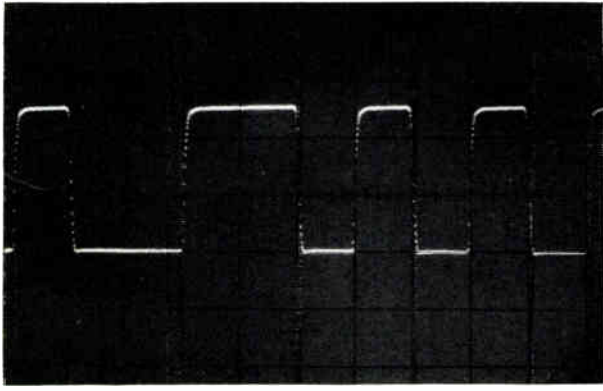


Fig. 4: Scope photos show that no degradation occurs with an NRZ output of 5 volt-amps at 20 mc.

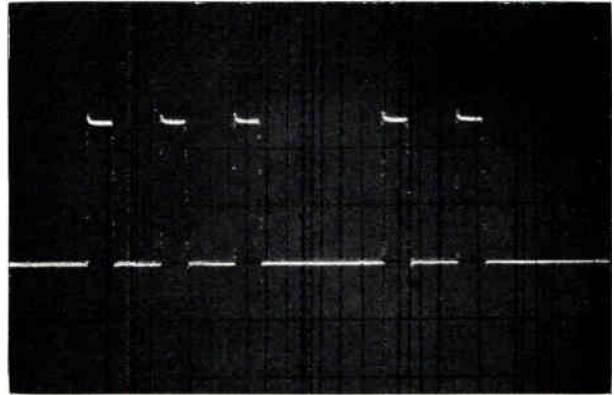
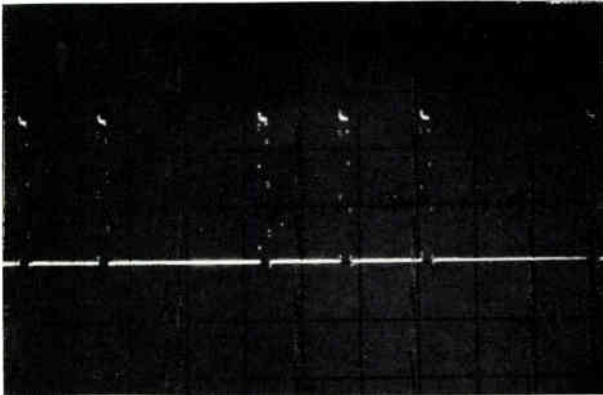


Fig. 5: Return-to-zero (RZ) output can be obtained from a wave-shaping module. These two photos represent 5 volt-amps at 20 mc.

RANDOM-PULSE GENERATOR (Concluded)

assured by collector-base clamping. Flip-flops are isolated from loads by single-ended emitter followers. Each common-base core driver has its collector output fed to the associated core. Flip-flop output threads the core with a one-turn loop.

Logic level is ± 1 volt; the low voltage swings required for action minimize capacity effects. Each clock pulse results in a 2 v. pulse. Flip-flops require about 2.5 v. for setting; the voltage is not critical. If the double-rail gating lines are in the conditions of "True" at +1 v. and -1 v. on the "Comp," then the next clock pulse raises the "True" line to about 3 volts and forces the upper flip-flop to "True" regardless of its previous condition. At the same time, the "Comp" line is raised to +1 v. by the action of the clock pulse. This is not enough voltage to set the flip-flop.

Action is similar for reversed initial states. In all cases, the condition existing in the preceding flip-flop is gated into the succeeding flip-flop regardless of what was in the latter prior to clock pulse action. Operation is reliable up to 25 mc and the circuitry is more simple than other approaches, such as complementing formats, also considered by TI design engineers.

Output is taken from the final flip-flop in the register chain, shaped and delivered through an output amplifier. Pulses have rise and fall times less

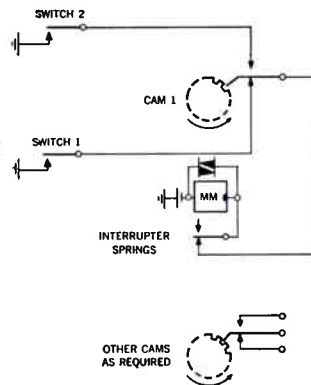
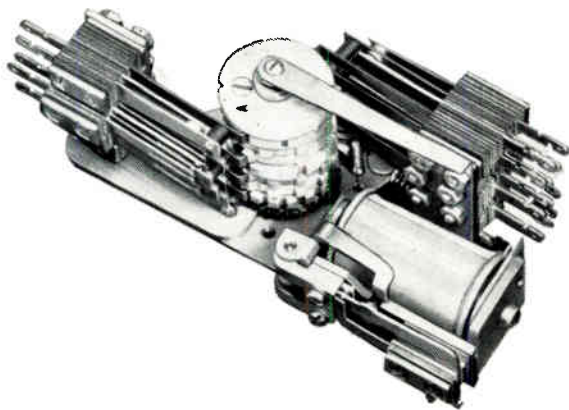
than 6 nsecs. and are variable in amplitude from 0 to 5 v. into a 93 ohm load. Fig. 4 shows that no degradation in waveform occurs even at maximum prf.

The psuedo-random operation mode generates sequentially and automatically, all 10-bit word combinations from zero to binary 1024. Maximum power spectra are thus assured when making various bandwidth tests. The psuedo-random output is achieved by inserting a serial binary adder into the register chain each 10th bit. Logic for the adder differs from the conventional because high-speed transistors are used in current-switching circuits to provide non-saturating operation. Fig. 3 shows the elements with an emitter-follower driver and the same type flip-flop as used in the shift register. No dead time is required for addition.

When used in its repetitive mode, the binary word desired is set in manually by front panel switches. This set-in-word is also the initial word when psuedo-random operation is started. A return-to-zero output can be obtained by using the generator in conjunction with an "And" gate so that when the clock pulse and NRZ "1's" are both present, a "spike" output is obtained. When the NRZ output is "0," no output occurs for that bit time. The resulting spikes are then fed into another TI wave-shaping module—a plus-minus unit—so that the "spikes" become RZ bits with amplitude and duration determined by the plus-minus module settings. Fig. 5 shows some typical waveforms.

Be a winner!

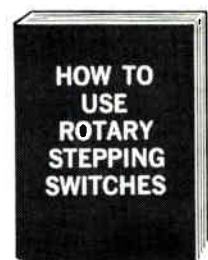
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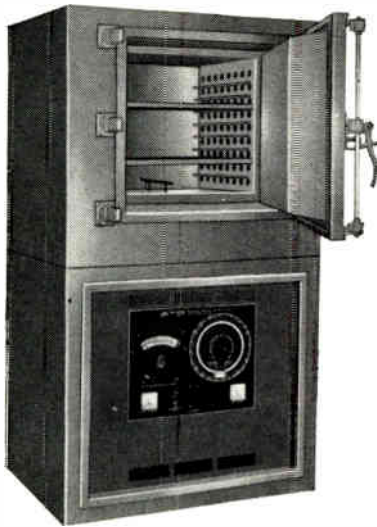
Winner's Handbook



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Circle 57 on Inquiry Card

RESISTOR RELIABILITY

IN THE AEROSPACE INDUSTRY component failures are absolutely intolerable. Mepco, Inc., uses a small computer system to help keep high reliability standards and to meet contract commitments in precision resistor output.

The system is an IBM 1620 computer, with a 10-million digit disk storage memory unit, coupled to a digital ohmmeter that reads values of 25 resistors per minute. Capacity can be stretched to 50 resistors.

Readings, expressed in ohms, are recorded and automatically compared with set nominals and with other readings already recorded. Readings go directly from component to a validating record, increasing speed, reducing cost, and minimizing error possibility. Readings include lead checks, extremes of temperature and power similar to space conditions.

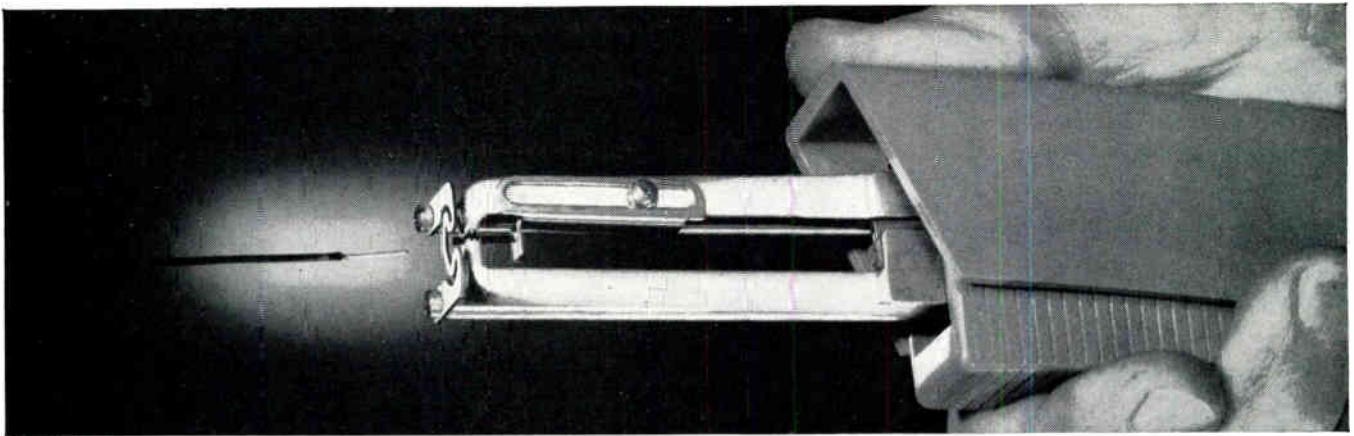
Resistance values not within specified limits are signalled out on the computer's console typewriter and by a punched reject card. The bad resistor is removed. After all tests, a card is made for each good resistor showing readings in punched and printed form. For each high reliability resistor, Mepco develops a complete history instantly available. Any combination of facts desired for any part of a production run can be called out immediately.

