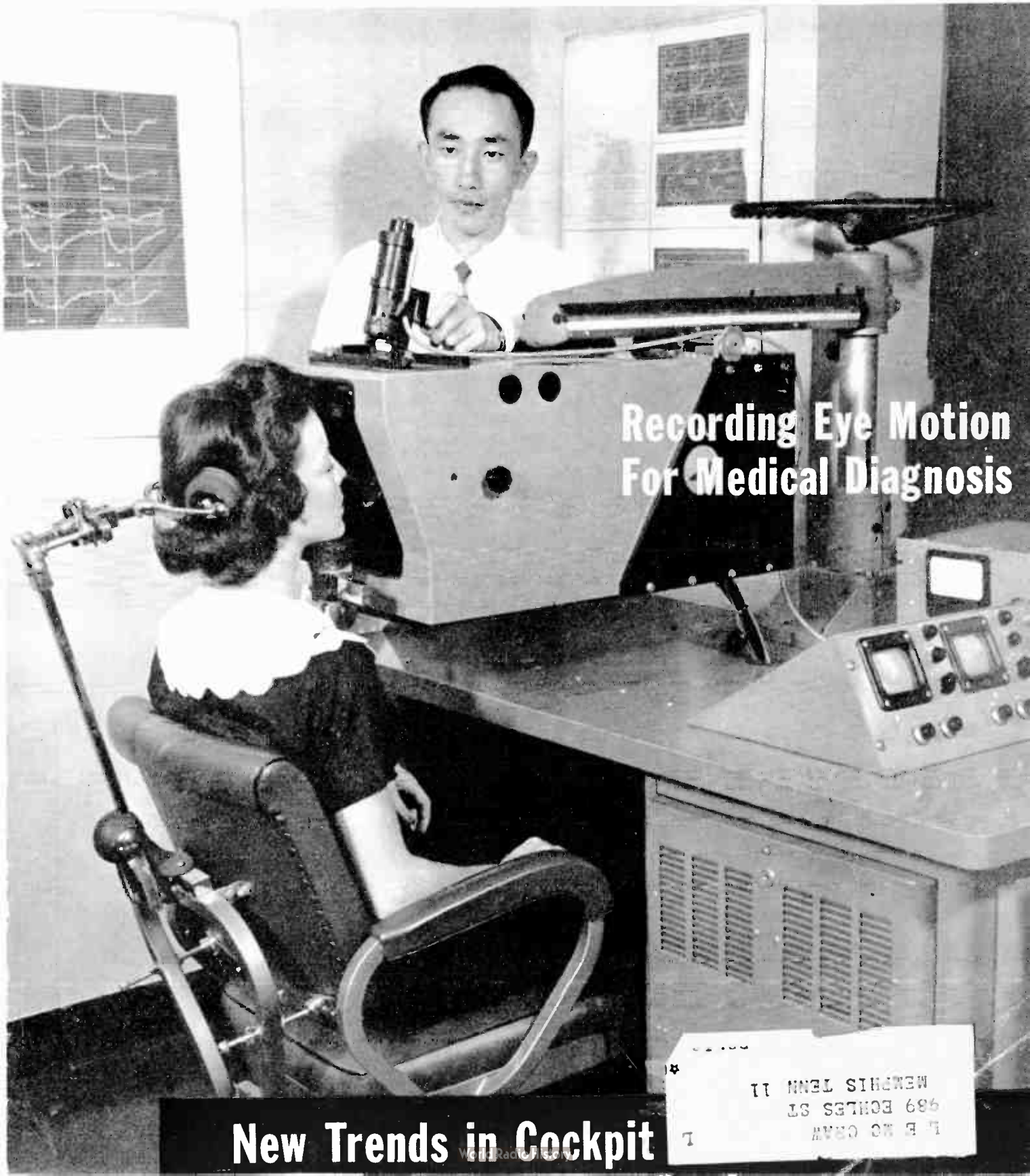
SEPTEMBER 25, 1959

electronics

A McGRAW-HILL PUBLICATION VOL. 32, No. 39 PRICE SEVENTY-FIVE CENTS



Recording Eye Motion For Medical Diagnosis

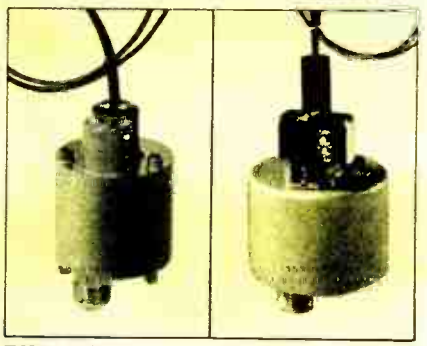
New Trends in Cockpit

Creative Microwave Technology

Published by MICROWAVE AND POWER TUBE DIVISION, RAYTHEON COMPANY, WALTHAM 54, MASS., Vol. 1, No. 5

NEW RAYTHEON MICROWAVE TUBE DEVELOPMENTS

Miniature pulsed magnetrons for missile beacon applications are ruggedly constructed with integral magnets. The RK-7461 is tunable from 9,300 to 9,500 mc and has minimum peak power output of 60 watts. It is 1¼" in diameter and 2½" long, and weighs only 6 ounces.



RK-7461 QK-735

The QK-735 is tunable from 5,400 to 5,900 mc with minimum peak power output of 400 watts. 1½" in diameter and 3¼" long, it weighs 8 ounces.

CIRCLE 182
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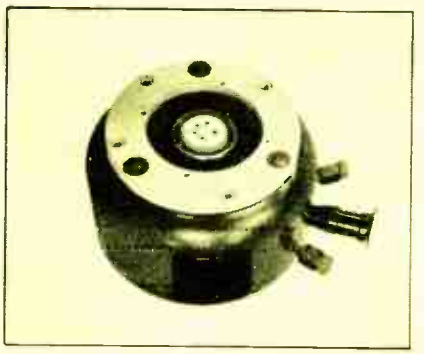
* * *

Designed for electronic countermeasures and FM/CW operations, the QK-625 BWO provides a minimum CW power output of 180 watts and a nominal CW power output of 250 to 350 watts over the 2,500 to 3,000 mc band. The tube is voltage tunable over the entire range with tuning sensitivity of approximately 0.4 mc/volt. Liquid-cooled, the QK-625 BWO is equipped with an integral



permanent magnet, and can be mounted in any position.

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* * *

Small-signal gain of up to 35 db in microwave relay links is achieved by means of a new compact traveling wave tube amplifier -- the QK-542. This permanent-magnet focused CW tube has nominal saturated power output of 5 watts over 5,900 to 7,400 mc. An integral UG 344/U waveguide-type flange is supplied as standard. With an optional coaxial output coupler the QK-542 covers 4,000 to 8,000 mc.

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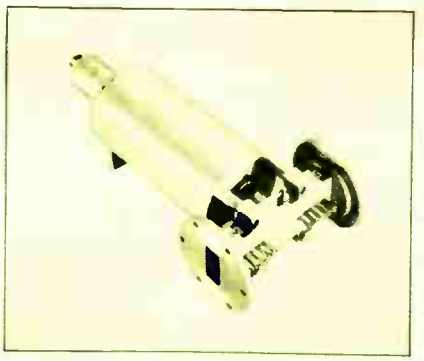

Ideal for linear accelerators and high-power radar systems. The QK-783 and QK-622 Amplitrons operate over the 2,700-2,900 mc and 2,900-3,100 mc bands, respectively, at a peak power of 3 megawatts and a typical efficiency of 75%. Because no heater is required, these tubes are capable of exceptionally long life. RF gain is 8 db under rated conditions, and as high as 12 db at lower peak power outputs. Phase pushing figure is less than 0.5 degrees for a 1% variation of anode current.

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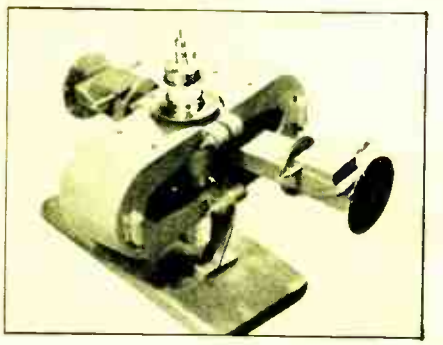


* * *

Compiled as a Raytheon service to the field, new Consolidated Data Booklet contains comprehensive information about principal unclassified magnetrons, klystrons, backward wave oscillators and special purpose tubes manufactured by Raytheon. Characteristics presented include maximum ratings, typical operating values, band or frequency ranges and other essential data for microwave engineers and purchasing departments.

CIRCLE 184
Reader Service Card

A Leader in Creative Microwave Technology

RAYTHEON

electronics

SEPTEMBER 25, 1959

A McGRAW-HILL PUBLICATION
Vol. 32 No. 39

Issue at a Glance

Business

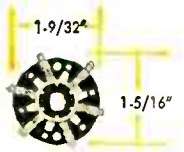
Engineering

Departments

Widest Option in Low-Power Rotary Switches

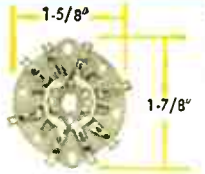
SECTIONS

THROW: 30°, 36°, 45°
INSULATION: stator glass silicone; rotor, KEL-F

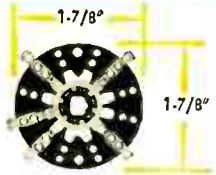


THROW: 30°, 45°, 60°, 90°
INSULATION: phenolic, Mycalex, ceramic

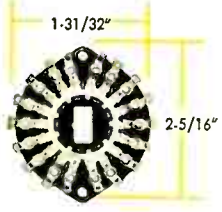
THROW: 25.7°, 30°, 36°, 45°, 60°
INSULATION: phenolic, ceramic



THROW: 18°, 20°, 30°, 36°, 45°, 60°, 90°
INSULATION: phenolic, Mycalex, ceramic

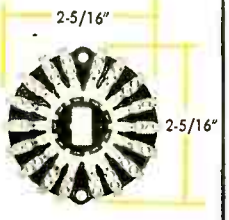


THROW: 30°, 36°, 45°, 60°, 90°
INSULATION: phenolic, Mycalex, ceramic

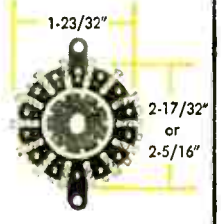


THROW: 20°, 40°
INSULATION: phenolic

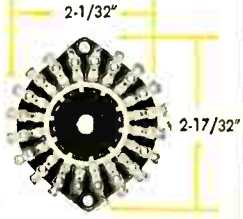
THROW: 15°, 30°
INSULATION: phenolic



THROW: 20°, 40°
INSULATION: phenolic, Mycalex



THROW: 12.85°, 25.7°
INSULATION: phenolic



THROW: 12.85°, 18°, 25.7°, 36°
INSULATION: phenolic

METAL PARTS AND FINISHES

STANDARD COMMERCIAL—Punched steel parts are lead-coated, cold-rolled steel. Parts such as nuts, lockwashers, etc., are cadmium-plated steel. Shafts may be cadmium-plated steel, brass, or aluminum. Brass parts are unplated.

