May 4, 1962

electronics

A McGraw-Hill Publication 75 Cents

(Photo at right)

CRYOTRON MEMORY

has associative read-out, p 31

ANALOG MULTIPLIER

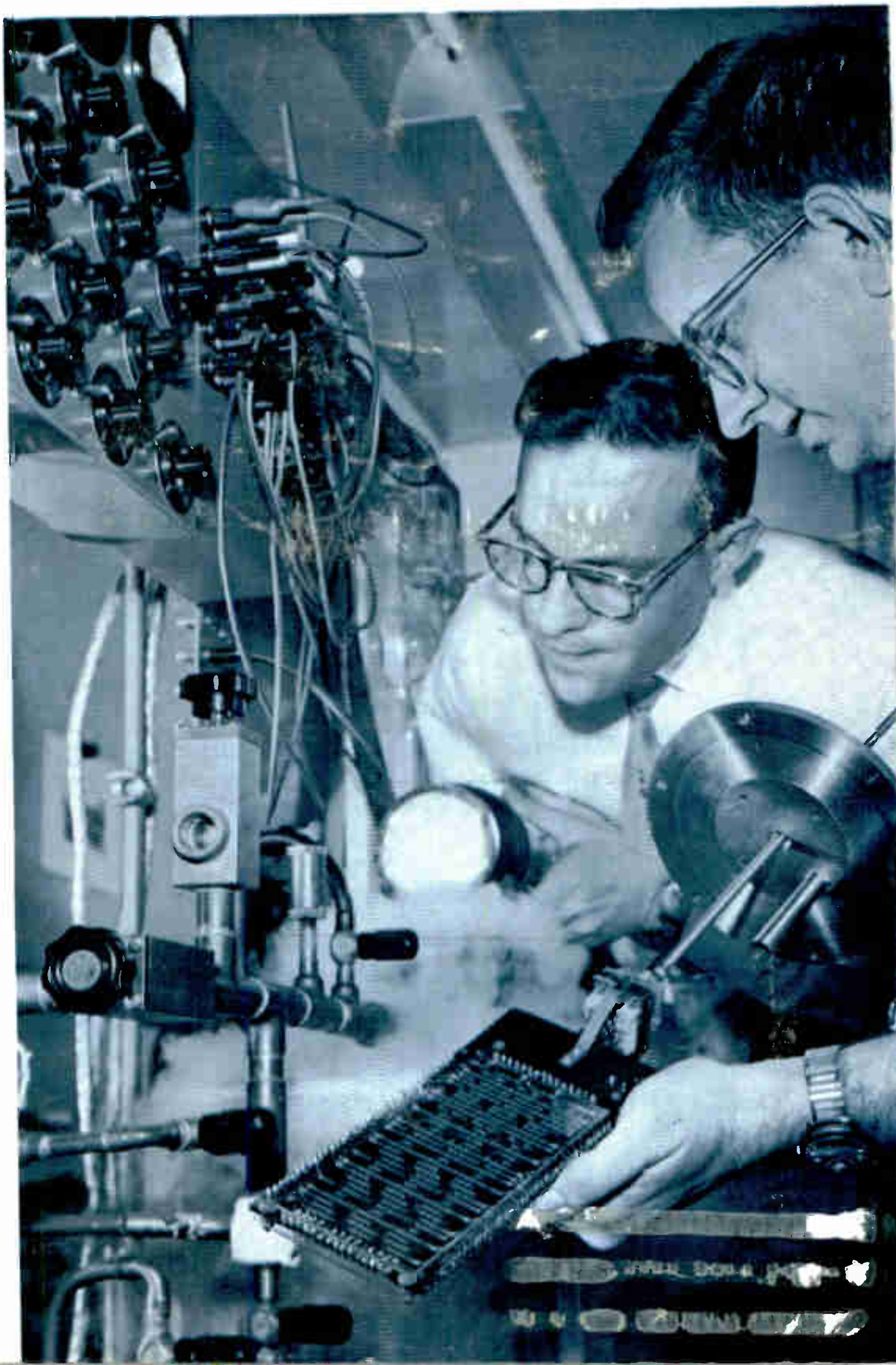
uses pwm and pam circuits, p 37

MEASURING TEMPERATURE

with semiconductor devices, p 38

POWER SUPPLY

precisely regulated reference, p 41



Now you can have a universal oscilloscope with dual trace vertical bandwidth capacity greater than 40 MC—with no sacrifice in sensitivity. Seven separate vertical and horizontal plug-in units give the new hp 175A the greatest versatility ever offered in a general purpose 50 MC scope. Available are dual-channel, single-channel and high-gain vertical plug-ins, plus these horizontal plug-ins: auxiliary, time mark generator, display scanner and sweep delay generator.

The new hp developed 12 Kv CRT presents an easy-to-measure 6 x 10 cm calibrated display without distortion or defocusing. The front panel astigmatism control common to other scopes is no longer necessary. In addition, phosphor and graticule are on the same plane—thus eliminating CRT parallax error. The front panel is engineered for the simplest possible operation.

hp 175A features simplified circuitry for more reliable performance and easy maintenance. Simple triode circuits (6DJ8 tubes) are used in the vertical amplifier. Complicated distributed amplifiers are not employed. In addition, an hp developed cable delay line eliminates still more adjustments. Only 6 tube types and 5 transistor types are used throughout.

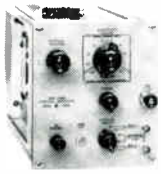
The hp 175A Universal Oscilloscope is housed in the new hp modular cabinet . . . a single instrument for both bench use and rack mount. Cover, bottom and sides are easily removed for simple servicing and routine maintenance. The hp 175A is as easy to service as it is to use!

These Plug-ins Give Utmost Versatility to the hp 175A OSCILLOSCOPE:

Vertical plug-ins

hp 1750A 40 MC Dual Channel Amplifier (pictured in 175A opposite)

Permits viewing of two phenomena simultaneously, bandpass dc to 40 MC, rise time 9 nsec, sensitivity 50 mv/cm. Differential input for common mode rejection. $285.00



hp 1752A High Gain Amplifier

Provides 5 mv/cm sensitivity dc to 18 MC with differential input for high common mode rejection. $225.00

hp 1753A 40 MC Single Channel Amplifier

Bandpass dc to 40 MC, rise time 9 nsec, sensitivity 50 mv/cm. $155.00

Horizontal plug-ins

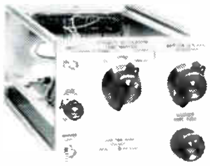
hp 1780A Auxiliary Plug-In (shown in 175A opposite), normal and single sweep, $25.00

hp 1781A Sweep Delay Generator

For detailed examination of complex signals or pulse trains. Permits viewing expanded waveform segment while still retaining presentation of earlier portions of the waveform. Delay time 1 μsec to 10 sec.; delaying sweep, 2 μsec/cm to 1 sec/cm. $375.00

hp 1782A Display Scanner

Provides output to duplicate on X-Y recorder any repetitive wave appearing on scope. Resolution with permanent records higher than CRT or photograph. (Available soon)



hp 1783A Time Mark Generator

Permits easy time measurements by providing intensity modulated time markers on scope trace. Range, 10 μsec, 1 μsec and 0.1 μsec intervals, ±0.5%. $130.00

SPECIFICATIONS hp 175A

Sweep Generator

Internal Sweep: 0.1 μsec/cm to 5 sec/cm, ±3%; vernier extends slowest speed to 15 sec/cm

Magnification: x1 and x10

Triggering: Internal, from vertical input signal causing 2 mm or more vertical deflection, or from power line. External, from signal 0.5 v p-p or more

Triggering Point: On positive or negative going signal; on external signal, level adjustable —10 to +10 v

Horizontal Amplifier

Bandpass: DC to 500 KC

Sensitivity: 0.1 and 1 v/cm

Vertical Amplifier

Bandpass: Main amplifier, dc to more than 50 MC

General

Power Requirements: 115/230 v ac ±10%, 50-60 cps. Maximum of 425 watts, depending on plug-ins used

Weight: Maximum of 70 lbs., depending on plug-ins used

Price: $1,325.00

Data subject to change without notice.
Prices f.o.b. factory.

HEWLETT-PACKARD COMPANY

hp

1501 Page Mill Road, Palo Alto, California, Area Code 415, DA 6-7000
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Canada, Hewlett-Packard (Canada) Ltd., 8270 Mayrand St., Montreal

hp 175A 50 MC Universal Oscilloscope with hp 1750A Dual Channel Amplifier, hp 1780A Auxiliary Plug-in installed.

175A 50 MC OSCILLOSCOPE

- Bright, 6 x 10 cm display with no parallax, reflections or astigmatism
- Over 50 MC main vertical amplifier
- Dual trace, dc to 40 MC vertical plug-in
- Horizontal and vertical plug-ins for specific applications
- Easier to calibrate and maintain—no distributed amplifiers
- Positive preset syncing over entire bandwidth

May 4, 1962

electronics

A McGraw-Hill Publication 75 Cents

W. W. MacDONALD, Editor

Contents continued

electronics

May 4, 1962 Volume 35 No. 18

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Audited Paid Circulation

CONTENTS continued

DEPARTMENTS

CROSSTALK

STAYING AHEAD. Associate Editor Michael Tomaino is regularly the editor of ELECTRONICS' Components and Materials Department. Next week we publish Tomaino's special 24-page report describing electronic components used in today's electronics industry. The report also gives a rundown of component and circuit trends, and points up what kinds of components the industry may be expected to use in large numbers in the future.

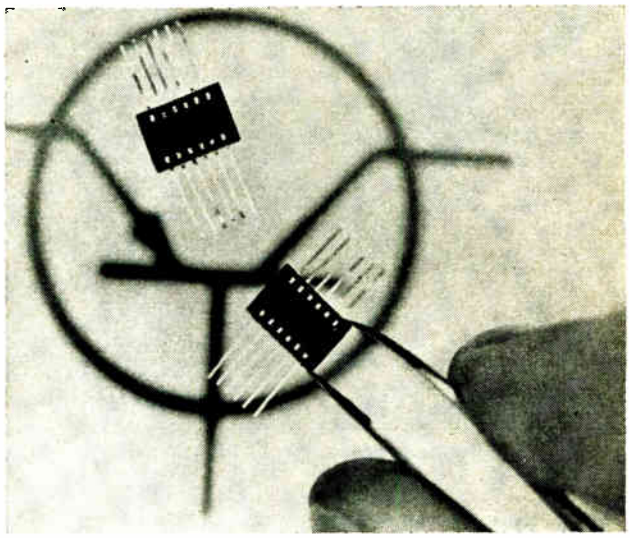
In 1953 the report tells us, both government and industry began a search for new methods of performing electronic functions simply and reliably to meet the need for radical changes in technology to meet requirements of space applications. With constant awareness of space application needs, the electronics art has been pushed to a midway point—one foot in the era of solid-state physics, and one foot in the era of improved miniature components of the types more familiar to the electronics industry.

Tomaino has attempted to show in his report where the search for more reliable electronic systems has taken us, and what has been accomplished—from individual components to functional blocks. What effect will this have on the electronics industry? What is the role of the circuit designer in modern electronic systems? Can we forecast trends with reasonable accuracy by reviewing past experience? What is the significance of the enormous effort to "go small"? Are component makers planning ahead? Do we have a revolution in electronics today, or are these changes merely evolutionary?

We have heard a lot about reliability; what promise do these overall trends hold for more reliable systems? Will there be big problems ahead in developing functional blocks? Will functional blocks replace conventional components as we know them today?

The report indicates greater activity in carving electronic circuits from the solid block than the casual observer might realize. Doubtless, individual resistors, capacitors and inductors will be used in certain circuit assemblies until doomsday; however, even these conventional components may undergo changes to meet the changing needs of the forthcoming integrated circuit era.

Many component manufacturers are giving more emphasis to research and development in an effort to keep their share of the market; but



those manufacturers who choose to wait and see, before committing themselves to a full-blown R&D program are playing a precarious game. The axiom that one must continually forge ahead to retain one's present standing was never more appropriately applied than to today's components industry.

For example: one manufacturer has produced an integrated-circuit receiver. A glass supplier (Corning, photo) is now offering black-glass packages for such circuits. And the military orders in quantity electronic equipment having a packing density of 10^6 components per cubic foot. Details on this sort of activity is an important part of Tomaino's report.

What, we think, the report particularly highlights are the opportunities for sudden breakthroughs, bringing unexpected developments and considerable rewards to the developers.

Coming In Our May 11 Issue

DISTORTED. A device for measuring distortion caused by tape flutter is described by author A. Schulbach, of RCA. J. W. Gratian, of General Dynamics/Electronics contributes a feature article on a time compression system using analog methods. A trio of authors from Stanford University J. R. Fontara, R. H. Pantell, and R. G. Smith, write about the advantages and effects of nonlinear quantum devices. Jacob S. Zuckerbraun discusses the high reliability scanner developed for star-tracking purposes aboard the astronomical satellite.

COMMENT

More on Photochemical Retina

The title, Electromagnetic Retina, of the letter by A. J. Reynolds in the March 23 issue (p 4) attracted my attention because of my interest in the perception of color by the eye. However, after reading the letter, I found I couldn't tell what Mr. Reynolds was talking about. What possible connection can ancient Egyptian wheat or the body temperature of the mouse have to do with the mechanism by which the retina operates? Also, if he had taken the trouble, he would have found that the size of the cone, far from being compatible with his theory of being a quarter-wave stub, is actually of the order of 100 wavelengths long.

You may be interested in the enclosed copy of my paper, Theory on the Receptor Mechanism in Color Vision, which was published in the Journal of the Optical Society of America, in October 1960. In it I propose a theory that requires only one, but may have more, photochemicals. There has been considerable interest among ophthalmologists in this theory, although it is hard for most of them to understand even the explanation in the paper, which most electronic engineers would find over-simplified.

ALFRED C. SCHROEDER
RCA Laboratories
Princeton, New Jersey

The abstract of reader Schroeder's paper:

A theory is proposed to account for the color discrimination in the eye which does not require three different kinds of photochemicals or three different kinds of cones. Color discrimination is accomplished by at least three identical receptors positioned at appropriate positions along the outer segment of each cone. Some examples of color matching diagrams that can be obtained with this theory are compared with the CIE [Commission Internationale d'Eclairage, which previously was ICI, International Commission on Illumination] color matching diagram. Some comments are made indicating how it might be possible to get three separate signals from three receptors which all are within one cone.

More On Electromagnetic Retina

The reply by Frank Leary (p 4, April 6) to my original letter (p 4, March 23) is in itself a classic reply to a letter that was deliberately provocative. In essence it says: "The man's views are unconventional, therefore, he must be some sort of nut. Q.E.D."

First. I did not say there was no such thing as a photochemical, I said that the mechanics of color vision can be explained electromagnetically.

Second. It is a straightforward (although expensive) matter to construct a working model of the eye using the electromagnetic approach. This model can be made in any part of the EM spectrum, and the system performance could approach that of the eye. The only concession asked for is that it be agreed that white light is "white noise" and that a broad-band noise generator may be used as the "light source." The output from this model could be processed by a computer, so that it is conceivable that the computer could use such an "eye" as a source of information on which to base decisions. Note that the only reason this model must be in the microwave region rather than in the visible light band is the mechanical difficulty of working with physical pieces of the correct size.

Is the photochemical school in a position to demonstrate such a device?

Mr. Leary, concentrating on photochemicals, failed to remark on some other, equally outrageous, suggestions. Contrary to the allegation, there is a close chain of reasoning behind these statements and one which ties many diverse phenomena into a coherent system.

A good case can be made for assuming that all living molecules extract power directly from the electromagnetic spectrum to perform their functions and that they do so on a frequency-selective basis.

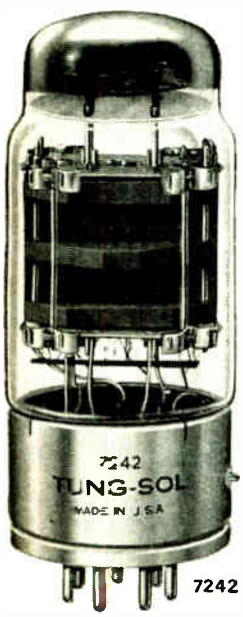
A. J. REYNOLDS
Babylon, New York

That last paragraph proposes a remarkable theory. Any takers?

8193

7802WB

6528



7242

TUNG-SOL SERVICE-DESIGNED SERIES REGULATOR TUBES

☐ FROM 14 WATTS TO 100 WATTS

☐ FROM 100 MILLIAMPS TO 1 AMP

Designed and developed expressly for use as passing tubes in series regulated power supplies (not adaptations of other tube types). Each of these mechanically rugged devices exhibits minimum tube drop when run "wide open", thereby assuring peak-efficiency operation. High current capability per tube plus a variety of power levels makes paralleling of tubes unnecessary. In addition, these series regulators possess the important advantage of requiring little grid-voltage swing to control current. All feature zirconium coated graphite anodes which, while lighter than similar metal anodes, remain warp-free and provide one of the best known methods of gas gettering. Use of hard glass envelopes permit the tubes to be outgassed at high temperatures during the exhaust process. This allows the tubes to be operated at very high temperatures without internally generating harmful gas. Gold-plated molybdenum wires are used in the rugged grid structures. Flexible metal vibration snubbers support the tube mount on its rugged button stem to insure maximum shock and vibration resistance. Stringent environmental and life tests guarantee reliable, long, trouble-free tube life.

Pictured are a family of medium Mu (μ=9), 6.3 volt heater, high environmental regulators. Also available are low Mu tubes, various heater voltage versions, and lower cost commercial counterparts.

TYPICAL VALUES FOR REGULATOR SERVICE PER TUBE

Type	Total Plate Current (Milliamperes)	Range of Tube Voltage Drop (Volts)	Minimum Tube Drop (Volts)	Grid Voltage Swing (Volts)
8193	75 50	110 180	80 60	15 25
7802WB	200 100	65 220	60 40	8 35
6528	400 200	65 225	70 45	10 35
7242	600 250	80 335	70 40	13 45

POWER DISSIPATION CHART OF TUBE TYPES

Total Plate Dissipation	14W	26 to 30W	60W	100W
Low Mu	6877	6AS7G 6080WB	6336A	7241
Medium Mu	8193	7802WB	6528	7242

Write for new series regulator portfolio. Complete technical information about all Tung-Sol series regulator tubes—the most supplied by any manufacturer—is contained in this handy reference kit. It's yours upon request. Just write: Tung-Sol Electric Inc., Newark 4, N. J. TWX:NK193. Sales Offices: Atlanta, Ga.; Columbus, Ohio; Culver City, Calif.; Dallas, Texas; Denver, Colo.; Detroit, Mich.; Irvington, N. J.; Melrose Park, Ill.; Newark, N. J.; Seattle, Wash. CANADA: Abbey Electronics, Toronto, Ont.

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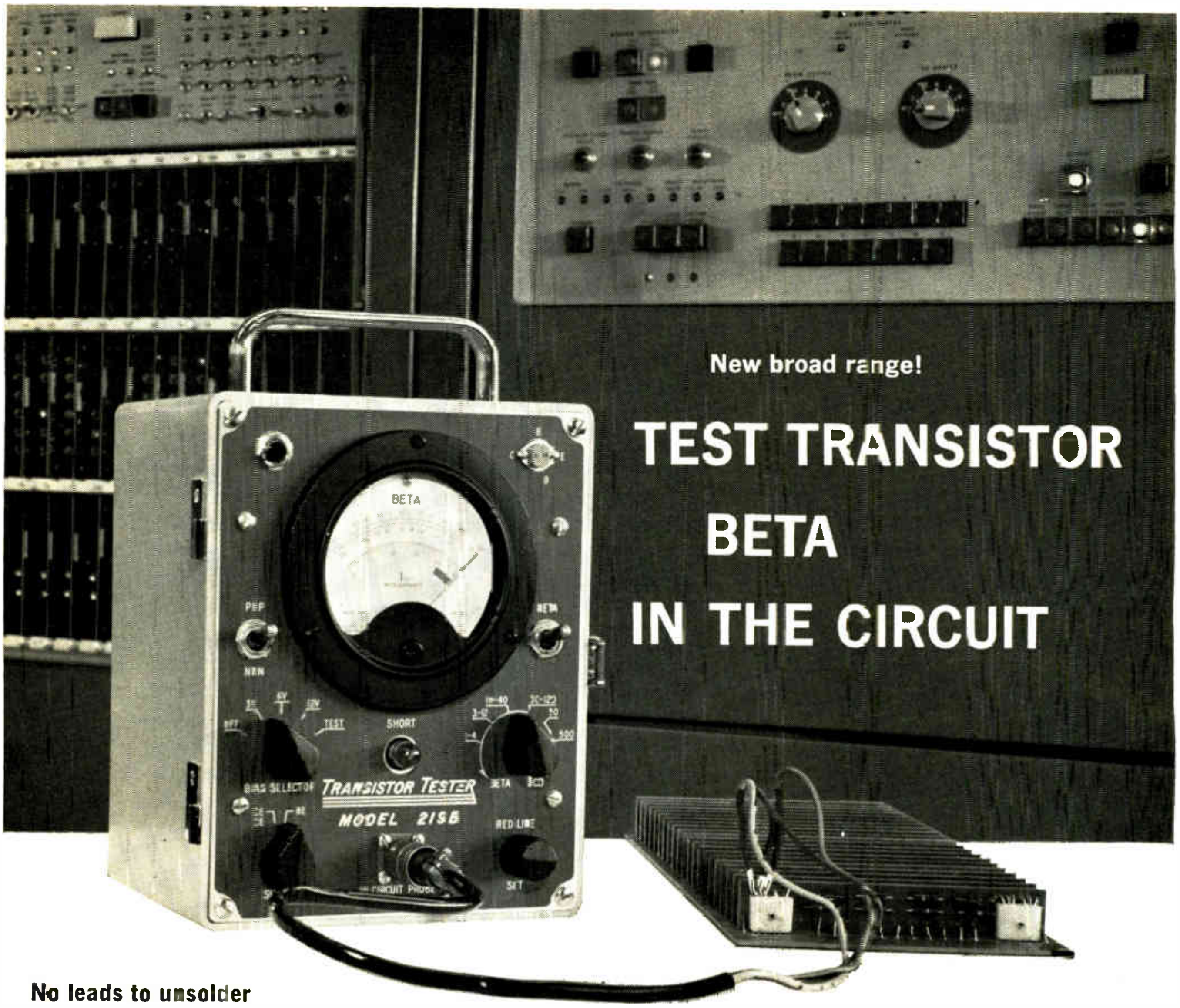

New broad range!

TEST TRANSISTOR BETA IN THE CIRCUIT

No leads to unsolder
Four overlapping Beta Ranges • High meter resolution
Direct reading with test circuit power off

New Sierra 219B 4-range Transistor Tester reads Beta directly in the circuit; also measures I_{co}, Beta out of circuit.

Less downtime and less danger of damage to transistors under test with this new Sierra instrument—battery-operated, light weight, portable, easy to use.

Maintenance, quality control, incoming inspection and production testing are just a few of the applications where you save time and money by testing transistors, even complete assemblies, without unsoldering leads. Model 219B reads Beta in the circuit, 1 to 120. I_{co} is measured on a straightforward basis; collector potentials of 3, 6 or 12 vdc may be selected. All controls are on the front panel . . . an instrument of convenience, speed, accuracy.

Write or phone today for information and demonstration.

SPECIFICATIONS

Test ranges	
Beta	1-4, 3-12, 10-40, 30-120*
I_{co}:	0-50, 0-500 ua
Accuracy	
In circuit:	±20% for external loads over 500 ohms. Improved accuracy above 500 ohms, usable readings below 500 ohms.
Out of circuit:	±10%
Power:	Internal battery, mercury or zinc-carbon type, 600 hrs. av. life; output indicated on front-panel meter.
Operating Temperature:	32 to 149° F
Size:	9" high, 7⅝" wide, 6½" deep, weight, 10¼ lb., including batteries.
Price:	$275.00

*Beta readings to 300 may be approximated.

SIERRA ELECTRONIC CORPORATION
A Division of Philco Corporation—A Subsidiary of Ford Motor Company,
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6919

ELECTRONICS NEWSLETTER

Superconducting Pumps Raise Magnetic Fields

WASHINGTON—Techniques for multiplying the strength of magnetic fields in superconducting niobium alloy devices were independently reported last week at the American Physical Society meeting by scientists from Jet Propulsion Laboratory and General Electric.

Both told how blocks of niobium are prepared with two adjacent holes. A field is set up through both holes. Then, a rod inserted in one hole forces all the field into the other hole. When the hole blocked is several times larger than the unblocked hole, the strength of the trapped field is multiplied. Fields up to 25 kilogauss can be obtained in this way.

JPL reportedly raised a 200-gauss field to 3.6 kilogauss by acually pumping the flux. The niobium block was fitted with two valves to control the flow of magnetic flux. These were operated over 25 10-sec cycles to attain 3.6 kilogauss, the critical field of niobium.

Both JPL and GE think that fields up to 100 kilogauss can be obtained; JPL said pumps would have to be larger and be made of materials with higher critical fields. According to GE, some unexplained phenomena will have to be understood first.

Such large, heatless (devices are cryogenically cooled), low-power-consumption fields could be used for radiation shielding in space, thermonuclear plasma containment, plasma propulsion engines, improving resolution of electron microscopes and a variety of scientific purposes.

Looks Like Conelrad Is on Its Way Out

WASHINGTON—Changes are being developed in the Conelrad system to "insure more effective presidential and civilian defense communications with the public in the event of a national emergency," FCC and the Department of Defense said last week.

The two agencies acknowledged what critics of Conelrad have been saying for years: combining all radio broadcasts into two frequencies (640 and 1,240 Kc) won't prevent enemy bombers from homing because better aerial navigation methods now exist. One major criticism was that switching local stations from assigned frequencies to a Conelrad frequency would confuse uninformed listeners.

For the time being, however, existing rules remain in effect, the agencies said. Broadcasters were cautioned "not to expect the disappearance of all emergency condition controls. Some restriction on electromagnetic radiation will still be required to insure effective civil and defense communications."

Proton Maser Is Tunable, Gives Continuous Output

BOSTON—National Company reports that it has achieved c-w amplification with a room-temperature proton maser. At 15 Mc, with an input signal of 3×10^{-13} watt, it gave 20-db gain and bandwidth of 100 cps.

The amplifier is tunable from 2 Kc to hundreds of megacycles, depending on field strength. The developers, Alexander Ganssen, Eugene La Vier and Earl Sloan, III, say they are also interested in stable oscillator application because of the maser's high spectral purity. An oscillator could have a linewidth of 1 part in 10^{11}.

Work on proton masers was begun in 1957 by French researchers. A two-level device, it takes advantage of the Overhauser effects in low-viscous liquids, to obtain excess population of upper energy levels. National uses tetrachlorosemiquinone, a magnetic field of 3.5 kilogauss, and supplies pump power at 9 Gc with a klystron.

At low-frequency, the maser might be used as an earth-field magnetometer. Atmospheric and galactic noise may restrict r-f applications, but it would be useful for research.

Tv Oneupmanship

TOKYO—Mitsubishi Electric now claims the title of producer of the world's smallest tv set.

Like the 5-in. Sony set reported last week, it operates on a-c or battery power. But it weighs 6 lb—2 lb lighter— and has a 6-in. screen. Mitsubishi says the smaller size is made possible by a new kind of tuner.

Mitsubishi plans to place the set on the U. S. market this fall. Domestic price is about $140. Export price has not been announced

U. S. and USSR Draft a Weather Satellite Pact

WASHINGTON—A draft compact for U. S.-Soviet cooperation in meteorology—including satellites—was revealed at a 20-nation conference held here late last month as part of the planning for the International Year of the Quiet Sun. The draft was drawn up at Geneva under auspices of the World Meteorological Organization.

The Washington meeting was one of a series aimed at intensifying international cooperation in satellite-assisted meteorological surveys and solar surveys.

Soviet delegates acknowledged that they have much to learn about satellite meteorology from the U. S. and confirmed the meteorological purpose of the current Soviet satellite series, which still lack cameras (Cosmos 3 and 4 were launched last week, but the Moscow announcements omitted equipment details).

Japanese EIA Against Radio Price-Cutting

TOKYO—Japanese Electronic Industries Association has advised its members not to cut prices for six-transistor radios despite price cuts by U. S. manufacturers. JEIA acted after the New York branch of the Japan External Trade Organization (an influential government-sponsored agency) said price drops in the U. S. were a "passing pathetic phenomenon." JETRO said the cuts could mean U. S. manufacturers were cleaning up inventory, stopgapping Japanese imports or using trade strategy so they could buy Japanese radios at reduced prices in the future.

Vapor Deposition Forms Transistors and Diodes

SYLVANIA this week announced a series of thin-film processing developments, including techniques for forming diodes and transistors from silicon vapor. The techniques are all still being studied at the company's microelectronics lab in Waltham, Mass.

A number of large-junction-area diodes and transistors have been formed. Objective is methods of forming active and passive elements on the same ceramic wafer. Other developments include methods of amplifying currents with ceramics; high-resistivity and high-capacitance films; glass coating for ceramic wafers to reduce circuit size by improving definition.

Sylvania also reported that it is in pilot production of thin-film circuits for military applications. A variety of computer, amplifier and oscillator circuits, in frequencies up to 152 Mc, are being made.

Last Week's Satellite Score: 1.5 Successes

ALTHOUGH RANGER 4 failed to send back data and photos from the moon, the mission was at least a half-success, reports from Jet Propulsion Laboratory and its contractors indicate.

The launch was a good one, ground support and initial guidance gear worked well. The unguided spacecraft hit the moon, a feat several earlier U. S. probes were unable to accomplish. The transmitter in the small lunar landing capsule operated and was used to track the craft to impact.

The first international scientific satellite (p 32, April 20) had better luck. It went into orbit as planned. Instrumented by several British institutions and launched by NASA, it is England's first space traveler.

Broadband Light Pumps Calcium Fluoride Laser

DEVELOPMENT of a laser triggered by broadband light—in the visible, infrared and ultraviolet spectra—was announced last week by RCA. The company said the crystal used "reduces by 10 times the amount of energy required by present types" to produce infrared beams.

It should soon be possible, the company indicated, to achieve continuous infrared emission from the crystal by using mercury or tungsten lamps to activate it. At present, it operates with a pulse duration of several milliseconds.

The crystal is calcium fluoride doped with divalent dysprosium. It emits radiation at 2.36 microns when pumped by energies from 1 to 0.3 micron. Energy input and output were not specified.

Rocket Failure Thwarts Reentry Reception Test

BOSTON—Rocket failure sets back for another year an Air Force experiment to test communications and telemetry through a reentry plasma sheath. The second stage of a Blue Scout failed to ignite and the vehicle landed in the ocean. Another try will be made next spring, Air Force Cambridge Research Labs said.

Five microwave transmitters and two receivers will serve as test sources, radiation receptors, radar beacons and telemetry components. They will span a frequency range from L band to X band and transmit modulated c-w and pulsed signals.

Road Gets Its Own Broadcasting System

NORTHERN INDIANA toll road is installing a radio system that will give motorists music, news, weather and safety information over car radios. Reception limit will be 150 ft from the highway.

In Brief...

FAA HAS WARNED airlines flying the Pacific to expect nuclear weapons tests to affect aircraft navigation and communications. Planes will be grounded temporarily.

LASER SURVEILLANCE techniques are being developed by Electro-Optical Systems under Air Force contracts for design of c-w oscillators, amplifiers and oscillators, and variable attenuator, phase shifter and power divider operating at 0.5 to 0.8 micron.

NORWEGIAN firm of Kongsberge Vapenfabrikk will be prime contractor for NATO production of Martin's Bullpup missile. Components will be bought from U. S. only until European suppliers can qualify parts to meet specs.

SWITZERLAND will use Hughes Aircraft's Taran-1 radar and fire control system in Mirage-III-S aircraft. The planes carry Hughes' radar-guided HM-55-S missiles.

GENERAL INSTRUMENT has won a Navy contract to develop oceanographic instrumentation and to conduct underwater studies for the Polaris program.

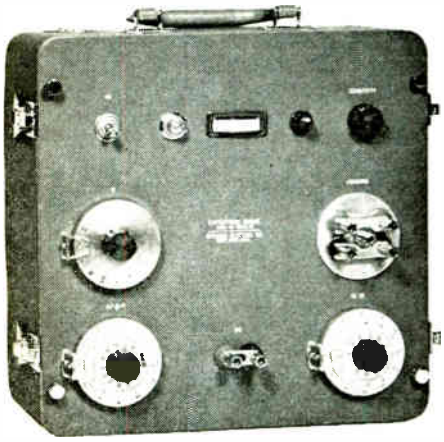
SPERRY GYROSCOPE has new Polaris contracts of $11.1 million, bringing fiscal year total to $40 million. New orders are mostly for navigation equipment for the 20th to 29th subs.

ELECTRONIC COMMUNICATIONS' share in Air Force airborne command post program rises to $15 million with $2 million contract for radio relays to go in B-47s.

NASA has awarded contracts of $1.9 million and $1 million, respectively, to RCA and Epsco for ground checkout systems. RCA will supply computer system for Saturn program, Epsco an edp system to check out various satellites.

NINE ASIAN countries are considering a 6,000-mile submarine cable communications system. The Japanese Ministry of Posts and Telecommunications estimates cost at $85 million.

Now! For the first time...



YOU CAN TEST ELECTROLYTIC CAPACITORS

Safely . . . Accurately . . . Simply!

The Sprague Model 1W1 Capacitance Bridge incorporates the best features of bridges used for many years in Sprague's own laboratories and production facilities. Unlike many conventional bridges, the 1W1 will not cause degradation or failure in capacitors during test, since the 120 cycle a-c voltage applied to capacitors never exceeds 0.5 volt!

SPECIFICATIONS

Capacitance
Range: 0 to 120,000µF at 120 cps
Accuracy: ±(1% of reading +10µµF)
Sensitivity: ±(0.1% of reading +10µµF)

Dissipation Factor
Range: 0 to 120% at 120 cps
Accuracy: ±(2% of reading +0.1% DF)
Sensitivity: ±(0.2% of reading +0.05% DF)

Maximum Voltage to Unknown
A-C: 0.5v RMS at 120 cps
D-C: 0-600v (external)

Null Detection
Built-in Galvanometer to Indicate Bridge Balance

Power Input
105-125v, 60 cps, 15w
(Also available in 115v and 230v, 50 cps models)

Case
Sturdy Aluminum Cabinet with Blue Textured Finish, Grey Panel

Dimensions
12" Wide x 12" High x 9" Deep

For complete technical data, write for Engineering Bulletin 90,010 to Technical Literature Section, Sprague Electric Company, 35 Marshall St., North Adams, Massachusetts.