When Mepco took on the computer system, it already had "a repetitive, controllable manufacturing process, and a strong, efficient quality control group well entrenched. Now, efforts have been strengthened in control of screening, and the ability to measure long term production through analysis of the failure rate. Mepco is able to reduce infant failure rate and give customers more meaningful data.

Screening tests have evolved from what was once thought by many as a frill into the most valued part of Mepco's reliability program. (Cont. on p. 114)

Serial number of Mepco made resistor is checked against data card to assure positive identity of test readings and results. IBM 1620, coupled with digital ohmmeter, is in the background.





UNIQUE ONE SQUEEZE THERMAL WIRE STRIPPER

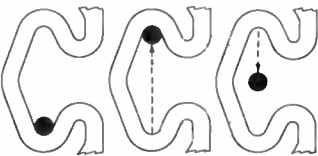
The new Ideal Swing-Grip® thermal wire stripper uses a unique mechanical action to strip in a single, continuous squeeze. Swinging grippers move the wire into contact with the thermal element so no twisting of the tool is necessary. The same grippers hold the insulation slug during removal, completely eliminating any contact with the conductor strands. Single element assures uniform heat.

"Beading" is reduced by the thin section of the element blade. "Drag-out" or "stringing" of insulation is eliminated since the heated element is not used to pull the slug.

The tool is light weight and designed to remain cool during production operations. Head size has been held to a minimum for easy access in close quarters. Three simple adjustments and a variety of element shapes permit

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Curved heating element contacts wire first on one side... then on other side, severing insulation all around wire. Removing wire from tool pulls off insulation held by the grippers.



IDEAL INDUSTRIES, INC.

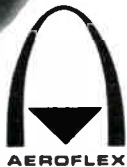
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113

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General Manager
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Daytona Beach Industrial Area
(Ormond Beach, Daytona Beach, Daytona Beach Shores, South Daytona, Holly Hill, Port Orange)
Box 1309 - Dept. IM-4, Daytona Beach, Fla.
Please send detailed information on the Daytona Beach Industrial Area.

Name _____ Title _____

Company _____

Address _____

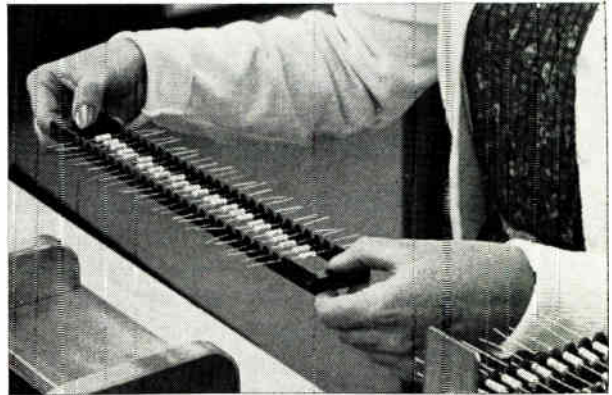
City _____ Zone _____ State _____

All inquiries held in strict confidence.

Circle 61 on Inquiry Card

RESISTOR RELIABILITY (Concluded)

Many of Mepco's customers use the punched cards as a record for individual resistors. Some buyers test only samples. For its buyers without punched-card systems, Mepco stores cards and gives data on request. The card is also a valuable marketing aid. A sample card, complete with readings, and a blister-packaged resistor is "impressive testimony."



Resistors are aligned in special racks to be placed in test fixture for reading by digital ohmmeter coupled to computer.

Mepco's failure rate on its hermetically-sealed carbon film resistor is 0.00083% per 1000 hours of load life at confidence level of 90%. Compiling such data for varied resistor types makes a computer system a must.



CRATEX®
RUBBERIZED
ABRASIVES

MAKE IT EASY

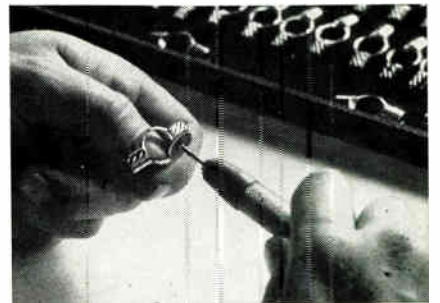
TO DEBURR, SMOOTH, CLEAN, POLISH

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Grit Textures:
Course, Medium, Fine, Extra Fine
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Wheels, Points, Blocks and Sticks
in a practical range of sizes.



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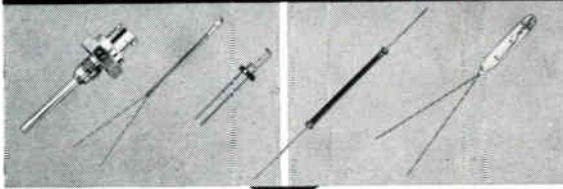
Put versatile Cratex rubberized abrasives to work after dimensional grinding or shaping.

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Cratex is sold through leading industrial distributors.

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ELECTRONIC INDUSTRIES • July 1964

When you need a better way to
MEASURE or CONTROL Temperature



... Check F.E.I.
Precision Thermistors

- Direct readout
- Exceptional accuracy
- Fast response
- High output level
- Excellent resolution
- High stability
- Small, rugged, versatile
- Interchangeable units available



Try them in your lab

F.E.I. experimental kits include an assortment of thermistor types with complete operating characteristics, application data, etc.

G700	4 thermistors	\$4.95
G701	10 thermistors	\$9.95
G200	12 thermistors	\$19.95



FENWAL ELECTRONICS, INC.
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Cut costs—save valuable space with these...

SUB-MINIATURE
"U, UA, and UB"
AIR VARIABLES



Precision machined for high reliability—exceptional mechanical stability!

- **HIGH "Q"—GREATER THAN 1500 AT 1 MC!**
- **HIGH TORQUE... 2½ TO 10 INCH OUNCES!**
- **LOW TEMPERATURE COEFFICIENT—PLUS 45 ± 15 PPM/°C!**

Cut costs—improve performance—save valuable space with these sub-miniature air variable capacitors! Type "U" requires less than 0.2 square inch for chassis or panel mounting—Types "UA" and "UB" require less than 0.23! No special tools required for installation—slotted rotor shaft accommodates large screwdriver. Rotors and stators precision machined from one piece of solid brass—provide outstanding mechanical stability. Units offer high "Q" (greater than 1500 at 1 mc.); low temperature coefficient; provide absolute freedom from moisture entrapment found in trimmer capacitors of the enclosed or solid dielectric type.

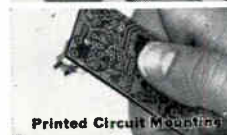
All metal parts are silver-plated—ceramic is steatite Grade L-4 or better. Exceptionally uniform delta C and voltage characteristics... voltage breakdown ratings available to 1300 volts DC.



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Three fast, easy mounting styles—Single Section types available in: "Loc-Tab", Printed Circuit and Two-Hole—Differential and Butterfly types available only in Printed Circuit mounting styles. Tuner (coil-capacitor) assemblies available in production quantities to your specifications.

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EXPLAINED!

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Clamp Engineering
Design Manual

Features 72 pages of prints, tables, illustrations, specifications, applications and installation tips for ANY clamp problem... military or otherwise. Plus the latest developments in clamp design, cushioning and insulating materials for space age requirements. Illustrates sizes and styles of loop clamps, bonding clamps, multiple clamps, center clamps, wire harness clamps, wave-guide clamps... plus blocks, brackets, bus-bars, line supports and related items. Sizes ½" to 6" diameter in aluminum, titanium steel or stainless in wide selection of high and low temperature insulating materials. **BEFORE YOU DESIGN OR BUY, CHECK WITH TA FIRST.** Over 41,000 clamp designs at your fingertips, ready for shipping at tremendous off-the-shelf savings. Write, wire, or phone today for a quotation.

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Foremost in clamp design since 1948

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ELECTRONIC INDUSTRIES • July 1964

KAY

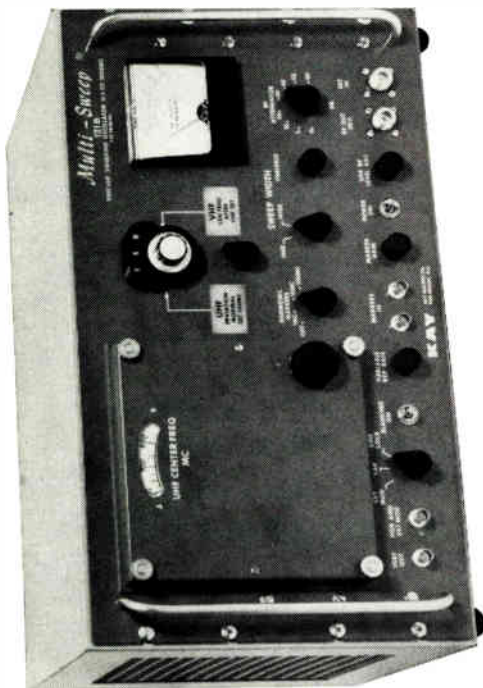
ELECTRIC COMPANY

Maple Avenue, Pine Brook, Morris County, New Jersey

Frequency Range: UHF—0.5 to 300 mc.
 UHF—200 mc to 1050 mc.
 P-122A—900 mc to 130 mc.
Sweep Width: 50 kc to 300 mc.
RF Output: .5 volt rms into 50 ohms, metered.
Flatness: \pm .25 db to 800 mc.
 \pm .5 db to 1300 mc, or as specified.
Markers: crystal-controlled harmonics of 1, 10, 100 mc.
Attenuation: 60 db in 10 db steps.
Sweep rate: 30 to 60 cps, external from 1 cps to 20 kc.

Price: \$1295. P-122A head: \$335. markers, \$145.

NEW!
KAY
Multi-Sweep
121-B



Circle 66 on Inquiry Card

0.5 mc to 1300 mc Sweep and Marker Generator

RADIATION-RESISTANT TRANSISTOR

THE METAL-BASE TRANSISTOR (MBT) extends the useful freq. range of these semiconductor devices by a factor of 10, and has 10 times the radiation resistance of present transistors.

Developed by Sprague Electric Co., North Adams, Mass., they have a unique design. Unlike conventional transistors which consist of 3 layers of different types of silicon or germanium with the middle layer no thinner than 2,500 Å, this transistor has 2 layers of single-crystal silicon separated by a layer of metal. This layer is only 100 Å thick (3 Å are approx. 10 billionth of an inch). This key center layer is 25 times thinner than the thinnest layers used in present transistors. Consequently, the device has an upper theoretical freq. limit of 20cc.