TROPICAL OR 50-HOUR SALT SPRAY MILITARY SPECIFICATIONS—All steel and brass parts are cadmium-plated and chromate-dipped. Stainless steel parts are passivated.

200-HOUR SALT SPRAY MILITARY SPECIFICATIONS—All brass parts are nickel plated. All stainless steel parts are passivated. Shafts, "C" washers and index springs, balls and plates are stainless steel.

CONTACTS

Famous Oak double wiping, high-pressure design. Riveted or eyeleted in place and keyed from turning. Rotors shorting or nonshorting.

TYPE 1—Contacts are spring brass, silver-plated. Rotors are brass, silver-plated. Temperature limit: 100°C constant ambient.

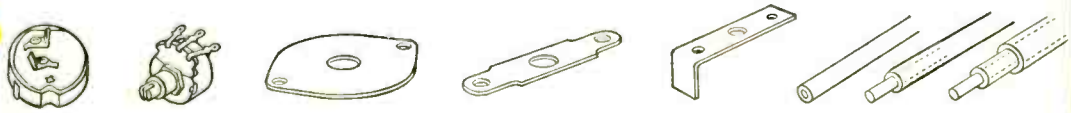
TYPE 2—Contacts, spring tempered-silver alloy. Rotors, coin-silver alloy. Temperature limit: 100°C constant ambient.

TYPE 3—Contacts and rotor blades made of Oak alloy CMS-202. This is a special alloy for high temperature operation to 150°C.

GOLD-PLATED CONTACTS—Type 1 or 2 contacts may be gold-plated .0002" thick. Not to be confused with gold flash.

FOR PRINTED CIRCUITS—Standard Oak contacts with a lug extending from the terminal end. Lug inserts in board for dip soldering.

ACCESSORIES



AC SNAP SWITCHES—36 models for use on most switch types. All are UL approved.

POTENTIOMETERS—Customers' choice. Mounts on rear of Oak switches. Operates by switch shaft or separate concentric shaft.

ELECTROSTATIC SHIELDS—Used between sections. Sizes and shapes for all switches.

BEARING STRAPS—Added shaft support on long switches. Steel, brass, and phenolic.

MOUNTING BRACES—Prevents frame twist on long switches due to torsion.

SPECIAL SHAFTS—Hollow, dual-concentric, and triple-concentric for many switches.

OAK MFG. CO.

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Phone: MOhawk 4-2222

When your design calls for a low-power rotary switch, you want a unit that matches job requirements exactly—not an "almost" fit. But in the process you don't want the switch to involve a lot of extra tooling and delay either. At Oak, the above options, plus numerous other alternatives in construction, are *pretooled* for economy, service, and convenience.

Lambda Power Supplies specified for newest radar installation

"Off-the-shelf" Lambda power supplies —modified only with special panels, MIL meters and tubes—will be part of the complex radar equipment housed in the 85-foot tower at Thomasville, Alabama, one of four identical installations.

Meet MIL-E 4158 environmental test requirements

Sperry Gyroscope Co., operating under the technical guidance of the Rome (N.Y.) Air Development Center, is producing the new SAGE radar equipment (AN/FPS-35). The power supplies employed to power transmitters and receivers must be able to pass stringent tests.

Sperry's choice: Lambda's COM-PAK,® already widely used as a component in many rocket and missile programs.

All Lambda stock industrial power supplies are made to MIL quality and *guaranteed for five years.* They are pictured and described in a new 32-page catalog. Write for your copy.

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electronics

September 25, 1959 Vol. 32, No. 39

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SHOPTALK . . . editorial

COMPONENT RESEARCH & DEVELOPMENT. Fear of some component manufacturers continues to be that they may suddenly find a large portion of their conventional product line made obsolete by radical technological change. How much basis is there for this fear, and what can be done to reduce it?

Three important trends have been slowly but surely gaining ground in the design of electronic equipment: packaged circuits, miniaturization and microminiaturization.

Packaged circuits involve putting several components together in a functional unit. Some manufacturing responsibilities are thus transferred from the equipment manufacturer to the components maker. This approach lends itself well to equipment involving circuit redundancy, as in large-scale digital computers. It lends itself less well, at least at this moment, to some other types of equipment.

Miniaturization involves use of smaller components. By and large, component manufacturers themselves have led the way in this direction, with an assist from the military that has led to increased consumer demand. But the practical limit appears to be the size of the largest component in a piece of equipment, such as the loudspeaker in a radio or the picture tube in a tv set.

In microminiaturization, the newest of the three approaches, the conventional component could disappear entirely. Among the methods of fabrication are vacuum deposition of resistive and conductive films to form passive circuits to which transistors are then joined, and fabrication of monolithic circuits from single semiconductor blocks in a manner that simultaneously provides both passive and active components. And there will be more such approaches, not necessarily limited to semiconductors.

Thus far, microminiaturization has been aimed largely at specialized military and scientific applications. Most developments are still in the laboratory stage. The difficulty of obtaining inductance is one problem to be overcome. Another is the dissipation of heat.

We're obviously talking about a revolution, but not a sudden one. One answer to fear of change, where it exists, is to keep abreast of these new techniques. A solid-state research group is a good investment, and one that pay off in many other ways.

Coming In Our October 2 Issue . . .

HIGH MAGNETIC FIELDS. In electronics and physics research laboratories, equipment for the generation of magnetic fields of high intensity is an indispensable tool. In nuclear resonance measurements, maser research, plasma studies for thermonuclear fusion, investigation of the energy-band structure of semiconductors, and in millimeter and sub-millimeter wave radiation for communications and missile detection, the generation of magnetic fields is essential. According to H. H. Kolm, of MIT's Lincoln Laboratory, activity in these fields has stimulated much interest in the problem of generation of high continuous fields over large volumes. Kolm's survey of the state of the art points up the need for sophisticated instrumentation and complex electronic equipment in this area.

SENSITIVE TRANSDUCER. A crystal oscillator circuit, using only one tube, is described by L. J. Rogers of the special instrumentation division of Union Carbide. This simple yet sensitive device is used in conjunction with a small, nonhazardous sensing head, which can be remote from the oscillator and other parts of the system. Transducers constructed with this system can measure pressure, displacement or temperature in chemical plants or other hazardous locations. Use in medical research or in aircraft and missile guidance appears feasible.

SPRAGUE® RELIABILITY in these two dependable wirewound resistors

MINIATURE

Blue Jacket®

VITREOUS-ENAMEL POWER RESISTORS

Sprague's new improved construction gives even greater reliability and higher wattage ratings to famous Blue Jacket miniature axial lead resistors.

A look at the small *actual sizes* illustrated, emphasizes how ideal they are for use in miniature electronic equipment with either conventional wiring or printed wiring boards.

Get complete data on these dependable minified resistors, **write for Engineering Bulletin 7410.**

TAB-TYPE BLUE JACKETS: For industrial applications, a wide selection of wattage ratings from 5 to 218 watts are available in Sprague's famous Tab-Type Blue Jacket close-tolerance, power-type wirewound resistors. Ideal for use in radio transmitters, electronic and industrial equipment, etc. **For complete data, send for Engineering Bulletin 7400A.**

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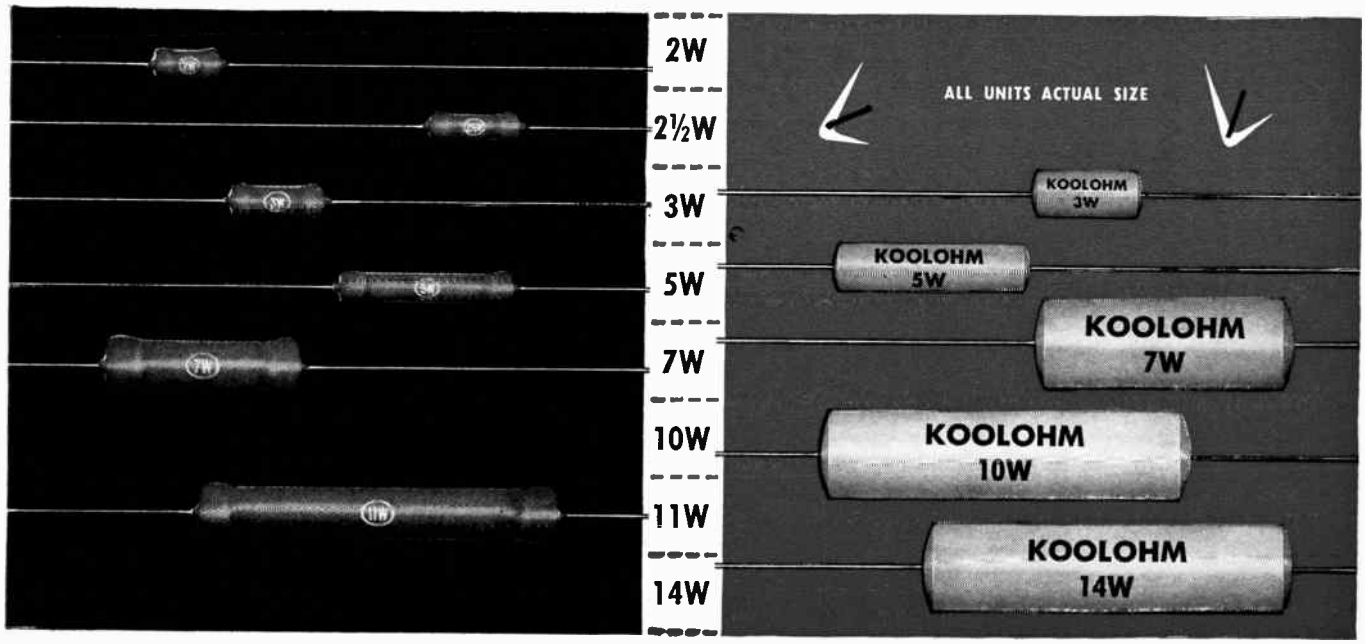
You can depend upon them to carry maximum rated load for any given physical size.