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THE MARK OF RELIABILITY

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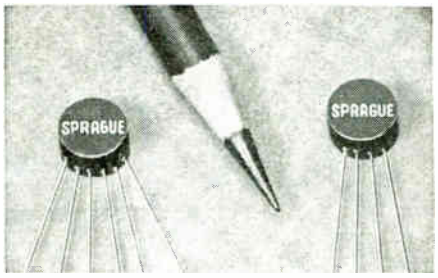
New Nanosecond* Pulse Transformers for Ultra-miniature, Ultra-high Speed Applications



Digital circuit designers will find the new Sprague Type 43Z Nanosecond Pulse Transformers of considerable interest. These tiny transformers have been carefully designed for the all-important parameter of minimum rise time at high repetition rates up to 10 mc.

The new Type 43Z series is comprised of a broad line of 72 pulse transformers in 10 popular turns ratios. They are Sprague's latest addition to the most complete listing of pulse transformers offered by any manufacturer for use in digital computers and other low-level electronic circuitry.

Type 43Z Pulse Transformers are designed so that the product of leakage inductance and distributed capacitance is at a minimum. They are particularly well suited for transformer coupling in transistor circuits since transformers and transistors are very compatible low impedance devices. Nanosecond transformers are equally suitable for transmission line mode of operation, in twisted-pair transmission line coupling, and in regenerative circuits.

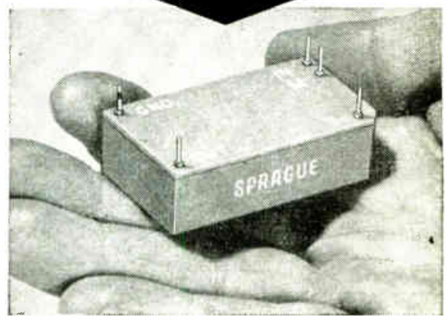
The epoxy-encapsulated "pancake" package is excellent for both etched wire board or conventional chassis mounting. To simplify etched-board design, these ultra-miniature pulse transformers are available with leads terminating at the side or the bottom of each unit.

For complete technical information on Type 43Z Nanosecond Pulse Transformers, write for Engineering Data Sheet 40235 to Technical Literature Section, Sprague Electric Co., 35 Marshall St., North Adams, Mass.

*millimicrosecond

CIRCLE 202 ON READER SERVICE CARD

Something NEW in counting techniques!



Sprague type 73Z1 core-transistor DECADE COUNTERS

Here is a simple yet versatile, low-cost yet reliable component for counter applications. Counting to speeds of 10 kc, the 73Z1 decade counter provides an output signal for every 10 input pulses, then resets in preparation for the next cycle. For higher counting, two or more counters may be cascaded. Typical characteristics are shown below.

CHARACTERISTIC	INPUT	OUTPUT
Amplitude	1.5 to 8 volts	6.5 volts
Pulse Width	1 µsec min.	35 µsec
Impedance	100 ohms	20 ohms

Utilizing two rectangular hysteresis loop magnetic cores and two junction transistors to perform the counting operation, the 73Z1 counter is encapsulated in epoxy resin for protection against adverse environmental conditions. It has five terminals —B+ (12v ±10%), input, output, ground, and manual reset.

The 73Z1 counter is available as a standard item. However, "customer engineered" designs can be supplied when other counting cycles, speeds, and package configurations are required for special applications.

For complete technical data or application assistance on the 73Z1 counter or other Sprague components, write to Special Products Division, Sprague Electric Co., 35 Marshall St., North Adams, Mass.

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A New Performance Dimension in Digital Frequency Meters

Already recognized as having the broadest range ever offered at its low price, the Model 8175 110 Mc Digital Frequency Meter now provides an added performance dimension: **the legibility of ELectroluminescent readout.** Displayed in-line and **in the same plane,** EL digits are easily read from extreme angles. EL's glareless, even illumination and automatic display of decimal point and Mc assure greater accuracy by minimizing human error.

Broad range (10 cps to 110 Mc) and readability are only two important advantages of the Model 8175. Accuracy of 0.00004% or better from 1 Mc to 110 Mc exceeds FCC requirements. Frequencies are measured with a flick of a switch – no "tuning." With this simplified operation, a measurement can be accurately made in about 15 seconds, even by personnel with limited technical experience.

Occupying only 8¾″ of vertical space in a 19″ rack, Model 8175 is small and light enough to be moved about easily when used on the bench. Price is just $2095. Write for Technical Product Bulletin 8175/7175, which also describes the Model 7175 with decade-columnar readout for $1895.

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T-47

WASHINGTON OUTLOOK

INDUSTRY FIGHTS OVERSEAS TAX

THE ELECTRONICS INDUSTRY has gotten deep into the battle against the administration's tax proposals to tighten up the taxation of profits of overseas subsidiaries of U. S. manufacturers.

Harold S. Geneen, of ITT, told the Senate Finance Committee that adoption of the bill would not produce any substantial new revenues, and would make U.S. subsidiaries noncompetitive with their foreign firms in the same markets.

Electronics Industries Association, representing the views of such firms as GE, RCA, Philco, Motorola and others, told the committee the bill would hurt foreign trade, causing many companies to slow down planned expansion of foreign trade activity. Hewlett Packard will, also, submit a report to the committee.

Without naming names, the EIA spokesman, David Flower, Jr., of Raytheon, gave several examples of specific electronics industry cases involving England and other European countries to show how the new bill would hamper operations and expansion.

Hearings of the Senate Committee were to end May 3, after which it would go into executive session to write amendments to the bill the House passed.

The guessing is, that the Senate will pass the tax bill in one form or another, but a great many compromises and deals will be made before a measure is finally sent to the White House.

SHANK GETS NEW FAA POST

AN ELECTRONICS EXPERT is taking over the job of managing development of a new air traffic control system for the Federal Aviation Agency. Administrator Najeeb E. Halaby selected Robert J. Shank, president of American Systems, Inc., for the job. Applying the systems concept already used by the Air Force, Shank will be in charge of research, design, engineering procurement, installation and maintenance of the future traffic control system—responsibilities that have been divided among a number of separate officials.

SURVEY SAYS FCC LAGS

FEDERAL REGULATION is failing to keep pace with the galloping technology of communications. This is the finding of a survey of the Federal Communications Commission by Booz-Allen and Hamilton, made at the request of the Bureau of the Budget.

The FCC will be enlarged, given improved equipment, and provided better personnel in key positions, if Congress heeds the advice of the management consultants.

Rate regulation of such common carrier communications companies as American Telephone and Telegraph and Western Union is found lacking in depth and scope and completely inadequate for the protection of the public interest. Under present conditions, the FCC is said to be unable to cope with the problem of regulating the rates of such a vast enterprise as AT&T.

The consultants include a kind word for Chairman Newton N. Minow, and express confidence that his "positive leadership" will help move the agency in the right directions. But the report urged broader executive powers for the FCC chairman, a step that Congress already has refused to take.

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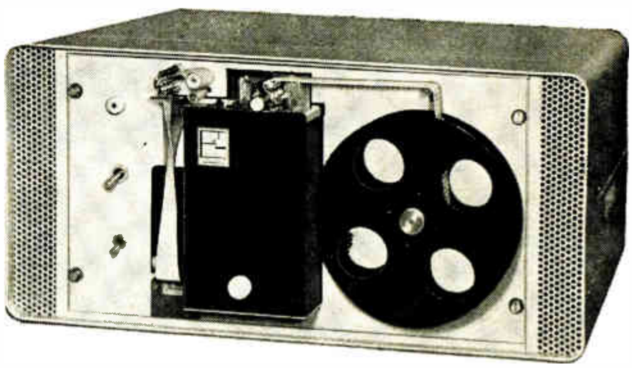

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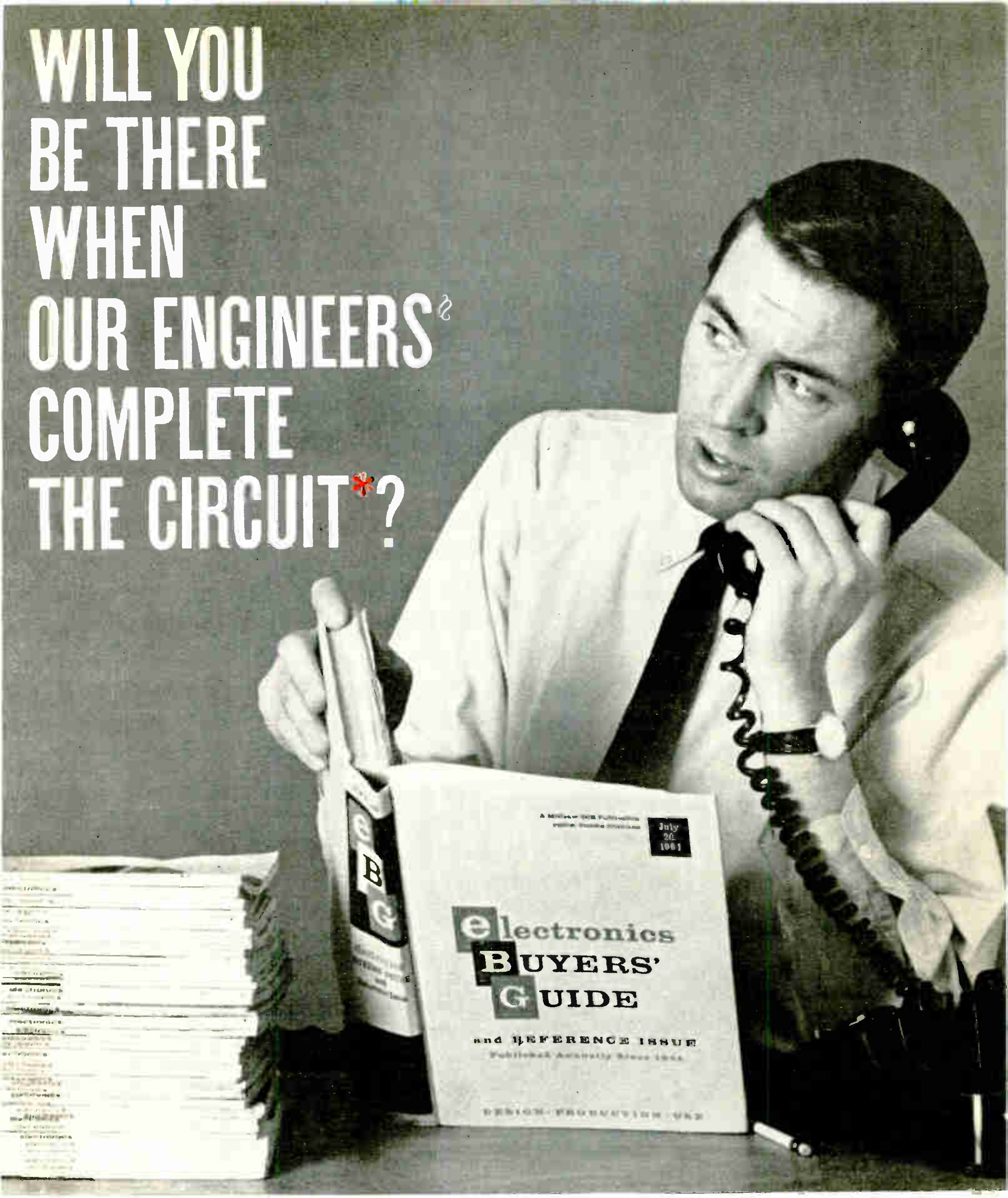
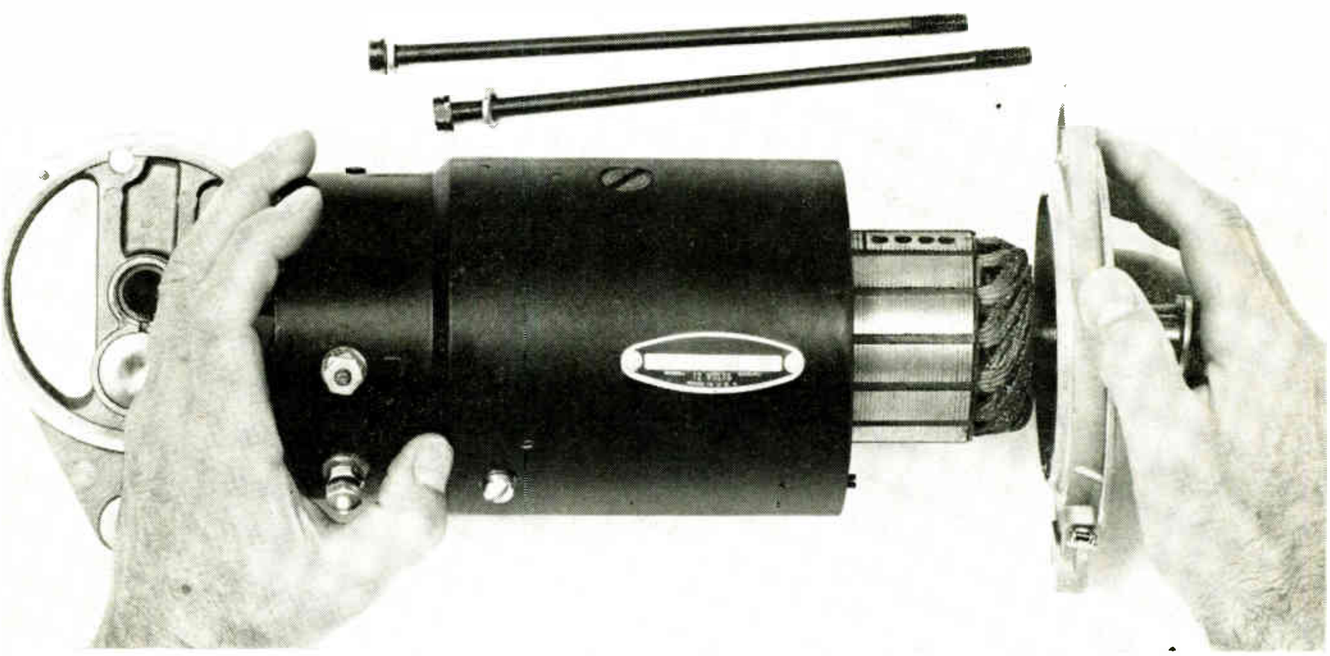

WILL YOU BE THERE WHEN OUR ENGINEERS COMPLETE THE CIRCUIT*?
July 26 1961
electronics BUYERS' GUIDE
and REFERENCE ISSUE



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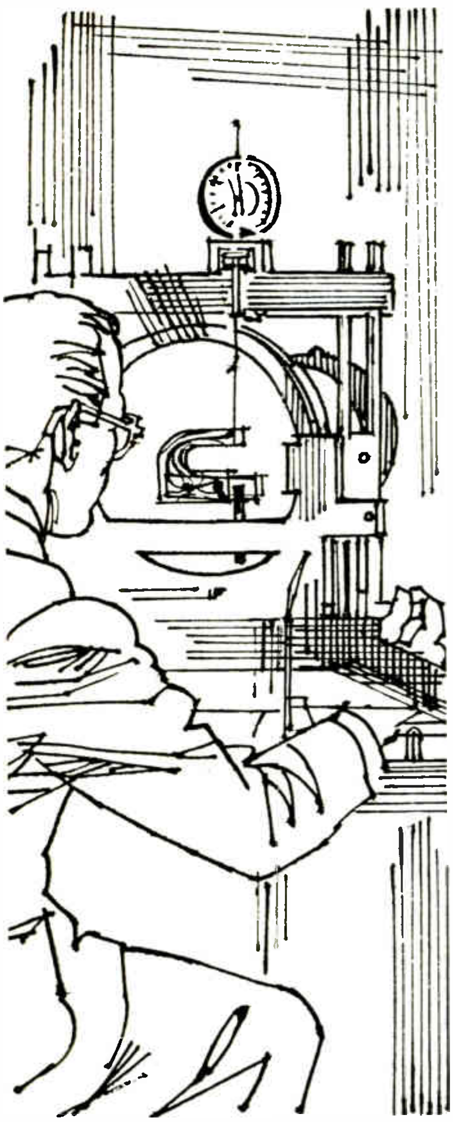
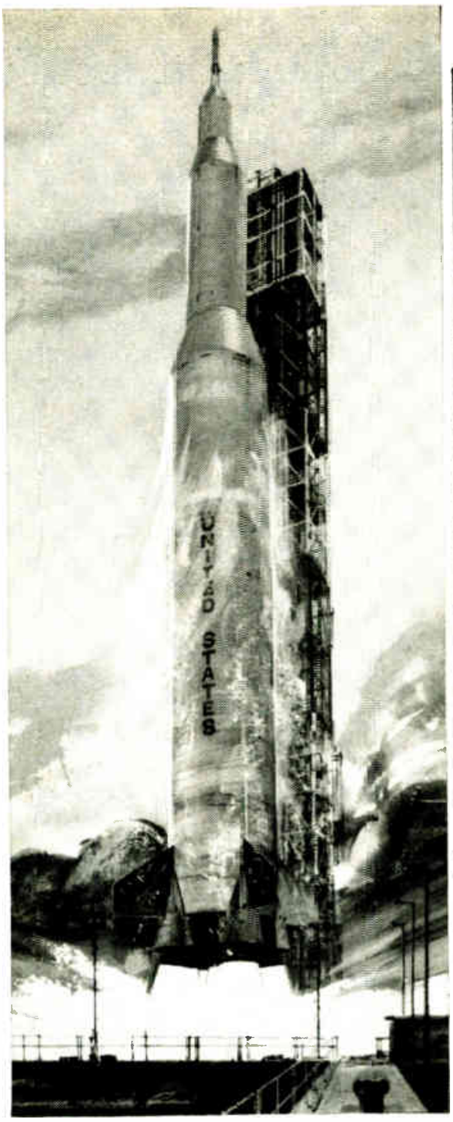
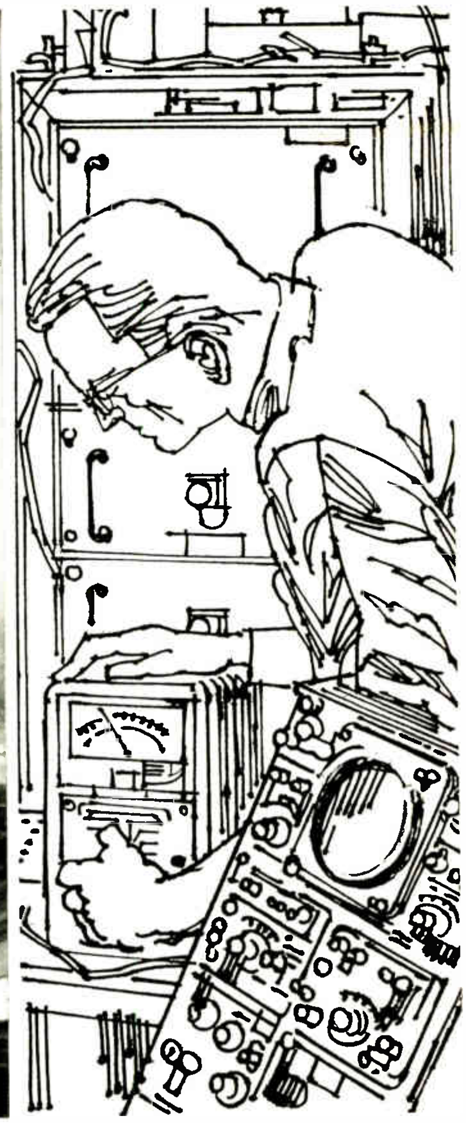
CIRCLE 17 ON READER SERVICE CARD ➤







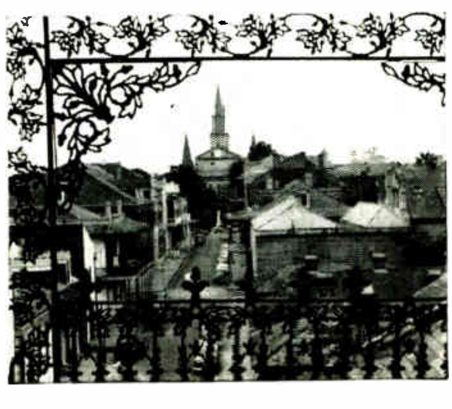
Saturn openings at Boeing for

STRUCTURAL AND ELECTRONIC/ELECTRICAL ENGINEERS

Boeing has been awarded primary developmental, building and test responsibility for the Saturn S-IC advanced first stage booster. The Aero-Space Division's newly-formed Saturn Booster Branch has a number of immediate, long-range openings offering professional challenge, rapid advancement and ground-floor opportunities to graduate structural and electronic/electrical engineers.

STRUCTURAL engineering openings require knowledge of acceleration loads, high heating rates, extreme differential temperatures, material oxidation and structural dynamics as applied to the design, development and construction of large booster systems.

ELECTRONIC/ELECTRICAL engineering assignments are available in many areas, including the design and development of monitoring, instrumentation, control and functional checkout circuitry; electronic subsystems and packaging techniques as related to the specific requirements of booster systems.



Salaries are commensurate with all levels of education and experience. Minimum requirements are a B.S. degree in any applicable scientific discipline. Boeing pays liberal travel and moving allowances to newly-hired engineers. Permanent assignment will be in New Orleans, with initial temporary assignment at Huntsville, Ala. Positions with Saturn and with other expanding missile and space programs at Boeing—including the solid-fuel Minuteman ICBM and Dyna-Soar boost-glide vehicle—are also available at Seattle, Cape Canaveral and Vandenberg AFB, Calif.

Send your resume, today, to Mr. R. R. Gregg, The Boeing Company, P. O. Box 26088-ECH, New Orleans 26, Louisiana. Boeing is an equal opportunity employer.

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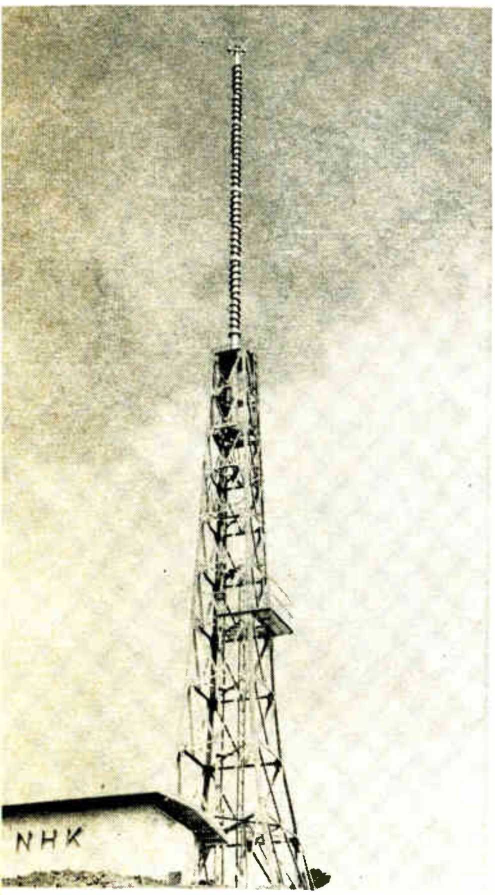
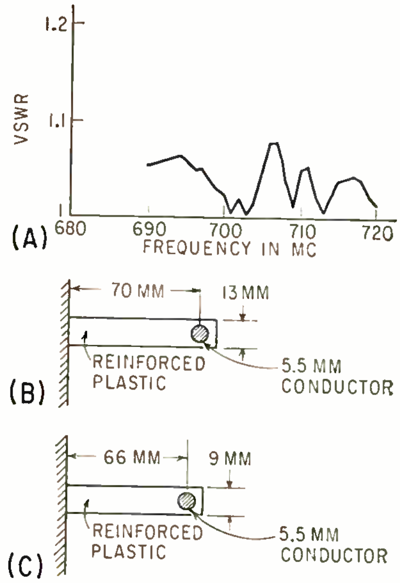


Rugged, screw-like design of helical antenna enables it to withstand typhoons



Standing wave characteristic of screw antenna (A). Conductor is encased in plastic. Dimensions of plastic support for upper two elements (B) and lower two elements (C) differ slightly

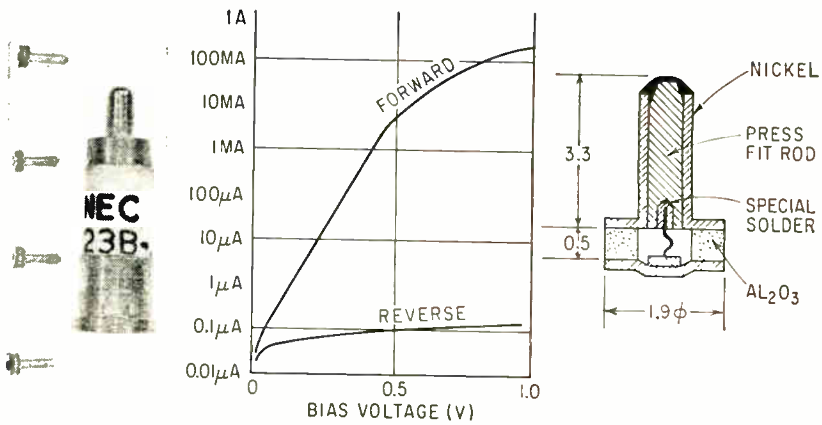
By CHARLES COHEN
McGraw-Hill World News

TOKYO—Integrated devices and diodes were featured at the semiconductor sessions during the annual convention of Japan's four electrical societies last month.

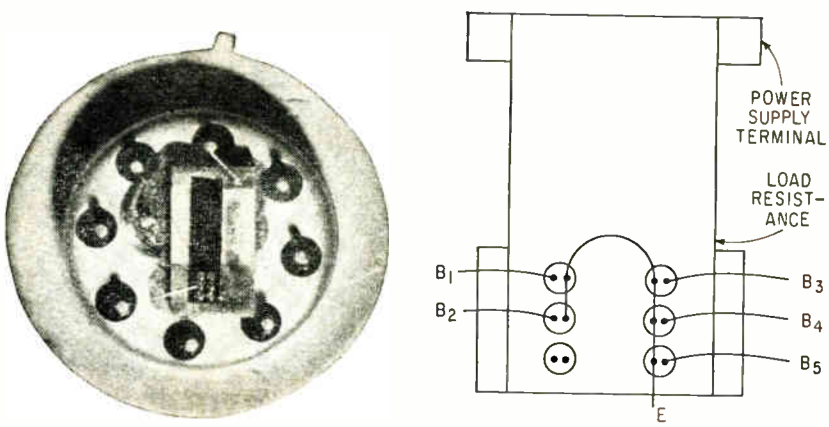
Semiconductor sessions of previous conventions have been dominated by high-frequency transistors, but a surplus of h-f transistor production capacity has decreased interest in this area. Also, the Japanese electronics industry, which was almost wholly communications-oriented, is diversifying.

Kunio Tada, of Tokyo University, introduced a solid-state module for dctl (direct-coupled transistor-logic) circuits. Six mesa transistors are formed at one end of an n-type silicon bar and their emitters connected together. The output connection is made to a plate soldered to the lower surface of a bar under the transistors. The power supply is connected to the far end of the bar, which acts as load resistance. Inputs are applied to individual bases, for AND or OR circuits (lower right).

The voltage margin is equal to that of circuits using germanium microalloy transistors. Storage in collector region, which is the main



Whisker diodes are dwarfed by standard-sized commercial diode (photo). Performance and structure of whisker diode developed for 6 to 11-Gc resonant and twt amplifiers



Several mesa transistors are formed on silicon bar for dctl logic circuits. Here, five of six transistors are connected. Emitters are connected; base inputs vary according to circuit needs

Integrated Circuits and Diodes

cause of propagation delay, has been reduced to 0.5 μsec by gold diffusion. Epitaxial techniques might reduce it further. Delay time is 0.5 μsec for two storages.

Negative resistance device for generating sawtooth waves has been developed by a group at Nippon Electric Co.; *pnpn* devices for this purpose require high-power supply voltages (making microminiaturization difficult) and have low output voltage. The new device consists of an *npn* transistor having high forward and reverse current gains, fabricated by epitaxial techniques on an n^+ silicon wafer.

Negative resistance appears at the approximately 8-v breakdown voltage of the collector junction. An approximately 7.4-v sawtooth output is obtained with 10-v power.

A magnetic-type stepping diode that can be used to perform most functions, except display, of gas-filled counters was developed by Koichi Omura, of Osaka University. Parallel double-base diodes are formed on single piece of semiconductor by making a series of junctions in a circle on a round wafer. Base connections are made at the rim and in the center.

Modulation of diode characteristics by holes injected from a neighboring diode effects current transfer. A perpendicular magnetic field provides directional characteristics. In use, the bias supply is connected between bases and stepping is obtained by applying 180-deg out-of-phase pulses simultaneously to alternate junctions which have been connected.

Variable capacitance silicon diodes were fabricated with an alloy-diffusion process by Tokuzo Sukegawa, of Tohoku University. Reproducibility is excellent, making for small shrinkage during production. Control of slope of impurity distribution (drift field) is simple; the wafer is easy-to-etch *p*-type silicon, so a thin base region is easily obtained. Lead connection directly to the wafer makes for low base resistance.

Interest in physical properties of semiconductor materials and thin films was also greater than previously. Papers on effects of illumination on semiconductor materials and devices were numerous.

The silver-bonded diode attracted attention at the microwave session. Applications included frequency multipliers, modulators and microwave switches.

Silver-bonded diode with whisker length of 0.6 to 0.7 mm and diameter of 45 microns was developed at Electrical Communications Laboratory (ECL) of Nippon Telegraph and Telephone. Subminiature size minimizes series inductance, spacing between diodes and discontinuities introduced into microwave circuits (upper right).

Measured series inductance is 0.49 nh, capacitance at −3 v is 0.127 pf, at 0 v 0.246 pf, at +3 volts 0.85 pf. Rectification ratio measured at plus and minus 1 v is more than 100,000.

Sumitomo Electric Industries Co. reported on an unusual antenna for NHK's experimental station at Hitachi. Looking like a screw, it is a horizontally polarized helix (left).

The radiator conductor is completely enclosed in a helical reinforced plastic insulator attached to the center pole. This construction is said to reduce cost and improve strength.

The antenna consists of four elements. Each has 10 turns, five spiraling in one direction and five in the other direction. Identical lengths of AX-20D coax feed to the center of each section. Length of each of the conductors is three wavelengths.

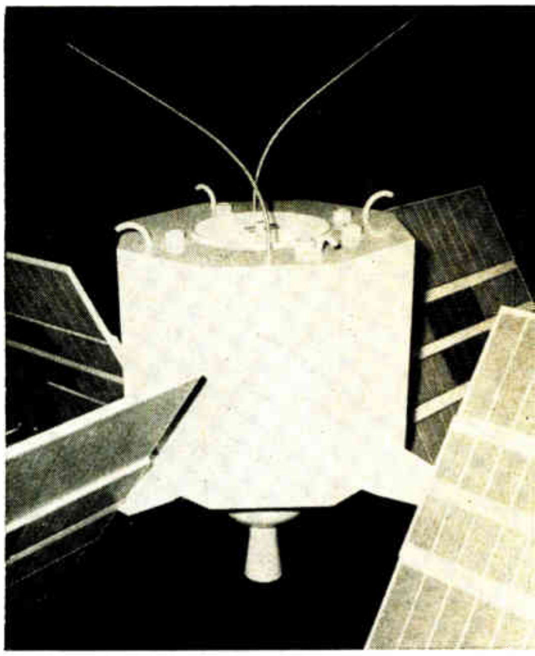
At 704 to 710 Mc, the antenna is horizontally nondirectional within 2 db, vertical gain is 13 db and beam tilt is 0.5 deg.

Japan Plans Tv Satellite For 1964 Olympic Games

JAPANESE SCIENTISTS hope to provide world-wide tv coverage of the 1964 Olympic games in Tokyo by three, or possibly four, active repeater satellites in synchronous orbits.

The satellites will be boosted into orbit by either a U. S. Scout or Thor-Delta rocket. Hovering positions will be over the equator at 170 deg W lat, 70 deg E lat, and 50 deg W lat. Choice of launch vehicles and hovering positions will be left up to the National Aeronautics and Space Administration.

Nippon Electric Company (NEC), now engaged in research on the project, proposes a 105½ lb cylindrical craft, 66 cm in diameter and 49 cm high, equipped with four solar cell panels (6,889 sq cm each), and three antennas. Mitsubishi Electric will build telemetry gear and Mitsubishi Shipbuilding & Engineering, an automatic position control system.



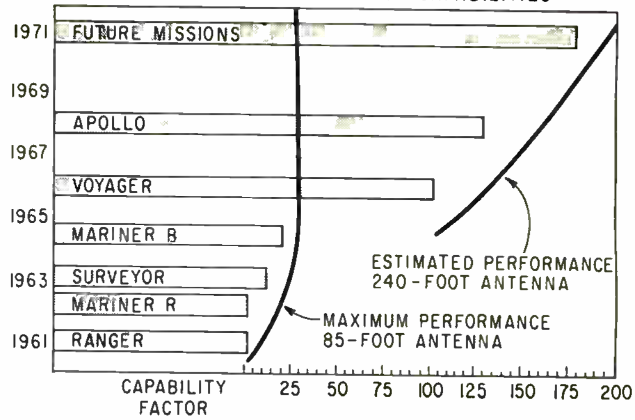
Active repeater tv satellites in research stage at Nippon Electric Company to hover over points along equator at 22,380 mi

MAJOR DEMANDS ON NASA'S TRACKING & DATA ACQUISITION SYSTEMS

CALENDAR YEAR

	1962	1963	1964	1965
MANNED FLIGHTS				
MERCURY	5	–	–	–
I DAY FLIGHT	2	2	–	–
GEMINI		4	6	2
APOLLO	–	–	–	–
SATELLITES				
SCIENTIFIC	12	8	16	20
APPLICATIONS	11	9	8	8
DEEP-SPACE MISSIONS				
LUNAR	3	4	4	8
PLANETARY	2	1	6	4
TOTALS	35	28	40	42

DEEP SPACE ANTENNA SYSTEM CAPABILITIES



NASA Needs New Ground Gear

THE NEW BREED of spacecraft now being readied for flight in 1963 is requiring a similar revolution in the ground stations that will track them and acquire their data.