The MBT is said to be the first practical layer-built device in single-crystal form, and is potentially the first practical microwave, super-high freq. transistor. It will allow communications with solid-state devices at freqs. presently far beyond the useful range of the spectrum. The amplification factors (beta) of the unit is 10.

The MBT has a good, radiation resistance factor. The improved resistance is due to 2 facts: The MBT is a majority carrier and therefore does not suffer recombination effects because of radiation damage. Second, the thin base region presents a small cross-section for damaging particles.



Model 400R1
 Output 70 CFM. As shown, with front and rear guards, \$7.95 in 1-9 lots; lower in quantity

NEW FROM HOWARD Cyclohm PANEL FANS

POWERED BY THE PERFORMANCE-GUARANTEED HOWARD UNIT BEARING MOTOR

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 Output 210 CFM. As shown, with front and rear guards, \$24.95 in 1-9 lots; lower in quantity

Model 400R2
 Output 140 CFM. As shown, with front and rear guards, \$15.95 in 1-9 lots; lower in quantity

Single, double and triple orifice models, with or without guards, guaranteed for 5 years to require no maintenance or re-lubrication. Attractively priced.

UNITS ILLUSTRATED AVAILABLE FROM STOCK
 FULL INFORMATION ON REQUEST



HOWARD INDUSTRIES, Inc.

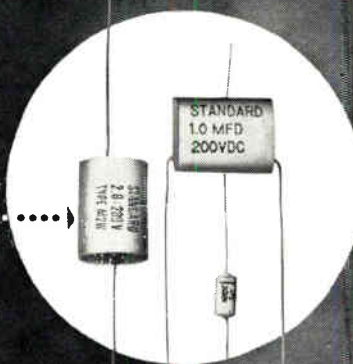
1760 State Street, Racine, Wisconsin

Sales offices and representatives in principal cities. Consult the Yellow Pages.

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ELECTRONIC INDUSTRIES • July 1964

made to
your
exact
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prices



METALIZED MYLAR CAPACITORS

Unique, self-healing units that remain in circuit during voltage surges with little or no loss of electrical properties. Use the M2W's where size and weight are limiting factors and long life and dependability are required. The units utilize metalized Mylar* Dielectric with film wrap and custom formulated epoxy resin end fill. Available in round and flat styles.

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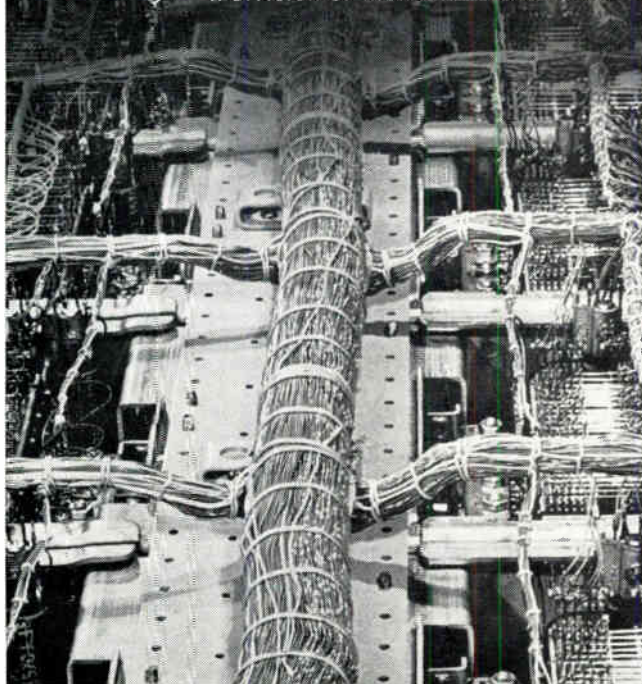
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think neat With LTCO electronic lacing cords and tapes. Write today for illustrated handbook of proper cords and tapes for your lacing operation. We make them all.



THE LINEN THREAD CO.

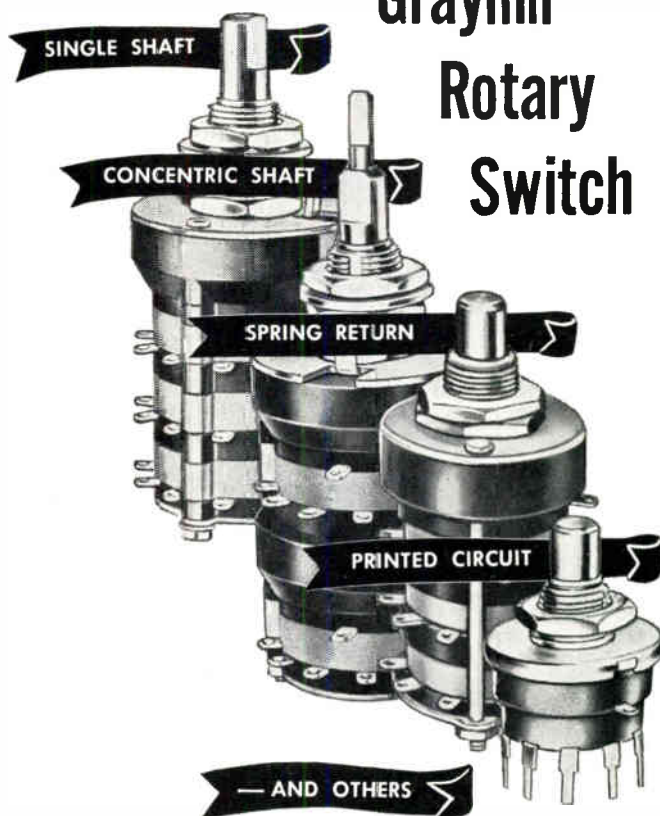
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A DIVISION OF INDIAN HEAD MILLS, INC.



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Every Grayhill Rotary Switch



**—gets over 75 Quality Control
Inspections and Tests**
**—you get over 100,000
operations**

- Contact Resistance .010 ohms typical
- 100,000 cycle life
- Make or Break 1 Amp.
115 VAC Resistive
- 1 to 6 Poles Per Deck
- 1 to 12 Decks
- 2 to 12 Positions Per Deck
- Explosion Proof

Write for Current Engineering Catalog

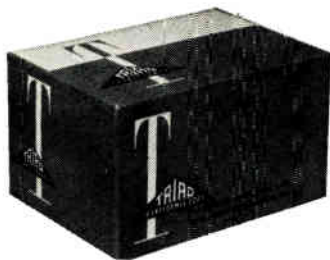
Grayhill
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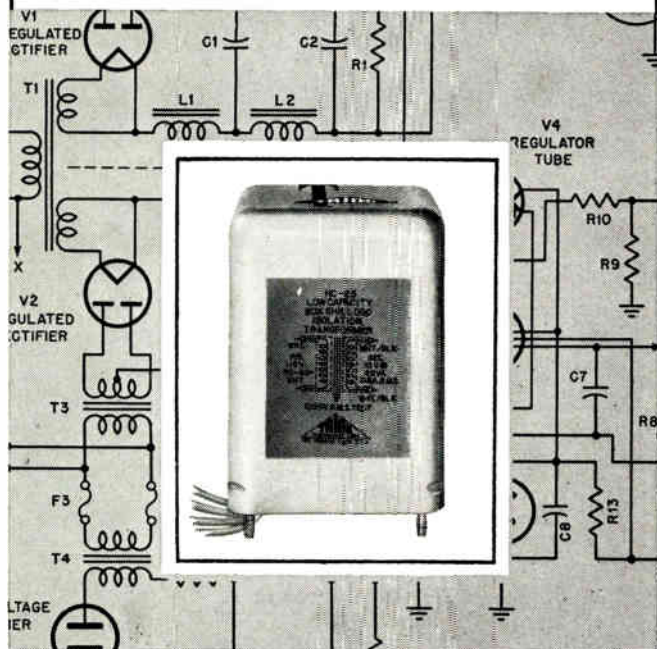
“PIONEERS IN MINIATURIZATION”

Circle 70 on Inquiry Card

117



SOLUTION!



If you're wrestling with a difficult design problem involving transformers — look to Triad. Over 1,600 off-the-shelf transformers are available for immediate delivery. Many of these transformers were developed to meet exacting military and commercial needs.



Typical of this advanced Triad technology are box-shielding techniques developed to hold winding-to-winding capacity to less than 0.03 mmfd and offer common-mode signal rejection to over 130 db for interferences of less than 400 cps. Other Triad transformers carry equally impressive specifications, from the smallest miniature transistor models to the largest heavy-duty power transformers.



Next time you have a design problem, check with your local distributor. Chances are great that there's just the right Triad transformer for your needs in stock. In the meantime, write for our latest catalog: TR-63/64.



TRIAD DISTRIBUTOR DIVISION

A DIVISION OF LITTON INDUSTRIES

305 No. Briant Street, Huntington, Indiana

SELF-TUNING HF TRANSMITTER

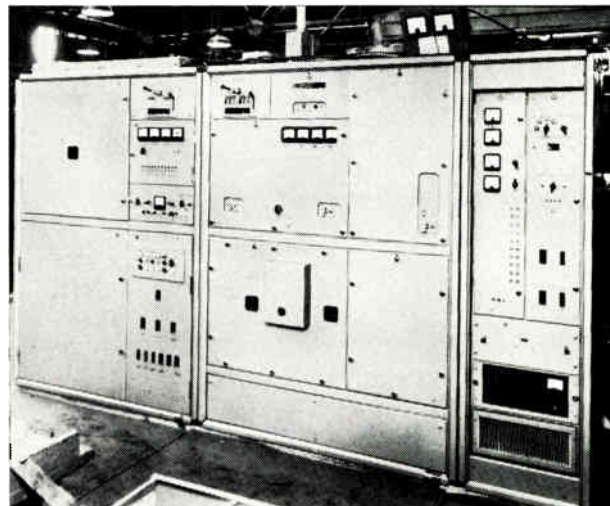
THE MST TRANSMITTING EQUIPMENT is for high-grade point-to-point telecommunications. The range covers all the equipment needed for a large modern transmitting station, and can be entirely controlled by one man from a central control room. The running costs with this new type of equipment are considerably reduced.