Send for Engineering Bulletin 7300 for complete technical data.



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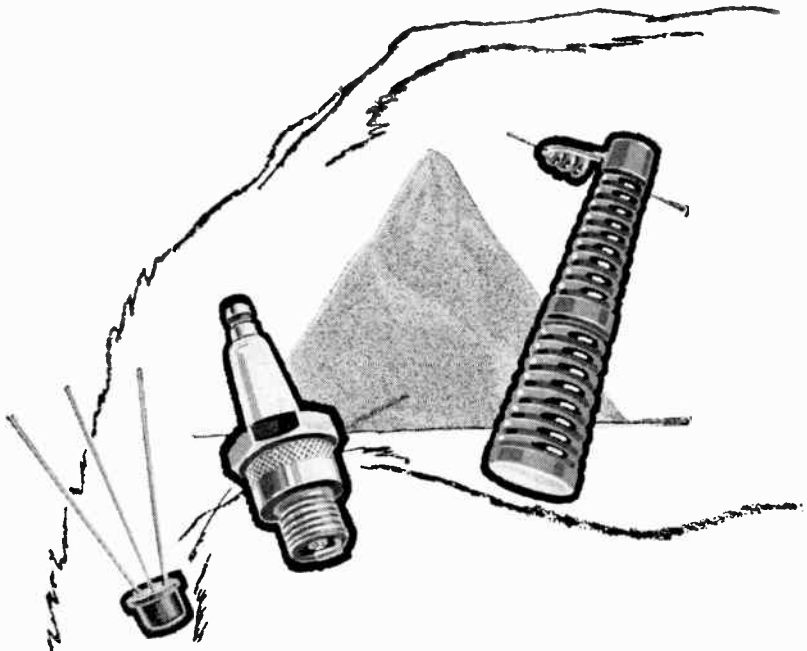

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Think of Norton Ceramic Compositions as essential components in equipment for metal and chemical processing, electrical, electronic, ceramic and nuclear applications . . . as "the answer" to literally hundreds of design problems. They're manufactured to meet highly exacting standards of purity, density, shape, size and wear resistance . . . available in granular and in fabricated form to meet *your* requirements efficiently and economically. For complete details, write for "Norton REFRACTORY GRAIN". NORTON COMPANY, Refractories Division, 938 New Bond Street, Worcester 6, Mass.

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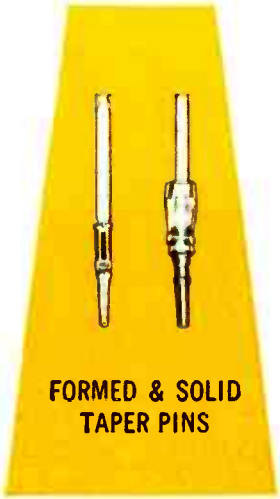

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If miniaturization has put your circuits in a tight spot, you can build reliability right into them with the AMP Taper Technique . . . formed taper pins or new solid, pre-insulated taper pins . . . two-piece or molded one-piece stackable blocks . . . plus a wide assortment of taper receptacles.

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And—with the addition to the AMP Taper Technique of the new Solid Pre-Insulated Diamond Grip Taper Pin and the new one-piece warp-free block, you can have the greatest flexibility of product choice for your circuit design and manufacturing operations.

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Sylvania has perfected a process by means of which germanium of high purity is cast in forms suitable for optical purposes . . . in sizes hitherto impracticable to manufacture (See panel for samples of work already delivered and in process).

Sylvania cast germanium is now in use in vital infrared systems . . . passive radar, missiles, reconnaissance equipment, spectroscopic devices, etc. Its industrial applications are just beginning to be explored.

As a prime supplier of both single crystal and polycrystalline germanium in all its usable forms, *Sylvania invites your inquiries.*

Transparency range
2-15 microns

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to 8½" dia.,
6" thick

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to 8½" dia.,
6" high

Strips—odd shapes
to 16" length

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to ½" dia.,
24" length
(Larger diameters in shorter lengths)

Sheets
to 8" x 16" x ½"

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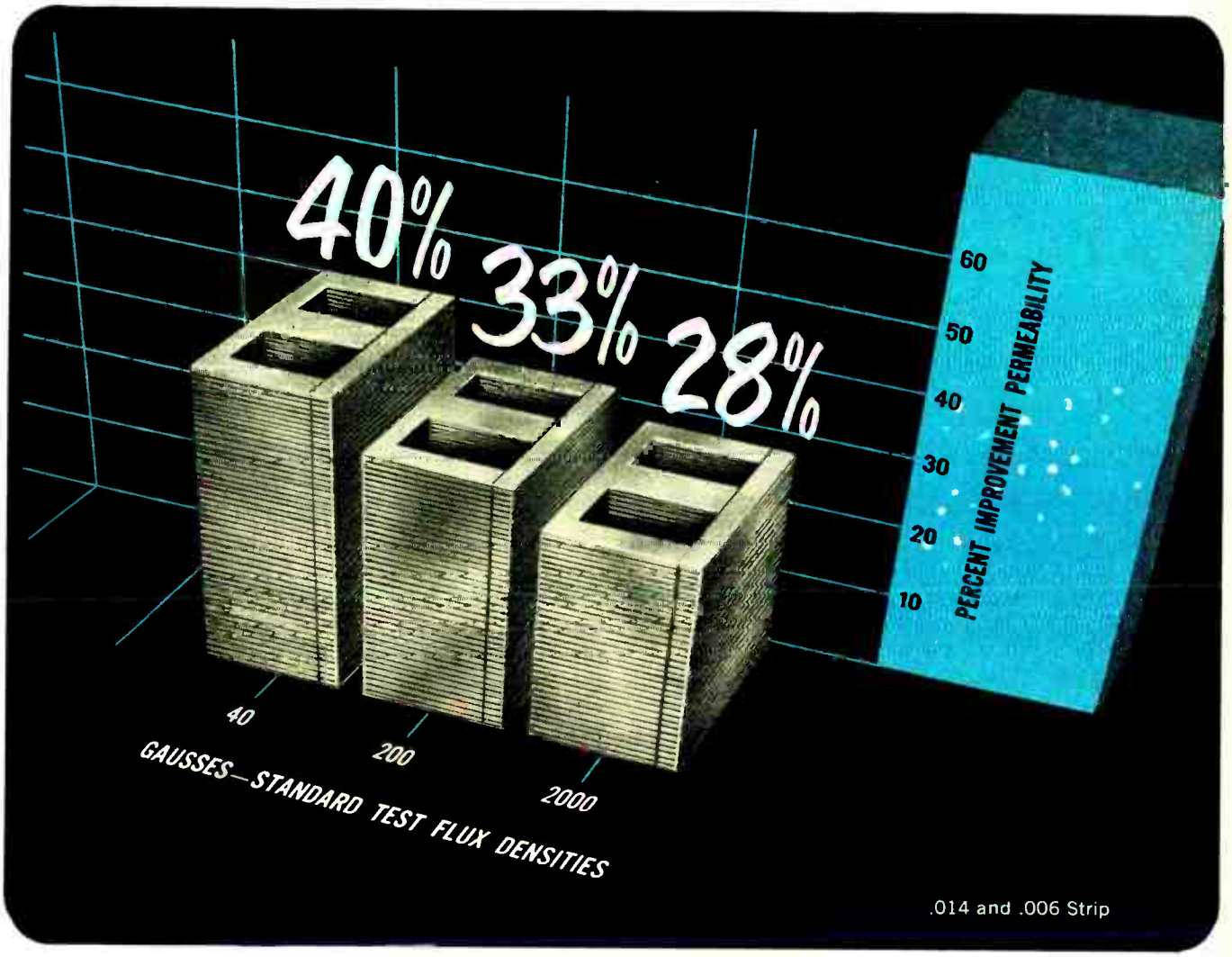

Higher permeability values now guaranteed for Allegheny Ludlum's Moly Permalloy

Means new, consistent and predictable magnetic core performance

Molybdenum Permalloy nickel-iron strip is now available from Allegheny Ludlum, with higher guaranteed permeability values than former typical values. For the buyer, this new high quality means greater uniformity . . . more consistent and predictable magnetic core performance.

This higher permeability is the result of Allegheny Ludlum's intensive research on nickel-bearing electrical alloys. A similar improvement has been made in AL-4750 strip steel. A-L continues its research on silicon steels, including Silectron, well-known grain-oriented silicon steel, and other magnetic alloys.