Although fewer in number during this year of transition than the number of spacecraft launched in 1962, the complexity, range of operation, mission duration, and volume of data will increase. The 3-orbit Mercury flights will be replaced by 18-orbit flights and the two-man Gemini missions. Most of the small scientific satellites will give way to the large orbiting observatories. The Tiros meteorological satellite will be replaced by Nimbus. The single Echo shots and the Relay active communications satellite will make way for the 3-balloon Rebound and the synchronous Syncom. Only the lunar and planetary probes will maintain their 1962 pace. By 1964, not only increased performance will be the norm but also a stepped up schedule —40 missions; in 1965, 42.

Ground facilities to handle the new generation of spacecraft will cost an estimated $158.4 million in R&D and $35.85 million for construction in 1963 funds. Here are the major requirements, as described by NASA's E. C. Buckley, Director, Tracking and Data Acquisition, to Congressional subcommittees.

The manned one-day missions will require one contact with ground stations per orbit. This means new telemetry gear at eleven Mercury sites. Also, all sites will be equipped with ground-to-vehicle command facilities. For the orbits that do not pass over Mercury sites, the mid-Atlantic ship will be moved to the Pacific, west of Chile, and the Indian Ocean ship to a point near Madagascar.

Although Gemini and Apollo missions will rely heavily on existing ground nets, more facilities—specifics are not yet determined—will be needed. The rendezvous and landing maneuver portions of the flights will both require specialized instrumentation-mating with the system in the capsule.

One big problem will come from spacecraft with highly eccentric orbits. The Eccentric Geophysical Observatory, for example, will have an apogee of 50,000 mi. Period of revolution will be about 40 hr. Time required for the satellite to move from one Minitrack station to another is too long to wait to determine its orbit. One technique now being developed is the Range and Range-Rate System. This consists of a transponder aboard the satellite and three ground stations. The transponder receives a signal on one frequency and retransmits on another. The three ground stations record the signal and obtain a radial velocity component of the satellite. A central computer receives information from all three stations simultaneously and computes the actual position of the satellite, its direction and velocity.

NASA's Deep Space Network reception capability must be increased to satisfy the growth in mission requirements by a factor of 200 over the decade. Mariner B launches, scheduled to begin in 1964, will be the last spacecraft our present complex of three 85-ft antennas can handle. A proposed 240-ft system will provide a capability adequate to meet the needs of future spacecraft beginning with Voyager, and Apollo, and including live tv from the moon. One 240-ft dish is requested for Goldstone, Calif.; an additional 85-ft at each of the other two sites, Woomera, Australia and South Africa.

Currently, parametric preamplifiers are being installed in the 85-ft systems to give overall receiving system sensitivities of 260 deg K. This will be a big improvement over the past sensitivity of 1,430 deg K. In the future, using a maser preamplifier, a low-noise Cassegrain feed system, and the 2,290-2,300 Mc frequency band assigned for space communications, a sensitivity of about 60 deg K will be possible.

Existing equipment for the big orbiting observatories consists of an 85-ft antenna at Rosman, N. C., and one in Alaska. In addition, one more is requested for Rosman and one for a station in the Far East. These antenna systems use two higher frequency bands, 400-401 Mc and 1,700-1,710 Mc. Also, higher power transmitters, which can be pulse modulated by a new digital tone coder, are being developed. These satellites will use information bandwidths of 1-3 Mc (communications satellite bandwidths are 3-10 Mc wide).

PULSED-DOPPLER TECHNIQUES FOR

Tracking Hurricanes More Accurately

By ROY J. BRUUN
Assistant Editor

PULSED DOPPLER weather radar techniques, conceived at Air Force Cambridge Research Laboratories, may provide surer warnings as to where hurricanes in the northern latitudes will strike. If these techniques are adopted, needless turmoil, such as that generated by Hurricane Esther in 1961, may be prevented.

Early in the morning, Esther was wrathfully bound for industrial cities in New England. Then, according to radar, it seemed to stall some distance off shore. Taking advantage of the respite, people along the coast continued to board up shops and stay home from work. It was 2½ hours before radar was able to determine that the "stall" had been a shift in course; the hurricane eye—center of the propelling circular winds—was now moving out to sea.

Reason for the confusion was the loose construction of hurricanes in temperate zones. In tropical areas, the eye is surrounded by precipitation bands—swirling winds containing tightly packed weather droplets. It is this water that existing radars detect. As the hurricane travels to temperate areas, like New England, these bands move out from the eye as much as 500 miles. Existing weather radars dependent on reflections from dense masses of water droplets are no longer able to determine the position of the eye, which is now surrounded by winds containing relatively small amounts of moisture.

The AFCRL group, headed by David Atlas, feels that pulsed techniques will enable radar to penetrate the wet outer winds with energy sufficient to reflect signals from the few water droplets in the eye-surrounding winds. These return signals will be strong enough to show up on radar scopes. The use of doppler techniques, they say, will permit phase detection of weaker returns that might not be picked up by amplitude detection. Combining the two techniques will provide very effective pickup of the eye-surrounding winds. This basic concept is the foundation for further techniques conceived by the AFCRL group.

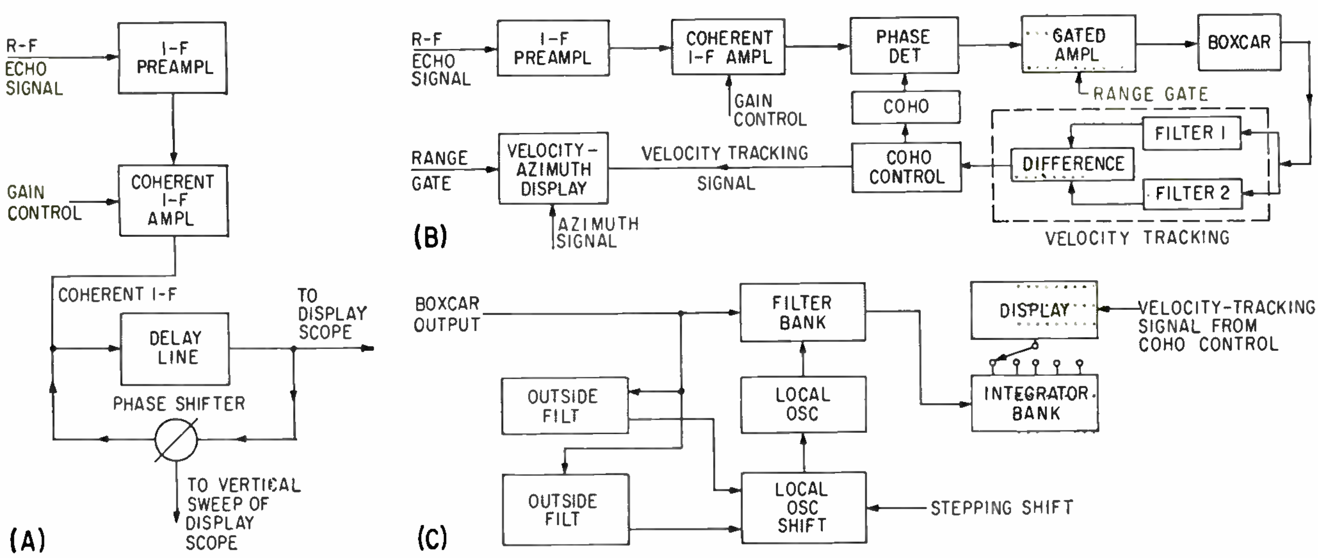
One of these methods is the coherent integration technique that phase-compares several successive echo signal pulses in a specified time. Phase differences indicate wind velocities. Velocities measured at different ranges in turn indicate eye location, since the fastest winds surround the eye.

Coherent integration would be provided by a coherent memory filter furnishing the equivalent of a filter bank at each range element (pulse width). It can analyze wind velocities at all ranges simultaneously.

The coherent memory filter recirculates successive pulse-to-pulse i-f signals N times through a unity gain delay line loop that includes a periodic phase shifter. Phase shifts are from 0 to 2π over a time equal to one pulse width. Return signals with pulse-to-pulse greatest frequency change will show on a scope the greatest energy increase from pulse to pulse at the delay-line output.

One version of the coherent memory filter, developed by General Electric, is being used by Cornell Aeronautical Labs for velocity mapping of weather echoes.

Other factors are direction and speed of winds and storm turbulence. These are measured by phase detection and filtering techniques designated as velocity-azimuth display and doppler power density spectrum display.



Coherent integration (A) to detect wind surrounding hurricane eye. Velocity-azimuth display shows wind direction and speed (B). Doppler power density spectrum display indicates severity of turbulence in thunderstorms (C)

Sales Earnings Gains Are

SALES AND EARNINGS OF 70 ELECTRONICS COMPANIES

COMPANY	1961 Sales	1960 Sales	1961 Earnings	1960 Earnings
Adler Electronics	$8,963,000	$3,613,000	$231,000	$56,000
Aerovox	22,307,735	20,521,815	−606,568	122,000
American Electronic Labs	3,371,688	2,691,119	81,207	73,127
A M P	59,250,729	53,901,779	6,311,450	5,618,346
Assembly Products	4,161,389	3,400,579	199,689	242,058
Analogue Controls	1,300,000	1,100,000	0	−430,000
Bell & Howell	113,076,000	111,116,000	3,902,000	5,105,000
Bendix	757,999,062	787,000,000	23,968,664	26,118,171
Borg-Warner	584,721,910	586,878,718	23,431,702	27,207,604
Burndy	38,751,765	36,625,528	1,383,022	1,301,091
Burroughs	401,210,737	389,210,550	10,489,369	9,235,867
California Magnetic Control	437,210	388,213	20,923	−29,160
Camloc Fastener	4,493,664	3,777,130	336,228	271,720
C-E-I-R	10,940,358	5,769,880	−927,156	−259,188
Chicago Aerial Industries	9,676,682	6,196,160	−310,697	−717,861
Clevite	91,874,110	95,525,348	5,112,689	6,825,635
Computer Instruments	3,052,212	2,136,318	325,000	205,061
Consolidated Electronics Ind	144,137,881	92,939,802	5,003,089	1,429,843
C T S	21,468,189	20,017,758	1,822,743	1,649,881
Data Control Systems	3,790,226	3,381,117	162,336	48,932
Eitel McCullough	27,000,000	28,308,038	450,000	−662,961
Electronic Associates	18,684,000	15,171,000	1,112,000	828,000
Electronic Specialty	27,754,379	11,735,516	1,482,144	37,219
Electronics Corp. of America	7,511,277	6,549,517	256,577	217,419
Emertron	14,005,269	10,366,187	333,499	−42,352
Erie Resistor	23,691,861	25,902,646	495,050	616,517
Fairchild Stratos	75,959,862	85,096,896	3,129,038	−5,994,650
General Electric	4,456,815,169	4,197,500,000	242,078,957	200,100,000
General Railway Signal	36,215,222	36,301,941	3,316,285	2,968,253
General Telephone & Electronics	1,226,584,000	1,178,175,000	73,774,000	72,430,000
Hewlett Packard	85,590,239	76,809,369	5,873,872	4,991,739
High Voltage Engineering	13,013,384	12,332,819	1,178,436	1,016,650
Hoffman Electronics	57,243,000	51,271,837	−647,000	−968,400
Indiana General	22,034,915	19,631,041	1,790,663	1,129,811
International Business Mach	1,694,295,547	1,436,053,085	207,227,597	168,180,880
International Electronic Resistance	6,289,729	5,239,834	452,571	316,507
International Resistance	23,005,301	20,821,173	2,021,432	1,943,450
International Tel. & Tel.	930,499,931	869,506,958	36,059,034	32,103,309
Itek	39,252,000	35,053,837	−1,036,000	866,337
Lear	92,116,000	90,979,000	3,257,000	2,822,000
Lockheed Aircraft	1,444,510,000	1,332,289,000	26,096,000	−41,900,000
Magnetic Controls	4,052,651	1,382,375	−205,760	29,133
P. R. Mallory	85,197,000	83,586,000	4,513,000	1,367,000
Minneapolis-Honeywell	470,205,911	426,183,310	24,959,912	26,228,148
Minnesota Mining & Mfg	608,230,326	549,675,000	71,914,576	70,692,000
Motorola	298,219,815	301,019,185	9,517,308	12,633,813
National Research	10,144,000	9,176,000	518,000	255,000
Oak Manufacturing	23,017,077	17,612,295	557,662	351,310
Pacific Automation	5,112,183	6,014,130	116,529	−860,110
Packard Bell	31,887,807	11,029,822	−9,511,162	207,704
Philips Electronic & Pharm	38,345,040	33,269,155	1,054,066	1,042,193
Premier Microwave	3,124,949	2,456,919	162,501	103,548
Radio Corp. of America	1,545,912,000	1,491,896,000	35,511,000	35,117,000
Raytheon	562,901,000	539,975,000	6,877,000	8,105,000
Republic Foil	8,750,493	4,429,137	306,793	103,254
Reeves Soundcraft	6,520,690	5,896,485	949,501	980,853
Royal Industries	14,588,000	13,390,730	400,000	467,583
Sigma Instruments	9,892,164	9,303,821	462,251	335,025
Standard Kollsman	104,289,860	95,568,805	3,183,966	3,459,992
Taffet Electronics	1,779,862	1,011,938	97,963	36,126
Technical Operations	5,095,500	4,285,000	208,100	119,200
Tensor Electronic Developments	625,000	690,968	34,000	49,424
Texas Instruments	233,223,325	232,713,153	9,446,386	15,488,209
Thermotech	1,372,554	1,342,261	62,688	71,029
Tung-Sol	65,946,154	66,171,971	1,510,577	1,476,259
United Electrodynamics	12,297,964	9,227,815	377,725	435,303
Vernitron	2,227,495	1,181,303	111,617	47,999
Victoreen Instruments	17,191,177	14,042,098	−144,777	490 496
Vitramon	3,030,788	2,681,958	165,829	151,830
Zenith	274,167,987	254,111,740	18,014,788	15,225,819

By THOMAS EMMA
Associate Editor

REVIEW OF THE ANNUAL REPORTS of 70 companies in the electronics industry reveals a generally healthy relationship between sales and earnings for 1961 as compared with the year 1960. Most of the companies show an increase in both sales and earnings (see table).

Five annual reports, those of Eitel McCullough, Fairchild Stratos, General Railway Signal, Pacific Automation and Tung-Sol, show declines in sales. Earnings for these five companies, however, were better in 1961 than 1960. Eitel McCullough, Fairchild Stratos and Pacific Automation lost money in 1960, but they showed a profit in 1961.

Seven companies showed a drop in both sales and earnings. In general, companies deriving income partially from electronics and partially from other sources reported that their electronics divisions did well, and attributed declines in sales and earnings to other operations.

Bell & Howell, for example, which derives about 42 percent of its volume from electronics said the decline of about $1 million in both sales and earnings was due to increased spending for R & D and lower performance in photographic sales. Sales and earnings in electronic instrumentation and related fields gained in 1961.

Bendix's electronics operations also did well, according to company spokesmen. Losses derived from drops in commercial aviation sales, lower profits in research and development contracts and other nonelectronic activities.

Other companies with declines in both sales and earnings blamed increased spending in capital improvement, increased overhead costs and financing of product developments.

Half of the companies reporting a drop in earnings despite increases in sales attribute the change to increased spending for R & D. Magnetic Controls, for ex-

Reported

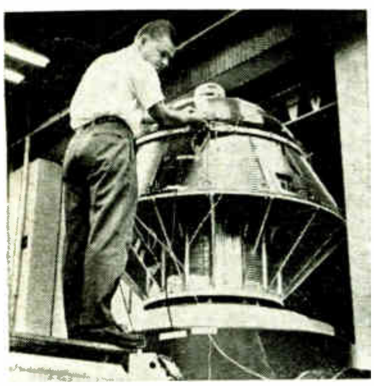
ample, spent $336,000 in 1961 on research and development as against $132,000 in 1960. Aerovox, Assembly Products, Itek, Minneapolis-Honeywell and Standard Kollsman include stepped up R&D spending in their reasons for lower earnings in 1961.

Minneapolis-Honeywell, which now does some 32 percent of its volume in space guidance systems reports that most of its electronics activities prospered during 1961. Decline in earnings of slightly more than $1 million is largely attributed to financing developments in data processing.

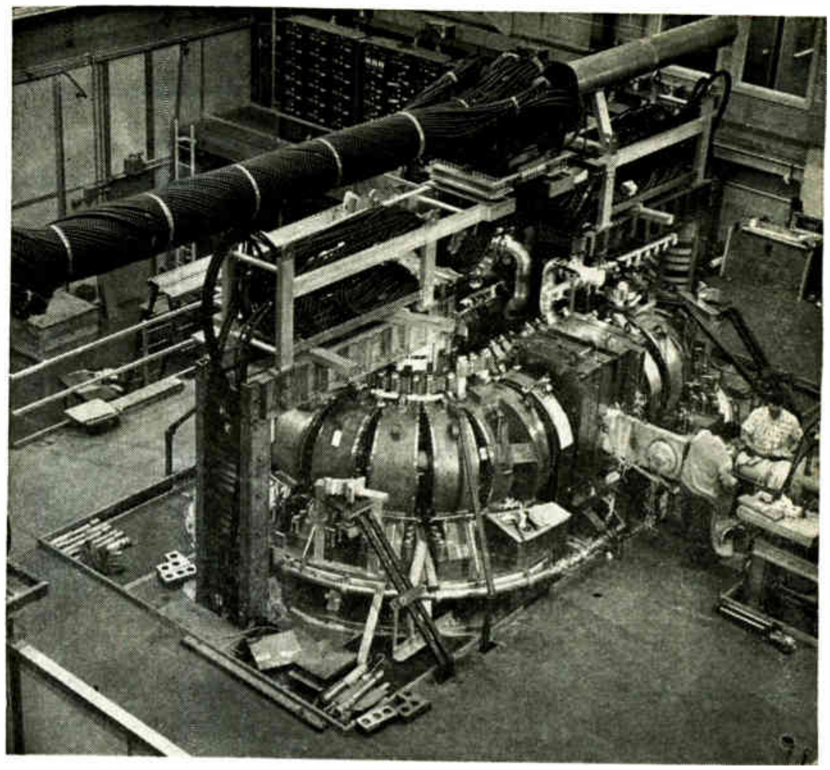
Texas Instruments, which showed a decline of $6,041,184 in earnings and an increase of $510,172 in sales for 1961 compared to 1960, attributes the change to severe pricing pressures in semiconductors and lower defense spending during parts of 1961. Added to this, according to the company, are the adverse affects of overseas austerity conditions on TI installations in Great Britain and elsewhere in Europe.

Other companies with declines in earnings despite higher sales report having used earnings to finance installations, initiate product developments and absorb costs of expansions started in 1960.

Echo II Canister



Being prepared for vibration testing on Grumman's new shaker, this canister will contain the 135-ft inflatable Echo II sphere which NASA will launch as a passive communications satellite



Model C Stellarator, now in experimental operation at Princeton University's Plasma Physics Lab, was designed and built by Allis-Chalmers and RCA according to concepts developed by Princeton scientists under AEC's Project Sherwood

REPORT PROGRESS IN

FUSION RESEARCH

PRINCETON, N. J.—Princeton University scientists recently reported results of the first few months of experimental operation for the model C Stellarator—third generation version of one of the major approaches to controlled thermonuclear fusion research.

The $35-million C Stellarator facility has been in preliminary operation since the Fall with ohmic heating, which is designed to raise the plasma temperature to approximately 1 million C (ELECTRONICS, p 50, Oct. 27, 1961 and p 29, Sept. 1, 1961).

It now seems established that, as was theorized, plasma containment time increases as the square of the discharge tube radius. Containment times of about 1 millisecond have been observed. This represents an order of magnitude increase over that for the typical B Stellarators.

Present work is concentrated on studying the energy losses that occur when the ohmic heating current is removed. Results so far indicate these losses, due largely to impurities, will have to be reduced before going to the magnetic pumping that would provide the heating from 1 million C to 100 million C.

Techniques being studied for reducing energy loss are low-level ohmic heating applied for several days, shielding the ceramic insulating sections and, most important, a divertor to magnetically separate the heavy-ion impurities. Scientists hope to install the divertor in six months; magnetic pumping may be tried next year.

Moving air is easy . . . controlling it takes an expert

This happy fella has blown smoke rings for millions of people who accept it as part of the excitement of Times Square. The imaginative engineering that went into his creation isn't given a second thought. That's the way it is with a skillful design. It is efficient, practical and taken for granted. That's the way we find it in our business of designing and building all types of air moving units. We consider it high praise when we are told we have created a simple design. Write for Brochure 102 to the Torrington Manufacturing Company, Torrington, Conn.

TORRINGTON

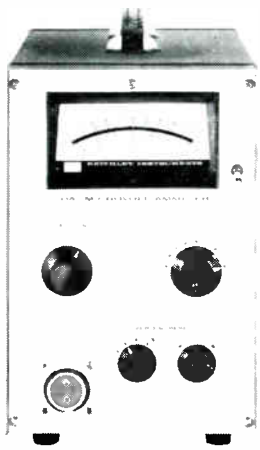
Keithley simplifies microvolt measurements!

(from .002 microvolt)

Keithley microvoltmeters make quick, direct measurements of low-level dc signals. Each instrument is direct reading, with recording capabilities, and can be used with floating or grounded input. Two units—Models 149 and 150A—feature zero suppression up to 100 times full scale, and all units are relatively insensitive to vibration, 60 cycle fields and thermal EMF's. Available in bench or rack mounting, Keithley has three basic models of microvoltmeters with range characteristics to meet your specific requirements.

MODEL 149 MILLI-MICROVOLTMETER is the most sensitive voltmeter available today. Ranges cover 0.1 μv to 100 mv full scale. Maximum gain is 100,000,000. Speed of response to 90% of full scale is less than 0.5 second on most ranges. Short term noise is within 3×10^{-9} volt peak-to-peak (6×10^{-10} volt RMS). Input resistance is 10,000 ohms on the 0.1 μv range, rising to 10 megohms on less sensitive ranges. Recommended for low source resistance applications, as with thermopiles and thermocouples, the Model 149 can also be used to measure outputs from bolometers, resistance bridges and barrier layer cells. Other uses exist in corrosion work, Hall Effect studies and differential thermal analysis. The 149 features a low-thermal copper circuit, low thermal switches and low-level magnetic shielding for the input compartment. **$895.00**

MODEL 150A MICROVOLT-AMMETER has extra versatility. As a dc voltmeter, ranges extend from 1 μv to 1 volt full scale, and noise is within 0.006 μv RMS. Input resistance is 1 megohm on the 1 μv range, rising to 90 megohms on less sensitive ranges. As an ammeter, ranges cover 10^{-10} to 10^{-3} ampere full scale. As a dc amplifier, gains are 10 to 10,000,000. The 150A can also function as a micro-microammeter to measure current from low voltage circuits, and (with external voltage supply) as a meg-megohmmeter. Applications include output measurements of thermocouples, strain gages, ion chambers, phototubes and scintillation counters. Also useful for Hall Effect studies, differential thermal analysis, cell studies, molecular weight analysis and to extend the range of Wheatstone bridges. **$750.00**



MODEL 151 MICROVOLTMETER can also function as a dc amplifier, bridge null detector and micro-microammeter. Eleven linear ranges and 5 non-linear ranges cover 0.1 mv to 10 volts, with a maximum voltage sensitivity of 100 μv full scale. Input resistance is constant at 10 megohms on all ranges. As a dc amplifier, maximum gain is 100,000; as an ammeter, currents as low as 2×10^{-13} ampere can be detected. The Model 151 has 500,000:1 in-phase rejection, with noise less than 2% of full scale on all ranges. Extremely stable and oblivious to stray fields or 60 cycle pick-up, the 151 is useful wherever a suspension galvanometer can be used, or where a galvanometer is not sufficiently sensitive, fast or rugged. **$420.00**

Brief Specifications

MODEL	RANGES	ACCURACY	STABILITY	POWER SENSITIVITY
149	13 overlapping in 1x, 3x steps, 0.1 μv to 100 mv.	2% full scale on all ranges.	After warmup, within 0.01 μv per day.	Greater than 4×10^{-18} watt.
150A/150AR* Voltmeter	13 overlapping in 1x, 3x steps, 1 μv to 1 v.	2% full scale on all ranges.	After warmup, within 0.1 μv per day.	Greater than 4×10^{-18} watt.
Ammeter	15 overlapping in 1x, 3x steps, 10^{-10} to 10^{-3} amp.	3% full scale on all ranges.	After warmup, $\pm 2 \times 10^{-11}$ ampere per day.	
151/151R* 151RC†	11 linear, 1x, 3x steps, 0.1 mv to 10 v; 5 non-linear, 0.001 to 10 v; three decades each.	Linear ±3% full scale. Non-linear ±10% of input.	After warmup, below 10 μv per day.	10^{-17} watt.

*Models for rack mounting   †Rack-Contact meter model, same as standard unit except for addition of a contact meter relay.

complete specifications in latest catalog . . .

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electrometers • milliohmmeters • ac amplifiers • power supplies • resistance bridges

MEETINGS AHEAD

COMPUTER CONFERENCE, Michigan State University; at the University, East Lansing, Michigan, May 7-8.

COMPONENTS CONFERENCE, IRE-PGCP, AIEE, EIA; Marriott Twin Bridges Hotel, Washington, D. C., May 8-10.

NORTHEASTERN DISTRICT MEETING, AIEE; Statler-Hilton Hotel, Boston, Mass., May 9-11.

BLOOD PRESSURE MEASUREMENT PROBLEMS DISCUSSION, Institution of Electrical Engineers (British); Savoy Pl., London, May 11.

NATIONAL AEROSPACE ELECTRONICS CONFERENCE, IRE-PGANE; Biltmore Hotel, Dayton, Ohio, May 14-16.

AERO-SPACE INSTRUMENTATION SYMPOSIUM, ISA; Marriott Motor Hotel, Washington, D. C., May 21-23.

ELECTRONICS PARTS DISTRIBUTORS SHOW, Electronic Industry Show Corp.; Conrad Hilton Hotel, Chicago, May 21-24.

SELF-ORGANIZING INFORMATION SYSTEMS CONFERENCE, Office of Naval Research and Armour Research Foundation; Museum of Science & Industry, Chicago, May 22-24.

MICROWAVE THEORY & TECHNIQUES NATIONAL SYMPOSIUM, IRE-PGMTT; Boulder, Colo., May 22-24.

POWER SOURCES CONFERENCE, U. S. Army Research and Development Laboratory; Shelbourne Hotel, Atlantic City, N. J., May 22-24.

TELEMETERING NATIONAL CONFERENCE, IRE-PGSET, AIEE, et al; Sheraton Park Hotel, Washington, D. C., May 23-25.

NUCLEAR CONGRESS & EXHIBIT, Engineers Joint Council; Statler Hilton Hotel, New York City, June 4-7.

RADAR ANNUAL SYMPOSIUM, University of Michigan; at the University, Ann Arbor, Mich., June 6-8.

MOLECULAR BEAMS CONFERENCE, Brookhaven National Laboratory; at the Laboratory, Upton, N. Y., June 11-13.

ARMED FORCES COMMUNICATIONS & ELECTRONICS CONVENTION & SHOW; Sheraton Park and Shoreham Hotels, Washington, D. C., June 12-14.

WESTERN ELECTRONICS SHOW AND CONFERENCE, WEMA, IRE; Los Angeles, Calif., Aug. 21-24.

ADVANCE REPORT

SPACEBORNE COMPUTER ENGINEERING CONFERENCE, IRE-PGEC; *Disneyland Hotel, Anaheim, Calif., Oct. 30-31. June 15 is the deadline for submitting 4 copies of a thousand-word summary to: Dr. R. A. Kudlich, Chairman, Program Committee, AC Spark Plug Division, General Motors Corp., 950 North Sepulveda Boulevard, El Segundo, Calif. Papers will be concerned with all engineering aspects of computers and digital information processing systems for missile and space systems. Necessary clearances should be obtained before submitting summaries.*

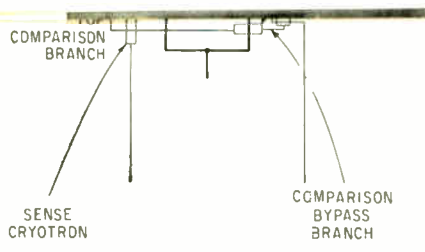

FIG. 2—Memory and comparison cell using thin-film cryotrons

I is applied to the digit line in a downward direction. Simultaneously, a write-line current is applied driving the write cryotron resistive and forcing the digit current to the right leg. The write current is then removed, followed by the digit current. Since the legs have equal inductance, this leaves a a 0 is applied to a cell in which a 0 is stored, the applied and stored currents will add in the right leg and cancel in the left leg. A 1 applied and a 0 stored or a 0 applied and a 1 stored will add in the left leg and cancel in the right leg. Thus a match between applied and stored information is indicated by a current *I* in the right leg and a mismatch by a current *I* in the left leg. Figure 2 shows how a match or mismatch is sensed by the match cryotron in the top branch of the comparison line. If a comparison is made on all bits in a word, the top comparison branch will be superconducting only for an exact match.

It is usually desirable to match with only a few of the bits in the ing only if all interrogated bits in a word match the corresponding bits of the applied word.

The comparison branches in each bit position of the selected word are also used for readout. This requires, if more than one match exists, the switching of current from the top comparison branches of all nonselected words.

To read out stored information, a 0 digit current *I* is applied upwards. This current divides, sending *I*/2 upward into each leg. These currents combine with the stored circulating current of *I*/2. If a 0 has been stored the result will be a current *I* upwards in the right leg and no current in the left leg. If a 1 has been stored the result will be a current *I* upwards in the left

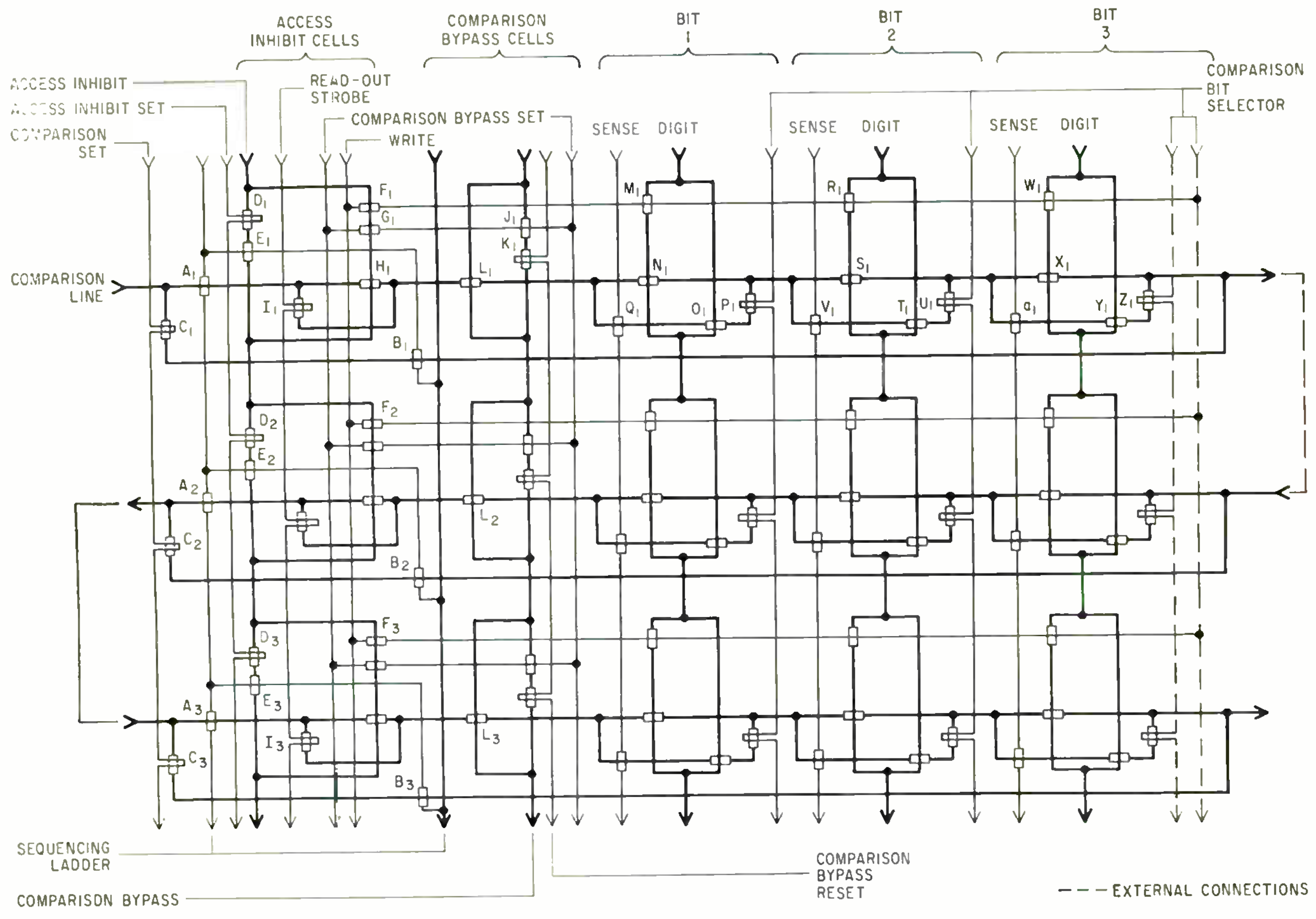

FIG. 3—Experimental data-addressed memory. Using 81 cryotrons, the memory can store 3 words of 3 bits each

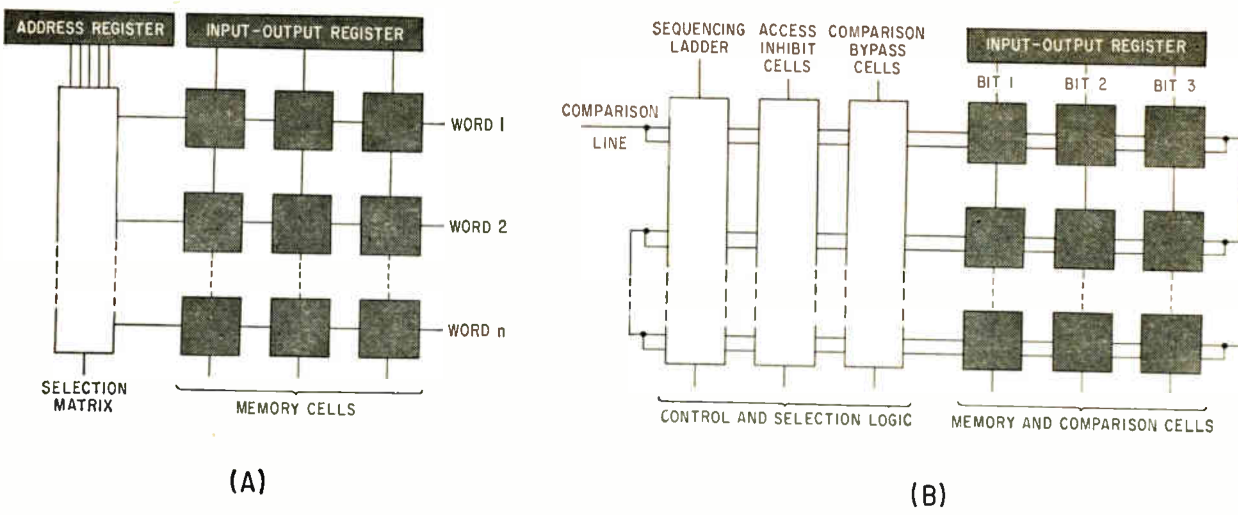

FIG. 1—Location-addressed memory system, (A); data-addressed memory system (DAM), (B)

ister nor a selection matrix is required.