Up to the final stage the system uses wideband distributed amplifiers which require no tuning. The final stage is self-tuned by a freq.-following servo system, and the antenna feeder system uses wideband matching transformers. Consequently, freq. can be changed by setting the decade dials on a freq. synthesizer. This enables one man to maintain full operational control of a station from line inputs to final radiation. He can change freq. in as little as 20 sec.

Using a wideband system reduces the number of stages in a transmitting channel. Improved insulating materials, dielectrics, and semiconductor rectifiers make power supply components much smaller, and they may be mounted in the transmitter units.

Equipment reliability is improved by using distributed amplifier techniques. Hence, failure of a single tube will not cause a complete system breakdown. Mechanical failure is also reduced because there are no tuned circuits which use moving parts, except in the final output stages.

Self-tuning characteristics of the MST enables one man to maintain full operational control of a station. The comprehensive modulator unit provides any type of modulation. Equipment design anticipates all foreseeable changes in h-f.



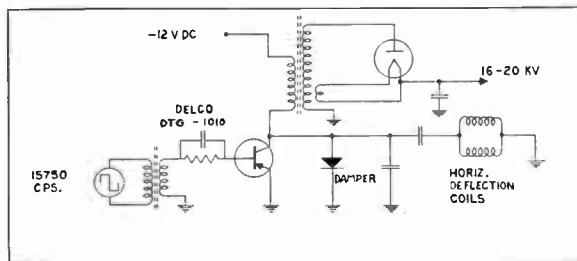
The drive equipment provides all types of modulation used in h-f communications. This includes freq. synthesizers which give a choice of over 250,000 operating freqs. with better accuracy and stability than crystal oscillators.

Most of the units making up the MST system are compatible with existing equipment. The transmitting equipment is a product of Marconi Co., Ltd., Chelmsford, Essex, England.

FROM DELCO NINE NEW SOLUTIONS TO CURRENT PROBLEMS

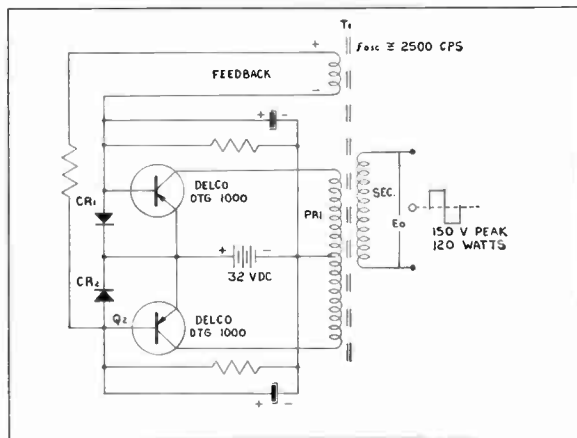


These are our latest: the DTG-1000 and 2000 series. Rugged 15 and 25 ampere germanium Nu-Base† transistors specifically designed for high-peak power switching applications.



Video horizontal deflection with the Delco DTG-1010

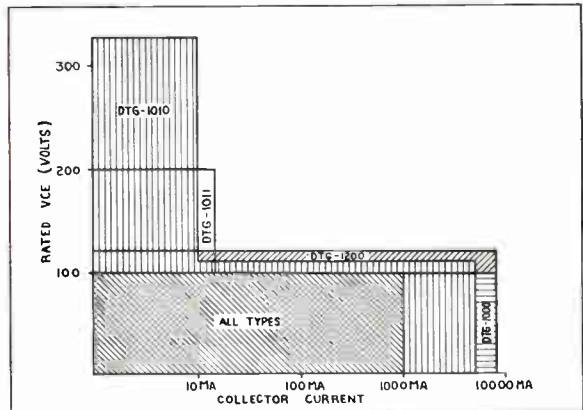
These devices are ideal for high-current inverter applications, high-voltage TV Horizontal and Vertical circuits, and automotive ignition applications. Nu-Base construction with H.K.†† spares you from junction "hot spots," too, so you don't have to worry about secondary breakdown.



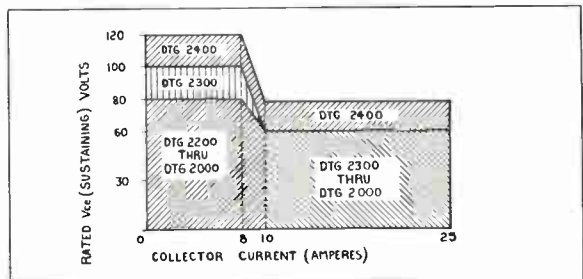
DC to AC inverter using Delco DTG-1000

Parameter stability is assured by Delco's Surface Passivation Ambient Control process. And the extremely low leakage of these de-

vices gives you all the circuit design flexibility you could ask for.



Recommended operating region DTG-1000 series



Recommended operating region DTG-2000 series

Your nearest Delco semiconductor distributor or any of our sales offices will be glad to give you more information about these new transistors. And about our other Nu-Base transistors. The 5 and 10 amp. units.

Just drop us a letter or give us a call. Anytime.

†Delco drift field non-uniform diffused base construction
††Delco hydrokinetic alloy process

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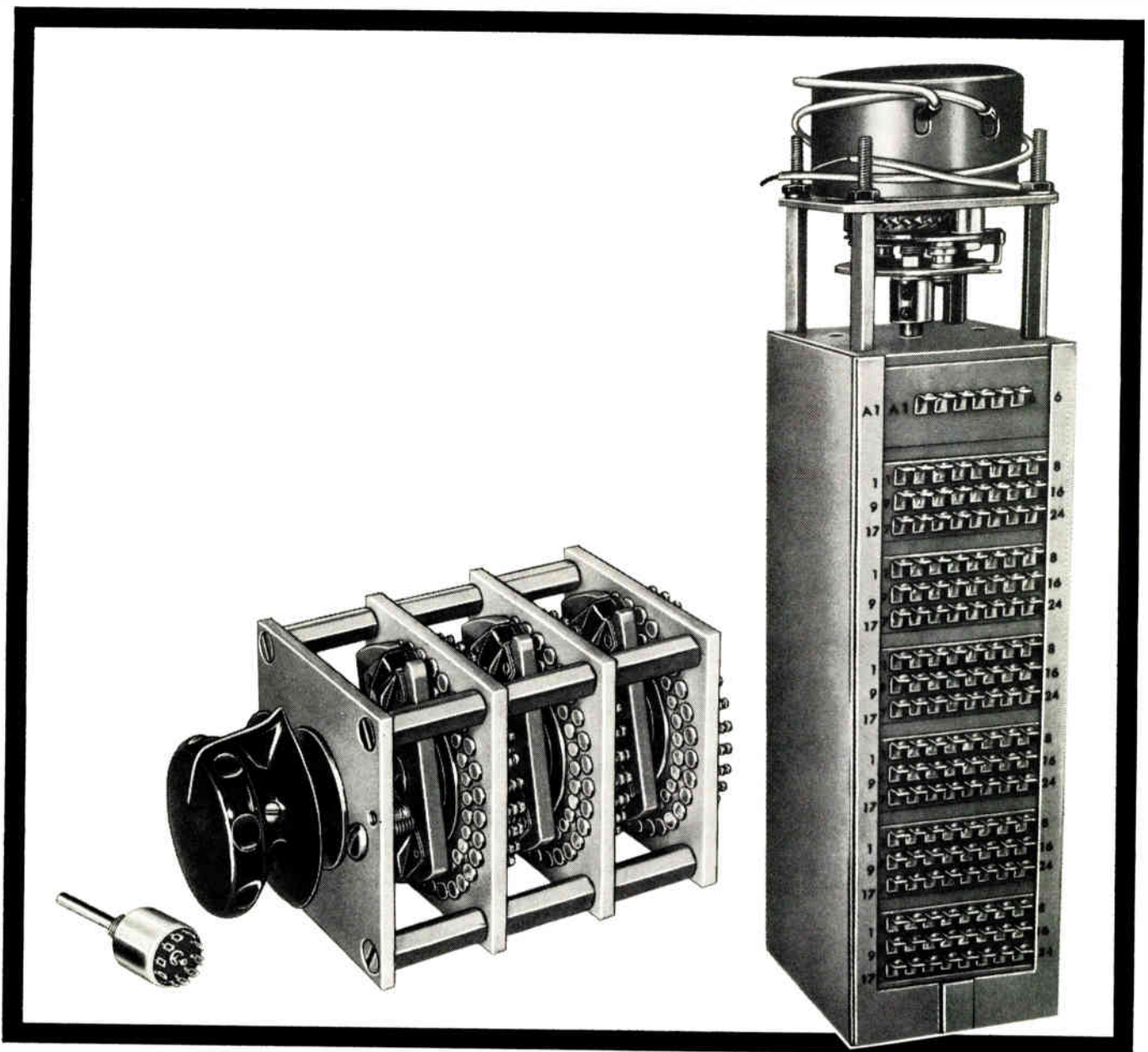
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DELCO RADIO 
DIVISION OF GENERAL MOTORS, KOKOMO, INDIANA



We can miniaturize or standardize or generalize.

For example: the Series G (shown at left) is the smallest rotary selector switch ever made. Daven whittled it down and nobody has been able to match it yet. One-half inch diameter. Explosion-proof and waterproof. Meets mil-specs on temperature, humidity, corrosion, vibration, acceleration, shock and immersion. A real beauty. (Incidentally, a lower-cost instrument grade switch of this type is now available).

We standardize in a big way, too.

Our 87 adjustable stop switches actually replace 2,001 standard types. All are available off-the-shelf in 48 hours. And the cost is equal to, or less than, standard counterparts.

Generally speaking, our general line of switches is the best in the business. And the widest. You can ask for the Series M miniature ceramic, pre-wired assemblies, terminal board, solenoid-operated, progressive shorting type, high speed, hermetically-sealed or spring return switch. And get it fast.

All are built with solid silver alloy contacts and wiper arms. Most have patented enclosed "knee-action" silver alloy multi-leaf rotor blades, high grade accurately machined dielectric, and accurate contact positioning. Switch stops are independent of switch blades.