Complete facilities for the fabrication and heat treatment of laminations are available from Allegheny Ludlum. In addition, you can be assured of close gage tolerance, uniformity of gage throughout the coil, and minimum spread of gage across the coil-width.

If you have a problem relating to electrical steels, laminations or magnetic materials, call A-L. Prompt technical assistance will be yours. And write for more information on Moly Permalloy. ***Allegheny Ludlum Steel Corporation, Oliver Building, Pittsburgh 22, Pa.***

Address Dept. E-21.

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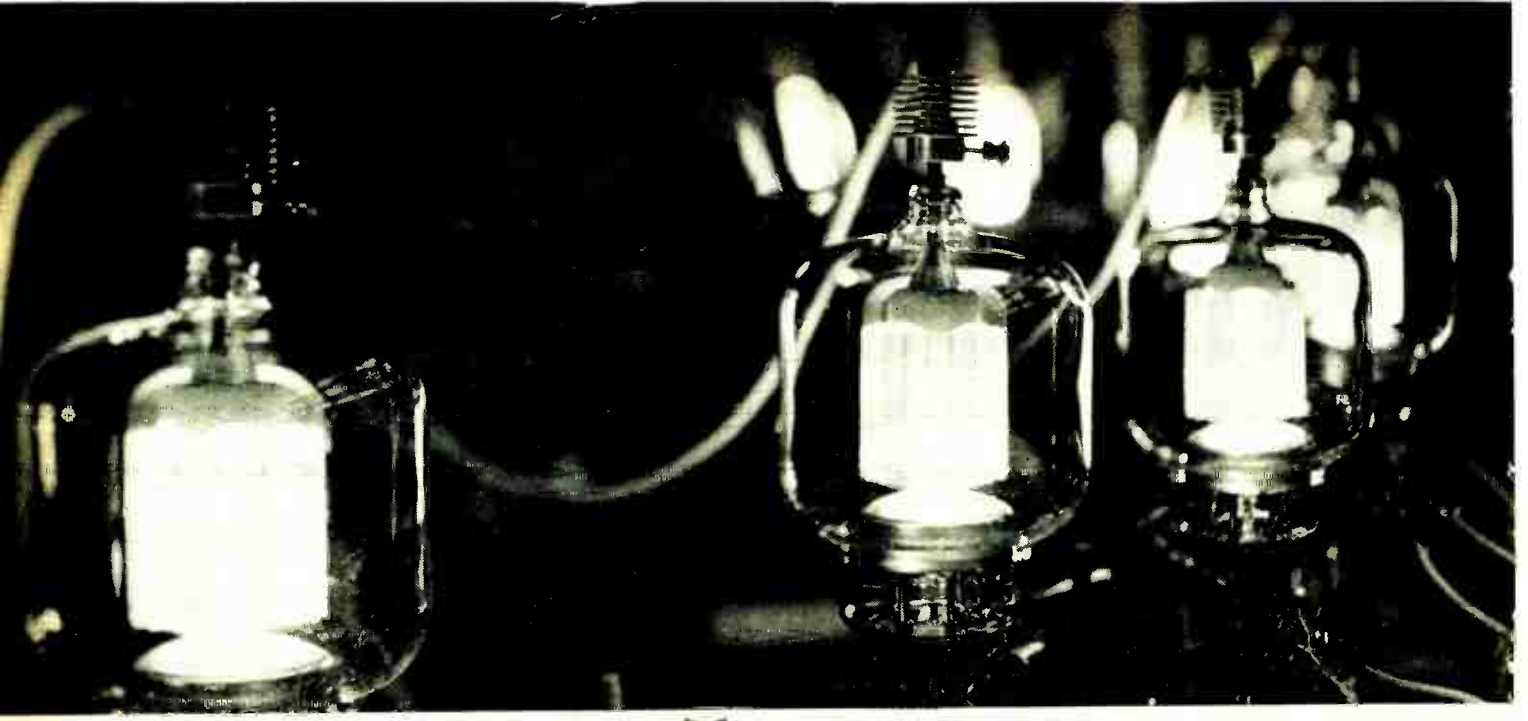

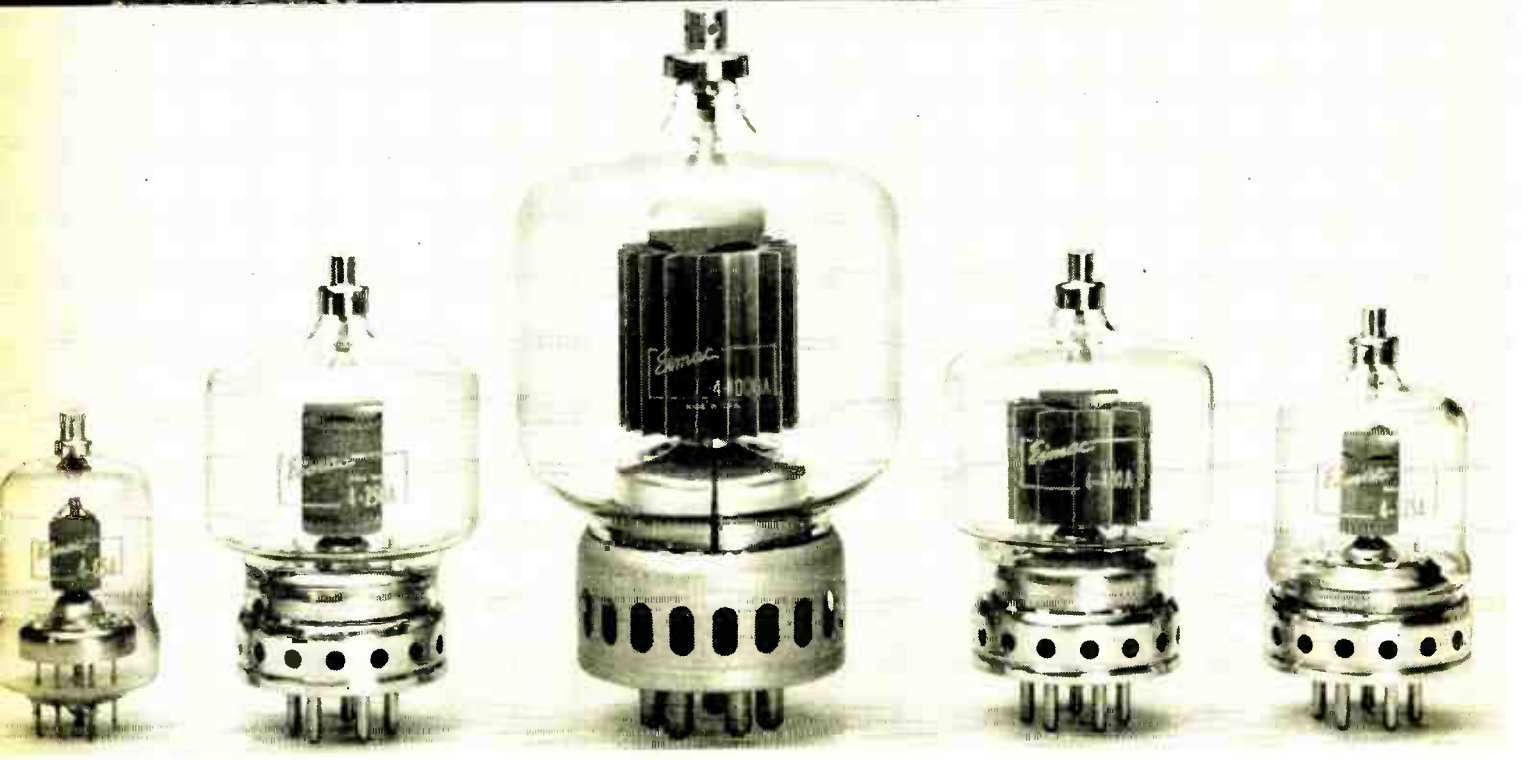

EIMAC PIONEERED INTERNAL-ANODE TETRODES PERFORMANCE LEADERS FOR OVER A DECADE

Developed and introduced to the industry in the mid 1940's, Eimac's line of internal-anode radial-beam tetrodes immediately received widespread and enthusiastic acceptance. Well over a million have been sold since that time. These tubes, quality leaders from the very start, still maintain that position through advanced processing techniques, inherently sound design and continuing concern with production refinements.

Clean electrode design, for example, and the exceptionally hard vacuums achieved on Eimac-developed rotary vacuum pumps, result in consistently reliable tubes with an exceptional ability to withstand high momentary overloads and peak powers. Rugged filament design with high reserve emission contributes greatly to their reliability and long life.

Stable operation at high frequencies is assured by low inter-electrode capacitances and low lead inductances. Driver requirements and associated circuitry are simplified by the high power gain and low driving power requirements of these tube types.

These features, plus other Eimac design innovations such as the Pyrovac* plate and non-emitting grids make Eimac internal-anode tetrodes your logical choice for new equipment designs, as well as tube replacements, when exceptional performance and reliability are required. Most types available for immediate delivery.

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San Carlos, California

ELECTRONICS NEWSLETTER

COMMUNICATIONS-TRACKING ANTENNAS will be installed for Project Courier—Army Signal Corps' orbiting teletypewriter relay station scheduled to go up this spring (ELECTRONICS, p 52, Sept. 11). Hawaii and Puerto Rico are under consideration as locations for antennas. The 28-ft diameter antennas are mounted on a 40-ft steel pedestal built on concrete pads 20 × 20 ft. Housed within each pedestal will be an instrumentation complex that includes four racks of control equipment, a control console, signal tracking display, plus azimuth and elevation indicators. The servo system provides for fast antenna control in local, remote and automatic tracking modes, and for "coasting" at a memorized rate when a temporary signal loss occurs. Other gear may be slaved to the antenna. Sector scan is provided in either remote or local operation modes, and secant correction is supplied for near-zenith tracking. Antenna system was designed and built by Radiation, Inc.