Where the contents of the entire memory must be compared with a specific item, a DAM system has a considerable speed advantage over a location-addressed system, except in certain search problems where list programming can be used.[2] DAM-type applications occur in pattern recognition, inventory control and document retrieval. In all such problems the DAM can compare the contents of all its locations simultaneously with the input information, whereas the conventional memory must search through all or part of its locations in sequence.

The large number of components with nondestructive read-out facilities required for each location of a DAM suggests the use of thin-film cryotrons.[3] Similar systems have been proposed[4, 5, 6] under the name associative memory. Experimental data-addressed cryotron memories that can deal only with a single matching location for any category have also been described.[7, 8] A model of a magnetic data addressed memory using a modification of the domain wall viscosity effect for nondestructive read-out has been described.[10, 11]

The cryogenic data-addressed memory is shown in Fig. 2. It uses

work is stable, positive-feedback circuits analogous to flip-flops need not be used.

The functions of a DAM can be described in a specific problem; a good illustration is cataloging books in a library. Each memory word location might contain the title, author's name, subject and shelf location of a book. Each category of information would be restricted to a specific portion of the word. If the book is to be listed under several subjects, it would be entered in several locations.

To find information, the title is entered into the input-output register of Fig. 1B. The system is switched into its comparison mode, in which the title position of the input-output register is simultaneously compared with the corresponding position of every storage location. Wherever a matching location is found (that is, wherever the title stored in a location matches that in the input-output register), a current is switched into the upper branch of the comparison line connected with that location (See Fig. 3).

In many cases the contents of several locations will match, so that several links of the comparison line will have been set. To deal with this problem, sequencing circuits

output register. Alternatively, the system can be switched to its write mode; new information is written on top of the information in the selected location. A word is erased by rewriting it as zeros. The control logic insures that access to the selected location is not lost even if its information content is changed.

When the nearest matching location has been dealt with, and before looking for the next nearest one, persistent current is induced in the comparison bypass cell attached to the first selected location. This bypasses the location during subsequent matching cycles. Without changing the contents of the input-output register, another comparison cycle takes place, allowing access to the next nearest matching location, and the cycle is repeated. When no further matching location exists a signal is produced by the control logic. The comparison and bypass cells of all the previously selected locations can now be reset simultaneously, thus releasing the system for interrogation with a new title.

If new information is to be entered into the memory the system is first interrogated with a title consisting of zeros; this automatically provides access to the first

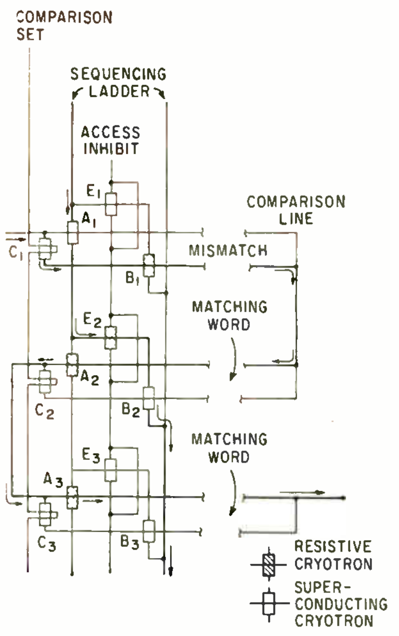

FIG. 4—Detailed schematic of the sequencing ladder, showing an example with two matches and one mismatch

leg and no current in the right leg. Thus a stored 0 will switch the "mismatch" cryotron resistive, forcing the comparison current through the comparison branch in that bit, leaving the sense cryotron superconducting. A stored 1 will switch the match cryotron resistive, forcing the comparison current through the comparison bypass branch, switching the sense cryotron resistive. Consequently, when a current is applied to the sense line a voltage will be read there for a 1 but not for a 0.

The selection and control logic finds the first matching location that falls into the category searched, so that read and write operations can be performed on that word only, and after that word has been processed, to bypass it during subsequent comparisons. These operations are performed by the sequencing ladder, the access inhibitor cells and the comparison bypass cells.

The sequencing ladder shown in Fig. 4 selects the word of the class being searched that is stored in the most accessible location. The ladder is controlled by the comparison branches from each memory location. In a matching word, current flows in the top branch; in a mismatched location it flows in the bottom branch. In all words before the first match, the control rungs will be blocked by a current in the bottom comparison branch. For instance, Fig. 4 shows croytron *B*1 driven resistive for a mismatch in word 1. Cryotron *A*1 remains superconducting, allowing current to flow from the top of the ladder down to word No. 2. Here, where the first match occurs, the rung will be superconducting (cryotron *B*2) and the left rail resistive. The current will deflect from the left rail to the right rail through the superconducting rung, identifying the first matching word. Since this current is now in the right rail, it cannot reach matching words further down the ladder.

A match is indicated externally if no voltage appears across the rails of the ladder. If no match exists, all the rungs will be resistive and a voltage will be sensed across the ladder.

The access inhibit cells, shown in Fig. 3, inhibit access to all words except the selected one, by storing a circulating current. This current is first stored in all these loops simultaneously by applying sequential and overlapping current pulses to the access inhibit set line and the access inhibit line. In the selected word, this circulating current will be quenched by current in the control rung of the ladder; this allows write and comparison bypass set currents to operate on the selected word. It also enables comparisons other than the selected one to be overridden. By applying a read-out strobe pulse, comparison currents in all unselected words will be diverted to the lower comparison branch. Only in the first selected word will the comparison current remain in the top comparison branch. This enables the comparison line to be used for read-out.

The comparison bypass cells eliminate a matching word from further consideration after operations on it have been completed. This is done by storing a current in the associated comparison bypass cell, thus making cryotron *L* in the top comparison branch resistive. A current is stored in the cell by applying overlapping and sequential pulses to the comparison bypass set lines and the comparison bypass lines. The access inhibit cells ensure that the comparison bypass set current is routed to the comparison bypass cell in the selected word only. Once a circulating current has been stored in this cell, blocking a match for the previously selected word, the system can be returned to the comparison mode to search for the next matching word. After all matching words have been processed the comparison bypass reset current is applied, quenching circulating currents in all comparison bypass cells simultaneously.

The modes of operation are discussed with reference to Fig. 3.

1. Comparison—the contents of all words in the memory can be compared simultaneously. This comparison can be made on any or all bits of the word. Any bits that are not pertinent can be masked out.

On those bits that are to be compared, a digit current corresponding to 1 or 0 and a comparison bit

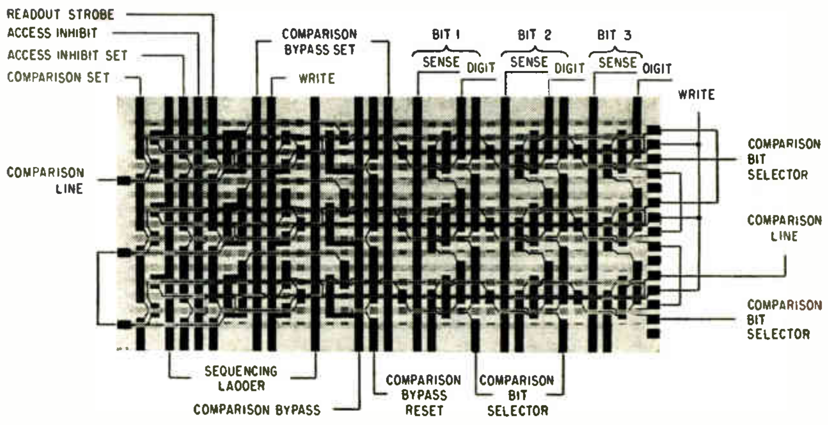

FIG. 5—Experimental memory plane. The circuit is deposited in five layers ranging from 3,000 to 10,000 angstroms in thickness. Plane measures 3 by 6 by 0.05 inch

select current are applied. On those bits that are to be masked from the comparison, only the digit current corresponding to a 0 is applied.

Next, the comparison set line is pulsed. In those words where a match exists, the comparison current (which is always kept on) is forced to the top comparison branch. This switches the sequencing ladder current (which is maintained throughout the comparison cycle) through the rung of the first matching word; it is blocked from the rungs of all nonmatching words.

Overlapping and sequential access inhibit and access inhibit set pulses are next applied, storing a current in all access inhibit cells. This current will be quenched in the first matching word by the current in the rung of the sequencing ladder.

Access to all but the first matching word is inhibited by currents now stored in the access inhibit cells. Therefore read, write and comparison bypass operations will act only on the first matching word.

Sequential access to all locations in the memory irrespective of their content can be obtained by comparing with all the input-output register bits masked. This is required when the memory is to be filled with zeros before starting operations.

2. The read operation must always be preceded by a comparison operation.

The top branch of the comparison line is used for reading. In all matching words, the comparison current has been diverted to this branch. By pulsing the read-out strobe the comparison current will be switched to the lower comparison branch in all except the first matching word, because this is the only word that does not have current stored in its access inhibit cell. Thus the comparison current can be maintained through cryotron *I*, only in the first matching word.

All masked bits have 0 digit and sense currents applied. A stored 1 in the selected location will then be indicated by a voltage on the sense line of that bit. The unmasked bits need not be read out since they are already known.

3. The write operation must also be preceded by a comparison opera-

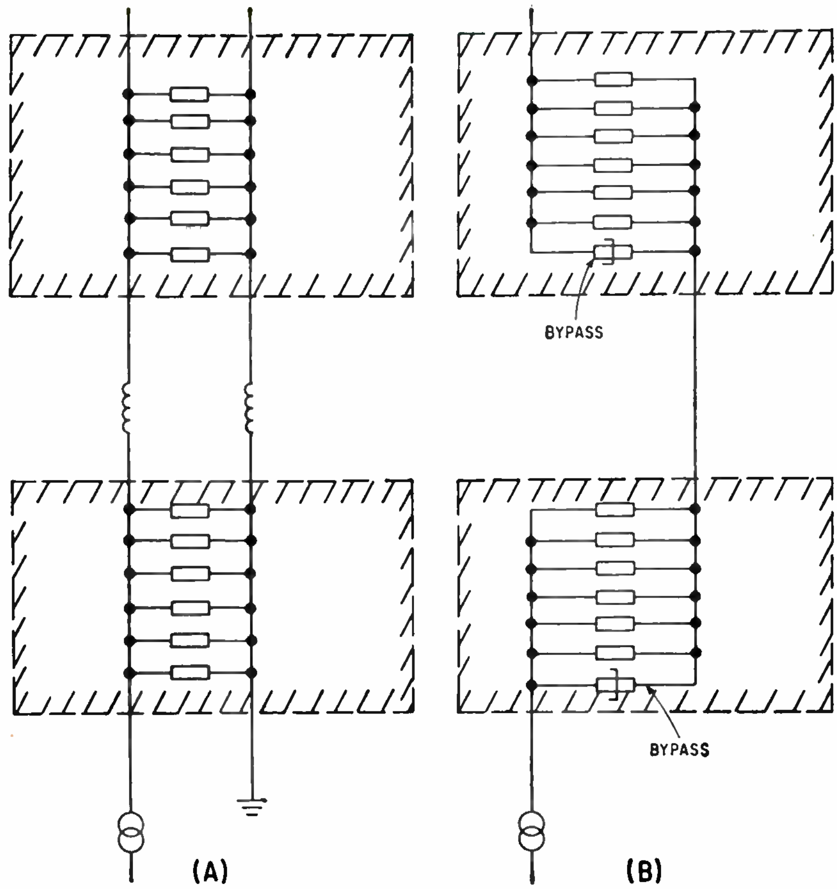

FIG. 6—Ladder circuit, (A), poses interconnection problems between substrates. This is overcome by modification (B)

TABLE I—TEST RESULTS

Substrate #	Temperature in °K: T_c	Temperature in °K: Operating T	Temperature in °K: ΔT	Nominal CFC Gate Resistance	Switch CFC	Sense CFC	Time Const. in Microsec.: Meas.	Time Const. in Microsec.: Calc.	Remarks
12/5/61	3.711	3.635	0.079	280					Manual switching of comparison function
12/6/61	3.710	3.630	0.090	300					All memory functions demonstrated
1/3/62	3.831	3.752	0.079	700	I3	A3	5.0	5.4	H_3 held resistive. Comparison loop time constants
					C3	A3	2.0	1.8	
1/12/62	3.807	3.711	0.066	700					All memory functions demonstrated
1/10/62	3.707	3.621	0.086	250	D3	F3	1.0	1.5	Access inhibit time constant
					L1, L2	F3	5.0	. . .	Reaction time of comparison loop and sequencing ladder

tion. To write in the first empty register a match is made with all 0's.

Digit currents, corresponding to the word to be written, are applied, followed by a write pulse. Digit currents are required even for masked bits. Therefore it will be necessary to read out the masked bits and rewrite them.

4. Comparison bypass—This operation is used to exclude the first matching word from further consideration. A current is stored in the comparison bypass cell of the first matching word by applying overlapping and sequential comparison bypass and comparison bypass set currents. When all matching words have been bypassed, an attempt to match will result in a voltage across the sequencing ladder. The comparison bypass currents are then erased by applying a comparison bypass reset.

Several data-addressed memory plates have been tested in all modes of operation. An arbitrary pattern was stored and various comparisons were made; read, write and comparison bypass operations were also performed by manually switching d-c currents of 200 ma.

Time-constant measurements made on several loops using single 200-ma pulses agreed with time constants calculated from the geometry. The method used[1] was to store a current in a loop. This current was quenched by switching a cryotron in the loop (the switch cryotron in Table I), resistive for an interval less than the calculated time constant. The current remaining in the loop was monitored by measuring the critical gate current of a sense cryotron controlled by this current. This method was used to measure:

(1) The time constant for transfer of a current from the lower to the upper branch of the comparison loop when pulsing the comparison set.

(2) The time constant for transfer of a current from the upper to the lower branch of the comparison loop when pulsing the read-out strobe with a persistent current in the access inhibit cell. This differs from the previous time constant because there is a low-inductance resistive path in parallel with cryotron *I*.

(3) The time constant for quenching a circulating current in the access inhibit cell.

TABLE II—CRYOTRON DIMENSIONS

Layer	Width in Microns	Thickness in Microns
Pb Shield	.....	1.0
SiO Insulation	.....	0.8
Sn Gates	1,600	0.3
SiO Insulation	.....	0.8
Pb Active controls	55	1.0
Pb Inactive controls	330	1.0

(4) The time required to invalidate a match in words 1 and 2 and to transfer the sequencing ladder current from word 1 to word 3. This was measured by observing the quenching of a circulating current in the access inhibit loop of word 3.

Typical results are shown in Table I. The switch and sense cryotron identifications refer to Fig. 3. Nominal dimensions are shown in Table II.

Since the substrate area was larger than usual, and since the logic design had never been previously tested, the crossed-film cryotrons used were made large, and a low-density layout used. By reducing cryotron dimensions (operating at lower temperature to maintain gain), and by using a denser layout, sixteen 21-bit words could be accommodated on the present substrate; 1,000 such substrates, interconnected and contained in a 1-cubic foot cryostat, would constitute a useful memory.

Since substrate-to-substrate interconnections have much higher inductance than those on the substrates, the interconnections should not be included in loops driven by cryotrons. Several ladder circuits such as the comparison bypass set circuit do not satisfy this criterion but can be modified so that they do. A ladder circuit is shown in Fig. 6A. The interconnection inductance will limit the operating speed of such a circuit; this can be overcome by the modification shown in Fig. 6B, at the cost of an extra bypass line on each plate. By using this bypass line, current can be directed through any or none of the other lines on each plate. The interconnection inductance is not included in a cryotron loop and no longer affects the circuit operating speed. This technique also minimizes the effect of sneak currents.[9] In this circuit the comparison bypass set current will initially divide equally between all lines on one substrate; thus, there must be enough lines on one plate to limit this current to a safe value or the current risetime must be limited to prevent partial switching in unselected words.

A more complex circuit, in which the top rung of the ladder on one plate controls the bottom rung of that on the next plate, is required for the sequencing ladder because this is the data transmission channel between plates. The time delay in this circuit can probably be reduced to about 50 nanoseconds by using a low-inductance interconnection between the plates together with some extra cryotron amplifiers. This time delay will probably be the factor limiting over-all system speed, since in the comparison cycle a signal may have to be propagated through every substrate.

The experiment shows that operating crossed-film cryotron circuits can be obtained on 6- by 3-inch substrates.

Estimates indicate the feasibility of a 300,000-bit memory with a 50-microsecond comparison cycle time. Such a system should be valuable since it is compatible with room-temperature data processors.

The authors thank P. H. Boucheron, J. W. Bremer, D. A. Donath and H. E. Tanis for their assistance.

REFERENCES

(1) V. L. Newhouse, J. W. Bremer, and H. H. Edwards, The Crossed Film Cryotron and Its Application to Digital Computers, Proc EJCC, p 255, Dec 1959.
(2) N. S. Prywes and H. J. Grey, Jr., "Multi-List Organized Associative Memory," Moore School of Electrical Engineering, University of Pennsylvania, Jan 1962.
(3) P. H. Boucheron, General Electric Co-HMED, Syracuse, N. Y., private communication.
(4) R. R. Seeber, Jr., Associative Self-Sorting Memory, Proc EJCC, p 179, Dec 1960.
(5) A. J. Learn, Superconducting Computers, ELECTRONICS, 34 p 50, Nov 24, 1961.
(6) P. M. Davies, A Simplified Superconductive Associative Memory, Proc SJCC; May 1962.
(7) A. E. Slade and H. O. McMahon, A Cryotron Catalog Memory System, Proc EJCC, p 115, Dec 1956.
(8) A. E. Slade and C. R. Smallman, Thin Film Cryotron Catalog Memory, Solid State Electronics, 1, p 357, Sept 1960.
(9) V. L. Newhouse, Superconducting Circuits for Computing Machines (Review), Electro-Technology, 67, p 78, April 1961.
(10) W. L. McDermid and H. E. Petersen, A Magnetic Associative Memory System, IBM J RES and Dev, 5, p 59, Jan 1961.
(11) J. R. Kiseda, H. E. Petersen, W. C. Seelbach and M. Teig, A Magnetic Associative Memory, IBM Res and Dev, 5, p 106, April 1961.

Inexpensive Multiplier for Analog Computers

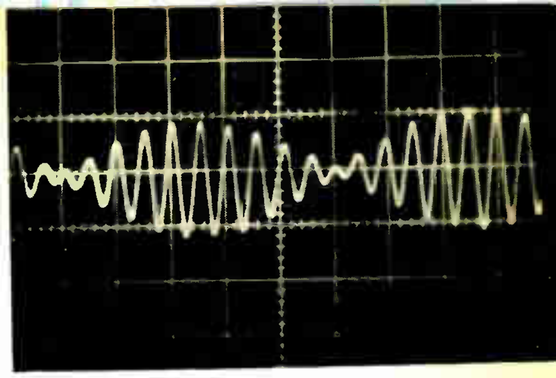

FIG. 3—Typical product obtained after filtering

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University of Alberta, Edmonton, Alberta, Canada.

THIS MULTIPLIER makes use of pulse-width pulse-amplitude modulation to form the product of two input voltages. Referring to Fig. 1A, the multiplier unit comprises a pulse-width modulator and a push-pull rectangular pulse generator driving a diode-bridge switch. Input variable Y is sampled whenever the switch is closed by the pulse generator output. Duration of the sample pulse is controlled by the amplitude of input variable X. The average voltage of the sample pulse is $V = KXY + LY$; the undesired term LY is subtracted from this signal to provide a demodulated voltage proportional to the product of the two input variables (KXY).

The input circuit of the pulse-width modulator, which comprises D_1 and V_1, is supplied by a negative-slope sawtooth and by input variable X. Tube V_1 conducts before D_1 conducts so that initially the plate voltage of V_1 is low. Diode D_1 conducts whenever the negative-going sawtooth voltage is equal to or less than input variable X; the grid of V_1 is then driven into the cut-off region causing the plate voltage to rise toward the supply voltage. When the sawtooth voltage returns to the maximum positive value V_1 again conducts and the plate returns to the low-voltage state. The result is a sequence of approximately rectangular pulses whose width depends upon the amplitude of X. The push-pull pulses required to drive the diode-bridge switch are produced by V_2 and T_1. Since the maximum amplitude of the current pulse supplied to T_1 is constant, the height of the pulse supplied by T_1 is a function of the pulse width. This limitation controls the permissable ranges of variables X and Y, which must be within the range of -10 v to $+10$ v.

The alignment procedure requires only two independent adjustments.

In Fig. 2A, which shows the subtractor unit, ground X, apply maximum Y input and adjust R_1 to obtain zero output for the KXY signal. Then apply maximum X and Y inputs and adjust R_2 to obtain the desired K.

Connecting the multiplier in the feedback path of a high-gain amplifier (Fig. 2B) permits division of one input variable by another.

Static accuracy of the unit is affected by the rise and fall times of the pulse output from the switch and the linearity of the driving sawtooth. An accuracy of about three percent of full-scale output has been obtained when using a simple Miller-integrator sawtooth generator.

Dynamic response is largely dependent upon the filter that demodulates the signal from the multiplier. Figure 3 shows the wave-form of a 100-cps carrier modulated (multiplied) by a 5-cps signal.

REFERENCES

(1) R. W. Landee, C. Davis and A. P. Albrecht, "Electronic Designers' Handbook", McGraw-Hill Book Company, New York, 1957.
(2) A. J. Ferraro, Multiplier for Analog Computers, ELECTRONICS, Nov. 4, 1960.

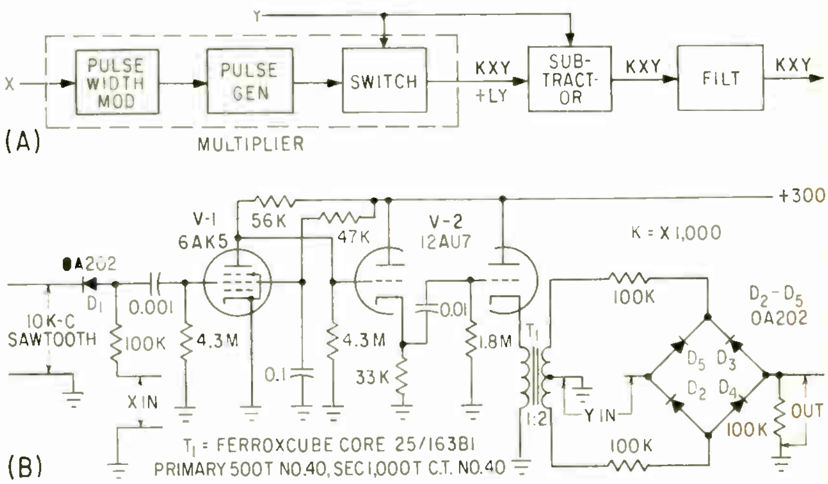


FIG. 1—Multiplier (A) forms products and subtractor removes LY terms. Multiplier schematic (B)

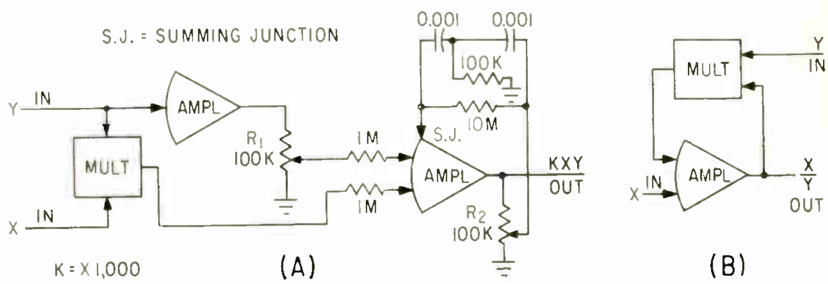
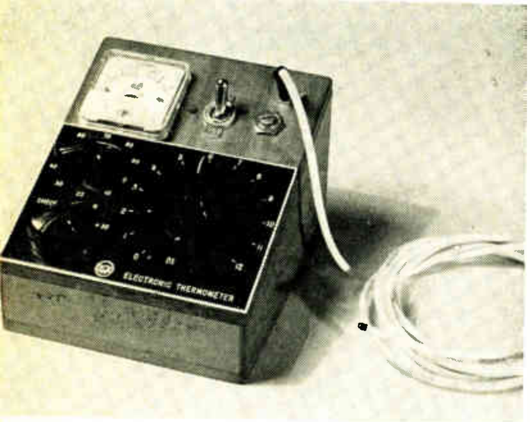
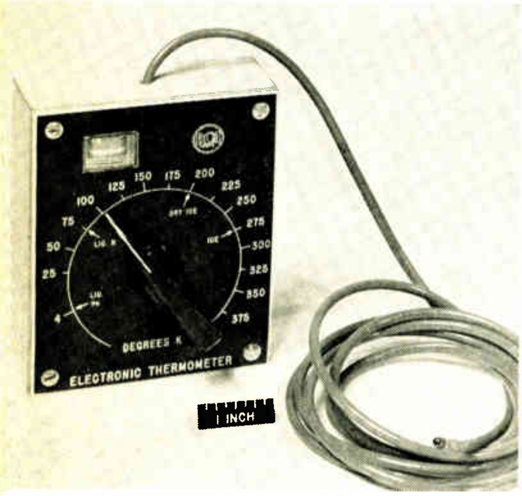


FIG. 2—Eliminating the LY term of the multiplier (A). Diagram in (B) shows how to hook up the multiplier unit in a division setup

Measuring Temperature

Variation of transistor characteristics with temperature is linear over a wide temperature range, permits a meter controlled by the transistor to be calibrated directly in degrees. The same principle is used with diodes





Thermometer with measuring transistor at end of ⅛-in. plastic tube, top photo. Diode thermometer calibrated in degrees Kelvin, lower photo, (See Fig. 4)

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IT HAS long been regarded as a drawback that transistors are temperature sensitive in their normal use; however, this adverse temperature instability can be used to advantage in the transistor electronic thermometer.

To maintain constant collector current, the base bias must be increased as the temperature decreases, and conversely. The relationship between base bias and temperature is linear over a wide range of temperatures and if the base bias for a constant collector current is calibrated in degrees, it becomes a temperature scale. For a typical germanium transistor (2N105), variation in bias is about 0.0014 volt d-c per deg F. The transistor thermometer can accurately measure the small base voltage increments corresponding to temperature changes for calibration into degrees of temperature.

A highly sensitive and accurate transistor thermometer is shown in Fig. 1A. This circuit is arranged for household and outdoor thermometer use. The temperature sensing element is a 2N105 transistor mounted in the end of a small diameter plastic tube through which the three transistor leads are connected to the control box.

Referring to Fig. 1A, switch S_3 applies power and variable resistor R_1 is adjusted for full-scale meter reading of 7 volts d-c. Circuit constants will change for other values of voltage.

A bias voltage in steps representing deg F is provided for the d-c input to the transistor; bias voltage increments to maintain a given collector voltage are about 0.0014 volt per deg F. The potential divider includes R_8 and R_2 while the other resistor elements to ground are arranged in units of 3.33 ohms for 0.0014 volt steps.

Potentiometer R_8 is calibrated for scale degree points at each 3.33

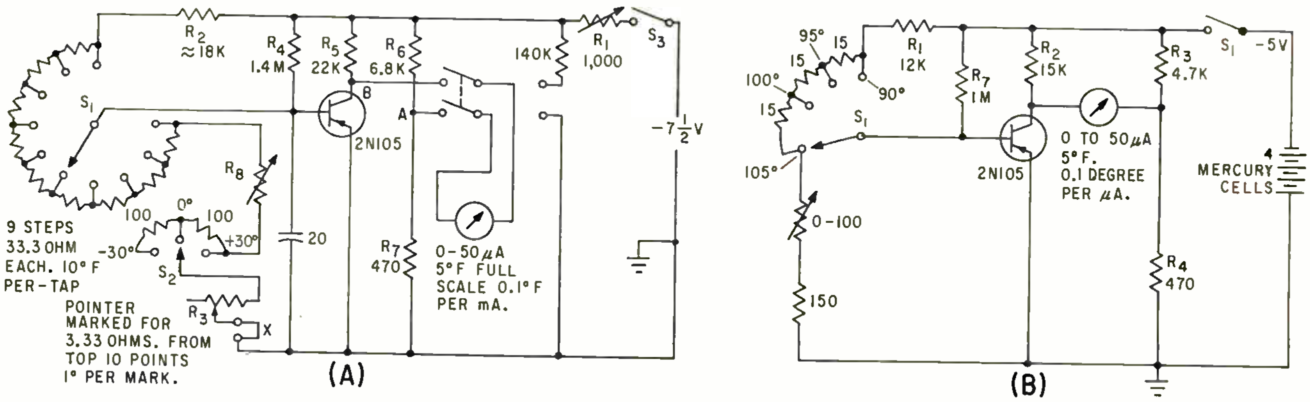


FIG. 1—Transistor probes temperatures in confined space (A); simplified circuit measures narrow range of temperatures in body-temperature region (B)

With Diodes and Transistors

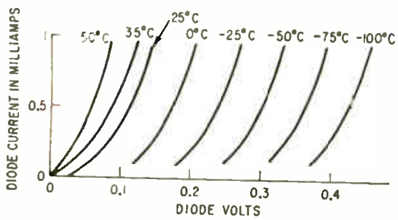


FIG. 2—Characteristic of 1N2326 diode (above) shows that voltage across the diode for a given current is proportional to temperature

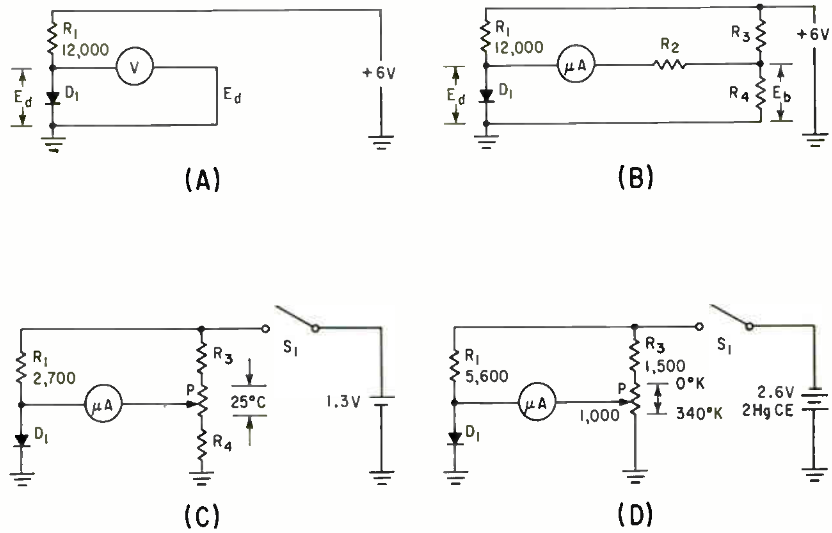


FIG. 3—Diode circuit gives direct wide range reading (A). Modified circuit (B) gives direct reading over limited range. Circuit (C) has limited range but temperature is derived from null on meter. Wide-range circuit (D) also operates through meter null

ohms, for at least 10 points. The complete range of R_3 is then 10 units of 1 degree for a total of 10 degrees. The 3.33 ohms per degree was chosen for convenience and because the input resistance to the base is low (1,000 to 2,000 ohms).

Switch S_1 provides 9 steps of 33.3 ohms for 10 degree steps and with the 10 degrees of R_3 gives a range of 100 deg F.

The range may be extended with switch S_2. Normal range is obtained with the switch at the 0-degree point. When S_2 is at +30, maximum temperature reading is 130 deg F; with S_2 at −30, minimum temperature is −30 deg F. Approximately 5 microamperes base current is supplied through R_4 permitting more accurate increments of base voltage with equal steps of resistors.

Collector resistor R_5 is selected so that a collector voltage of about 0.5 v is obtained when the transistor temperature corresponds with the temperature setting of the base input controls. A 0.5-potential at point *A* to equal the 0.5 volt collector potential is obtained with divider R_6 and R_7. The 0-50 microampere meter reads zero when points *A* and *B* are at the same voltage. If the temperature of the transistor changes, the base biasing decades and R_8 are adjusted for zero reading of the meter. The reading of base bias then gives the temperature of the transistor probe and the indication of bias is calibrated to read temperature.

Transistor temperature response can be made to fit calibration by adjusting R_8 with a possible slight change in R_2.

Tests made with dry ice and liquid nitrogen indicated linearity of base voltage versus temperature. To operate in this low temperature range, it is necessary to modify the circuit by inserting a resistance at terminals *X*. For a given R_2 the resistance necessary at *X* to produce a zero reading of the microammeter may be plotted against temperature to about 20 deg K. The voltage across *X* may not be linear because R_2 is not changed, therefore the curve of temperature versus resistance *X* may not be linear. The collector voltage should always be at least 0.5 volt higher than the base voltage.

A zero reading of the microammeter indicates no voltage differential between points *A* and *B*. However, if the meter is allowed to indicate a differential of voltage, then a meter resistance can be found to indicate full-scale deflection for 5 deg F. Each microampere would then represent 0.1 deg F. This sensitivity may be had at any selected temperature over the entire range of the thermometer which is from about 130 degree F. to near absolute zero. If silicon transistors are used, this can probably be extended to more than 300 deg F.

A high sensitivity thermometer for body-temperature ranges may be simplified as shown in Fig. 1B. The basic circuit is the same as for Fig. 1 except the temperature range is limited and no provision is made to check battery voltage.

The diode thermometer uses simpler circuits and fewer parts than the transistor thermometer, but with reduced sensitivity of about 0.5 to 1.0 deg F.