Ask yourself if the switch is important to your equipment. Then ask Daven for details. Today.

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Reporting late developments affecting the employment picture in the Electronic Industries

40% SCIENTISTS, ENGINEERS ON GOVERNMENT PROJECTS

President Johnson in his first manpower report to Congress pointed out that 2 out of every 5 U. S. engineers and scientists are employed by the government, or are on government-funded projects.

Vast federal research and development in aerospace/defense has concentrated this specialized manpower in government. President Johnson observed that the trend was spreading rapidly enough to require special attention. A special committee will appraise the effects of government policies and programs on U. S. manpower needs and resources.

In a special analysis of manpower effects of government programs, a Department of Labor report, in addition to the President's message, said that of R&D engineers, no fewer than 3 out of 5 are on the government payroll, directly or indirectly.

More than 120,000 engineers and scientists are now employed directly by the Federal Government, the report discloses; about 60,000 are in state and local governments. Something above 300,000 are believed to be employed on Federally-financed programs in private industry, and in universities and other nonprofit organizations.

The manpower report estimates that by 1970, one U. S. agency, NASA, will need 100,000 engineers and scientists. NASA's roster grew from 8,400 in 1960 to 43,000 in 1963.

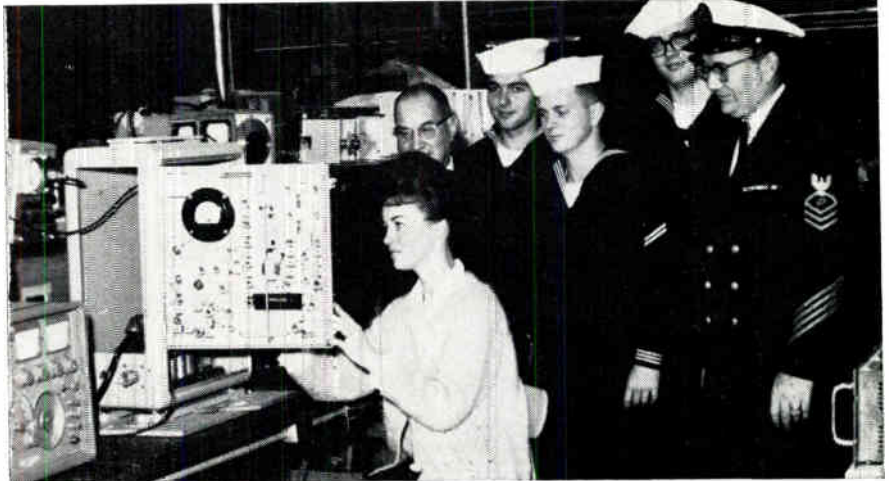
STARTING SALARIES REACH PREDICTED HIGH LEVELS

Starting salaries for 1964 engineering graduates are hitting levels predicted at the beginning of the year, according to recent surveys.

The College Placement Council and the American Association of Industrial Management report that top offers are going to electrical and aeronautical engineers. The two fields average about \$621 a month to start.

The AAIM survey also reports that more than half of the firms pay extra for job-related experience.

NAVY ELECTRONIC STUDENTS ON PLANT TOUR



Introduction to electronic manufacturing is given Navy students from electronics school at Treasure Island, Calif., during visit to Raytheon Company's Marine Products Operation. Part of group watches VHF radiotelephones being tested for Navy.

MEDICAL ENGINEERING RISES AS NEWEST SCIENCE STUDY

College students soon "may be studying for a new kind of degree in a new profession—medical engineering." Dr. Hans H. Zinsser, Columbia University College of Physicians and Surgeons, made that prediction at the 1960 convention of the Institute of Radio Engineers.

At latest estimate by several medical and electronic engineering spokesmen, there may be as many as 40 schools in the U. S. offering courses toward degrees in medical engineering by academic year 1965.

In Autumn 1961, the University of Arizona scheduled a course in Electronic Instrumentation. This interdisciplinary teaching and research program involved the life sciences and electrical engineering departments. The first course was open only to graduate students and selected senior pre-medical students majoring in the life sciences.

By 1962, the National Institutes of Health had funded nine bio-medical

engineering school curricula; there were then 75 graduates. By 1965, such schools may be graduating as many as 100 *each* in medical engineering.

In Spring 1964 Jefferson Medical College and Drexel Institute of Technology, both in Philadelphia, announced a dual doctorate program for bio-medical engineers.

BATTELLE, OHIO U. TO OFFER RESEARCH MANAGERS SHOP

Battelle Memorial Institute, of Columbus, Ohio, and Ohio University, at Athens, will combine resources this fall to present their second Research Management Program.

Aim of the Program, set for October 4 to 16 in Columbus, is to provide experiences that will help participants become better research managers. Emphasis will be on management of ideas, of people, and of money.

The two-week program is designed mostly for scientists and engineers who recently have taken on managerial jobs; many veteran members of research management also find the program valuable, according to M. N. Brinkman, director of management development programs at Ohio University's Business College.

FOR MORE INFORMATION . . . on opportunities described in this section fill out the convenient resume form, page 122.

ELECTRONIC INDUSTRIES Professional Profile

Please type or print

The ELECTRONIC INDUSTRIES Job Resume Form for Electronic Engineers

Name _____ Tel. No. _____

Street Address _____ Zone _____

City _____ State _____

Single Married Citizen Non-Citizen Date of Birth _____

Will Relocate Yes No. If Yes Another City Another State

Salary Desired to Change Jobs in present area _____

Salary Desired to Change Jobs and relocate in another area _____

Professional Memberships _____

College or University	Major	Degree	Dates

RECENT WORK EXPERIENCE

Company	Div. or Dept.	Title	Dates

SIGNIFICANT EXPERIENCE AND OBJECTIVES

STATE ANY FACTS ABOUT YOURSELF THAT WILL HELP A PROSPECTIVE EMPLOYER EVALUATE YOUR EXPERIENCE AND JOB INTERESTS. INCLUDE SIGNIFICANT ACHIEVEMENTS, PUBLISHED PAPERS, AND CAREER GOALS.

Mail to: ELECTRONIC INDUSTRIES—Professional Profile—56th & Chestnut Sts.—Philadelphia, Pa. 19139. This resume is confidential. A copy will be sent only to those Companies advertising for engineering personnel in this issue, whose number you circle below.

800 801 802 803 804 805 806 807 808 809 810

Self-instruction training techniques are catching on in the electronic industry as technology demands employee retraining. Programmed Instruction has been used efficiently and economically. But, management must know how to select and evaluate the program and the materials to fit needs and objectives.

EVALUATING AND USING PROGRAMMED INSTRUCTION

MANAGERS, SALESMEN, TECHNICIANS AND WORKERS of tomorrow's electronic firms will need skills they do not have today. Major companies will have to change their corporate objectives as the country shifts from a defense to a peacetime economy. The day is past when a man could learn a single craft to practice throughout his lifetime.

The Department of Labor predicts that the worker in today's labor force will need a complete skill overhaul every ten years of his working life! No industry is more vulnerable to progressive skill obsolescence than the electronic industry.

This massive retraining task implies many things in our industry. Companies are turning to radical new approaches to training in order to maximize yield, minimize costs, and put the whole manpower development process on a profit and loss basis. Of these new techniques the most exciting, so far, is called Programmed Instruction (the teaching machine technology).

Programmed Instruction (PI) is gaining rapid acceptance in industry because it has been proven effective, economical and easy to administer. Such blue chip firms as IBM, AT&T, GM, Sperry Rand, du Pont, and scores of others are using PI for internal and customer training.

Programmed Instruction permits controlled, efficient and predictable learning. AT&T employees taught themselves binary arithmetic with Programmed Instruction. Even though the slowest man took 5 hours and the fastest only 2.5 hours, they all scored uniformly high on a comprehensive final examination. Such findings as these have led industrial leaders to investigate and apply Programmed Instruction to internal and customer training tasks.

What Is PI?

Programmed Instruction is a method of teaching or training. The technology is based upon the princi-

ples of learning theory developed by psychologists who specialize in the analysis of behavior. Dr. B. F. Skinner of Harvard University is credited with major contributions to this body of knowledge and its direct application to Programmed Instruction.

Programmed learning occurs through presentation of discrete units of information to the learner, requiring him to respond actively and providing him with right-wrong feedback. The instructional program may be presented in a simple text or by a complex electronic device, depending upon the kinds of skills being learned and the costs involved.

Read the following statement taken from a training manual for computer operators:

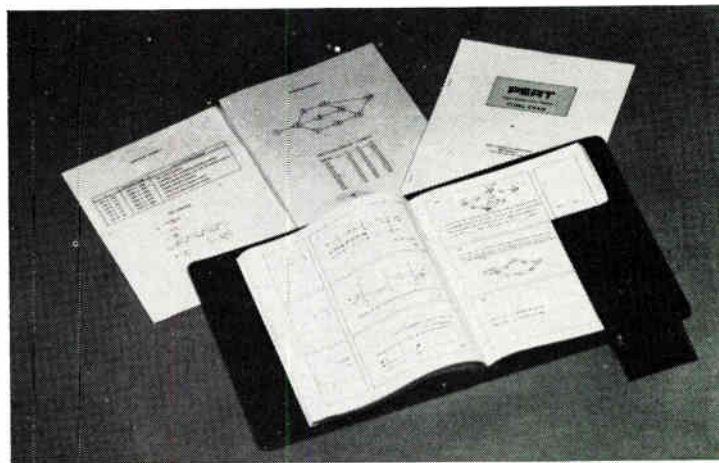
"The operational phase of the UNIVAC® 1004 Card Processor consists of card reading—an initial or input phase which provides for the reception of data in the form of punched cards, an intermediary phase in which the processor operates on the data, manipulating or changing it, and a final phase—output—in which resultant data are generated on printed forms or punched cards."

Now, without looking back, describe briefly the basic operation of the 1004 Card Processor. Chances are you had difficulty. You probably had to go back and read the sentence again after reading the question. This is because you did not know at the outset

By GENE A. KELUCHE

Vice President, Operations
Basic Systems, Inc.
(Chairman—Project on Programmed
Instruction and Teaching Machines,
Electronic Industries Association)

An example of Programmed
Instruction materials for
a class in PERT (Perform-
ance Evaluation Review
Technique).