Electronic gear for extracting data from photographs of very low contrast has been devised by the Air Force and described in a report just released by the Office of Technical Services, U. S. Department of Commerce.

RADAR ANTIJAMMING DEVICE developed by Temco Electronics division of Temco Aircraft with its own funds has just been classified by the Defense Department. But this much was already known: The device, attached to a radar, eliminates natural as well as manmade interference, including random white noise. Black box design can be modified to accommodate any radar by a simple change in the final output circuit configuration. Commercial possibilities include clear, close-in presentation of ships on a collision course and the filtering out of noise around air traffic control radars. Jamming caused by proximity of other radar installations is also counteracted.

Strategic Air Command headquarters can now transmit weather maps of the northern hemisphere by facsimile to all SAC facilities in the U. S. in 28 minutes.

MAGNETIC DOMAIN INTERACTION is basis of RV-2 airborne digital computer being developed by an Army-Navy Instrumentation Program (ANIP) team consisting of Douglas Aircraft, Servomechanisms, Varo Mfg. and Litton Industries. Servomechanisms, which has been researching the use of magnetic domain interaction in thin evaporated films, says this approach "should do much to miniaturize digital circuitry and increase its reliability." Magnetic domain memory and logic elements are fabricated by high vacuum thermal evaporation techniques. The RV-2 computer is slated for completion in about two years.

SECOND VENUS RADAR PROBE from MIT Lincoln Laboratory's Millstone Hill installation in Westford, Mass. took place this month. In the latest experiments, a lower sideband up-converter type parametric amplifier using a silicon mesa diode was substituted for the uhf maser which provided the low-noise receiving front end in the first series of interplanetary radar contacts (ELECTRONICS, p 35, Apr. 17, '59). Most favorable time in the new series came in first week of September, when Venus passed relatively close to earth. Runs were begun several weeks before, and were continued after the optimum date. Among the new experiments was an attempt at real-time digital processing of the signals. In the first series, signals were directed at Venus in February 1958; it wasn't until March 1959 that success was announced, after cross-correlation studies of the "frozen" data established genuinity of the return signals.

NATIONWIDE CHAIN of large-scale computer service centers is planned by C-E-I-R, Inc., which now operates an independent commercial computing service in Arlington, Va. Firm says it will install $25 million worth of computer gear in five cities, starting with three IBM 7090's in New York, Houston and Washington; Chicago will get a comparable machine next year, Los Angeles another one in 1961.

During recent war game an IBM 704 computer at Strategic Air Command headquarters made up individual flight plans for 2,100 bombers that took off from 70 bases bound for different targets. The bombers had to fly through varying altitude and weather conditions. Work took 10 man hours, with three men working 3½ hours. Navigators would have needed about 3,000 man hours to do the job.

LABORATORY EQUIPMENT for instructional use in high schools and colleges is being developed by universities, professional scientific organizations and research institutes under new National Science Foundation grants totaling $189,000. Among the aids: modified research gear for quantitative experiments on the properties of waves for college physics courses; an inexpensive digital computer easily assembled for mathematics courses; a set of about 30 instrument "building blocks" which illustrate fundamental principles involved in complex instrumentation and can be used to build 35 instruments for analytical chemistry; aids for instruction in design and use of analog computers.

MINUTEMAN PCM TELEMETRY responsibility is now claimed by Radiation Inc. with the announcement two weeks apart of two contracts from Boeing totaling $5.9 million.

NEW FROM NARDA

Wide Range

KLYSTRON POWER SUPPLY—$475.00 Model 438

Operates more Klystrons than any comparable unit!

This new Narda Wide Range Klystron Power Supply operates virtually all medium and low voltage Klystrons, as well as some high voltage tubes (at reduced power output). It literally operates more Klystrons, including Sperry and Varian tubes, than any other unit in its price range!

What's more, all components, including tube sockets, are operated within manufacturers' ratings. (Many other supplies exceed plate-cathode, cathode-filament or socket-ground voltage ratings.)

Want more information about this new Power Supply that gives you greater versatility and longer trouble-free service at lower cost? Then write us for complete spec sheets. Ask, too, for your free copy of our complete catalog. Address: Dept. E-6.

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- **Accurate Ten-Turn Dial Calibration**
- **5 mv max. Reflector Ripple**
- **Diode Protection Circuit**
- **Oil Filled Capacitors in High Voltage Filters**
- **Square Wave Modulation 0-150 Volts, 300 to 3000 cps.**
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- **Sine Wave Modulation 0-150 Volts, 60 cps.**

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New

CRYSTAL CAN

5 amp Relay

GENERAL FEATURES

Contact Arrangement:
Two pole double throw.

Contact Rating:
d-c non-inductive—low-level
up to 5 amperes at 29 volts.

a-c non-inductive—low-level
up to 2 amperes at 115 volts.

a-c or d-c inductive—1 ampere
at 29 volts d-c and 115 volts a-c.

Initial Contact Resistance:
.05 ohms maximum.

Minimum Operate Sensitivity
100 milliwatts with a contact
rating of 2 amperes non-inductive.

Ambient Temperature:
−65°C to +125°C.

Dielectric Strength:
1,000 volts rms at sea level.
450 volts rms at 70,000 feet.
350 volts rms at 80,000 feet.

Insulating Resistance:
10,000 megohms minimum.

Vibration:
5-28 cps at 0.5 inch double
amplitude and 28-2000 cps at 20 g.

Shock: 50 g operational. 100 g mechanical.

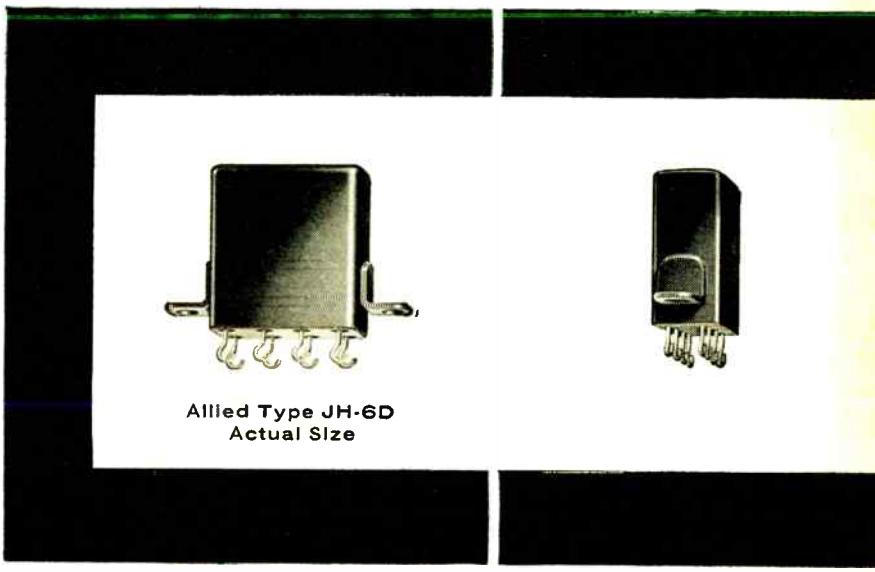
Operate Time:
10 milliseconds or less at rated voltage at 25°C.

Release Time:
5 milliseconds or less at rated voltage at 25°C.

Maximum Over-all Dimensions:
height 1.0″ length 0.8″ width 0.4″.

Terminals:
0.2 inch grid spaced. Plug-in printed circuit
and hooked type solder terminals.

Weight: 0.8 ounces maximum.



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CIRCLE 12 ON READER SERVICE CARD

WASHINGTON OUTLOOK

WASHINGTON—U. S. SPACE EXPERIMENTATION, still running at a fair head of steam, may be accelerated in the wake of the successful Soviet moon-shot. U. S. scientists acclaim the shot as a major scientific achievement, also hope it will reverse the recent mild trend toward trimming space budgets.

Four major space experiments are planned for the rest of this year by National Aeronautics and Space Administration. First, tentatively set for Sept. 30, is an earth satellite shot that will attempt to put some 91 lbs of instruments into orbit around the earth, primarily to measure radiation.

The U. S. try for a moon satellite—to go around the moon and photograph its hidden face—is scheduled for around Oct. 4. Then in late October or early November an attempt will be made to put a satellite into the same orbit as Venus—not around the planet, but in its orbital path.

Another deep-space probe to go beyond the earth's gravitational pull is planned for later in November. And there will be more tests this year of the vehicles that will carry a man into space next year.

Besides these NASA experiments, the armed services will also be conducting space shots of their own. Late in September a communications satellite is scheduled to be launched. And additional polar-orbit satellites are planned by the Air Force in its Project Discovery series.

Up to now, the U. S. space program has largely been run with makeshift military weapons, mostly modified Atlas, Thor and Jupiter missiles. By mid-1960, however, the first of a series of specially developed space launching craft will be coming into use. Result should be less trial and error, more firm and reliable experiment.

- **House Armed Services Investigations subcommittee,** under Rep. F. Edward Hebert (D., La.), has completed separate inquiries into defense contracting and into the defense industry's employment of retired military brass. The subcommittee is now hammering out recommendations to be made in January when Congress reconvenes.