The voltage versus current characteristic curves of a representative germanium diode, 1N2326, are shown in Fig. 2.

This set of characteristic curves indicates that the voltage across the diode for a given current is proportional to temperature. The curves also indicate the upper temperature limit for linearity. In Fig. 2 at about 35 deg C, a curve of the same shape as for lower temperatures passes through zero current at zero volts. Therefore, at higher temperatures the diode current curve becomes steeper and a deviation from diode volts versus temperature linearity begins. The linear range of temperature indication for a germanium diode with a forward current of about 0.5 ma, was found to be about 45 deg C to about −250 deg C. At low diode currents, linearity extended to about 35 deg C.

For a given current, voltage across the diode is a linear function of temperature from near absolute zero to some higher temperature value. The limit of high temperature is a function of the bandgap voltage of the semiconductor material.

Many circuits may be used to measure the voltage across the diode. The voltage per degree C is about 0.002 volt for germanium, varying with circuit constants, diode current and base material.

Because of the low source impedance of the diode-derived voltage at about 0.5 ma (approximately 90 ohms), a 50-microampere meter may be used to measure voltage. Such meters have resistances of about 800 to 2,000 ohms, and may be used to measure voltage directly.

Figure 3 shows different arrangements for specific diode thermometer applications.

The simplest circuit is Fig. 3A in which R_1 limits the diode current to about 0.5 ma. As the temperature decreases the voltage across the diode increases. The temperature of the diode then may be calibrated in voltmeter reading of E_d. Temperatures of any range may be measured with this circuit from near absolute zero to the upper limit of the diode base material.

Figure 3B operates over limited ranges of temperature that may be selected between any two values. Full range of a 50-microampere meter may be as low as 25 deg C. The function of R_1 is the same as in Fig. 3A except the indicating means is built into the thermometer. Resistance R_2 in series with the meter determines the range of temperature for full scale. Potential dividers R_3 and R_4 select the part of the temperature spectrum to be measured.

The values of R_4 and R_3 can be switched to make the meter a decade device reading temperature in steps of 25 deg C plus the meter reading. This decade arrangement may extend from about 20 deg K to 40 deg C with no correction for deviation from a straight line, or operate down to about 2.5 deg K with calibration.

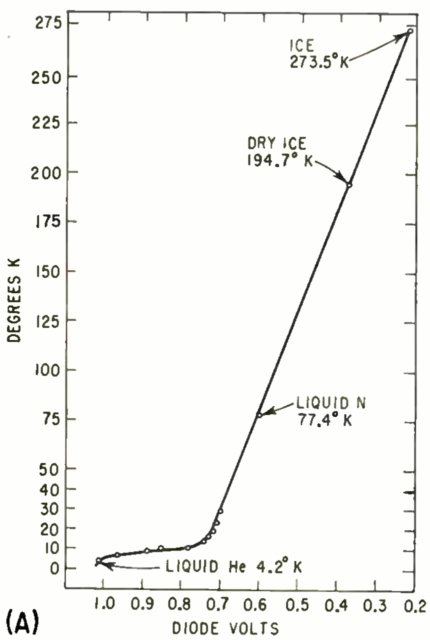
The circuit of Fig. 3C is a modification of Fig. 3B. This circuit derives a limited range bucking voltage across the potentiometer while the microampere device is used as a null indicator. When the potentiometer is adjusted so that the voltage at the arm is the same as the diode voltage, the position of the potentiometer arm indicates volts and may be calibrated in temperature. The temperature range of this circuit is limited by the resistance of the potentiometer, R_3 and R_4. Again, a range of about 25 deg C. may be selected at any temperature from near absolute to about 40 deg C.

The range of the potentiometer may also be increased as shown in Fig. 3D to the full range of near absolute zero to about 45 deg C.

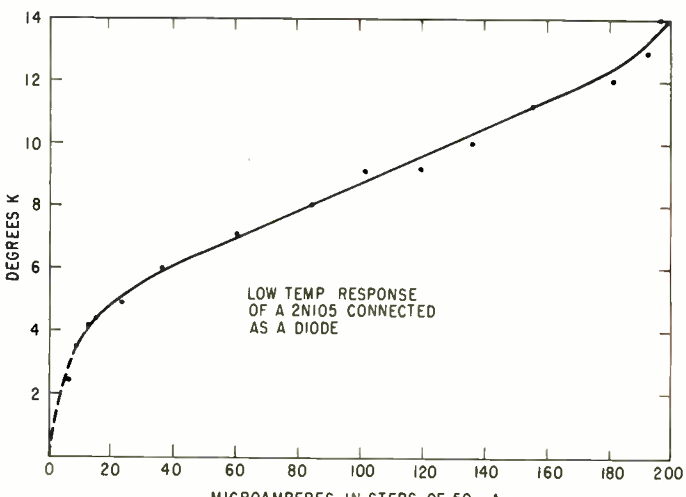
The curve in Fig. 4A is the complete curve from liquid helium, 4.2 deg K., to ice at 273.5 deg K. The linearity is nearly perfect from about 20 deg K.

The lower end of Fig. 4A curve is expanded in Fig. 4B. This curve indicates the unexpected temperature response of the 2N105 connected as a diode over the region of about 13 deg K to about 5 deg K. The curve in this region is linear with a sensitivity much greater than expected, (about 0.02 deg C reading accuracy).

Below 5 deg K, the curve turns down through three points of calibration at liquid helium at atmospheric pressure (4.2 deg K) and 3.2 deg K and 2.5 deg K at reduced liquid helium pressure. It is expected that if other temperatures below 2.5 deg K were available the temperature indication would fall on the dotted line to absolute zero. If this assumption is true, a thermometer is on hand to measure temperature to absolute zero.



(A)

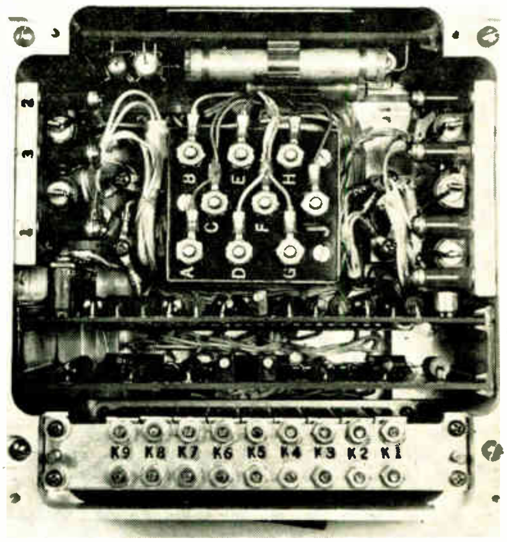


(B)

FIG. 4—Response of 2N105 transistor connected as a diode is linear down to 20 deg K (A). Expanded portion of characteristics shows increased sensitivity below 20 K (B)

Author Beebe demonstrates the reference supply. Unit is in an aluminum case

Reference Supply Delivers Half-Volt Increments



Careful packaging avoids mutual interference between components, permits small unit size

Supply is switched by internal relays to deliver voltages between minus 63.5 and plus 63.5 volts. Binary arrangement of relays switch in half-volt steps. Output is stable for 1,000 hours without readjustment

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THIS POWER SUPPLY was developed to meet military specifications and is used in automatic test equipment as a stable source of reference voltage. Regulation is 0.05 percent for a 5-percent change in input voltage, while ripple and noise are less than 40 millivolts peak-to-peak. The unit will sustain 50 g shock during a 7-millisecond rise time, while the whole package is about the size of a cookie jar. The power supply is of modular construction, using separate assemblies for power transformer, relays, diodes, voltage divider and control board. Additionally, there are two assemblies for shunt regulating transistors and two for shunt resistors.

The supply is in an aluminum enclosure consisting of a chassis and a cover plate, with a single connector on the rear of the chassis. The three required adjustments are accessible by removing the front cover plate.

The unit contains two independent solid-state d-c power supplies: a fixed-voltage channel delivering 20 volts, and a stepped-voltage channel delivering from 20 volts to 83.5 volts in 0.5-volt increments. See Fig. 1. The voltages from these two channels are subtracted to provide a variable 0 to 63.5-volt final output, which is switched by the relays to deliver negative voltages.

Eight 12-volt command signals can be combined in a binary manner to provide any output desired. As an example, simultaneous application of commands 3, 5, 7 and 8 will provide an output of −10.5 volts.

The 115-volt three-phase 400-

cycle input power is applied to a three-phase transformer, whose six secondary windings supply a-c to two sets of bridge rectifiers. The d-c output from the rectifiers is filtered and applied across a shunt regulator to the output. Line and load fluctuations are sensed by a temperature stabilized, differential amplifier having a zener reference. The output of the differential amplifier is fed through two stages of amplification to control the shunt regulator.

Each channel is regulated by an individual shunt transistor, while high-gain differential amplifiers provide sensing and control for each of the two channels. The two differential amplifiers, however, use the same zener diode for a reference. Because the final output of the unit is the difference between the two channels, compensations are automatic for input voltage variations, temperature changes and zener reference drift. Subtractive outputs eliminate the problem of low-voltage sensing and regulation (0.5 volt, 1.0 volt, 1.5 volts). Sensing and regulation below the 20 volt level is not required.

In the differential amplifier that controls the 20-volt channel, a fixed resistor bridge is used opposite the zener reference for sensing. The differential amplifier that controls the variable channel also uses a resistor bridge for sensing. However, this bridge, is made up of seven precision (0.01 percent) resistors with a small trimpot and a 1-percent resistor at each end.

The seven precision resistors are bridged by the normally closed contacts of the command relays, and are removed from the sensing circuit. As a command is applied, the relay contacts are opened, throwing an additional precision resistor into the sensing bridge, and changing the output of the variable channel. A combination of commands will throw a combination of precision resistors into the sensing bridge, raising the output of the variable supply to 20 volts above the desired output. The output of the 20-volt channel is then subtracted from the output of the variable channel to provide the output of the unit.

The a-c input to power diodes D_7 through D_{12} is 13 volts rms per phase (Fig. 2). The filter components are C_2, C_4 and R_{48}. Zener diode D_{16} provides a reference to the high gain differential amplifier (Q_7 and Q_8), maintaining a precise 6.2 volts at the base of Q_8. The base circuit of Q_7 contains the fixed resistor bridge, R_{15} and R_{12}, as well as the trimmer potentiometer R_{25}. Regulation of the voltage level of the 20-volt power supply is controlled by the differential amplifier. Potentiometer R_{25} is provided for minor adjustment of this power supply. The output of the differential amplifier is amplified by high-gain stages Q_5 and Q_4, and is applied to the base of shunt regulator transistor Q_2. Emitters of amplifiers Q_5 and Q_4 are clamped by zener diodes D_{15} and D_{14} at 9 volts and 15 volts respectively. Transistor Q_2 then regulates the channel output voltage by varying the current through shunt resistor, R_{48}. Short-circuit or overload protection is inherent in the system.

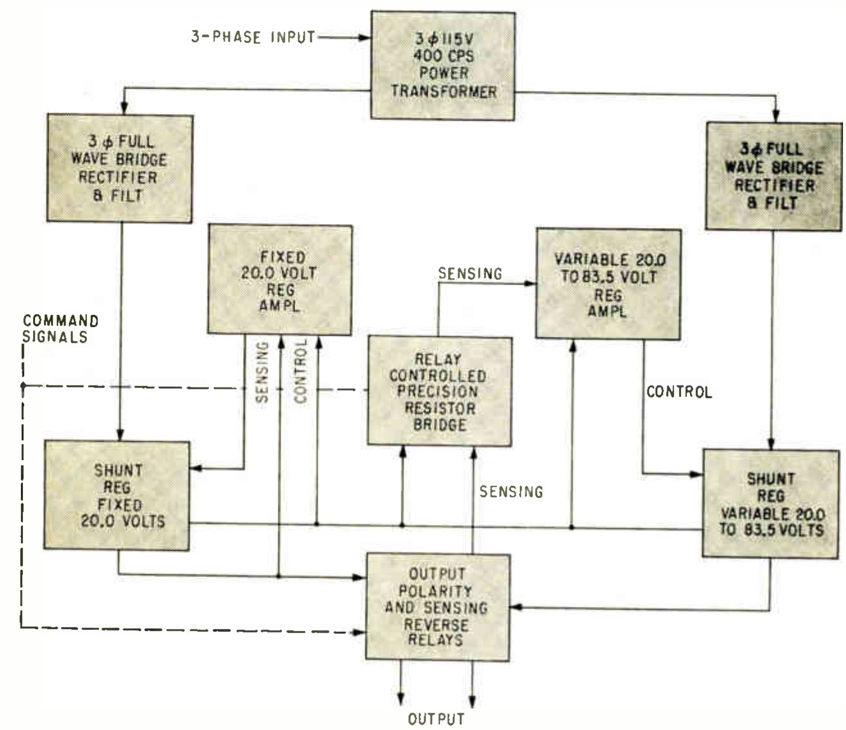

FIG. 1—Three-phase input at 400 cycles minimizes filtering requirements

The a-c input to rectifiers D_1 through D_6, is 46 volts rms per phase. Capacitors C_1, C_3 and resistor R_{35} are the filter elements. Resistors R_{32}, R_{33} and R_{35} may be filter elements depending on the position of the command relays. Zener diode D_{16} also provides the reference to the second high-gain differential amplifier (Q_{12} and Q_{13}). The zener maintains a precise 6.2 volts at the base of Q_{13}. The base circuit of Q_{12} contains the relay-controlled precision resistor bridge. This bridge uses precision resistors R_1 through R_9. Resistors R_2 through R_8 are the seven 0.01-percent wire-wound resistors that are switched in or out of the circuit by relays K_1 through K_7.

Output of the differential amplifier is amplified by high gain stages Q_{10} and Q_9, and is then applied to the base of shunt regulator transistor Q_1. As in the low-voltage channel, the emitters of amplifiers Q_9 and Q_{10} are clamped by a zener diode. Transistor Q_1 then regulates the channel output voltage by varying the current drawn through shunt resistor R_{35}.

Because it is impossible for Q_1 to operate throughout the range of current levels that would be required to vary the output voltage a full 63.5 volts, shunt resistor R_{35} must be varied to keep Q_1 within its operating range. Resistors R_{32}, R_{33} and R_{34} are switched into the circuit, in parallel with shunt resistor R_{35}, by commands to relays K_1, K_2, and K_3 respectively.

Relay K_8 reverses the polarity of the output, and operates on a polar-

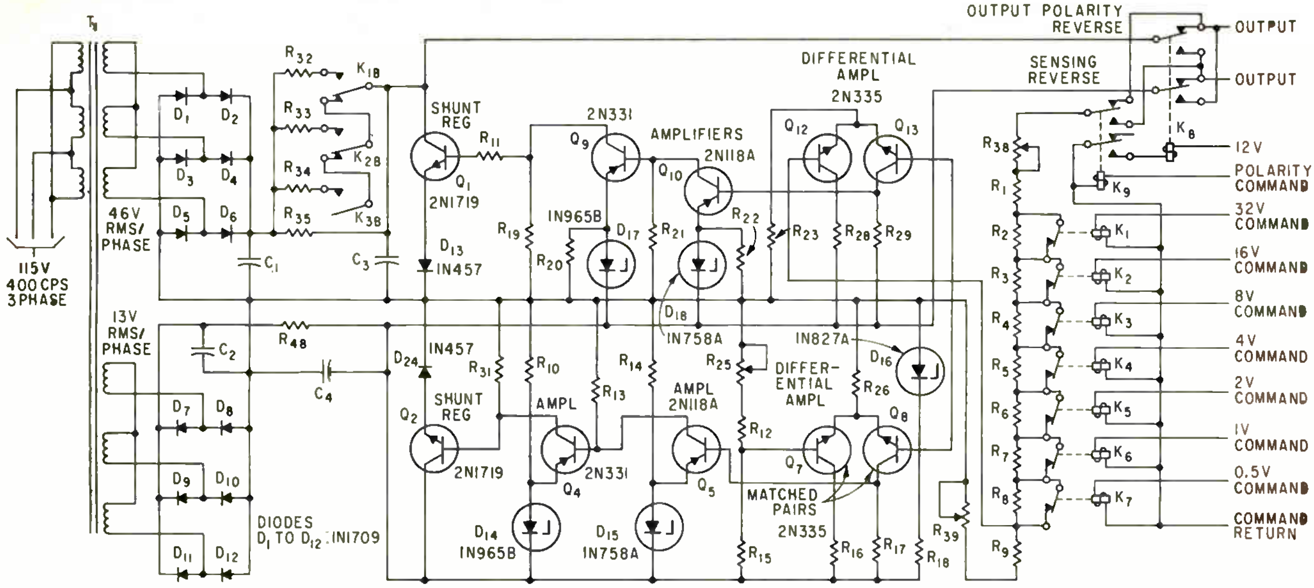

FIG. 2—Separate d-c sources are subtracted to give reference outputs. One source has fixed voltage, the other variable

ity-reverse command signal. To maintain optimum regulation in the unit, it is important that the output sensing leads be taken at the output connector, so that all of the internal connector and line resistances in the power supply could be compensated. It would be even more desirable to sense the output at the actual load. Relay K_9 reverses the sensing leads at the output connector as the polarity of the output is reversed. Relays K_8 and K_9 are not connected in parallel because the unit was designed for command operation directly from digital logic of an automatic test set, and it was desirable that no command input requirements exceed 100 ma.

The ability of this power supply to maintain long-term stability and drift-free operation over a temperature excursion is based on a stable reference voltage and stable drift-free amplifiers.

Manufacturing techniques have provided stable silicon zener reference diodes having a standard deviation neighboring 4 ppm[1] measured over a 16-week period. These silicon reference diodes also exhibit a minimal temperature coefficient if the zener bias current is adjusted and maintained. The current level of D_{16}, which is the basic reference for this supply, was adjusted to operate at this point.

One way of minimizing d-c amplifier drift is by using a chopper-stabilized amplifier; however, size, weight, noise and reliability (if mechanical choppers are used) are serious considerations in the use of this method. This method of drift regulation was discarded.

Use of two separate power supplies, one output being subtracted from the other, minimizes amplifier drift due to ambient temperature changes. Advances in transistor technology have provided transistors with stable characteristics that do not exhibit appreciable change over long periods. The design of a low-drift nonchopper stabilized amplifier is largely based upon stable zener reference diodes and transistors, however, to maintain low drift, several other requirements must be met.

The drift due to ambient temperature changes must, in addition to being small, be in the same direction for both amplifiers. Both amplifiers must be referenced against the same silicon reference diode. High-quality low-temperature-coefficient resistors must be used throughout, and especially in all the high-gain amplifier stages. The effect of I_{co} changes must be minimized by the use of silicon transistors in the first amplifier stages.

Drift direction can be determined by allowing the major drift to be contributed by the second stage amplifier.

Higher gain could have been realized from the first and second amplifier stages by use of an emitter follower between the differential amplifier and the first voltage amplifier, or by using a double differential amplifier system, but then only at the cost of an added transistor. In addition, use of an emitter follower doubles the influence of dV_{be}/dT upon amplifier drift, while the use of a double differential amplifier complicates the ability to predict the direction of drift due to ambient temperature changes. No temperature compensating devices are used within the power supply.

Because the power supply must provide both positive and negative outputs, a polarity reversing relay (K_8) is used. The relatively high relay contact resistance requires special relays to maintain an adequately low power supply output impedance. Selection of low contact resistance relays is not sufficient to maintain proper regulation and another relay K_9 is used for reversing the sensing leads, enabling tight coupling of the sensing system to the output terminals of the power supply. Contact resistance problems in the precision bridge network are also avoided by use of high-quality relays.

REFERENCES

(1) Baker & Nagy, Stability Of Zener Voltage Reference, I R E Transactions On Instrumentation, Sept., 1960.

SIMPLE LOW-VOLTAGE

Alarm with 0.2-volt threshold consists of three parallel branches: zener diode reference circuit; resistor voltage divider; and transistor differential amplifier with a relay

AMONG the various alarm devices required for telephone and power utility installations is a low-voltage alarm. This device must provide normally open or normally closed contacts for actuating local and remote signaling apparatus, when the system battery voltage drops below normal.

A low-voltage condition could be caused by loss of power to the battery charger, internal failure of the battery charger, overload of the battery charger or cell failure in the battery bank. The alarm device must be reliable and rugged, easy to install and adjust, relatively insensitive to ambient temperature changes and able to withstand reasonable mechanical shock without giving false alarm signals.

Figure 1 is the circuit of the transistor low-voltage alarm. The values shown are for a telephone system battery bank having 23 to 26 lead-acid battery cells in series. Potentiometer R_6 adjusts for the number of cells used.

The circuit consists of three branches. Branch *ABC* is a reference circuit consisting of zener diode D_1 in series with ballast resistor R_1. Resistor R_1 is chosen so that the current through D_1 is about 10 ma.

$$R_1 = \frac{E_{max} - E_{zener}}{I_{zener}}$$

$$= \frac{56 - 10}{0.010} = 4{,}600 \text{ ohms.}$$

Branch *HJK* is a resistor voltage divider. The current through the divider is chosen to be about 20 ma. Values of R_5, R_6 and R_7 are chosen so that the voltage drop across R_7 can be adjusted to be equal to the zener voltage of D_1 over the specific range of E_{in}. The voltage tolerance of D_1 must also be considered.

$$R_5 + R_6 + R_7 = \frac{E_{in(max)}}{0.02}$$

$$= \frac{56}{0.02} = 2{,}800 \text{ ohms}$$

$$R_7 = \frac{E_{zener}}{0.02} = \frac{10}{0.02} = 500 \text{ ohms}$$

$$R_5 = \frac{E_{in(min)}}{0.02} - R_7 = \frac{44}{0.02} - 500$$

$$= 1{,}700 \text{ ohms}$$

$$R_6 = 2{,}800 - 500 - 1{,}700 = 600 \text{ ohms}$$

Branch *DEFG* is a transistor differential amplifier. Transistors Q_1 and Q_2 are mounted on a common heat sink to equalize the case temperatures, thereby reducing the temperature drift of the transistors.

To provide equal load impedance to each transistor, R_3 is made equal to the relay coil resistance. The relay coil is rated for 8 volts d-c and has 250 ohms resistance; therefore R_3 is 250 ohms.

In a differential amplifier, the sum of the currents through the differential arms is constant, and thus the current through R_2 and R_4 is constant. For the proper mode of operation, the transistors must have the common emitter (point *F*) at or slightly above the base voltage of Q_1 and Q_2. If sufficient current is provided to insure reliable operation of the relay under minimum voltage 40 ma must be made available under maximum voltage. Resistor R_4 would therefore be 250 ohms, and the voltage from point *G* to point *E* would be −20 volts.

$$R_2 = \frac{E_{in(max)} - E_{cg}}{0.04}$$

$$= \frac{56 - 20}{0.04} = 900 \text{ ohms}$$

The base of Q_1 is held at a fixed level by zener diode D_1, while the base of Q_2 may be set at a desired level by potentiometer R_6, and will vary with respect to the base of Q_1 as the input voltage E_{in} varies.

Assuming the characteristics of Q_1 and Q_2 to be identical, when the base voltages of both transistors are equal, the currents through the transistors are equal. When the base voltage of Q_2 is more negative than that of Q_1, Q_2 will conduct while Q_1 will not. When the base of Q_2 is less negative than Q_1, Q_1 will conduct and Q_2 will not.

The differential amplifier is inherently high-gain, and therefore a small change in input voltage (E_{in}) produces changes in current through Q_1 and Q_2. The unit of Fig. 1 requires only 0.2 volt change in E_{in} to switch the relay from pull-in to drop-out, and conversely.

Figure 2A is a block diagram of a typical application of the low-voltage alarm in a telephone power installation.

The battery charger is the full-float type that normally furnishes the current to the load, and at the

ALARM

By C. J. KIEFFER
Raytheon Co., South Norwalk, Conn.

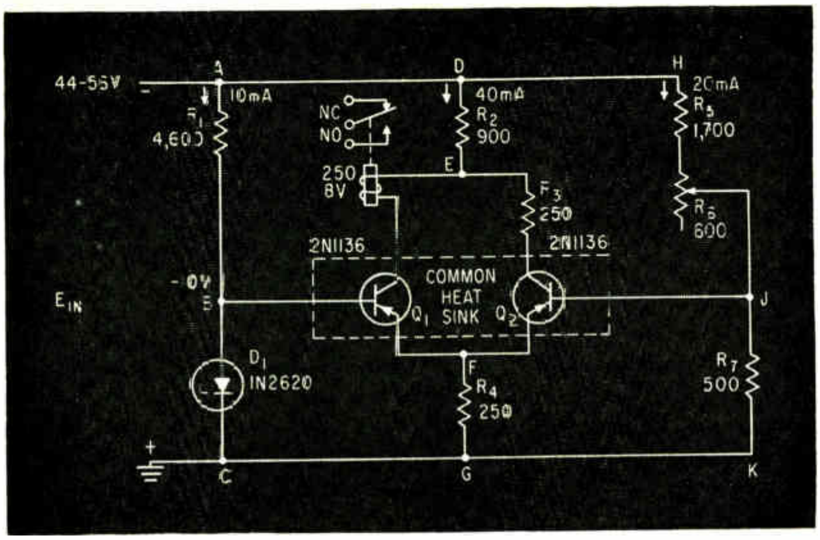

FIG. 1—Low-voltage alarm

same time maintains the batteries at a fully-charged state. In a 24-cell lead-acid system, the normal float voltage range is 51.6±1 percent, or 52.12 to 51.08, volts. If power to the charger fails, or if the charger fails, the no-load terminal voltage of the battery is 48 volts. The low-voltage alarm must provide an alarm signal when the battery voltage is less than 51.08 volts. This low-voltage alarm meets the requirement.

Since the device described in Fig. 1 is an on-off device, it can also provide an alarm to signal high-voltage. If the relay must operate when high voltage exists, R_5 and the relay should be interchanged in the circuit.

With the addition of other components, the basic unit has other applications. If it is desired to detect overload in a-c devices, the addition of a current transformer, rectifier and filters, as shown in Fig. 2B, will adapt the high-voltage version. The alarm contacts can interrupt the a-c power if desired.

The voltage alarm can also detect low or high a-c voltage when used with a rectifier and filter as shown in Fig 2C. If a motor-driven variable autotransformer is placed at the input of the Fig. 2C circuit, the contacts of the low-voltage alarm connected to the increase winding of the motor and the contacts of the high-voltage alarm connected to the decrease winding of the motor, the result is a line-voltage regulator.

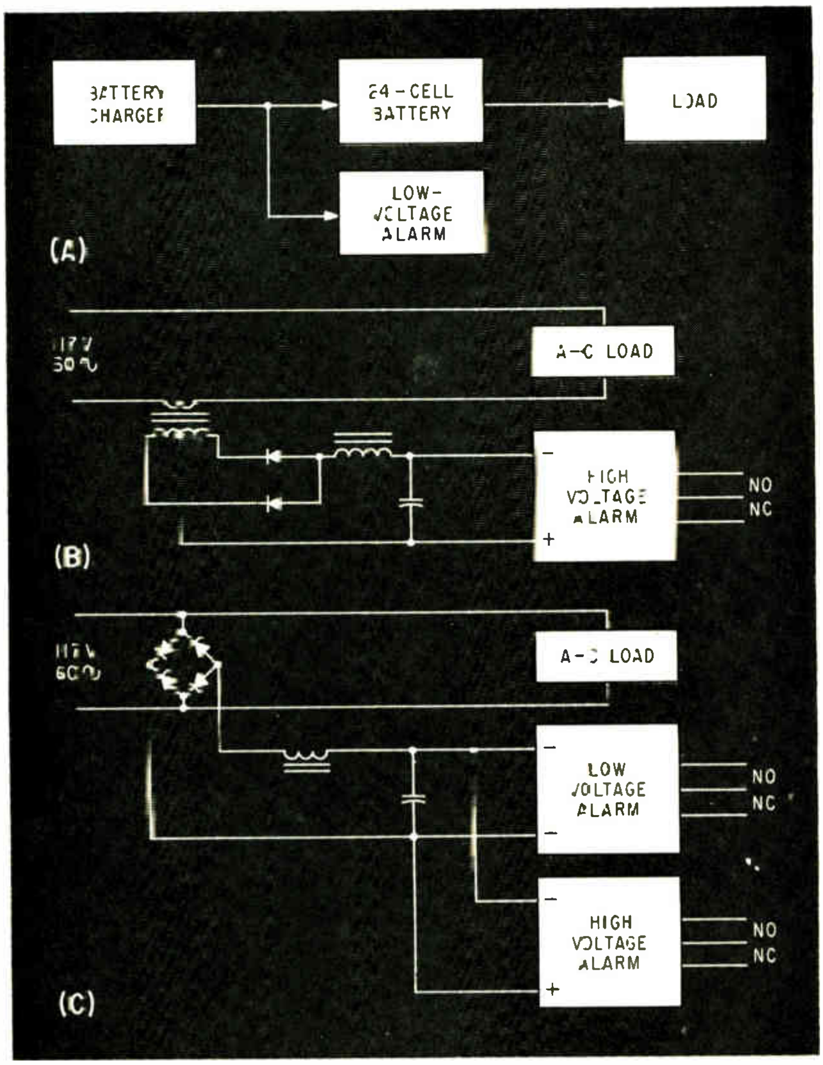

FIG. 2—Typical low-voltage alarm installation (A); adaptation of a high-voltage alarm for a-c (B); and voltage alarm for detecting both high and low a-c (C)

DESIGN CHARTS

For Microwave Antennas

Nomographs for determining gain, beamwidth and estimated space for installation of rectangular horn and parabolic antennas

By GEORGE J. MONSER
Antenna Section,
American Electronics Laboratories
Colmar, Penna.

DESIGN AND SELECTION of a microwave antenna for a system frequently is predicated upon fitting an antenna of specified gain into a space or volume. With these charts it is possible to determine the type of antenna with the highest gain that can be installed in a given space.

These charts provide information to permit rapid estimate of volume required to satisfy a given gain requirement. Charts are given for two commonly used microwave antennas—parabolic reflector (dish) antennas and rectangular aperture (horn) antennas.

Dimensions and gain of a rectangular horn[1,2] can be related by

$$\text{Gain} = \frac{41253}{\theta\,\phi} \times \eta \qquad (1)$$

where $\theta = 88\lambda/b$ = E-plane 10-db beamwidth, $\phi = 31 + 79\lambda/a$ = H-plane 10-db beamwidth, η = horn efficiency factor, b = E-plane horn aperture dimen-

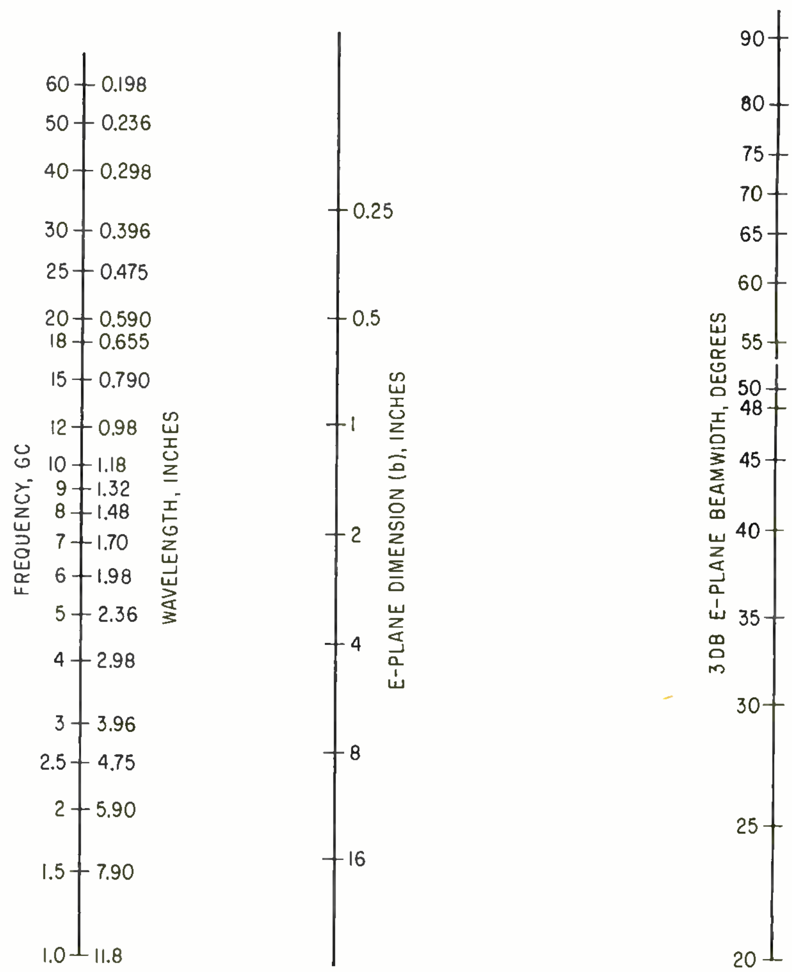

FIG. 1—Chart for finding E-Plane beamwidth

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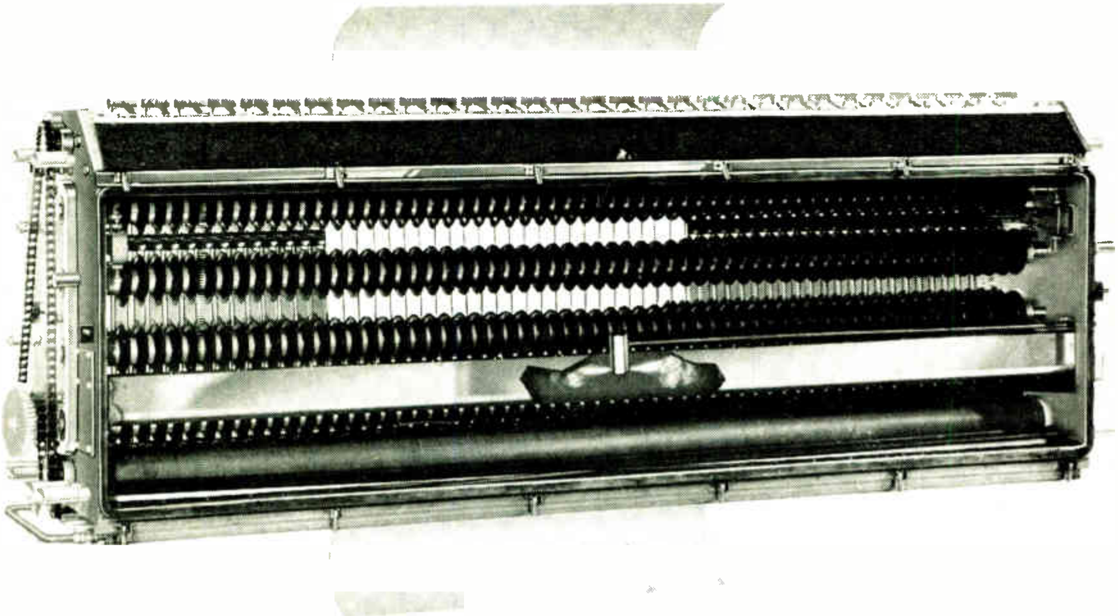

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sion, a = H-plane horn aperture dimension and λ = wavelength. Parameters a, b and λ are in similar units. The dimensions are shown in Fig. 1 and 2.