PROGRAMMED INSTRUCTION

(Continued)

what you would be required to answer. The sentence, as in all ordinary texts, presents information, but it does not teach.

PI differs from an ordinary text by focusing the student's attention on significant points while he learns. It calls for an active response from the student, as he constructs an answer to questions in each *frame* of information. As soon as he answers a question he is informed of

the correct answer. This immediate reinforcement adds a small but definite amount to his knowledge. The student advances to more difficult and complex material only after he has proved his mastery of the previous steps. Thus, by proceeding in small, measured steps, his chances of faltering or of making an error are rare.

Now, go to the chart labeled UNIVAC® 1004 Card Processor and teach yourself its basic operation by Programmed Instruction. Answer each question before looking at the answer given.

It Teaches Faster

The programmed version of a statement typically contains about four times as many words as the original statement. Yet it teaches faster! The student never gets stuck, never has to go back, and never tries to build new knowledge on a faulty foundation. The UNIVAC® 1004 sequence was carefully designed by psychologists, and repeatedly tested on actual students. It was then revised accordingly, until learning the basic operation of the 1004 was a smooth and rapid process.

The skilled student who knows how to learn from a textbook improvises a form of programmed instruction as he studies. He asks himself questions as he proceeds, and he reviews when he feels that previously learned material is beginning to slip away. These practices are sometimes called *good study habits*. However, very few men succeed in acquiring these difficult learning skills during their academic careers. In most cases, the student is not very well qualified to program material which he is just learning. He does not always know which points are the most important. He wastes time on irrelevant detail, and expends major portions of his energy sifting the important from the unimportant.

Effectiveness of a particular self-instructional program depends upon the process by which it was produced.

Obvious characteristics of PI (input, output and feedback) have attracted the attention of many disciplines. The activities of many people with different backgrounds and skills have produced a confusing array of materials, devices and techniques for the manager to select from.

Fortunately, if a producer of PI materials has been careful in stating the program's teaching objectives and describing the intended trainees, preparing a criterion test to measure effectiveness, and supplying enough performance data developed under the intended use conditions, then the potential user should be able to de-

IMPROVED PERFORMANCE BY USE OF PROGRAMMED INSTRUCTION

COMPANY	PROGRAM	TRAINEES	AVERAGE PERFORMANCE SCORES		
			Conventional Instruction	Programmed Instruction	Improvement Performance
IBM	7070 Computer Course	High School Graduates	86.2	95.1	10%
Schering	Dermatology and Mycology	Drug Retailers	60.1	91.9	53%
Du Pont	Reading Engineering Drawings	Maintenance Mechanics, etc.	81.2	91.2	12%
Bell Laboratories	Basic Electricity	Technicians	64.9* 47.5†	76.8* 66.4†	18%* 40%†

Performance of Programmed Instruction materials as compared with skilled classroom instructors teaching the same course to a matched group of trainees.

TRAINING TIME SAVED BY USE OF PROGRAMMED INSTRUCTION

COMPANY	PROGRAM	TRAINEES	TRAINING HOURS PER TRAINEE		
			Conventional Instruction	Programmed Instruction	Time Reduction
Du Pont	Reading Engrg. Drawings	Maintenance Mechanics, etc.	17	12.8	25%
	Analog Computation	Graduate Engineers	40	11.0	72%
IBM	7070 Computer Course	High School Graduates	15	11.0	27%
Spiegel	Package Billing	Clerks	40	26.0	35%

SOURCE: Basic Systems Inc., 1963.

Savings in time possible through the use of programmed materials instead of conventional techniques.

CONTROLLED-PREDICTABLE LEARNING

TRAINEES	1	2	3	4	5	6	7	8	AVG.
Yrs. with Company	5½	9	2½	21	3	1	7	11	6.1
Education	H.S.	B.S.	H.S.	H.S.	B.S.	B.S.	H.S.	H.S.	H.S.+
Time to Complete	4.5	3	4	2.5	5	3	2.5	3.5	3.5 hrs
Age	33	32	24	41	31	24	32	31	31 yrs.
Pre-Test Score %	37	0	5	8	5	76	34	6	21.3%
Post-Test Score %	100	98	97	82	94	100	97	91	94.9%

SOURCE: Basic Systems Inc., 1963.

H.S.—High School B.S.—Business School

Advanced sales training personnel at AT&T taught themselves the fundamentals of Binary Arithmetic with the following results.

termine the quality of a self-instruction program to meet his needs.

Materials Criteria

A joint committee of the American Educational Research Association, American Psychological Association, and the Department of Audio-Visual Instruction of the National Educational Association, was set up to develop criteria for assessing PI materials. In 1963 the AERA-ATA-DAVI joint committee issued its final guideline report. It was directed mainly to public school educators, from kindergarten to 12th grade, but its basic recommendations hold for this selection of PI materials in industry.

Both the joint committee report and the American Society of Training Directors, (ASTD) Committee on Programmed Learning's Guidelines provide a good base for selecting, evaluating and administering PI by an operating manager.

Determine Training Needs:

A manager should first assess his operating objectives in terms of manpower needs, which can be spelled out in terms of job descriptions numbers of employees, and locations. The skills to perform critical job functions can then be determined and target dates established for each set of skills to be on-line. The manager may find that training is needed to satisfy a portion of his manpower needs within the available time. He should then define in detail the training objectives in each critical performance area.

After deciding on the scope of training and establishing objectives in critical skill areas, the manager should consider PI as one of several training resources.

Determining the Utility of PI:

Because PI is self-instructional and provides uniformly high and predictable performance, it can be used to decentralize training at locations not serviced economically by other methods. It also enables simultaneous training at many locations, thus compressing overall training time. The manager should, therefore, define training needs in each skill-performance area in terms of

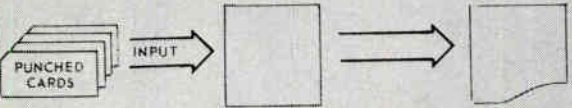

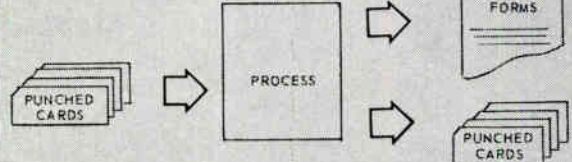
(1) numbers of trainees at each location, (2) importance of uniformly high performance, and (3) allowable lead time. This will allow him to estimate potential utility of PI within his system.

Examine Training Resources:

Major costs of training are normally the trainee's salary while in training, his travel to the training location, per diem maintenance, and the loss of the trainee's production time. The cost of providing instruc-

tion is seldom a major cost although the availability of trained instructors and adequate facilities may be a critical limitation. The manager should compare the economic yield of each of his alternative training resources to determine the most appropriate method to satisfy specific training needs. A convenient format for the comparison of alternative resources is presented in the chart—"ECONOMIC YIELD OF AVAILABLE TRAINING RESOURCES." (Continued)

SAMPLE OF PROGRAMMED INSTRUCTION FOR UNIVAC 1004 CARD PROCESSOR

Question	Answer
<p>1</p> <p>There are three phases of operation in a program for the UNIVAC 1004 Card Processor.</p> <p style="text-align: center;">INPUT → PROCESS → OUTPUT</p> <p>The input phase refers to how the 1004 receives data. The processing phase refers to how data is manipulated or changed. The output phase refers to how the data comes out of the 1004.</p>  <p>In the illustration above, input data to be processed is in the form of _____.</p>	punched card (or cards)
<p>2</p>  <p>After the input phase has been completed, data is _____.</p> <p>Following this phase, the output data is _____.</p>	processed printed
<p>3</p>  <p>From the illustration above, you can see that there are two forms of output data: _____ and _____.</p> <p>The input data comes from _____.</p>	printed forms (and) punched cards punched cards
<p>4</p> <p>In what form does the 1004 receive input information? _____.</p> <p>In what form does the 1004 produce output information? _____.</p> <p>What is the intermediary phase between input and output? _____.</p>	punched cards printed forms and/or punched cards processing
<p>5</p> <p>Describe briefly the basic operation of the UNIVAC 1004 Card Processor. _____.</p>	cards are read by the 1004, the data is processed, and then is generated as printed form or punched card output (or equivalent response)

PROGRAMMED INSTRUCTION

(Continued)

Personnel Cost Greater

In most cases, the "cost of personnel in training," Column (a), is five to ten times greater than the "cost of providing instruction," Column (b), with the major variables being the length of instruction and the cost of employee travel to a central location. The availability of trained instructors and adequate facilities may begin to restrict the capacity of conventional training installations to provide the critical skills in time.

If the personnel undergoing training are company employees, the cost of losing several hundreds of thousands of productive man hours may control the selection of the training resource used. Each of these factors should be examined to determine which combination should control the decision. Should it be one training resource, or should it be a combination?

If the manager's preliminary analysis indicates that Programmed Instruction should be considered to satisfy a portion of his training needs, he should separate his training tasks into two categories: (1) those which are skills or knowledge of a general nature or which have training lead times of less than three months; (2) those which are peculiar to his company or industry and which have sufficient lead time to consider the development of special materials.

If the demand for special training is in excess of 100 persons and the

allowable lead time is at least four months, the manager may economically consider the development of specialized PI materials to meet his needs. For example, the cost of developing a well designed and validated 10-hour self-instructional program will be approximately \$15,000 to \$30,000, depending upon its complexity and quality. It is usually uneconomical to consider such a custom program if the training need is for less than 100 men. The need for uniformly high performance, a widely dispersed trainee population, or the shortage of trained instructors and adequate facilities may, however, justify PI below this suggested minima. The design, development and validation of a significant self-instructional training unit can rarely be accomplished in less than a three month period.

Training of a general nature (category 1) may be accomplished by self-instructional materials commercially available. This category of requirement and the growing numbers of commercially available materials provides the manager with the most immediate and economical opportunity to utilize Programmed Instruction.

Selecting, Evaluating

All users of PI materials should use similar selection techniques. Evaluation and administration methods may differ according to the scope of the training requirement and how PI is to be applied within an organization. PI materials should be chosen with these thoughts in mind:

1. Do skills and knowledge imparted by the program meet required training objectives?

2. Do trainees have the required background to use the particular program effectively?
3. What level of performance can be anticipated from the typical trainee after he has completed the program.