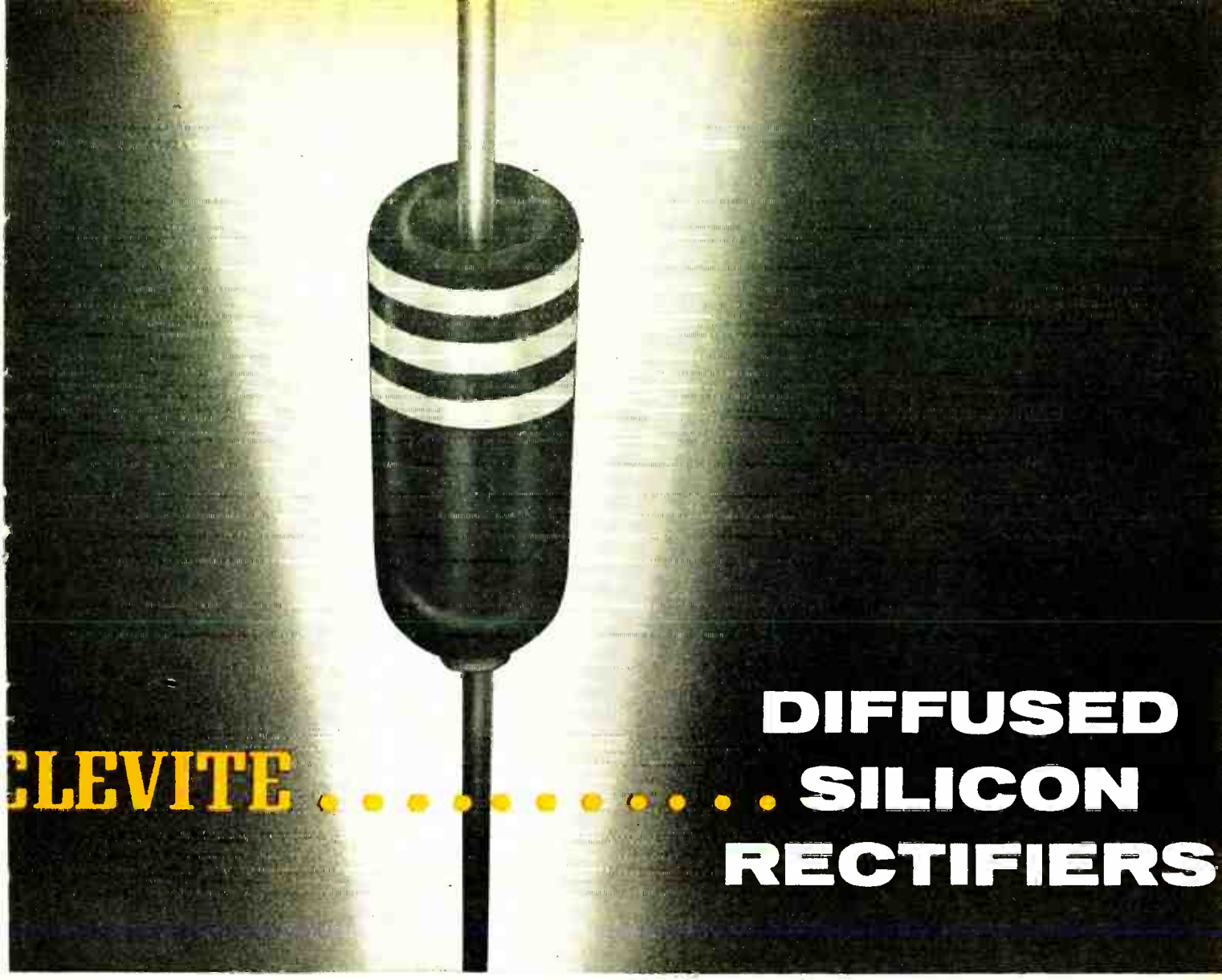
  On the contracting side, the Hebert committee will probably recommend tougher verification of contractors' cost estimates and tighter military scrutiny of contract performance. Pentagon is already pushing through such measures administratively; legislative action would throw the weight of Congress behind the Defense Department's administrative moves.

  The new restrictions were generated by General Accounting Office disclosures that the government was overcharged a total of $42.2-million during two years in 12 Air Force and 14 Navy contracts.

- **On the other issue—that of retired brass** in defense industry—the outlook for Congressional action is not as clearcut. The question cannot easily be clarified by statute. Besides, Congressional investigators were unable to come up with specific cases of procurement hanky-pinky involving influence-peddling by retired brass.

  Present laws forbid retired officers from selling to the military. Hebert wants to spell out in law just what "selling" constitutes. He also wants to liberalize the rules restricting retired officers from taking civil service jobs. He thinks such action would retain military talents for the government, discourage defense industry recruitment of the retired brass.

  Some lawmakers are pushing for rules to bar retired officers from industry contact with military projects with which they were directly responsible while in uniform. But any new curbs are unlikely to discourage industry from hiring retired military men.



CLEVITE . . . . . DIFFUSED SILICON RECTIFIERS

TECHNICAL DATA:

Diode Type	Maximum DC Inverse Operating Voltage (volts)	Maximum Average Forward Current @ 25°C (ma)	Maximum Forward Voltage Drop @ 25°C (volts @ ma)
1N645	225	400	1.0 @ 400
1N647	400	400	1.0 @ 400
1N649	600	400	1.0 @ 400
1N677	100	400	1.0 @ 400
1N681	300	200	1.0 @ 200
1N683	400	200	1.0 @ 200
1N685	500	200	1.0 @ 200
1N687	600	200	1.0 @ 200

Clevite offers silicon rectifiers designed for maximum reliability in the severest military and commercial applications.

Check these features:

- **HIGH DISSIPATION — 600 mw**
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- **HIGH VOLTAGE — up to 600 volts**
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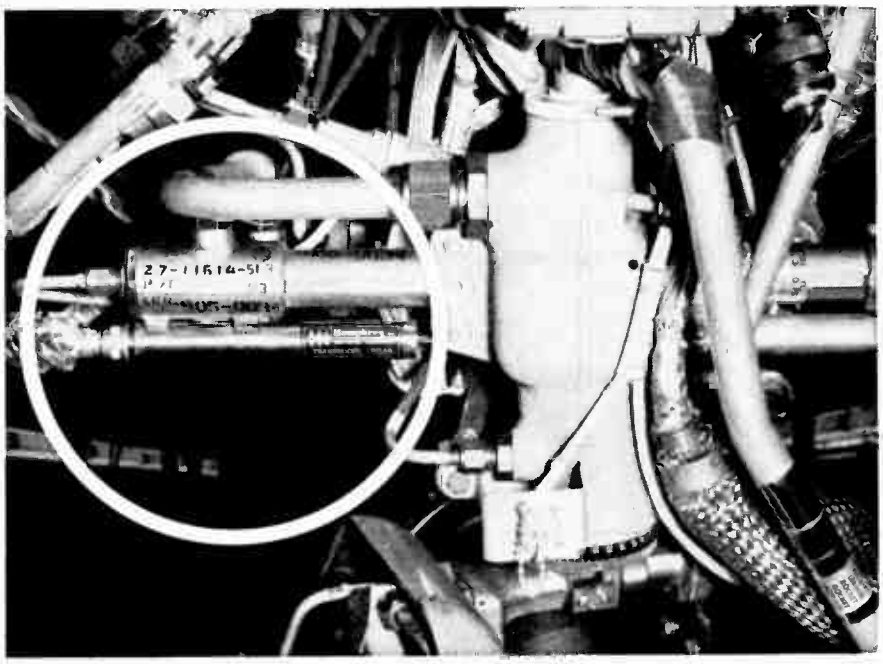

Humphrey potentiometer measures position of vernier rockets on Atlas

The above photograph of a vernier rocket on the Atlas intercontinental ballistic missile shows the installation of the Humphrey RP-23 linear potentiometer. This transducer measures the vernier engine pitch and roll displacement for the telemetry system. The signal is fed to the telemetering package for transmission to the ground, providing an exact record of the operation of the vernier engine pitch-roll motion during missile flight.

The Humphrey RP-23 linear potentiometer offers extremely low resolution, down to less than 1/1000 of an inch. Accuracy is better than .1%. It is completely pressure-sealed in a stainless steel case to withstand tough environmental conditions. Service life of the potentiometer is in excess of one million cycles.

Humphrey makes a complete line of linear and sector potentiometers for severe duty applications. Typical of the environmental conditions they are meeting in current missile applications are vibration 25 G, 10 to 2,000 cps, and shock of 100 G while operating.

Humphrey Potentiometers are available in a wide selection of standard models. Precision pots such as the RP-23 shown here are available for immediate shipment. Specialized types to your specifications can be built on short notice. Development, qualification and production of hardware on the RP-23 all took place in 60 days.

Phone or write today for information on Humphrey ruggedized precision potentiometers. Humphrey, Inc., Dept. E-99, 2805 Canon Street, San Diego 6, Calif.

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ELECTRO-MECHANICAL INSTRUMENTS

GYROSCOPES, ACCELEROMETERS, POTENTIOMETERS
WHEN OTHERS CAN'T—HUMPHREY CAN!

One of the earliest and most basic breakthroughs in fastener design was the common safety pin. And, although DOT is not a manufacturer of safety pins, many a DOT industrial fastener has had an equally revolutionary effect on modern fastening technique. Hundreds of different DOT fasteners have created relatively minor revolutions in specific industries.

A DOT fastener may save a few man-minutes of labor. It may save material. Or it may improve product performance and hence saleability. But multiply each small improvement by the number of units in a true mass-production operation and the savings really pile up to impressive proportions.

Rather than spend your own design staff's time on fastening problems, it might pay you well to call in DOT. You'll have at your service a design and production organization with large-scale facilities for genuine mass-production of special-purpose fasteners and self-fastening devices of all kinds.

Supplementing the Carr Fastener Company are a number of other plants which form the United-Carr Fastener group. They are located in the principal production centers of the United States, Canada, England and Australia. Your nearest United-Carr Field office (see below) is no further away than a telephone call from your desk.