To use Eq. 1, the 3-db beamwidths are found by multiplying the 10-db beamwidths by $(3/10)^{1/2}$

$$\theta_H = 48\ \lambda/b \qquad (2)$$

$$\phi_H = 17 + 43\ \lambda/a \cong 57(\lambda/a)^{1/2} \qquad (3)$$

and replacing wavelength with frequency since $f_{Gc} = 11.8/\lambda$, where f_{Gc} = frequency in Gc and λ = wavelength in inches.

For an assumed efficiency η = 0.65, the gain equation becomes

$$\text{Gain} = \frac{27{,}000}{\theta_H\ \phi_H} \qquad (4)$$

Equations 2, 3, and 4 are plotted in Fig. 1 through 3.

Assuming that phase deviation across the horn aperture remains less than 1/8 wavelength,

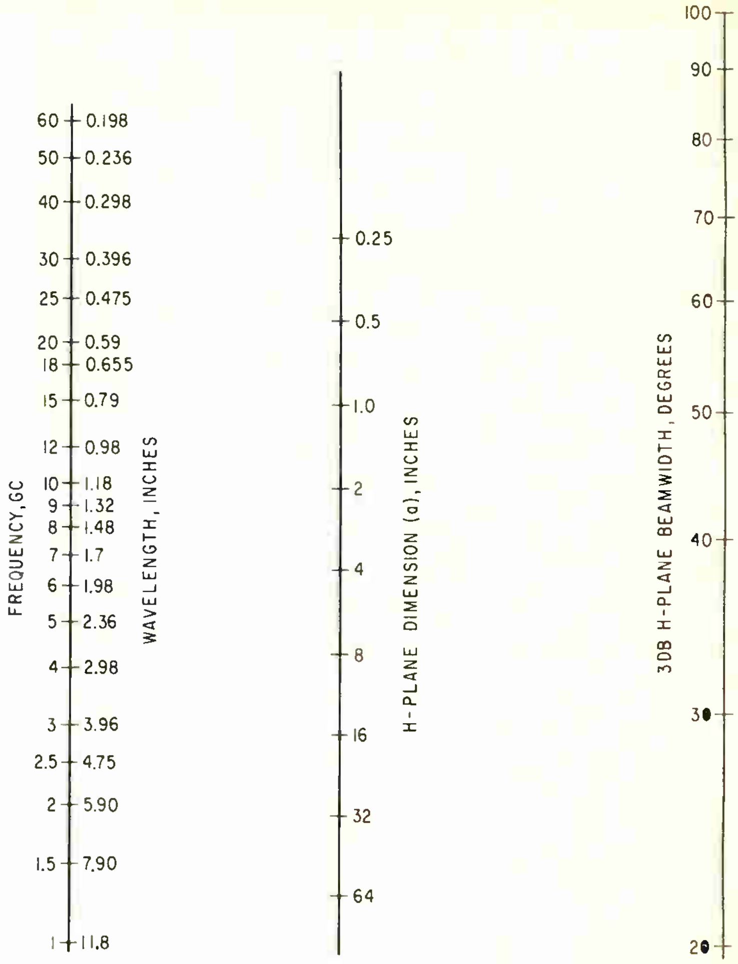

FIG. 2—Chart for finding H-plane beamwidth

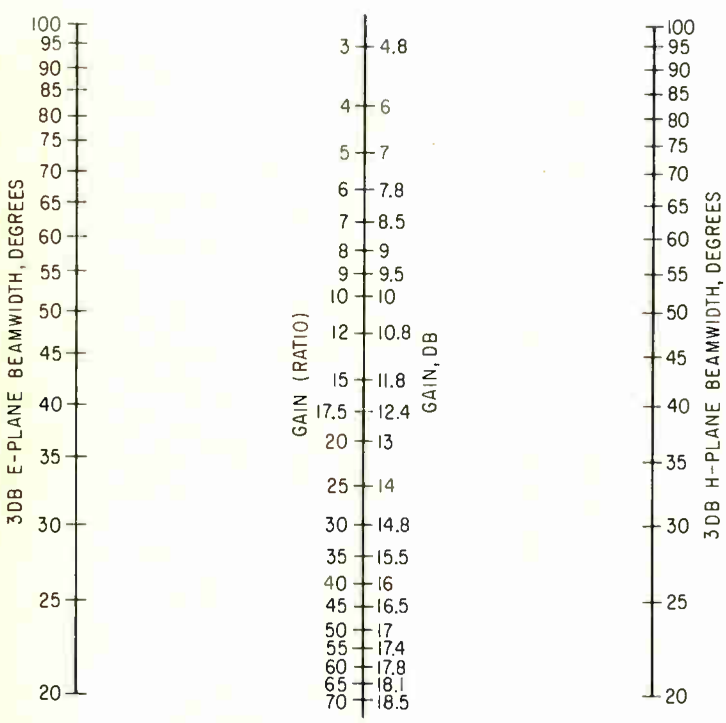

FIG. 3—Chart for finding gain of rectangular horn

flare length is given by

$$F = C^2/\lambda \qquad (5)$$

where C = a or b whichever is larger (a, b and λ are as previously defined.) Equation 5 is plotted as Fig. 4.

Dimensions and gain of a parabolic reflector[2] can be related by

$$\text{Gain} = \frac{41253}{\theta_d^2} \times \eta \qquad (6)$$

where $\theta_d = 63\lambda/d$ = 3-db beamwidth, d = reflector (dish) diameter, λ = wavelength, and η = reflector efficiency factor, with d and λ in similar units.

Wavelength is replaced by frequency in the beamwidth equation. And, for an assumed re-

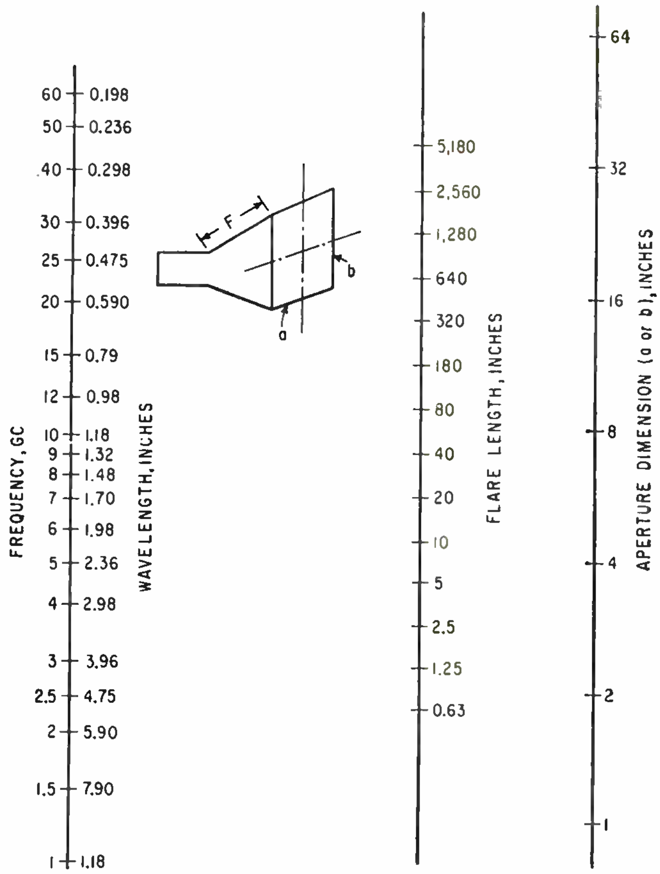

FIG. 4—Chart for finding flare length of rectangular horn

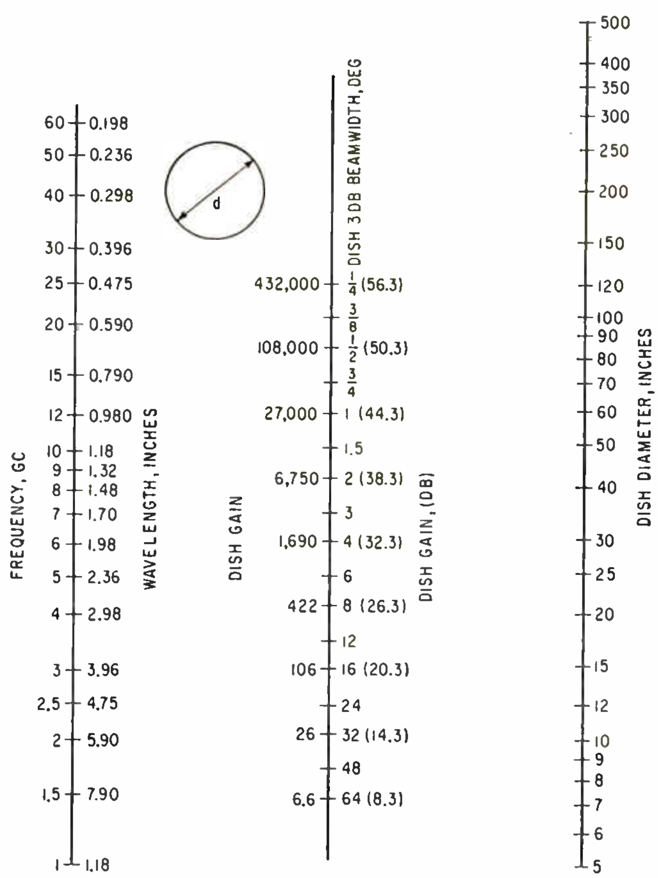

FIG. 5—Gain and beamwidth of parabolic antenna

flector efficiency of 0.65

$$\text{Gain} = \frac{27{,}000}{\theta_d^2} \qquad (7)$$

and

$$\theta_d = 745/df_{Gc} \qquad (8)$$

where f_{Gc} = frequency in Gc and d = reflector diameter, inches.

Equations 7 and 8 are plotted in Fig. 5. Two examples illustrate the use of the charts. First, consider a compound horn with an E-plane aperture of 2 inches and H-plane aperture of 4 inches, designed for use at 9 Gc. Find the gain and estimate the approximate space (volume) required for the installation. From Fig. 1, θ = 35 deg; from Fig. 2, ϕ = 32 deg; from Fig. 3, G = 14 db; from Fig. 4, $F \cong 12$ inches.

Using the aperture dimensions and flare length, the volume is estimated (including allowance for flanges and supporting structure) as about 50 cu in. Multiply aperture area by flare length, then divide by 2, since the horn is essentially a pyramid.

Next, consider a reflector 6 inches in diameter for use at 9 Gc. Again, find the gain and estimate the installation space (volume). From Fig. 5, $\theta \cong 14$ deg; from Fig. 5, G = 21 db.

For estimating installation space, a focal length to diameter ratio of 0.5 may be used, and allowing for support structures, etc., the volume is estimated as about 90 cu in.

REFERENCES

(1) J. D. Kraus, "Antennas," McGraw-Hill Book Co., New York, N. Y., 1950.
(2) S. Silver, "Microwave Antenna Theory and Design," McGraw-Hill Book Co., New York, N. Y., 1949.

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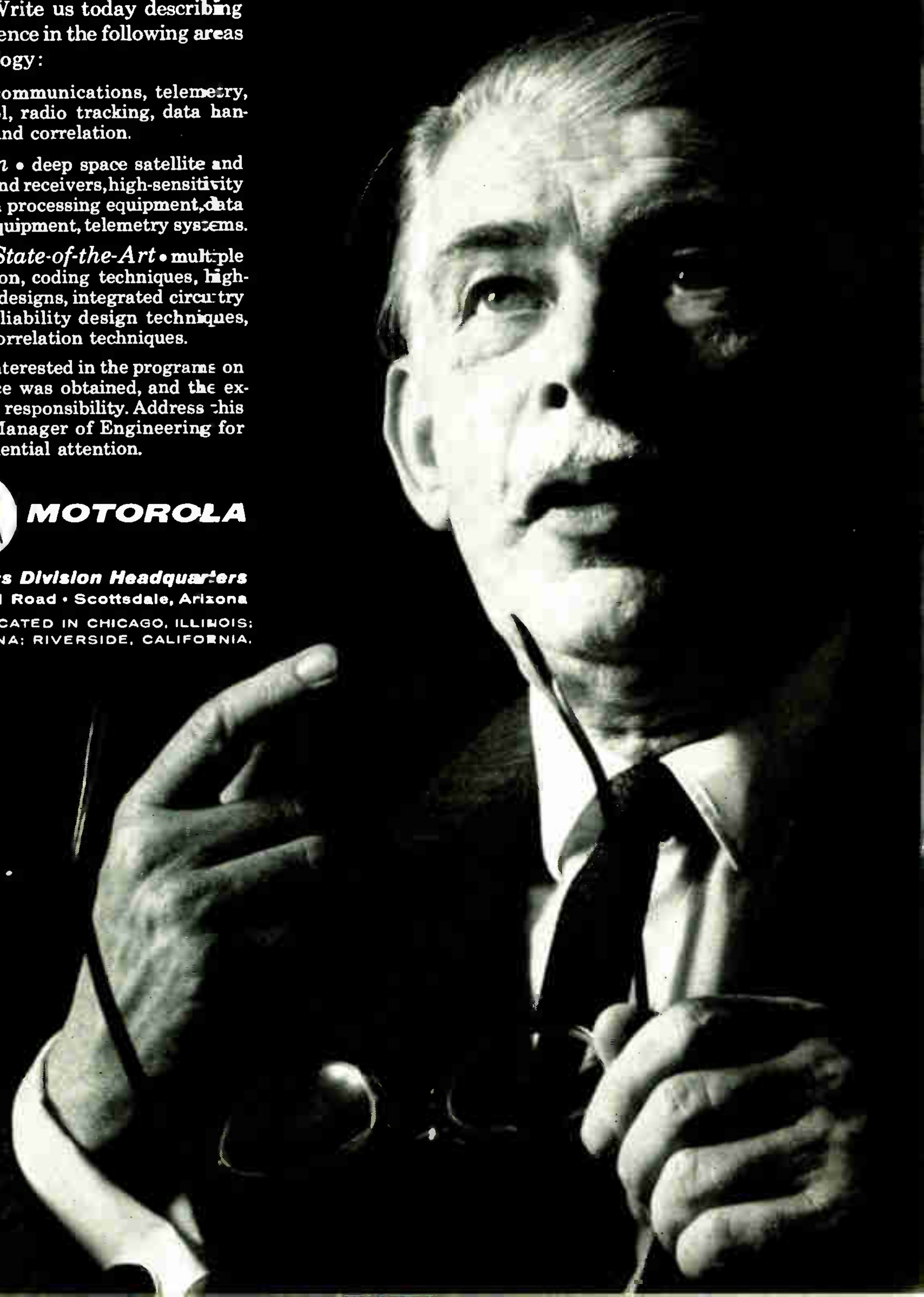


Nonlinear Filter Detects Envelope or Backbone

By N. D. DIAMANTIDES,
Engineering Scientist
Goodyear Aircraft Corp., Akron, Ohio

FILTERING - DETECTION technique could enable recovery of meaningful information from noise-contaminated signals. The active, nonlinear filter could be useful in communications, biological instrumentation, control and other systems. It can be used to extract either the envelope or the backbone of the signal of interest.

The basic principle of the technique, which has been implemented on an analog computer, could readily be incorporated into a final circuit.

Operation of the nonlinear filter in Fig. 1 is based on a sampling and holding unit controlled by an electronic switch. If positive and negative pulses are applied simultaneously to the inputs of amplifiers 1 and 2, respectively, diode switch S_1 closes. Feedback around amplifier 3 results in an output equal to the input and with negligible time lag. When the pulses are removed, the bias voltages of amplifiers 1 and 2 open S_1, and amplifier 3 stores the value of input voltage at the moment of switching. If polarity of the switching pulses were reversed, S_2 would close.

If the signal of interest is applied to the common input of amplifiers 3 and 4, properly timed switching pulses would enable amplifier 3 to read the signal during positive values and amplifier 4 during negative values.

Such a filter can be adapted to two operating modes, one involving multiplicative or modulation noise in which the signal envelope is of interest. For envelope detection, the signal must be sampled at its peaks and troughs. Zero crossings of the second derivative of the signal can be used to generate switching pulses at maxima and minima of the raw signal.

The filter can also be adapted to another operating mode involving additive noise in which the signal backbone is of interest. For backbone detection, the signal must be sampled at its inflection points. Zero crossings of the third derivative of the signal can be used to generate switching pulses at the inflection points of the raw signal.

Amplifier 5 is connected as a differentiator with practically infinite gain and limited output. It produces a positive output pulse when the signal derivative is positive and a negative pulse when the derivative is negative. Amplifier 6 is a similar differentiator that produces corresponding negative and positive

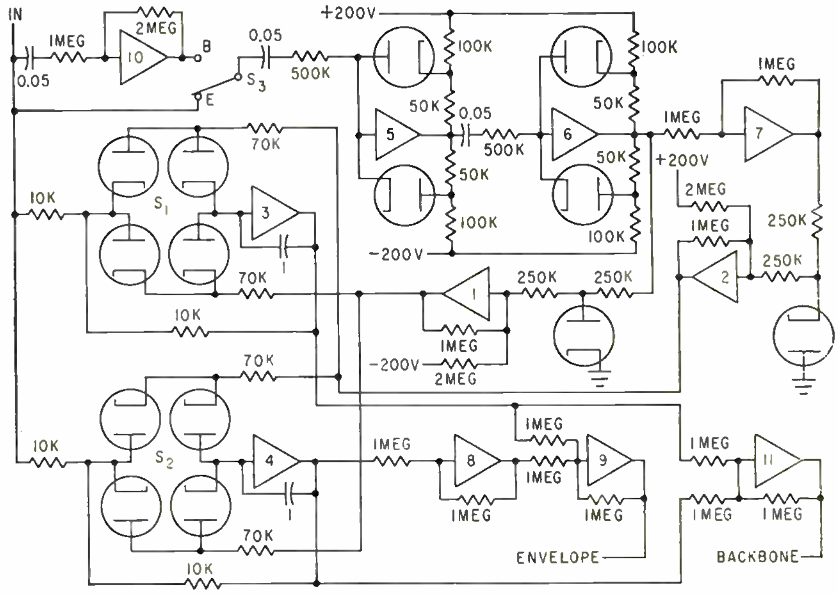


FIG. 1—Time derivatives of raw signal control electronic switches to sample and hold signal values in nonlinear fashion

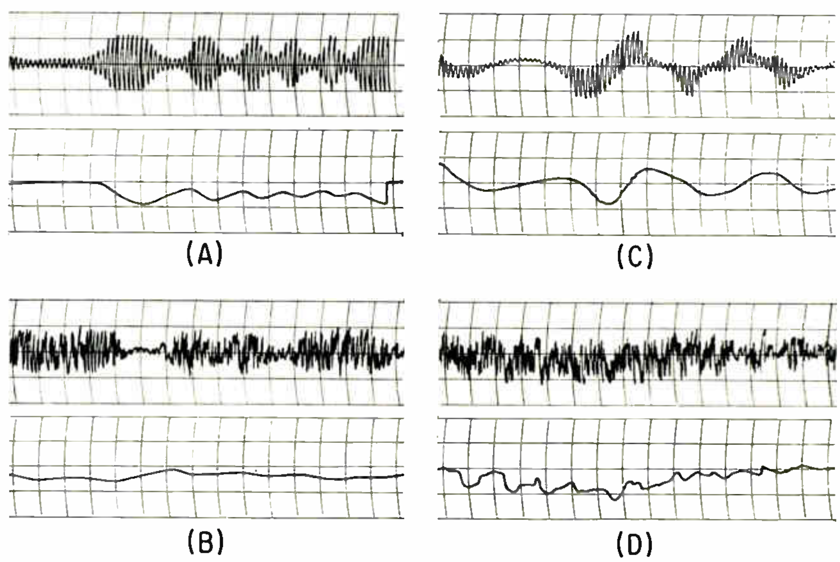
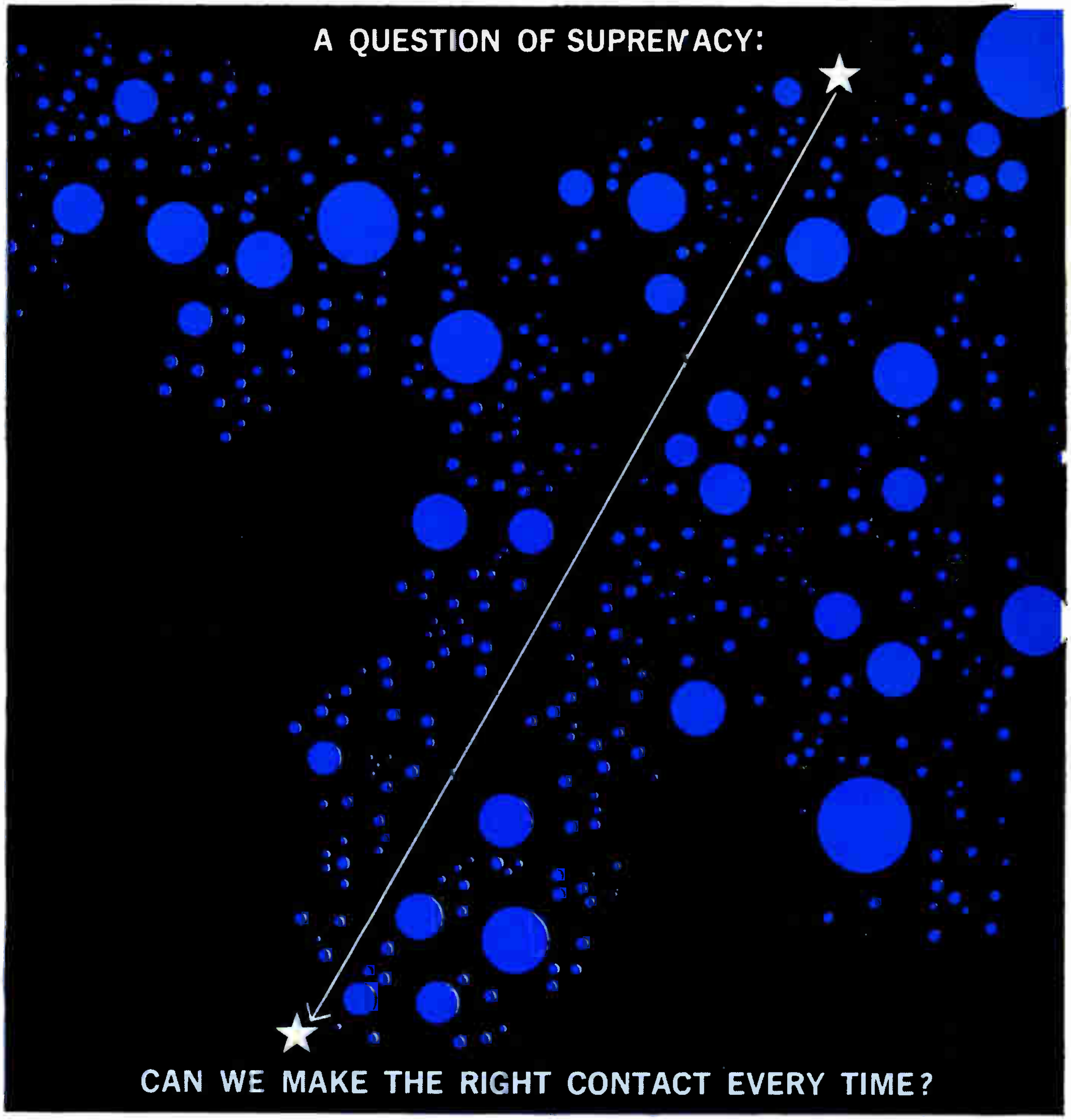


FIG. 2—Detected envelopes are shown of modulated sinusoidal carrier (A) and modulated noise carrier (B), while backbones are shown of modulated and biased sinusoidal carrier (C) and modulated and biased noise carrier (D). Horizontal divisions represent 1 second and vertical divisions represent 50 volts



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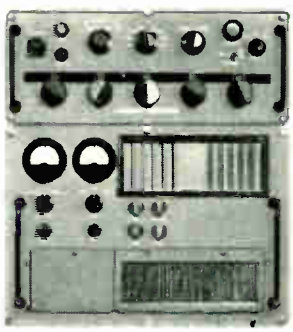


GENERAL DYNAMICS | ELECTRONICS – ROCHESTER pulses each time polarity of the derivative changes. Thus switching pulses are provided for envelope sampling. Subtracting the output of the two sample and hold units through amplifiers 8 and 9 yields the filtered signal.

Amplifier 10 functions as another differentiator and is switched in when S_3 is at position B. Outputs of the two memory units averaged in amplifier 11 provide the extracted backbone of the signal.

Filter outputs shown in Fig. 2 include the effect of a 0.3-second delay in the switching circuits, which was required for a particular application but is not a feature of the filter.

Envelope detection of an amplitude-modulated carrier is shown in Fig. 2A, while the signal in Fig. 2B is similar to those encountered in electroencephalographs and electromyographs. Backbone detection is shown in Fig. 2C and D.

The author acknowledges the assistance of W. W. Martin.

Test Gear Developed for Electron-Beam Recording

SPECIAL TEST EQUIPMENT is expected to speed development of high-performance recording systems. The equipment has been designed to evaluate thermoplastics and other materials for use in proposed electron-beam recording.

The test equipment, developed under contract at Ampex Corp. Applied Research Laboratories, has been delivered to the Reconnaissance Laboratory, Aeronautical Systems Division, Wright-Patterson Air Force Base.

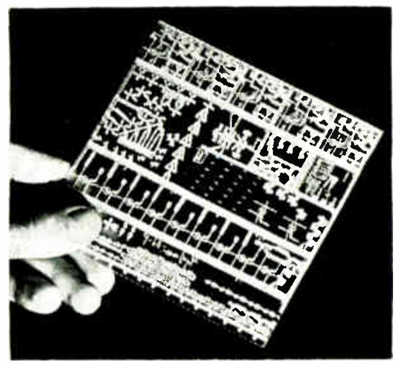
Electron-beam recording is expected to record electronic information at rates up to 10 times those of presently used recording techniques. An electron beam scanning a thermoplastic material imposes a pattern of electrostatic charges on the surface. Application of heat to the material causes microgroove pictures to be formed.

The test equipment will enable standards to be established on which the continuing development of electron-beam recording systems can be judged.

Development Program For Fluid Amplifiers

NINE-MONTH investigation will be made to develop fluid amplifier elements, circuits and subsystems. Work will include the fabrication of digital fluid amplification subsystems such as flip-flops, logical elements and associated circuits.

The contract has been awarded to Corning Glass Works by Diamond Ordnance Fuze Laboratories. The fluid amplification concept uses the interacting flow of fluids (gas or liquid) to perform logical and control functions. Fluid amplifiers



Etching photosensitive glass leaves channels, chambers and ports for carrying and controlling fluid flow in fluid amplifier subsystems

made by the agency are self-contained and have no moving parts.

The contract also calls for fabrication of proportioning amplifiers for flow, pressure and power amplification. The remainder of the project will involve determining dimensional and operational accuracies and the redesign of subsystems where performance indicates that it is necessary.

Optical fabrication techniques will be used. A picture of a desired configuration is imposed on Fotoform (photosensitive) glass, the image is developed by heat treatment and the exposed portions are partly or completely etched out. This approach is said to be particularly useful in making large numbers of interconnected, complex shapes for miniature fluid amplification systems. Pure fluid systems can be produced directly from drawings and photographs without mechanical tooling.

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Abrasion Resistance, Janco Tester grade 400 alum., inches	50
Cut through, anvil at 90°, 350 gm. minutes at 280°F	730
Soldering test, flare back	None
Flammability	self extinguishing

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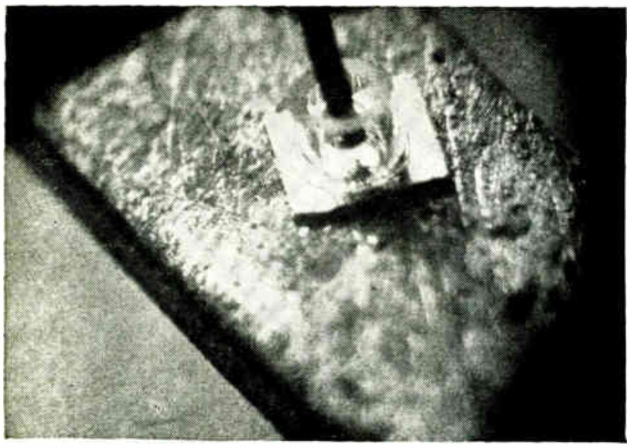
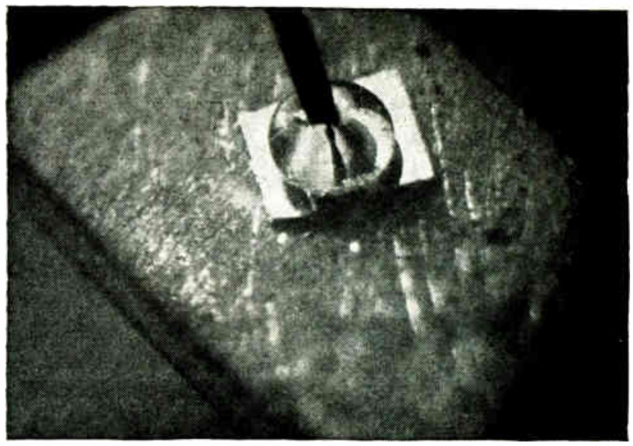

As a first step in the encapsulation process (left), the outer Nonex glass cylinder is sealed to the silicon, and the 0.010-in. diam. tungsten wire, prebeaded and pointed, is brought into contact with the diode. Application of heat underneath the silicon (right) causes the outer glass cylinder to melt and seal to the glass bead on the tungsten wire, completing the hermetic seal around the diode

Glass-To-Silicon Seals for Components

POINT TO PROTECTIVE FILMS A FEW MILS THICK

By B. KUNKEL
J. KOSTELEC
W. W. GAERTNER
CBS Laboratories, Stamford, Conn.

SURFACE PASSIVATION of semiconductor components has made devices considerably more resistant to ambient conditions but has not eliminated the need for hermetic seals. At present the protective package occupies a multiple of the volume of the actual device or the integrated circuit. Furthermore, in devices and functional blocks intended for high-frequency operation, the package usually introduces capacitances comparable to or exceeding those of the device itself.

Sealing Process

One possible solution to this problem is a glass-to-silicon sealing process which actually uses the silicon substrate wafer as part of the package and encloses hermetically only the *p-n* junctions on the active side of the wafer. This idea has been tested at CBS Laboratories by making surface passivated switching diodes (see diagram p 58).

N-type silicon is first doped with phosphor to insure a good ohmic contact at the base of the diode and to lower the series resistance of the device. Then the silicon slice is lapped on one side to appropriate thickness and polished. The silicon is oxidized and 4-mil diam holes are etched into the oxide by photographic techniques, so that the silicon is exposed in these etched areas. *P*-type dopant is diffused into the small areas, while the rest of the surface is protected by the silicon-dioxide layer. A special diffusion is also carried out to obtain the fast reverse-recovery times expected from these devices.

The glass-to-silicon sealing process at CBS is as follows:

The silicon dice is placed on a heating ribbon and a glass cylinder, Nonex 7720, whose thermal expansion coefficient matches that of silicon, is positioned around the diffused area of the diode and sealed through the thin silicon dioxide onto the silicon. After cooling, a tungsten point, beaded with Nonex glass, is brought into contact with the diode and heat is applied again, sealing the bead around the tungsten lead to the Nonex cylinder. Thus, the final bond consists of a glass-to-glass seal. It is also possible to perform the glass-to-silicon and glass-to-glass sealing operation in one step.

Smaller Packages Seen

The encapsulated diode is approximately 0.04-in. in diameter and about 0.025-in. high. Considerably smaller packages are possible. The volume enclosed by the glass and by the surface-passivated diode may contain an atmosphere of dry gas; or the glass may be a solid mass hermetically-sealed to silicon with no air or gas volume between the enclosure and semiconductor surface.

The sealing technique yields about 80 per cent good diodes by adhering to special precautions of cleanliness that avoids diode contamination.

A satisfactory sealing schedule of 900 deg C for ½ minute was determined, but longer times could be used if necessary. Temperatures higher than 900 deg C. tend to produce diodes with linkage paths across the junction.

Good encapsulated diodes depend upon the wire metal and type of glass used. Tungsten wire seems

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1 Constant-current from less than 0.5 microampere up to 3 A.

2 Models to 1500 V DC compliance.

3 Voltage-limiting control to limit compliance.

4 Remotely programmable.

5 Modulation input . . . power supply can also be used as general purpose or operational amplifier.

Electronic Measurements Constant-Current Power Supplies were designed specifically for constant-current output. In this respect, they offer advantages in the field of semiconductor work that can't be matched by conversions of constant-voltage (voltage-regulated) power supplies . . .
Ask for Specification Sheet 3072C for all the facts.

*BRIEF SPECIFICATIONS

MODEL	CURRENT RANGE		†VOLTAGE COMPLIANCE AT	
	MIN.	MAX.	MAX. I	MIN. I
C612A	1 μa	100 ma.	260 V	100 V
C631A	1 μa	100 ma.	420 V	300 V
*C638A	0.5 μa	100 ma.	2100 V	1500 V
C624A	2.2 μa	220 ma.	260 V	100 V
C632A	2.2 μa	220 ma.	420 V	300 V
*C636A	2.2 μa	220 ma.	735 V	600 V
C629A	2.2 μa	300 ma.	205 V	150 V
C633A	2.2 μa	300 ma.	420 V	300 V
C620A	5 μa	500 ma.	110 V	50 V
C621A	5 μa	500 ma.	160 V	100 V
C613A	10 μa	1 AMP	115 V	50 V
C614A	10 μa	1 AMP	170 V	100 V
*C628A	10 μa	1 AMP	215 V	150 V
*C630A	10 μa	1 AMP	280 V	200 V
*C625A	22 μa	2 AMP	150 V	75 V
*C626A	22 μa	2 AMP	190 V	100 V
*C615A	22 μa	3 AMP	125 V	50 V
*C618A	22 μa	3 AMP	170 V	100 V

* Voltage limiting control standard. Optional on all other models.
† For current vs. voltage compliance curves, request Specification Sheet 3072C.