Partial answers usually can be found in specifications offered by the PI materials producer. The AERA-APA-DAVI committee draws a useful distinction between internal and external characteristics for assessing a program. Useful external characteristics are:

1. Stated objectives of the program.
2. Description of the intended user population.
3. Sources of content and the qualifications of the producer.
4. Test data derived under field conditions showing pre- and post-program performance of a sample of the intended user population.

If after an external examination, the program appears useful then examine its internal characteristics. Perhaps the most reliable indicator of useful skills imparted by a program is its *criterion examination*, used to develop the published performance test data. The criterion examination should be inspected by those who know the subject matter and the job requirements to see whether useful knowledge and skills are actually displayed. Some poorly designed programs teach "about" a subject instead of building the actual skills needed on-the-job.

The program itself should be reviewed by someone familiar with the

ECONOMIC YIELD OF AVAILABLE TRAINING RESOURCES

Training Resource	YIELD			DIRECT COST OF TRAINING PER MAN		Total Cost of Training
	Capacity	Quality of Instruction	Length of Instruction	Cost of Personnel in Training	Cost of Providing Instruction	
A. Classroom instruction, manuals, visual aids.	Dependent upon instructor and facilities available.	Varies with instructor and class composition.	X	(a) Includes trainee salary, travel to central location and per diem.	(b) Materials, facilities, instructor's salary.	(a) + (b)
B. Programmed Instruction	Unlimited.	Independent of instructor, uniformly high.	Typically 30%-50% less than conventional techniques.	No travel or per diem; salary optional.	Programmed Instruction materials only.	(a) + (b)

A PROCEDURE to SELECT, EVALUATE and ADMINISTER PROGRAMMED INSTRUCTION.

1. Define Operating Objectives.
2. Determine manpower requirements to attain objectives.
3. Identify critical job performance requirements.
4. Inventory existing manpower resources.
5. If training is required, establish training objectives and target dates.
6. Consider Programmed Instruction as an alternative training resource.
7. Establish a procedure to select, evaluate and administer Programmed Instruction according to its potential utility.

subject matter to determine the emphasis given to topics and general organization. The joint committee and the ASTD caution, however, that:

1. The reviewer may be inappropriately influenced by structural features.
2. Some steps may seem too difficult—or too easy.
3. Difficulty and usefulness of steps cannot accurately be judged by inspection alone.
4. Visual inspection cannot substitute for try-outs using a sample of the intended user population.

After reviewing and approving the program, the manager should introduce materials into use on a limited basis.

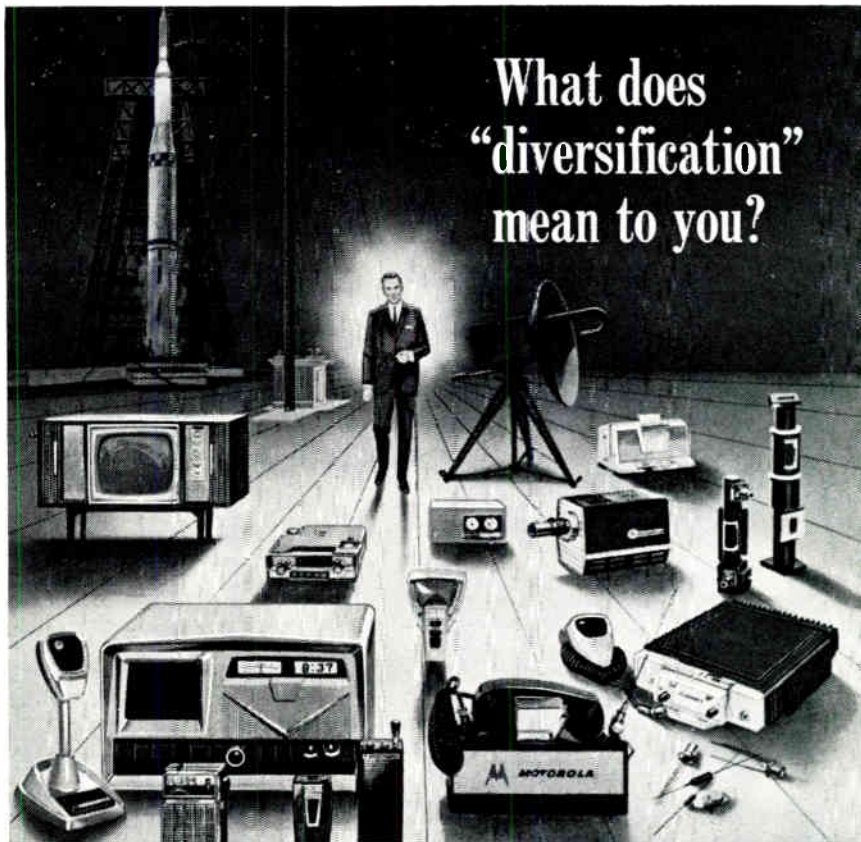
Evaluate Materials

Because there are many devices and materials offered under labels of Programmed Instruction, Programmed Learning, Auto Instruction, etc., the large user should evaluate specific materials before introducing them into wide scale use.

The potential user should evaluate materials and devices with the following questions in mind:

1. What are the performance characteristics of a particular program on his trainees under actual field conditions?
2. What is the best method of administering this training using PI?

(Continued on page 128)



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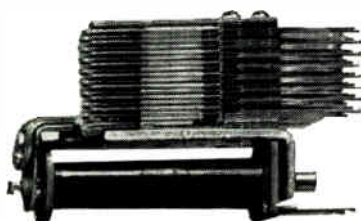
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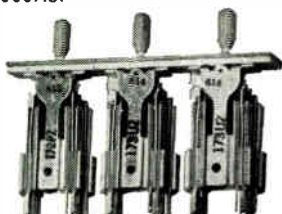


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PROGRAMMED INSTRUCTION

(Continued)

3. What are the training costs associated with the mode of administration?
4. How well has PI been received by employees or customers as a training media?
5. What are its potential effects on supervisory personnel, and customer relations?

The manager should establish a group of interested supervisory, technical and personnel representatives to select and evaluate PI materials and projects. Inspection and selection requires both a knowledge of the subject matter, job needs, and the make-up of the entire trainee production.

A program should be evaluated on a representative trainee sample which includes extremes in age, I.Q., experience, education, and other variables that usefully describe the majority of trainees. Because a well designed program exerts considerable control over the trainee, it is

not necessary to use a large sample to obtain projectable results. A well selected sample of 10 to 20 employees will usually provide enough data to allow a reliable performance forecast.

Simulated Conditions

Program evaluation should be conducted under simulated field conditions and be designed to yield at least the following data:

1. Trainee's pre- and post-program performance on a criterion examination.
2. Range of times and average time required to complete the program.
3. Period of time preferred for each session of self-instruction.
4. Trainee's preference in location and mode of program use.
5. Trainee's attitude towards the particular program and PI technique.

An example of such data was presented in the chart on AT&T and

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	Model 500	Model 501											
Range:	59.0°F to 122.0°F	000.0°C to 100.0°C											
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the fundamentals of binary arithmetic. These kinds of data can be obtained easily by recording performance results, tabulating questionnaires, and interviewing trainees.

Because much economic benefit derives from its ability to provide decentralized training, the administration of PI should have enough top-management support to insure cooperation at all organizational levels affecting installation and use of self-instructional materials.

The major economic value of Programmed Instruction is that it:

1. Provides predictable and uniformly high trainee performance.
2. Enables completely decentralized self-instruction.
3. Provides a measurable return-on-investment in manpower resources.

These advantages are not inherent in the technology. Poor or mediocre programs will not provide them—and the poor to mediocre program looks very much like the effective version at first blush.

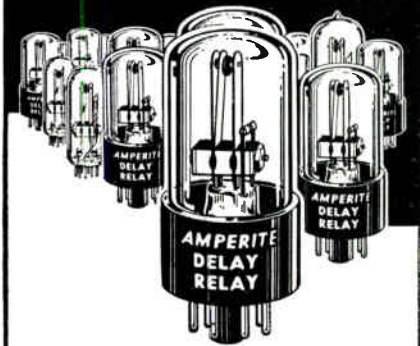
Only through applying sound criteria to the selection, evaluation and administration of programs can the real pay-off of Programmed Instruction be realized.

The manager will need to ask the following questions when he considers using Programmed Instruction:

- 1) What is the training need? (Given his operating objectives, what are the skills required of his personnel which they do not now possess?)
- 2) Can Programmed Instruction play a useful role? (What are the available training resources and what economic advantage does Programmed Instruction have in imparting the skills specified in the first-state analysis?)
- 3) How do you evaluate and select from among available programs? (What are the relevant characteristics which can be identified in advance about a given program and which are known to affect the program's ability to provide the needed skill?)