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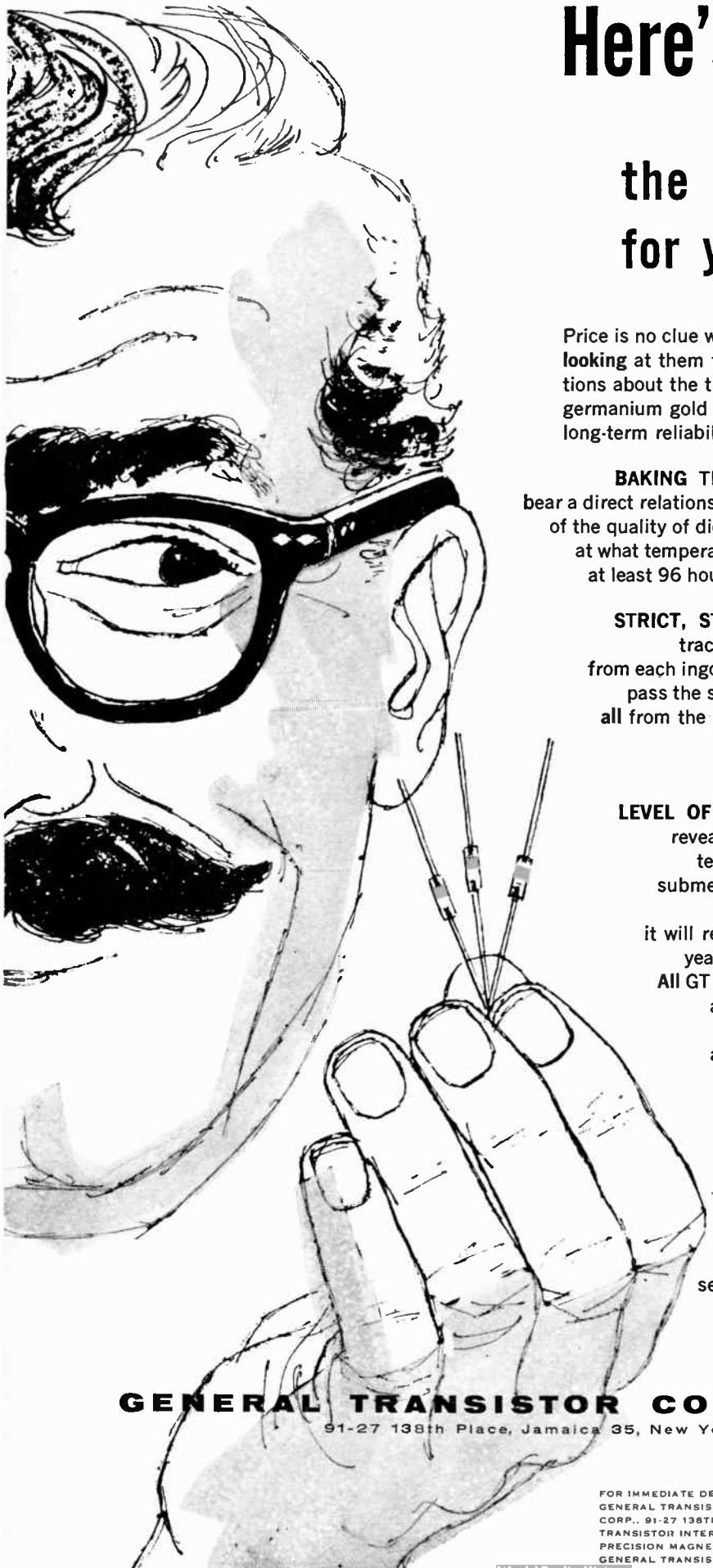

Here's how to pick the best DIODES for your money

Price is no clue when diodes sell for about the same, and just **looking** at them tells nothing. But if you ask the right questions about the three key factors in the production of **quality** germanium gold bonded diodes, you have your clues to more long-term reliability for your money. Here they are:

BAKING TIME AND TEMPERATURE
bear a direct relationship to long-term stability. You get a measure of the quality of diodes by asking: "How long do you bake, and at what temperature?" (**All** GT diodes are baked at 140°C for at least 96 hours—the highest and longest in the industry!)

STRICT, STATISTICAL, HISTORY LOGGING
traces the progress of every single wafer made from each ingot of germanium. At GT, if a few wafers fail to pass the stringent GT quality tests along the way, then **all** from the ingot are suspect and can be identified and pulled out. There are no "stowaways" in a shipment of GT quality diodes.

LEVEL OF TESTING STANDARDS
reveals the level of quality. Ask about "everyday" test standards. (In the GT Seal Test, diodes are submerged in a penetrant-dye solution for 24 hours under 75 psi. This test is so sensitive that it will reveal a leak so small it would take over 300 years for 1 cc of gas to diffuse through the case.) **All** GT quality tests—100% electrical, 100% shock and vibration, and 100% temperature cycling—are at the highest industry level... and as a final mark of quality, the color bands on GT Germanium Gold Bonded Diodes are baked on to stay.

GT is equipped to supply diodes tested to individual customer requirements, such as JAN Qualification Inspection Tests and many others.
To get the full measure of quality in Germanium Gold Bonded Diodes, see your GT representative; or write directly to the company with know-how **NOW.**

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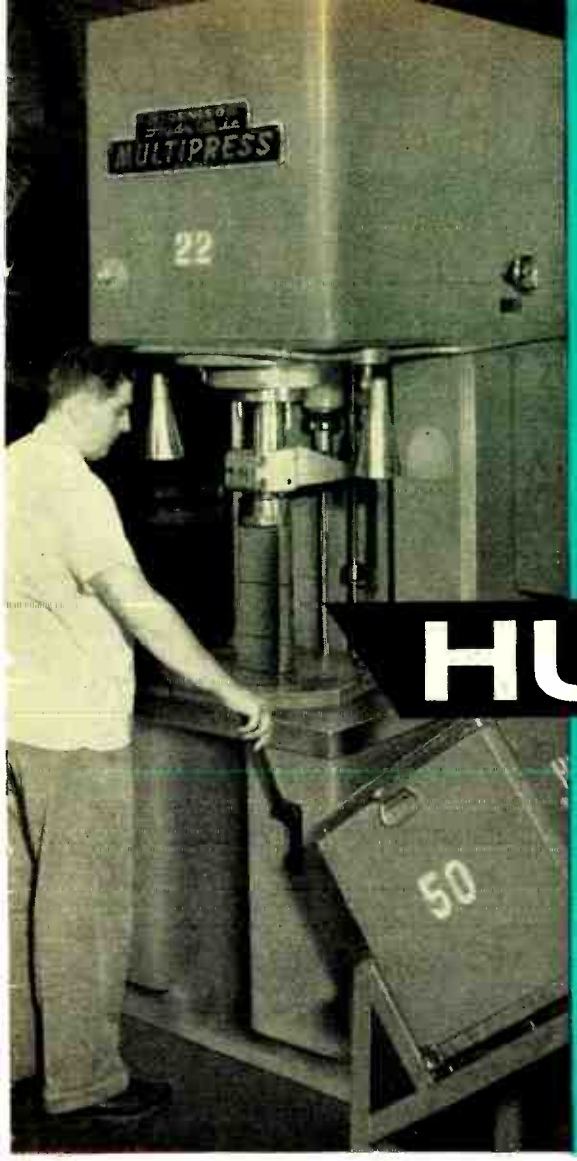

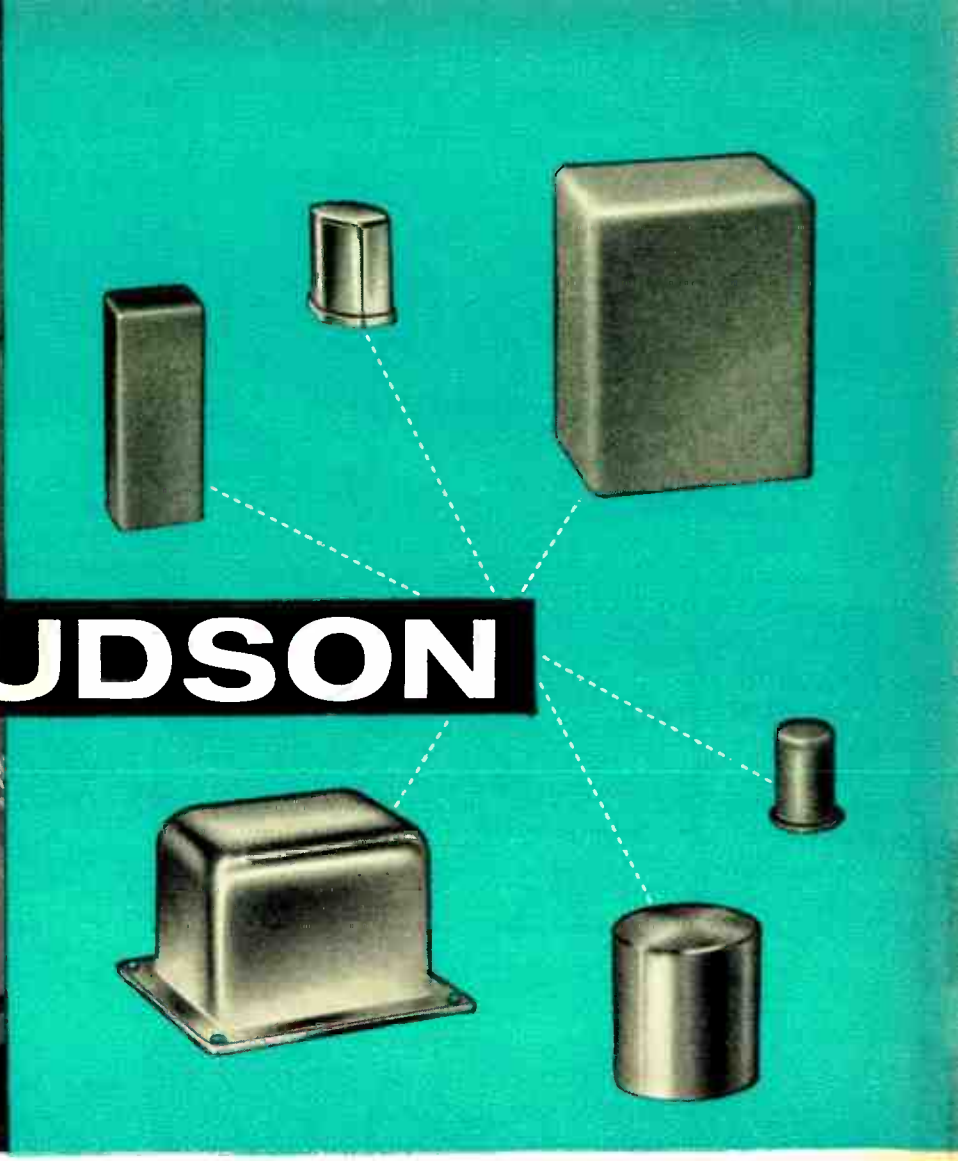

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*The Most Complete Line in the Industry, too!