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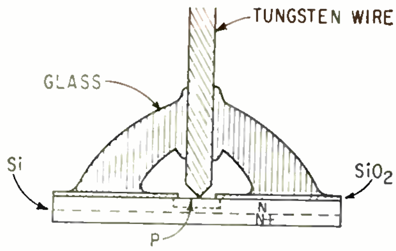
CIRCLE 57 ON READER SERVICE CARD



Cross section of a planar surface-passivated silicon p-n diode, hermetically encapsulated by a glass-to-silicon seal

to be superior to Kovar, and Nonex glass seems superior to number 7052 Kovar sealing glass.

A helium leak detector with a sensitivity of 10^{-10} atmosphere cc/sec ascertained the hermeticity of the seal. Mechanical strength of the seal was determined by pulling the seal apart and noting whether the silicon adhered to the glass or broke away from it. In a good seal, the point of bonding remains intact and the silicon itself fractures, indicating that the seal was stronger than the silicon.

The point contact to the diode is generally satisfactory, since the surface is highly doped and thus highly conducting. If a further reduction in contact resistance and the resulting increase in forward current are desired, a silicon-platinum eutectic can be formed on the *p* region of the diode, to which a very low resistance pressure or thermocompression bonding contact can be made. The contact to the highly doped *n*-type base of the diode can be made by pressure or by a low-temperature alloy such as silicon-gold eutectic. If proper precautions are taken during sealing, the reverse current characteristics are hardly affected. The I_R at -10 v is still in the low nano-ampere range and the breakdown voltage is still essentially unaltered, in our case above 40 volts.

Measurements show that if the capacitance of unsealed units is approx. 1.1 pF at v = zero volts, the capacitance of the sealed units is about the same or has increased to not more than 1.25 pF. This is, of course, important in fast switching diodes. Some very low capacitance diodes were measured before and after sealing and found to have an unchanging capacitance during sealing. Any capacitance change is usually associated with an increase in the reverse current. If the diodes deteriorate, etching usually restores their original characteristics, indicating that contamination is only at the surface.

The glass seal will eventually be made as an enclosure a few mils above the surface. Also an attempt will be made to integrate the glass-to-silicon sealing process more closely with the diffusion and alloying processes of the actual device fabrication.

Programs have been started to extend the glass-to-silicon hermetic sealing process to the following structures:

(1). A wire feed through into a semiconductor wafer using glass as an insulator. This will make it possible to use the semiconductor wafers themselves as multilead headers.

(2). A transistor enclosure containing two wire feedthroughs in the glass top.

(3). A structure where a thin layer of glass is wiped onto the hot silicon surface. This is accomplished by heating the silicon touching it with a thin piece of glass and sliding the latter over the surface, leaving a smooth thin layer which hermetically seals the junctions and can be used as a substrate for passive circuit components.

The authors acknowledge the early experimental work on this process and informative discussions with Raymond Heck of CBS Laboratories.

Metal Imperfections Found To Occur At Surface

DRAMATIC CHANGES in the strength, plasticity and fatigue life of metals may be produced by removing layers of atoms at the materials' surface.

Irvin R. Kramer, principal scientist at Martin's Space Systems Division finds that the removal of surface layers of atoms results in marked changes in the structural characteristics of metals.

The Martin metallurgist has been studying the effects of environment on the surface of metals.

Imperfections, called dislocations were found to collect in a submicroscopic layer.

advanced

PRECISION COMPUTING RESOLVERS

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Cascaded Resolver Systems

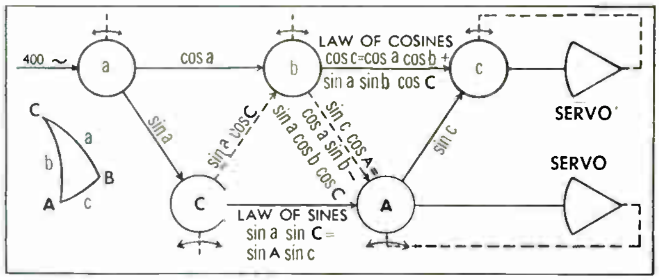
SIZE 8 FEEDBACK WINDING RESOLVERS

These resolvers are designed for use with transistorized "booster" amplifiers in cascaded chains.

Chains of precision size 8, winding compensated resolvers accurately solve the trigonometry of coordinate translation, rotation and conversion.

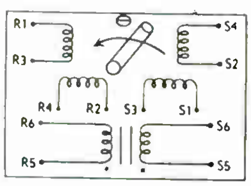
A chain of five resolvers is typically employed to solve for an unknown side and angle of oblique spherical triangles.

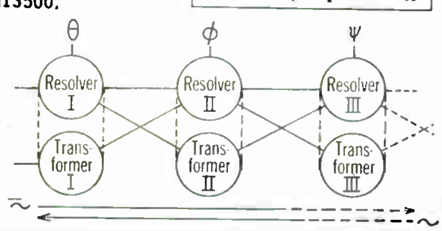
Individual resolvers exhibit functional errors of less than 0.1% and axis perpendicularity errors of ±5′ max. In combination with the CPPC RESOLVERAMP, the closed loop phase shift is 0.00° ±0.01° and the transformation ratio is 1.0000 ±.0005. The residual null voltage is 1 mv/v max. over a range of 10V, 400~.



SIZE 11 "BOOSTERLESS" RESOLVERS FOR SERVICE IN REVERSIBLE CHAINS

The frame of these size 11 computing resolvers also houses a matching transformer which simulates a pair of resolver windings at maximum coupling. In a reversible chain of alternately interconnected resolvers (only partially diagrammed), the excitation may be applied to either end of the chain and the outputs taken from the other end. Quick disconnect allows ease in harnessing. Accuracy: ±5′ of arc or less; winding perp. ±5′. Electrical characteristics: Input to EITHER rotor or stator. Input voltage 115v 1600 ~; output voltage 110v with either stator or rotor as primary; phase shift (stator primary) 1.1°; phase shift (rotor primary) 1.9°; Zso (nom.) 990 + j13500; Zro (nom.) 1150 + j13500.





SIZE 11 RESOLVER TRIMMED FOR ZERO PHASE SHIFT CONTAINS ALL COMPENSATION IN 2¼″ LENGTH

The YZC-11-E-1 precision computing resolver has been developed for use in a cascaded, amplifierless resolver system at 900~.

These units have been trimmed to provide zero phase shift and compensated for transformation ratio stability, under temperature, when working into their iterative impedance.

Accuracy: Functional error .1% or less; winding perp. ±5′. Electrical characteristics: Input voltage (stator) 40v900 ~; output voltage (rotor) 33.2v; phase shift 0; max. null voltage 1 mv/v.

Also ready for delivery is an equivalent, compatible pancake resolver. By its use, differential information from an inertial platform may be obtained and introduced into the system.

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Electron Beams Weld Ceramics and Metals

By TOM MAGUIRE
New England Editor

BOSTON—Application of electron beams to the direct fusion welding of ceramics and to microwelding circuit packages presents new construction possibilities for power tubes and microelectronic modules.

At the Fourth Electron Beam Symposium, sponsored by Alloyd Electronics Corp., preliminary work was reported on joining ceramic materials to themselves and to metals. H. A. Hokanson, S. L. Rogers and W. I. Kern of Hamilton Standard said structurally sound, vacuum-tight alumina welds were produced with precise controllability and extreme cleanliness.

The technique may allow fuller use of ceramic materials in power tubes and for microwave windows, and in other areas where high dielectric strength and high-temperature properties are desirable. Electron beam welding will minimize many of the difficulties associated with brazing ceramics, the symposium was told.

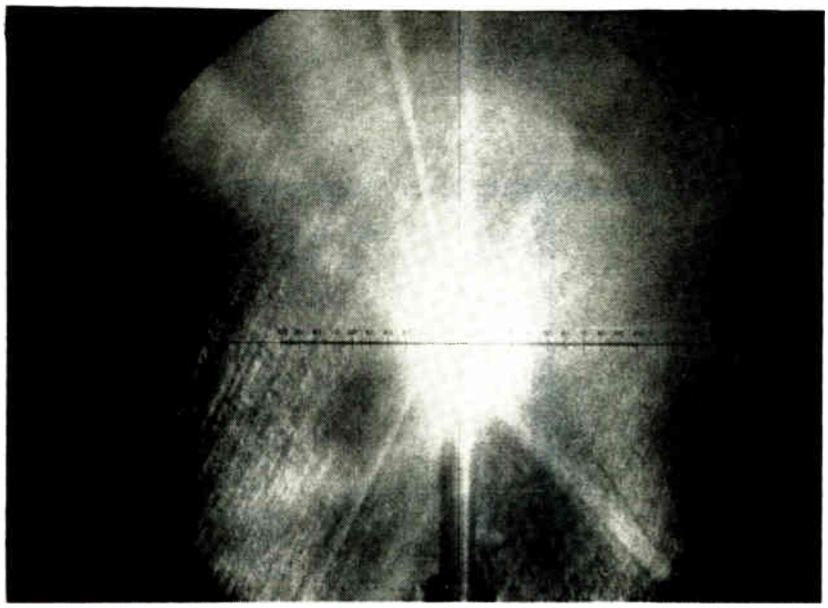
Equipment used was a Hamilton-Zeiss high-power-density electron beam welding machine rated at 3 Kw, with accelerating potentials to 150 Kv negative and beam currents to 20 ma. Beam spot size can be controlled by electromagnetic focusing to a diameter of less than 0.010 in. The optics allow the workpiece to be viewed coaxially with the electron beam, at magnifications of 20 or 30 power, so the exact location of beam impact point and the joint itself are seen, as well as formation of the weld.

For both edge and butt welds of alumina sections, the major factors controlling weld quality are accelerating voltage, beam current, welding speed, preheating temperature, and cooling rate after welding.

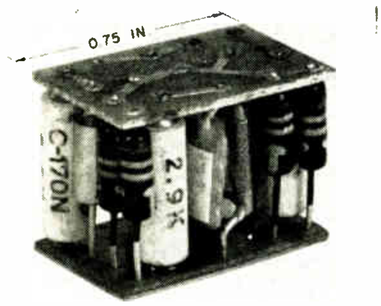
Relatively high voltage (90 Kv.), low current (2 ma) beams gave the most satisfactory welds. Low speeds (15 inches per minute or less) produce a glassy structure in 96 percent alumina; flexural tests indicate that glassy structures are relatively weak. Advantage of higher welding speed (30 ipm) appears to result from the decreased time the weld zone is above the 1,800 F preheat temperature. The necessity for preheating and controlled cooling was apparent from early results. Without preheating, welds invariably showed evidence of cracking.

Similar methods were used to produce crack-free welds of 96 percent alumina to tungsten, to molybdenum, and to columbium. Molybdenum feed-throughs have been welded into alumina for electron-tube support rods. Leak-tight welds are accomplished by moving the beam around the base of the 0.040-in. diameter pins. Optical viewing is used to locate the circular beam directly over the pins.

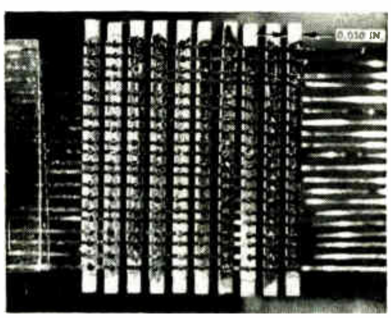
Advances in electron beam welding have also provided a joining



Optical viewing system permits operator to sight down path of electron beam to line it up with spot he wants to weld and to allow observation of the weld as it is made



In end-weld or "rivet" process for cordwood package, component leads are fed through holes in a metallized substrate, with the leads trimmed close to the substrate



In Signal Corps microminiature program, 20 ribbon wires located on 25-mil centers are welded to 10 wafers located on 50-mil centers, forming 800 welds per sq in.

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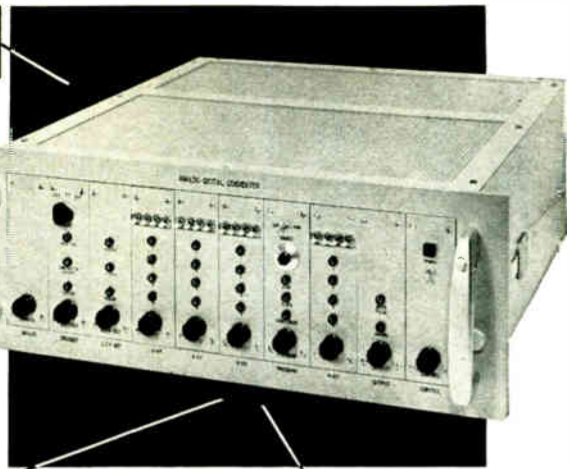

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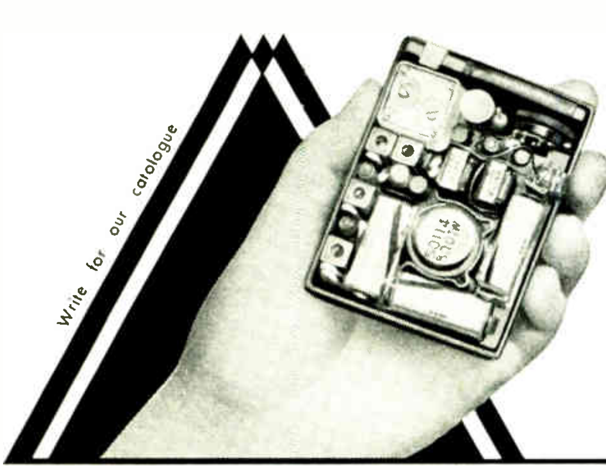

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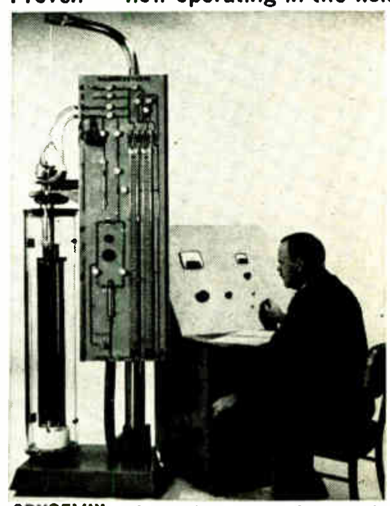

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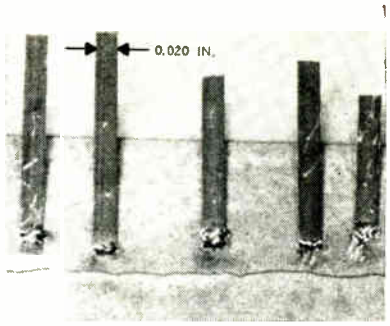
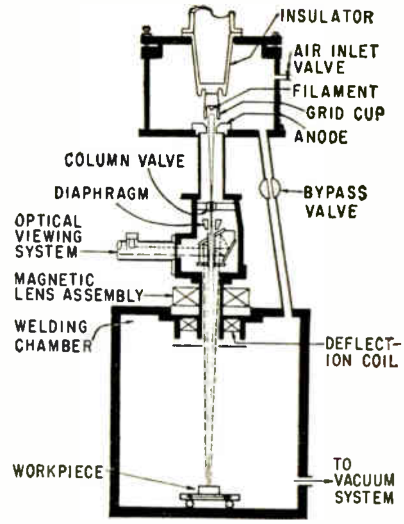


Gold and Kovar leads welded to 0.0002 in. nickel



Gun is mounted outside work chamber in Hamilton-Zeiss high-power-density electron beam welding machine

tool for electronic packages. F. R. Schollhammer of Hamilton Standard outlined work on three design approaches: the cordwood concept, micro-element welding or the module concept, and interconnections for thin film and solid circuits.

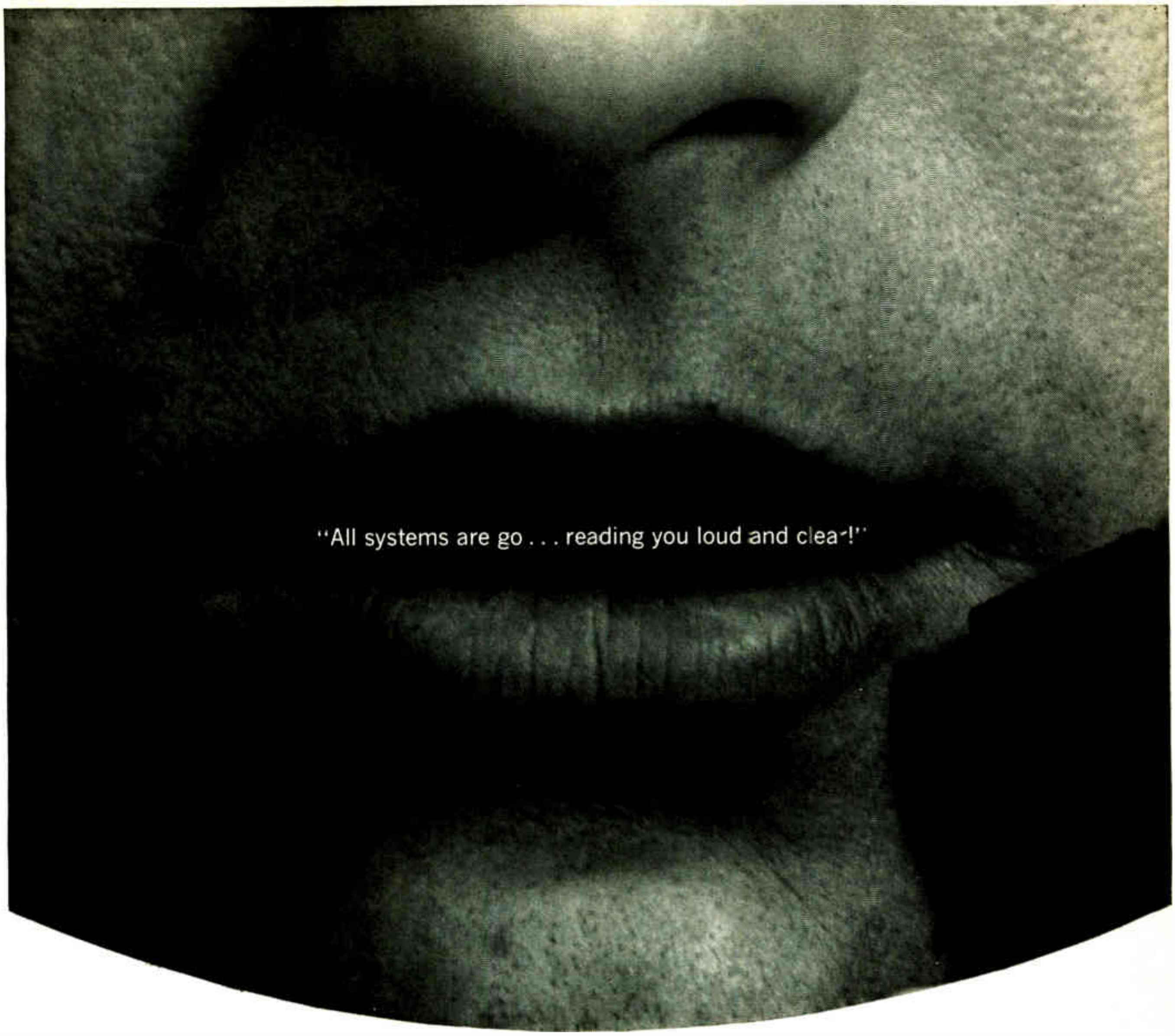
As a result of the experimental program, Hamilton Standard will soon market a combination micro-welding and cutting machine. In addition to using electron beam welding for fabricating electronic packages, it will cut and drill precise miniature patterns in most metals and ceramics.

The cordwood concept involves use of end welding or the "rivet" process. The component leads are fed through holes in a metallized substrate with the leads trimmed close to the substrate. To form the welded joint, the electron beam is impinged axially upon the end of the lead, causing the lead to melt and join to the metallized surface, thus forming a rivet-like cap over the feed-through hole.

The tier concept represents a variation of the cordwood package. As with the end-weld technique, metallized substrates are used for component termination. The components are arranged so they extend approximately to the substrate rails or supporting strips. The leads are then welded to the rails by deflecting the beam over the ends of the leads.

In a microminiature program sponsored by the Signal Corps, Hamilton Standard experimented with welded electrical connections having a termination density order of magnitude greater than that obtained with solder joints. Initially, 2 × 10-mil copper ribbons were welded to metallized ceramic wafers. The program has been extended to welding conductor ribbons to multiple wafers. A termination density of 1,600 welds per square inch is required and this has been accomplished in part by welding 20 ribbon wires, located on 25-mil centers, to 10 wafers (0.03 in. thick) located on 50-mil centers, thus forming an initial termination density of 800 welds per sq. inch. To achieve the 1,600 terminations per sq. in., 0.01-inch thick alumina wafers will be located on 25-mil centers. Copper wire spaced on 25-mil centers will then be welded to the metallized wafers to form the required termination density. Prior to completing this phase, interconnections will be completed on all four surfaces of the module cube, producing a total of 800 connections for a wafer module assembly of approximately 0.6 × 0.6 × 0.25 in. Weld reliability being demonstrated in the Signal Corps contract is a minimum pull strength value of 220 grams in 100,000 welds, and a weld resistance no greater than 1 milliohm in 100,000 welds.

Among typical interconnection welds in the experimental program are: gold and Kovar tabs of 1-mil thickness welded to copper plate electroplated with a gold deposition; Kovar and gold leads of 0.5-mil thickness welded to 0.0002 in. of nickel plated on 3,000 A of chromium deposited on quartz; 0.0005-in. gold tabs welded directly to 2,500 A of gold deposited on quartz substrate.



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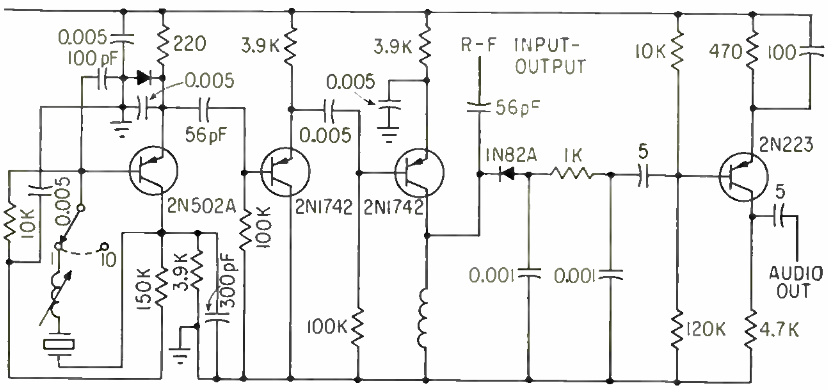
DESIGN AND APPLICATION



Portable Frequency Standard Between 10 and 480 Mc

VACUUM FLASK MOUNTED

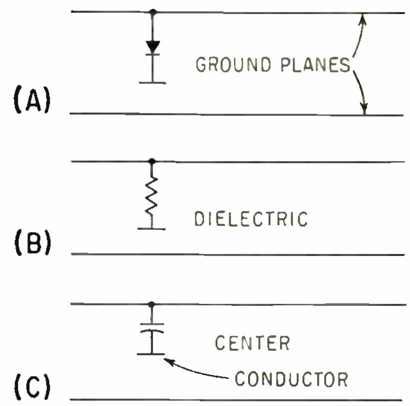
RECENTLY announced by Stancor Electronics, Inc., 3501 West Addison, Chicago 18, Ill., is the model SC-1 portable frequency standard that operates at any ten preselected frequencies between 10 and 480 Mc at temperatures between −22 and +104 F. The electronics are mounted within this 7¾ × 4 × 4½ inch, 2.6 lb unit, in a compact mechanical rigid assembly suspended inside a vacuum flask in which the temperature is thermostatically controlled to precise limits. The flask in turn is completely encased within insulating and cushioning foam. The circuit (see sketch) consists of a stable oscillator, isolation amplifier, multiplier, diode mixer and audio amplifier. The frequency of each crystal can be independently adjusted over a range ±250 cps with a fundamental frequency between 10 and 20 Mc. Harmonic output is 20 to 480 Mc. Output voltage at fundamental is minimum 10 mv, 3 mv to 60 Mc, 1 mv to 120 Mc, 150 μv to 250 Mc and 10 μv to 480 Mc. The termination is 50 ohms. An r-f signal input of 1 mv will produce an audible beat at the earphones. Stability is ±0.1 part/million/day, ±1.0 part/million/week and ±3.0 part/million/month. A companion instrument, model 102 FM Deviation Meter can be used to provide visual readout of carrier deviation from specified frequency as well as average or peak modulation deviation.

CIRCLE 301 ON READER SERVICE CARD

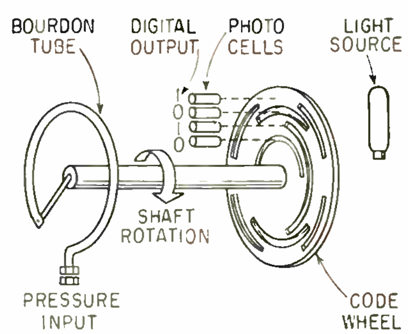
Solid State Switch

HIGH POWER, LOW LOSS

INTRODUCED by Hyletronics Corp., 185 Cambridge St., Burlington, Mass., is the model SL5 solid state switch. For applications over any 10-percent band from 100 to 2,000 Mc, these reactive coaxial transmission line units are used to protect receivers during transmission from leakage through gaseous or ferrite duplexers or from reflections due to antenna mismatches. The units can handle more than 10 Kw peak in the isolating stage and switches in less than 1 μsec. A typical unit operates between 1,250 and 1,350 Mc with 30 db isolation in forward bias state and 0.3 db loss in back-bias state. The switches are in a dielectric filled stripline. The illustration shows the diode connected in parallel with 50-ohm dielectric filled line with no bias applied (*A*), with forward bias (100 ma and +0.8 v) the diode appears as approximately 1 ohm and reflects most incident power (*B*). With reverse bias (0.2 ma and −30 v), the diode is essentially a capacitor of a few picofarads and permits almost complete transmission of incident power (*C*). Broadband tuning elements optimize performance with insertion loss and bandwidth limited ultimately by *Q* of the diode.



CIRCLE 302 ON READER SERVICE CARD



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PHOTOELECTRIC TYPE

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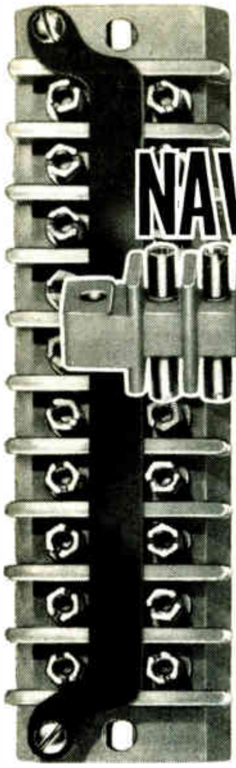

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Feed-Thru Terminal Block 7TB12

Gen-Pro military terminal boards are manufactured and inspected in accordance with latest revision of MIL-T-16784, BuShips Dwg. 9000-S6505-B-73214 and BuOrd Dwg. 564101. Molding compound, per MIL-M-14E assures low dielectric loss, high insulation resistance, high impact strength.

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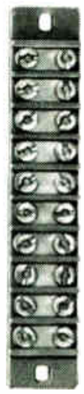

Miniature 26TB10

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and have an accuracy unaffected by long transmission or loading. In a transducer as shown in the sketch (p 64), digital output is obtained by converting the information input to a shaft rotation within the transducer. A code wheel is placed on the shaft and photo techniques are used to develop the digital output. The code wheel interrupts the light source according to the pattern of holes in the disk. Photoelectric cells convert this light information into digital output signals. Transducers are produced for such analog inputs as pressure, temperature, flow rate, shaft position and liquid levels.

CIRCLE 303 ON READER SERVICE CARD

MAGNETIC MODULATOR AND CHOPPER COMPARISON

	Reliability	Waveshape	Phase Stability	Carrier Freq.	Temperature
Magnetic modulator	indefinite life	sinusoidal	±1°	to 100 Kc	−100 to + 250C
Mech. chopper	5,000 hrs	square	±15° at 400 cps	to 3 Kc	−65 to + 125C
Transistor chopper	semiconductor reliability	square	±5°	to 100 Kc	−55 to + 125C

Suppressed Carrier Magnetic Modulator

LOW DISTORTION, LONG LIFE

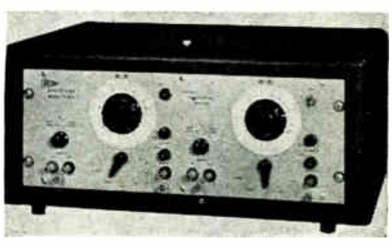
MANUFACTURED by Transmagnetics Inc., 40-66 Lawrence St., Flushing 54, N. Y., is the model 220 suppressed carrier magnetic modulator having 1-percent distortion, 1 degree phase shift and 125 cps signal bandwidth with 800 cps carrier. Output is $\frac{1}{4}$ v from this approximately 1 cubic inch, $1\frac{3}{4}$ oz package. The above table, supplied by the manufacturer, compares the magnetic modulator with mechanical and transistor choppers.

CIRCLE 304 ON READER SERVICE CARD

Power Supply

CARAD CORP., Stanford Industrial Park, Palo Alto, Calif., offers a 500-5060 v precision power supply with output current range of 0 to 20 ma.

CIRCLE 305 ON READER SERVICE CARD



Electronic Filter

HAS STEEP CUTOFF

SPECTRUM INSTRUMENTS, INC., Box 61, Steinway Station, L.I.C. 3, N. Y. Type LH-42 analog filter features true seventh-order Butterworth response as either highpass or lowpass device and wide, continuously tunable cutoff range at 42 db-per-octave slope. Lowpass response is flat to zero frequency (d-c), highpass to 2.5 Mc. Dual-unit package may also be applied as bandpass, band rejection, or 84 db/octave highpass/lowpass filter.

CIRCLE 306 ON READER SERVICE CARD

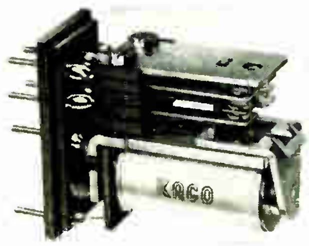
Symbol Generators

UNIVERSAL TYPE

INFORMATION PRODUCTS CORP., 156 Sixth St., Cambridge, Mass. Series SG universal symbol generators can convert digital codes into readable alphanumeric characters at rates up to 32,000 characters per sec. Up to 64 characters can be provided in

16-character groups. Standard inventory groups include all of the letters of the alphabet, all numbers and all standard punctuation marks. In addition, any special characters can be provided at no extra cost. Prices range from $2,580 to $3,995.

CIRCLE 307 ON READER SERVICE CARD

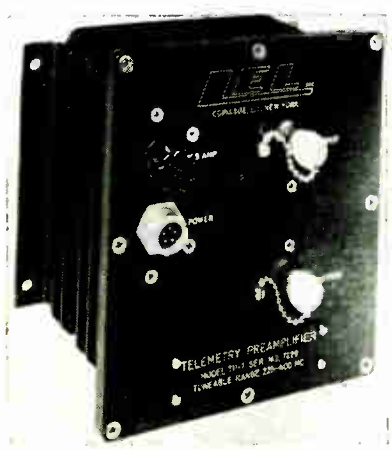


Plug-in Relays

TELEPHONE TYPE

INTER-MARK CORP., 80-00 Copper Ave., Brooklyn 27, N. Y. The Kaco RC low cost relays are supplied with matching sockets for plug-in installation. Four types of contact arrangements available: spst-no, dpst-nc, dpst-no and dpdt. Each is available for operation at coil voltages of 1.2, 2, 4, 6, 12, 24 and 48 v. Weight is approximately 0.7 oz. Relays are supplied with plastic dust cover with maximum dimensions of 0.61 by 1.11 by 1.165 in.

CIRCLE 308 ON READER SERVICE CARD

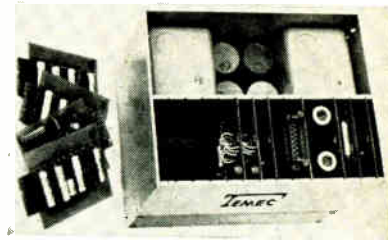


Antenna Preamplifier

FOR UHF BAND

LEL, INC., 75 Akron St., Copiague, N. Y. The TP-7 is a low noise, fixed-tunable r-f preamplifier operating in the 225 Mc to 400 Mc uhf band with a nominal bandwidth of 10 Mc. It features excellent gain stability and a regulated solid state power supply. Gain is 26 db min and noise figure 4 db max. It is built in a weatherproof sealed unit, suitable for mounting directly on the antenna. Also available as a rack-mounted unit. Price $995.

CIRCLE 309 ON READER SERVICE CARD

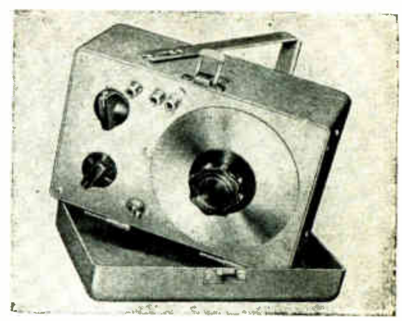


Servo Amplifier

MODULAR DESIGN

TEMEC, INC., 7833 Haskell Ave., Van Nuys, Calif. Model 7-2 is designed to control up to 1 h-p, 2-phase, 60-cycle servo motors. Operating temperature range goes from −30 C to +50 C. Amplifier employs plug-in p-c boards to achieve flexibility and ease of repair, adjustment or trouble shooting. With an input impedance of 10,000 ohms, a power output of 120 v at 20 amp for phase one, and 208 v at 10 amp for phase two, unit measures 7⅝ by 9¾ by 7½ in.

CIRCLE 310 ON READER SERVICE CARD



Oscillator

FULL TRANSISTOR

STEWART BROTHERS DIVISION of Instrument Laboratories, 315 W. Walton Pl., Chicago 10, Ill. Model TO uses a special Wein Bridge circuit, printed circuit wiring and diode voltage regulation. The 4½ in. dial of 300 deg excursion and 6/1 knob ratio permit accurate setting of frequency. Frequency span is 5.5 cps to 600 Kc in 5 bands; dial span, 10 to 1; output impedance, 600 ohms—balanced; max output voltage, 5 v into 600 ohms, price, $270.