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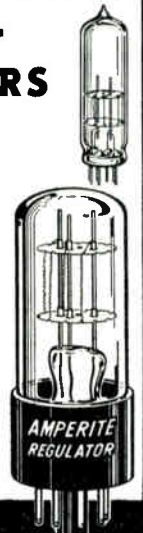
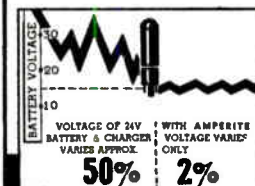
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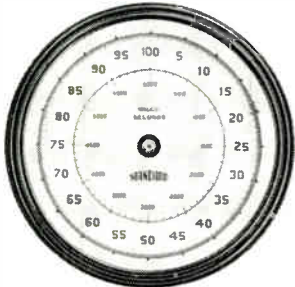
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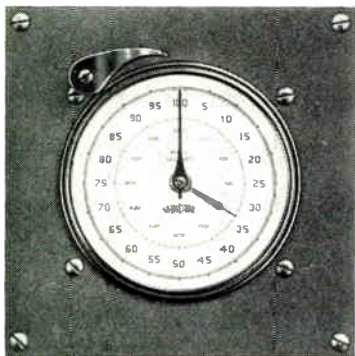
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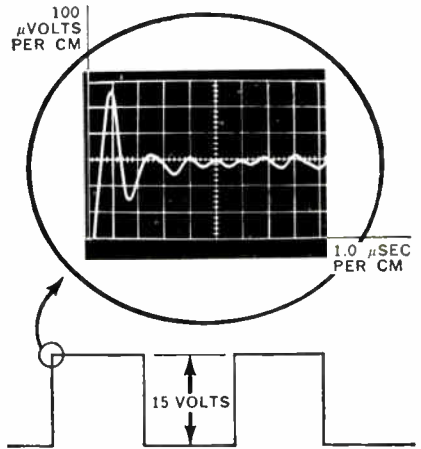


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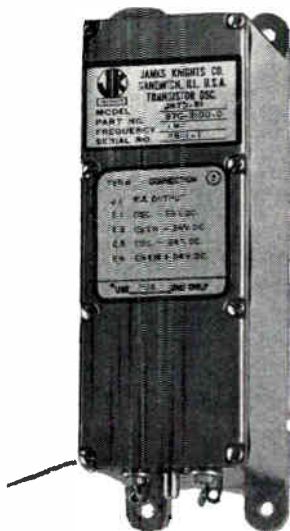
James M. Beveridge, now president of J. M. Beveridge and Associates, a management consulting firm in Playa Del Rey, Calif., stresses the carefully planned and integrated approach to the total marketing effort. He believes that a good marketer is "a User-Oriented - Requirement - Understander, and for more than just a salesman." In addition to discussion on marketing, planning, bidding, pricing and proposals, the seminars include new-look in DOD and NASA procuring.

Sessions are scheduled for July 27 and 28 in Los Angeles, and for August 4 and 5, in New York.

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Illustrated condensations of all conference papers from the First International Conference on Worldwide Communications—GLOBECOM IV—are available. The talks—800 to 1000 words long—have been compiled for a letterpress edition of a DIGEST OF TECHNICAL PAPERS for distribution to registrants at GLOBECOM IV, held in Philadelphia during the week of June 1st.

Additional copies of the DIGEST, at \$5.00 each, may be had from H. G. Sparks, The Moore School of Electrical Engineering, University of Pennsylvania, 200 S. 33rd Street, Philadelphia, Pa. (19104).



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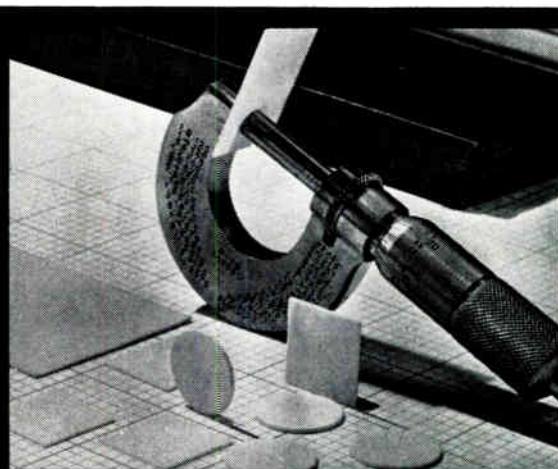
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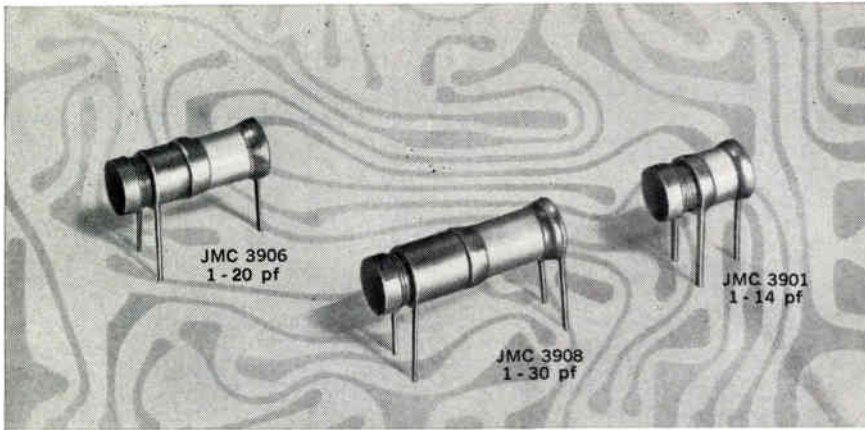
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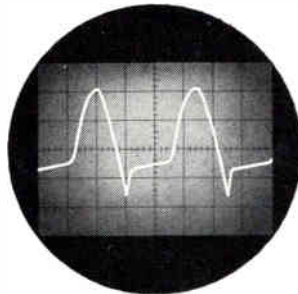
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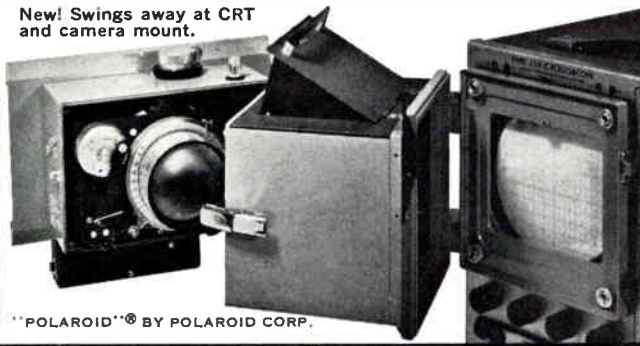


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MICROWAVE SYSTEM SENDS POWER WITHOUT WIRES

A microwave system that can deliver large amounts of power through the air without wires has been disclosed by Raytheon Co.

W. C. Brown, of Raytheon, said that in recent tests at the company's Spencer Laboratory in Burlington, Mass., several hundred watts of power have been air-transmitted a distance of 25 feet. He said that today's technology allows the sending of more than 100,000 watts of power five miles through the air.

SEMICONDUCTORS, INTEGRATED CIRCUITS AT UNION CARBIDE

Union Carbide Corp. is broadening its field in the electronic industry. The firm will include production of semiconductors, integrated circuits, and related devices in the Palo Alto, Calif. area, Birny Mason, Jr., president, announced.

The corporation has been developing and making basic components—such as barium getters, capacitors, and synthetic crystals—for a number of years. This is the firm's first venture into semiconductors.

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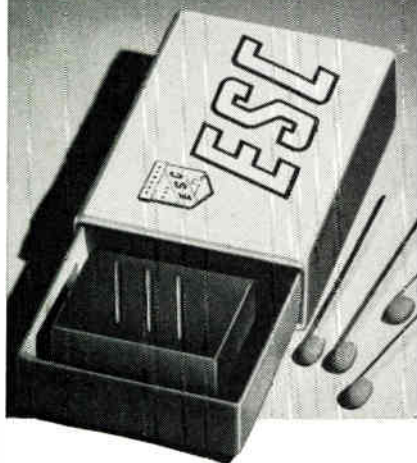
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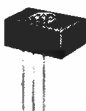


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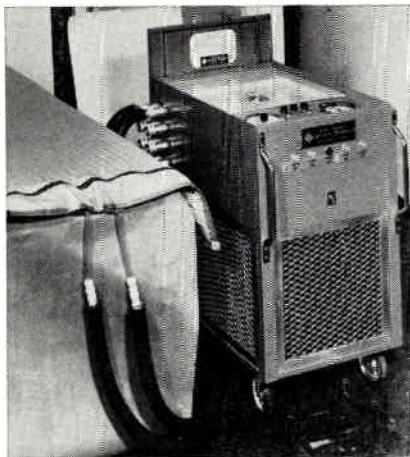


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FAIRCHILD DEVELOPS HOME TV TAPE RECORDER

A home TV tape recorder has been disclosed by Fairchild Camera & Instrument Corp. The device may be priced for less than \$500 in mass production.

Developed by Winston Research Corp., Fairchild subsidiary, the unit can record TV programs from a receiver, or it can produce movies for showing on the receiver with an added recording camera. Cost of making a one-hour recording or movie would be \$15 to \$20, including tape. The extra camera would cost about \$150.

The Fairchild device records video and sound on a quarter-inch, four-track tape. The tape, on an 11-inch spool, with enough on each track for 15 minutes of recording, moves past stationary recordings and reproducing heads at 120 inches a second. The tape reverses direction automatically.

BOEING CAREER BROCHURE

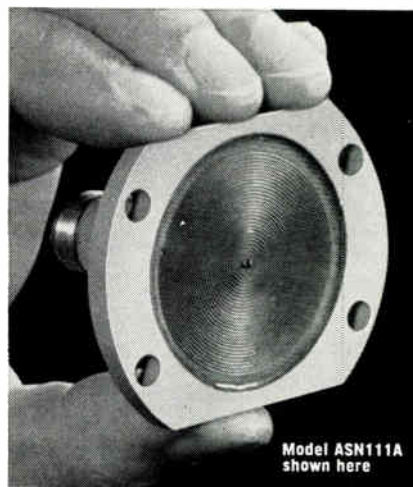
A brochure entitled *Environment for Dynamic Career Growth* has been issued by the Boeing Company describing opportunities for technicians, engineers and scientists in its many divisions across the U. S.

Copies of the brochure can be obtained by writing to the Professional Employment Manager at any of Boeing's divisions or branches, or to The Boeing Company, P. O. Box 3822, Seattle, Wash. (98124).



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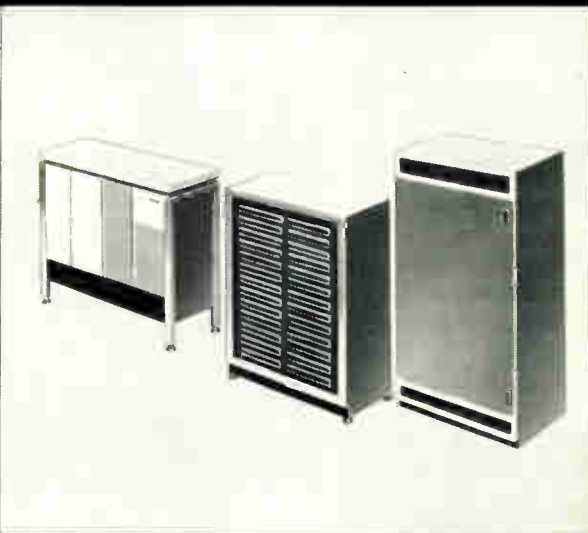
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