CIRCLE 311 ON READER SERVICE CARD

PRODUCT BRIEFS

TRANSFORMER microminiature device. New England Transformer Co., 47 McGrath Highway, Somerville, Mass. (312)

CONNECTOR in combination with coupling mechanism. The Deutsch Co., Municipal Airport, Banning, Calif. (313)

FILTERS AND TRANSFORMERS miniaturized units. Bundy Electronics Corp., 171 Fabyan Place, Newark, N. J. (314)

GROUND SUPPORT POWER SOURCE features multiple output. Mid-Eastern Electronics, Inc., Springfield, N. J. (315)

MINIATURE CERAMIC CAPACITORS axial lead type. Gulton Industries, Inc., 212 Durham Ave., Metuchen, N. J. (316)

SINGLE CENTRIFUGAL BLOWERS five compact models available. McLean Engineering Laboratories, Princeton, N. J. (317)

DUST-FREE CABINET features double-filtered air flow. Specialties, Inc., Skunks Misery Road, Syosset, L. I., N. Y. (318)

SHIFT REGISTER MODULE 5 Mc, four-stage unit. Harvey-Wells Electronics, Inc., 14 Huron Drive, Natick, Mass. (319)

FERRITE SWITCHES high isolation, low insertion loss. Micro-Radionics, Inc., 14844 Oxnard St., Van Nuys, Calif. (320)

WIDEBAND AMPLIFIER solid state design. RHG Electronics Laboratory, Inc., 94 Milbar Blvd., Farmingdale, N. Y. (321)

MARKER BEACON RECEIVER self powered, low current drain. Fran Air Products, P. O. Box 478, Pawtucket, R. I. (322)

AUDIO COMPRESSOR AMPLIFIER solid state instrument. Quindar Electronics, Inc., 5 Lawrence St., Bloomfield, N. J. (323)

FERRITE Y-CIRCULATOR for microwave system application. Ferrotec

Inc., 217 California St., Newton 58, Mass. (324)

R-F CONVERTERS for 30-100 megacycles. Centimag Electronics, 312 E. Imperial Highway, El Segundo, Calif. (325)

CERAMIC CAPACITOR rated 47 $\mu\mu$f to 100,000 $\mu\mu$f. U.S. Capacitor Corp., 8917 Melrose Ave., Los Angeles 69, Calif. (326)

INVAR ALLOY TUBING designed for microwave cavities. The Carpenter Steel Co., 101 W. Bern St., Reading, Pa. (327)

VARIABLE A-C SUPPLY two models available. Plastic Capacitors, Inc., 2620 N. Clybourn Ave., Chicago 14, Ill. (328)

RADIO-FREQUENCY ENCLOSURES leakproof. Temperature Engineering Corp., One Tempcor Blvd., Riverton, N. J. (329)

FERRITE CIRCULATOR features wide-bandwidth. Quantatron, Inc., 2500 Colorado Ave., Santa Monica, Calif. (330)

INTEGRATED COLOR SYSTEM photoelectronic. PEI Systems Inc., 410 E. State St., Ontario, Calif. (331)

CRYSTAL DETECTOR MOUNT inexpensive. Hycon Mfg. Co., 700 Royal Oaks Dr., Monrovia, Calif. (332)

PULSED SAWTOOTH GENERATOR for chirp technique. Alfred Electronics, Porter Dr., Palo Alto, Calif. (333)

FLANGE SHAFT optional input. Fae Instrument Corp., 16 Norden Lane, Huntington Sta., L.I., N.Y. (334)

DISCONE ANTENNA 225 to 500 Mc. Temec, Inc., 7833 Haskell Ave., Van Nuys, Calif. (335)

SPEED TIP for plastic welding. Laramy Products Co., Inc., 220 Beechwood St., Cohasset, Mass. (336)

DELAY EQUALIZERS for a-f range. CircuitDyne Corp., 480 Mermaid St., Laguna Beach, Calif. (337)

STEATITE INSULATING TERMINALS low-voltage. Ceramaseal, Inc., New Lebanon Center, N. Y. (338)

DRY REED SWITCH d-t unit. Hamlin, Inc., Lake Mills, Wisc. (339)

electronics

Editorial Opportunity

IT DOESN'T HAPPEN OFTEN, but **electronics**, "bible of the industry" and a McGraw-Hill publication, has an opening for an Assistant Editor.

Ideally, the man we are looking for and to whom a post on our New York staff could be a long-term challenge, would have an electrical engineering degree or technical equivalent, practical experience in our field and a demonstrated aptitude for editing, writing, reporting. He probably lives somewhere in the metropolitan area and therefore would have no relocation problem.

Write **The Editor, electronics, 330 W. 42nd St., New York 36,** stating experience, aspirations and past earnings. Mark the envelope "Confidential" and it will be **kept** that way.

Literature of the Week

GROUND SUPPORT EQUIPMENT Raytheon Co., Lexington 73, Mass., offers a brochure on ground support equipment and capabilities. (340)

DIRECTIONAL COUPLERS Microwave Development Laboratories, Inc., 15 Strathmore, Natick, Mass. Catalog covers broad-wall multi-hole directional couplers. (341)

BEAM POWER PENTODE Amperex Electronic Corp., 230 Duffy Ave., Hicksville, L. I., N. Y., offers a technical booklet on Cavitrap plate tube type 6GB5. (342)

GROUND STATION Epsco, Inc., 275 Massachusetts Ave., Cambridge 39, Mass., announces a brochure on its pcm/video quick-look ground station, model PCG6. (343)

RECORDING PAPER Alfax Paper and Engineering Co. Inc., Alden Research Center, Westboro, Mass. Booklet describes type A2 electrosensitive recording paper for commercial facsimile, industrial scientific data recording uses. (344)

PANEL METERS Assembly Products, Inc., Chesterland, O. Highly accurate indicating panel meters are covered in bulletin 30. (345)

DISPLAY STORAGE TUBES International Telephone and Telegraph Corp., 3700 E. Pontiac St., Fort Wayne, Ind. An 8-page brochure defines storage tubes, lists specifications for 12 types. (346)

ENVIRONMENTAL TEST CAPABILITIES Acton Laboratories, Inc., 533 Main St., Acton, Mass. A 6-page folder illustrates and describes facilities of the firm's Environmental Test division. (347)

SERVO MOTORS Kearfott Division, General Precision, Inc., 1150 McBride Ave., Little Falls, N. J., has published a 16-page condensed catalog of its servo motors. (348)

PRINTED CIRCUITS Arthur Ansley Mfg. Co., New Hope, Pa., has published a 12-page booklet entitled "Military Specifications On Printed Circuits." (349)

Dmetro Andrychuk

Morton E. Jones

King Walters

TI Names Three Senior Scientists

TEXAS INSTRUMENTS INC., Dallas, Texas, has established the new position of senior scientist to recognize the achievements and essential role of its outstanding scientists and has selected three members of its technical staff as first appointees.

They are: Dmetro Andrychuk, Morton E. Jones and King Walters.

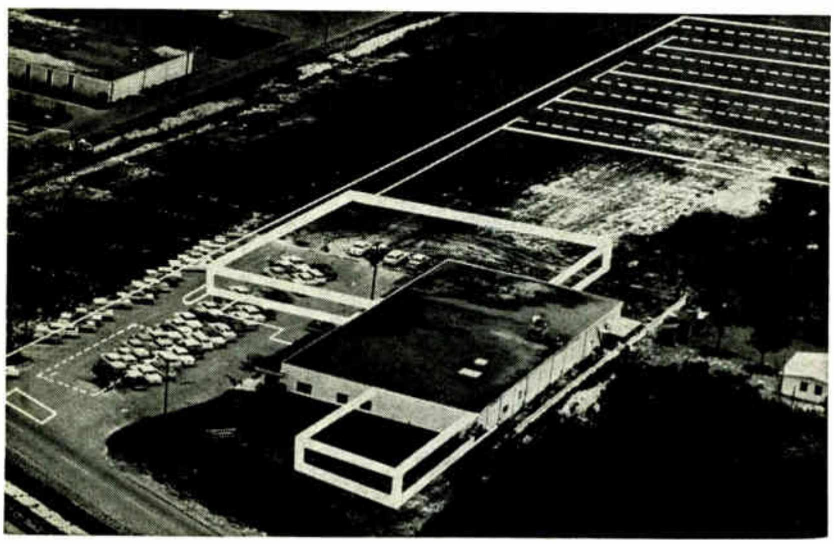
The position is designed for scientists who, by personal choice or company request, remain in and are particularly successful in work which is primarily technical rather than managerial, the company announced. Appointment is by invitation and based on unanimous judgment by a committee of TI technical management.

Andrychuk heads the physical methods section of the Materials Research Laboratory.

Jones is the technology consultant in the Semiconductor Research Laboratory.

Walters heads magnetic resonance research within the Physics Research Laboratory.

Dearborn Begins Plant Expansion



Further expansion of Dearborn Electronic Laboratories, Inc., components manufacturer in Orlando, Fla., will more than double its existing facilities, according to Raymond J. Simpson, president. Construction of the addition has begun and it is anticipated that the firm will occupy the new area (heavy solid white lines in the photo) in August of this year. Full production of the entire new plant will be underway by October. There will be no interruption of operations of the existing facilities

General Radio Elects Directors

TWO new directors have been elected to the board of the General Radio Co., West Concord, Mass.:

Ivan G. Easton, vice president for engineering, and Harold M. Wilson, vice president for manufacturing.

Hathaway Heads Up New Company

CLAUDE M. HATHAWAY, until his retirement five years president of Denver's Hathaway Instrument Co., has announced formation of Western Electrodynamics Co. in Colorado Springs, Colo., initially a 30,000 sq ft plant which will employ 100 upon completion in mid-1962.

The new corporation was formed for precision production of measuring and testing equipment for the public utility industry, transportation industry, and laboratory market.

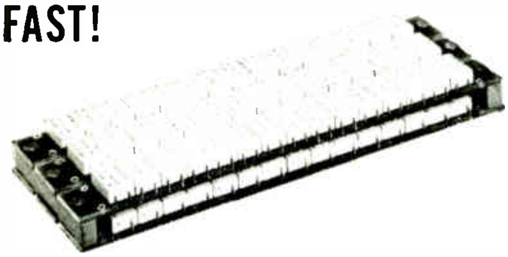
Zenith Constructing $7 Million Plant

ZENITH RADIO CORP., Chicago, Ill., recently broke ground for a new plant to be constructed at a cost of more than $7 million on a 28-acre tract just south of its main plant.

The 725,000 sq ft structure will permit rearrangement of existing

WEE LINES

SOLVE YOUR DELAY LINE PROBLEMS FAST!



Wee Lines are unique sectional, custom-fabricated delay lines *shipped from the factory to you 24 hours after the order is received.* Do away with costly waiting for other types of delay lines. *Save time, money and still achieve extra high performance.* Design with sectionalized Wee Lines. Available with delay times of 10 nanoseconds to 100 nanoseconds in 10 nanosecond increments. Sections are also available with 200 nanoseconds delay.

For complete descriptive literature, write to Dept. WL-11, or phone 464-9300.

NYTRONICS, INC.

550 SPRINGFIELD AVENUE, BERKELEY HEIGHTS, N. J.

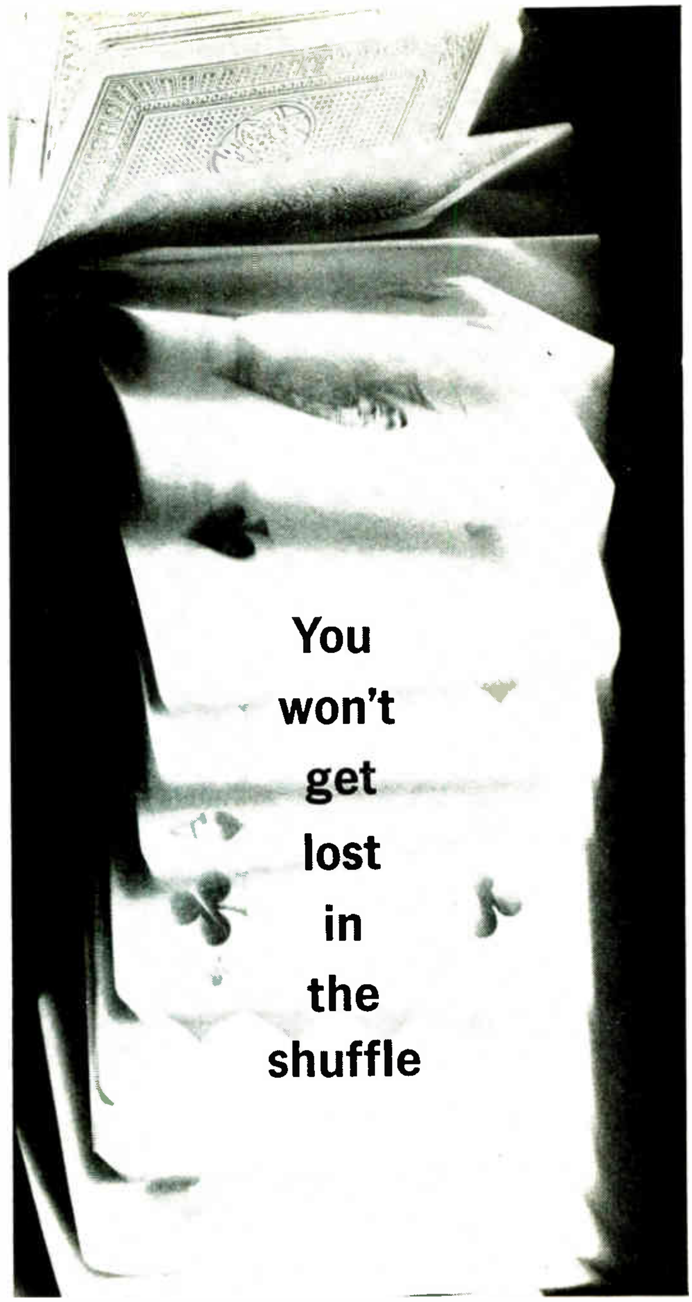
CIRCLE 209 ON READER SERVICE CARD

How to grow a beard...

Sit back and wait for your copy on that routing list. Okay if you like beards. Otherwise, look in this issue for the Reader Service Card. Fill in the "for subscriptions" section. Mail. Only 7½ cents a week.

electronics

A McGraw-Hill Publication, 330 West 42nd St., N. Y. 36



at Eimac.

As a development engineer at Eimac you follow each project through from start to finish. You are consulted on customer requirements and applications. You conduct feasibility studies and have complete device development responsibility. You deal directly with engineering management — no complicated chains of command. You're an individual, recognized for your achievements. And at your command are three specialized tube development labs and model shops, each one concentrating on a specific area: high power microwave, microwave and power grid. If you are interested and have relative experience, we'd like to tell you more.

No resume necessary. Just write to: Mr. C. F. Gieseler, Department B, Eitel-McCullough, Inc., San Carlos, Calif. An equal opportunity employer.

Eimac ®

facilities to provide for expansion of research, engineering and manufacturing operations.

The manufacturing and warehousing areas of the new building are expected to be completed late this year. Construction of the administrative section is scheduled for completion by the summer of 1963.

Cook Electric Co. Appoints Nail

COOK ELECTRIC CO., Chicago, Ill., has appointed James J. Nail as division manager of its NRK Microwave Division. NRK, a recent acquisition of the company, is actively engaged in the design and manufacture of microwave antennas used in radar equipment both for industry and military.

Prior to the acquisition, Nail was chief engineer and later vice president of NRK.

UAC's Norden Division Hires Lapidge

SAMUEL C. LAPIDGE has joined United Aircraft Corporation's Norden division, Norwalk, Conn., as senior project engineer-synchros and resolvers. He has been assigned to the division's precision components department.

Lapidge comes to Norden from

Dubrow Electronics Industries Inc., where he was senior engineer in charge of rotating component engineering.

M. Ten Bosch, Inc. Appoints Rosaler

M. TEN BOSCH, INC., Pleasantville, N. Y., producer of electronic and electromechanical devices for industrial and military purposes, has named Robert C. Rosaler vice-president and general manager.

Rosaler was formerly vice president and director of the Pitometer Log Corp.

PEOPLE IN BRIEF

Robert S. Jacobson and **George Smith** promoted to engineering mgr. and general services mgr., respectively, at Sperry Gyroscope's Sunnyvale Development Center. **Christopher Karabats**, previously with GE, named mgr. of production control and parts fabrication in Varian Associates' Tube div. **Manuel J. Gordon**, former asst. professor of research at Michigan State U., appointed mgr. of applications research for the Spinco div. of Beckman Instruments, Inc. **J. Walton Colvin**, from Bendix Corp. to General Dynamics Electronics as mgr. of plans and programs. **Ned S. Rasor**, ex-North American Aviation, Inc., now director of research at Thermo Electron Engineering Corp. **Philip N. Hambleton** leaves CBS Electronics to join Itek Laboratories as mgr. of the Electronics Division's image-processing dept. Daystrom, Inc., advances **Richard E. Bennett** to g-m of its Transicoil div. **Charles M. Horsley** moves up at Hughes Aircraft Co. to head of production control for the semiconductor div. **Hazard E. Reeves**, president of Reeves Soundcraft elected a director of Control Circuits, Inc. **W. E. Thomas** elevated to president of Magnaflux Corp. **William A. McCracken**, formerly with Philco appointed v-p operations of General Instrument's Capacitor div. **Terence R. Gregory**, ex-Sonex, Inc., elected president and director of DATA-tronix Corp.

EMPLOYMENT OPPORTUNITIES

electronics

WEEKLY QUALIFICATION FORM FOR POSITIONS AVAILABLE

ATTENTION: ENGINEERS, SCIENTISTS, PHYSICISTS

This Qualification Form is designed to help you advance in the electronics industry. It is unique and compact. Designed with the assistance of professional personnel management, it isolates specific experience in electronics and deals only in essential background information.

The advertisers listed here are seeking professional experience. Fill in the Qualification Form below.

STRICTLY CONFIDENTIAL

Your Qualification form will be handled as "Strictly Confidential" by ELECTRONICS. Our processing system is such that your form will be forwarded within 24 hours to the proper executives in the companies you select. You will be contacted at your home by the interested companies.

WHAT TO DO

1. Review the positions in the advertisements.
2. Select those for which you qualify.
3. Notice the key numbers.
4. Circle the corresponding key number below the Qualification Form.
5. Fill out the form completely. *Please print clearly.*
6. Mail to: D. Hawksby, Classified Advertising Div., ELECTRONICS, Box 12, New York 36, N. Y. (No charge, of course).

COMPANY	SEE PAGE	KEY #
BOEING COMPANY New Orleans, Louisiana	19	1
COLLINS RADIO COMPANY Dallas, Texas	63	2
DALMO VICTOR CO Div. of Textron, Inc. Belmont, California	142*	3
EITEL-McCULLOUGH INC. San Carlos, California	73	4
FAIRCHILD STRATOS CORPORATION Aircraft-Missiles Div. Hagerstown, Maryland	67	5
INTERNATIONAL BUSINESS MACHINES CORP. New York, New York	141*	6
INTERNATIONAL BUSINESS MACHINES CORP. Poughkeepsie, New York	77	7
LABORATORY FOR ELECTRONICS Boston, Massachusetts	112*	8
LEL, INC. Copiague, L. I., New York	145*	9
MICROWAVE SERVICES INTERNATIONAL, INC. Denville, New Jersey	77	10
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION Washington, D. C.	143*	11
PHILCO WESTERN DEVELOPMENT LABS. Palo Alto, California	79	12
RAYTHEON CO. Missile & Space Div. Bedford, Massachusetts	142*	13
REMINGTON RAND UNIVAC Div. of Sperry Rand Corp. St. Paul, Minnesota	126*	14

CONTINUED ON PAGE 78

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electronics WEEKLY QUALIFICATION FORM FOR POSITIONS AVAILABLE

Personal Background

NAME ....
HOME ADDRESS ....
CITY ....................ZONE......STATE............
HOME TELEPHONE ....

Education

PROFESSIONAL DEGREE(S) ....
MAJOR(S) ....
UNIVERSITY ....
DATE(S) ....

FIELDS OF EXPERIENCE (Please Check) 5462

☐ Aerospace	☐ Fire Control	☐ Radar
☐ Antennas	☐ Human Factors	☐ Radio—TV
☐ ASW	☐ Infrared	☐ Simulators
☐ Circuits	☐ Instrumentation	☐ Solid State
☐ Communications	☐ Medicine	☐ Telemetry
☐ Components	☐ Microwave	☐ Transformers
☐ Computers	☐ Navigation	☐ Other ....
☐ ECM	☐ Operations Research	☐ ....
☐ Electron Tubes	☐ Optics	☐ ....
☐ Engineering Writing	☐ Packaging	☐ ....

CATEGORY OF SPECIALIZATION

Please indicate number of months experience on proper lines.

	Technical Experience (Months)	Supervisory Experience (Months)
RESEARCH (pure, fundamental, basic)	......	......
RESEARCH (Applied)	......	......
SYSTEMS (New Concepts)	......	......
DEVELOPMENT (Model)	......	......
DESIGN (Product)	......	......
MANUFACTURING (Product)	......	......
FIELD (Service)	......	......
SALES (Proposals & Products)	......	......

CIRCLE KEY NUMBERS OF ABOVE COMPANIES' POSITIONS THAT INTEREST YOU

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25

EMPLOYMENT OPPORTUNITIES

NATIONAL COVERAGE

The Advertisements in this section include all employment opportunities—executive, management, technical, selling, office, skilled, manual, etc. Look in the forward section of the magazine for additional Employment Opportunities advertising.

Positions Vacant	Civil Service Opportunities
Positions Wanted	Selling Opportunities Wanted
Part Time Work	Selling Opportunities Offered

Employment Agencies
Employment Services
Labor Bureaus

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An advertising inch is measured ⅞" vertically on a column—3 columns—30 inches to a page.

Subject to Agency Commission.

UNDISPLAYED: $2.70 per line, minimum 3 lines. To figure advance payment count 5 average words as a line.

Box numbers—count as 1 line.

Discount of 10% if full payment is made in advance for 4 consecutive insertions.

Not subject to Agency Commission.

COMMUNICATIONS APPLICATION ENGINEER

Analysis of advanced electronic communication systems including radio, carrier, telephone, microwave:

Must have design and marketing experience with commercial and military users.

EE degree, 5 yrs. exp. min.

Send Resume to:

Microwave Services International Inc.

Consulting Engineers

Route 46 Denville, N. J.

ADDRESS BOX NO. REPLIES TO: Box No. Classified Adv. Div. of this publication. Send to office nearest you. NEW YORK 36: P. O. Box 12 CHICAGO 11: 645 N. Michigan Ave. SAN FRANCISCO 11: 255 California St.

POSITION VACANT

Design Engineer—Electro Mechanical; Excellent opportunity for engineer with three years of experience in electro mechanical design. Products are precision weights and balances some of which incorporate automatic readout, recorder outputs, etc., involving electronic circuitry. Please forward qualifications stating salary desired to Ohaus Scale Corporation, 1050 Commerce Avenue, Union, N. J.

SELLING OPPORTUNITY AVAILABLE

American company in Japan is seeking distributors, commission agents or international mfgrs reps with established contacts in electronics field to sell complete line new, industrial type miniature DC electric motors ideally suited for many applications. Company currently enjoying good component sales to mfgrs of medium quality tape recorders and other consumer-grade products throughout U.S. RW-8863, Electronics.

"Put Yourself in the Other Fellow's Place"

TO EMPLOYERS
TO EMPLOYEES

Letters written offering Employment or applying for same are written with the hope of satisfying a current need. An answer, regardless of whether it is favorable or not, is usually expected.

MR. EMPLOYER, won't you remove the mystery about the status of an employee's application by acknowledging all applicants and not just the promising candidates.

MR. EMPLOYEE you, too, can help by acknowledging applications and job offers. This would encourage more companies to answer position wanted ads in this section. We make this suggestion in a spirit of helpful cooperation between employers and employees.

This section will be the more useful to all as a result of this consideration.

Classified Advertising Division
McGRAW-HILL PUBLISHING CO., INC.
330 West 42nd St., New York 36, N. Y.

OPERATIONAL SYSTEMS ENGINEER | Your new career opportunity

IBM offers career opportunities in its Operational Systems Projects organization — a career abounding with challenge and opportunity. You will work on the creation of new IBM TELE-PROCESSING® systems — an exciting new extension of computer applications in which computers, high-speed files, terminals, and communications networks are combined into balanced systems that will integrate the data-flow and processing needs of American industry. An example of such a system is IBM's SABRE—an airline reservations system.

Customer problems must be analyzed, solutions developed, data processing equipment specified, and a communications network designed. Then, the system must be installed and tested. You can help create these new systems.

You will enjoy professional freedom, comprehensive educational programs, and the assistance of specialists of diverse disciplines in gaining a wealth of know-how. Working independently, or as a member of a small team, your individual contributions are quickly recognized and rewarded. This is a unique opportunity for you to have a career with a company recognized for its outstanding growth record and stable employment.

Company-paid relocation assistance and liberal benefits apply. IBM is an Equal Opportunity Employer.

CAREER OPENINGS IN THESE AREAS:

Applied mathematics	**Systems logic design**
Applied statistics	**Systems integration**
Computer systems analysis	**Information theory**
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QUALIFICATIONS: Experience in one of the career fields; a B.S., M.S., or Ph. D. in electrical engineering, physics, or mathematics; and proven ability to assume a high degree of technical responsibility in your sphere of interest.

For details, write, outlining your background and interest, to:

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Development Laboratory
IBM Corporation
P. O. Box 390
Poughkeepsie, New York

INTERNATIONAL BUSINESS MACHINES CORPORATION **IBM**®

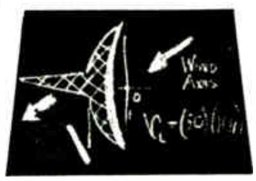
electronics

WEEKLY QUALIFICATIONS FORM FOR POSITIONS AVAILABLE

(Continued from page 76)

SORENSEN Unit of Raytheon Co. South Norwalk, Connecticut	145*	15
SPACE TECHNOLOGY LABORATORIES, INC. Sub. of Thompson Ramo Wooldridge Inc. Redondo Beach, California	13*	16
SPERRY GYROSCOPE COMPANY Div. of Sperry Rand Corp. Great Neck, L. I., New York	144*	17

* These advertisements appeared in the 4/27/62 issue.



SYNONYMS FOR YOUR FUTURE: CAREER...ACHIEVEMENT.

Working at Philco Western Development Laboratories is synonymous with playing an important role in development of communications and control systems for the nation's frontiers of space. Philco WDL designed and produced the complete satellite package for the Courier Communications Satellite program; Discoverer, Midas and Advent space age programs benefited, too, from advanced technology, research, prototype and fabrication from WDL. This adventure... complete program-oriented evolution of tomorrow's answers to tomorrow's space age challenges... is yours, if you want a career that is measured in terms of achievement. Achievement is WDL's history . . . and future.

Write in confidence for information on how you can find your career at Philco WDL, with the additional rewards of ideal living on the San Francisco Peninsula and professional and monetary advancement commensurate with your own ability. Requirements include B.S. or advanced degree (electronics, mathematics, physics), U. S. Citizenship or current transferable D.O.D. clearance. Address Mr. Patrick Manning, Department E-5.

PHILCO ***WESTERN DEVELOPMENT LABORATORIES***

A SUBSIDIARY OF *Ford Motor Company*

3875 Fabian Way, Palo Alto, California

an equal opportunity employer

7757

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• See advertisement in the July 20, 1961 issue of Electronics Buyers' Guide for complete line of products or services.

This Index and our Reader Service Numbers are published as a service. Every precaution is taken to make them accurate, but ELECTRONICS assumes no responsibilities for errors or omissions.

electronics

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Audited Paid Circulation

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McGraw-Hill Building, Copley Square, Congress 2-1160 (area code 617)

PHILADELPHIA (3):
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6 Penn Center Plaza, LOcust 8-4330 (area code 215)

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645 North Michigan Avenue, Mohawk 4-5800 (area code 312)

CLEVELAND (13):
Paul T. Fegley
55 Public Square, Superior 1-7000 (area code 216)

SAN FRANCISCO (11):
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255 California Street, Douglas 2-4600 (area code 415)

LOS ANGELES (17):
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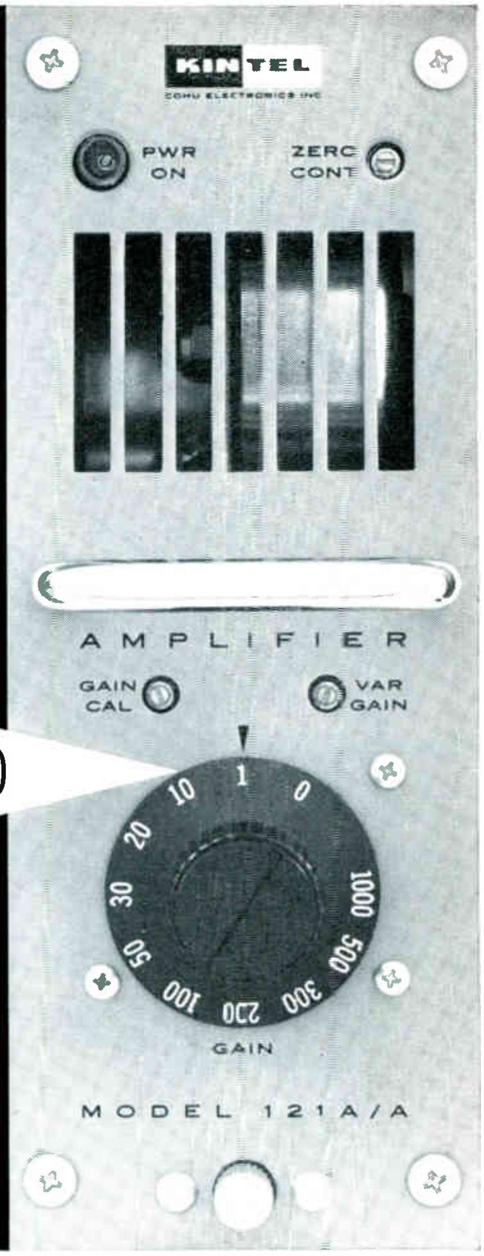

KIN TEL'S Model 121A/A non-inverting DC amplifier has fixed gains of 0, +1, +10, +20, +30, +50, +100, +200, +300, +500, and +1000. A variable gain control adjusts any fixed gain from X1 to X2.2. A gain calibration control gives ±2.5% adjustment for each gain other than +1.

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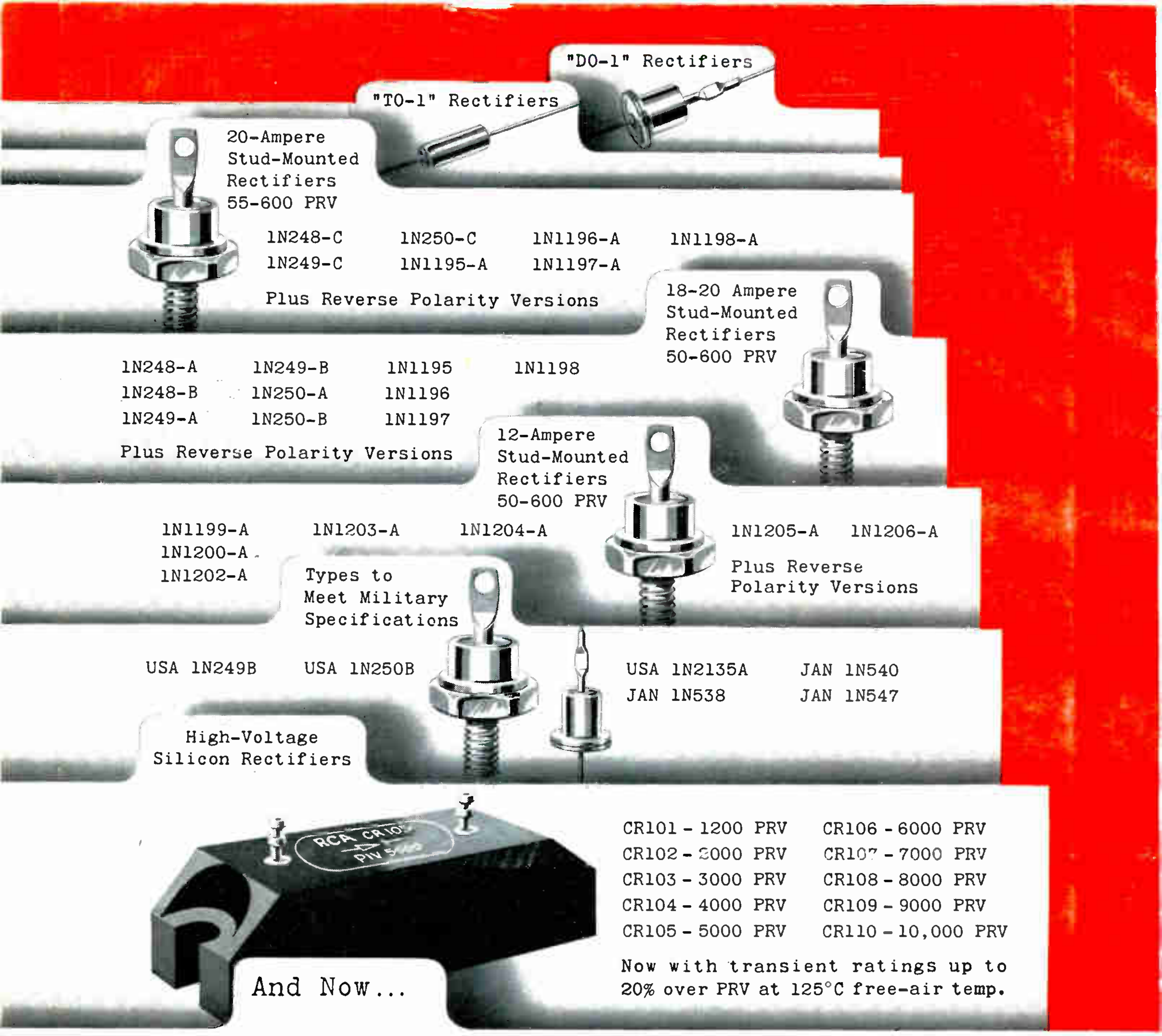

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