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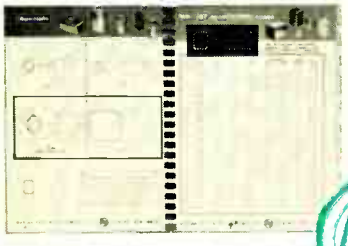
For precision quality at commercial prices, consult the new HUDSON catalog. Call or write for this cost and time-saving handbook, today!



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Precision Metal Components for Electronics, Nucleonics, Avionics and General Industrial Applications

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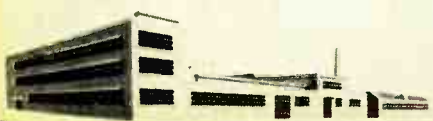
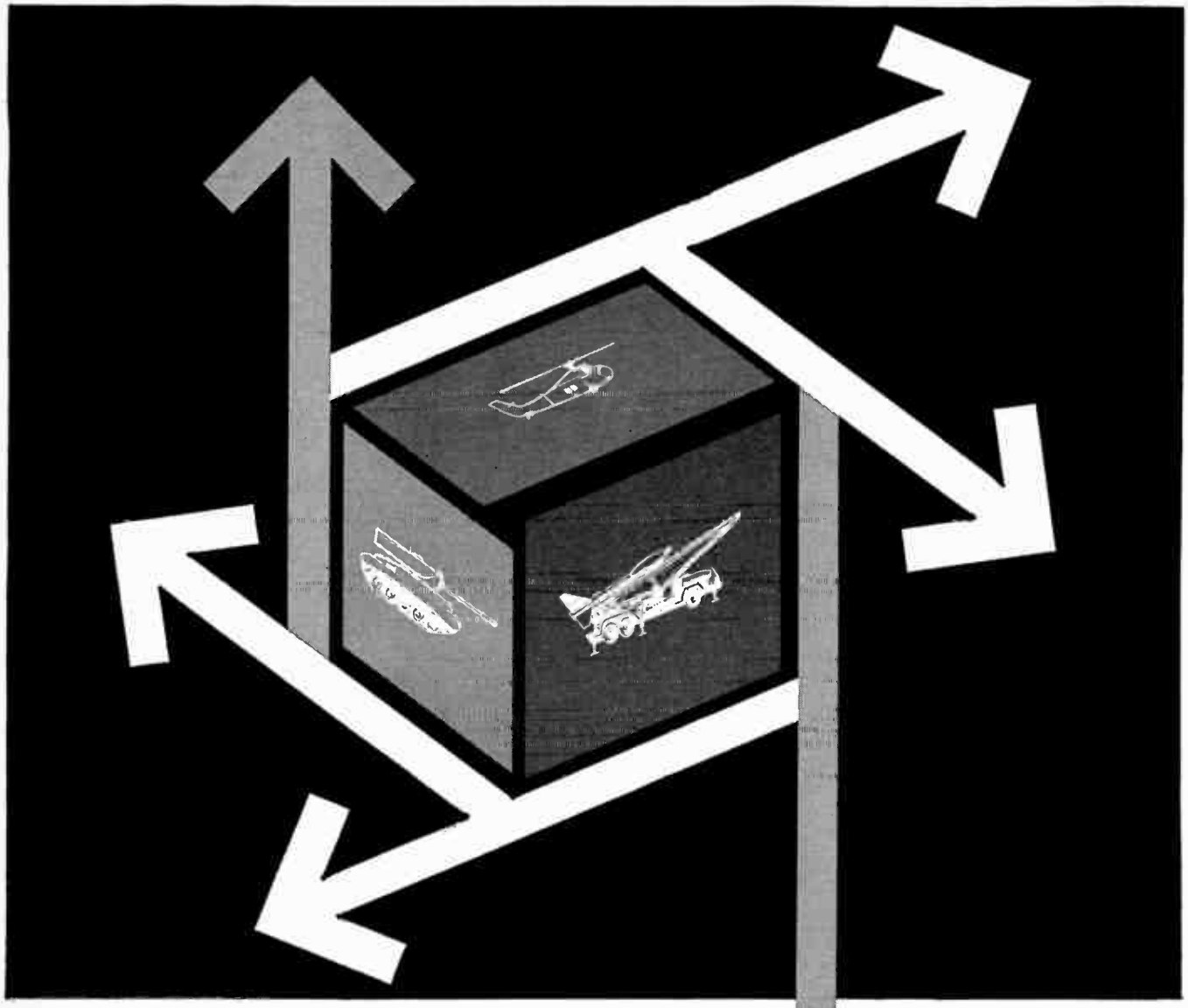
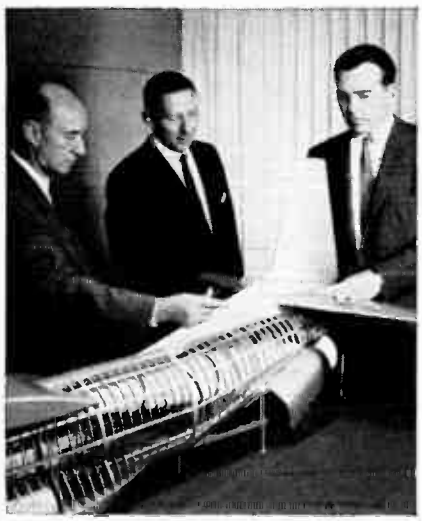




How to put wings on a warehouse



Giving overseas air bases what amounts to local warehouse service on important parts is an Air Force objective. Its present system has slashed delivery schedules up to *20 times*...saved taxpayers several *billion* dollars over the past decade. To improve it further, Douglas has been selected to develop specifications for a comprehensive Material Handling Support System involving better communications, control, cargo handling and loading, packaging and air terminal design. Douglas is well qualified for this program by its more than 20 years in all phases of cargo transport. Air logistics is only one area of extensive Douglas operations in aircraft, missile and space fields in which outstanding openings exist for qualified scientists and engineers. Some are listed on the facing page.

Schuyler Kleinhans and Charles Glasgow, Chief Engineers of the Santa Monica and Long Beach Divisions, go over air transport needs relating to advanced cargo loading techniques with Donald W. Douglas, Jr., President of **DOUGLAS**

JETLINERS ■ MILITARY AIRCRAFT ■ CARGO TRANSPORTS ■ MISSILE SYSTEMS ■ SPACE SYSTEMS ■ AIRCOMB ■ GROUND-HANDLING EQUIPMENT

Sales Increases Announced

SALES for **Eitel-McCullough**, San Carlos, Calif., are up 66 percent for the first half of the firm's fiscal year, compared to the same period last year. Sales for the latest period amounted to $12,047,746. Earnings were 90 cents a share, as compared with the two cents a share deficit for the initial half of 1958 and the 26-cent total reached last year. Total 1958 sales came to about $16 million. while company predictions for total 1959 sales are in excess of $25 million. This prediction is partly based on a backlog of about $9,700,000, compared with $7,100,000 a year ago.

• **Smith-Corona Marchant** reports net sales of $90,411,280 for the fiscal year ended June 30, 1959. Sales in the previous year were $87,145,774. Net earnings decreased to $551,396, equal to 30 cents a share, compared with $2,244,258 or $1.38 a share for last year. Company officials attribute the dip to building programs and accelerated research and engineering activities which added to operating expenses. As an example, they cite R&D expenditures of $4.3 million, as compared with $2.8 million in 1958.

• **Chicago Aerial Industries**, Melrose Park, Ill. manufacturer of drone and manned aircraft reconnaissance systems, airborne data displays and missile guidance systems, reports sales for the first half of this year of $6,007,478, a 60-percent increase over the first half of 1958. Earnings per share and total earnings were up 80 percent to 76 cents and $400,525, respectively. Backlog is counted at over $6 million, mainly in production orders for precision avionics equipment.

• **Industrial Electronic Hardware Corp.**, New York, reports net sales for its fiscal first quarter amounting to $854,211. This compares with a total of $547,583 in the similar quarter of 1958, a gain of about 56 percent. Net profits totaled $33,573, equal to 5½ cents a share. Net profits in the first quarter of last year were $8,066 or 1.3 cents a share on the company's 611,568 outstanding shares of common stock.

• **Telemeter Magnetics, Inc.**, Los Angeles, announces acquisition of **Invar Electronics Corp.**, Pasadena, Calif., manufacturer of solid state power supplies and electronic instruments. Company officials say the move will provide Invar with financial support for development of new products and extension of present product lines. No changes in personnel or management are contemplated as a result of the acquisition.

• **Granco Products, Inc.**, New York, reports sales of $3,070,486 for the fiscal year ended June 30. This represents a 38-percent increase over the previous fiscal year. Net earnings for the period were $49,152 this year, compared with $2,812 for last year. The firm makes f-m radio receivers.

25 MOST ACTIVE STOCKS

WEEK ENDING SEPTEMBER 11

	SHARES (IN 100's)	HIGH	LOW	CLOSE
Int'l Tel & Tel	776	33	30¼	32½
Sperry Rand	721	22⅞	22	22⅜
Raytheon	686	48⅜	43½	43⅜
RCA	647	59½	55⅞	58½
Burroughs	607	31⅜	30⅛	30¼
Gen Elec	529	78½	75⅜	78¼
Avco Corp	516	13⅞	13⅛	13¼
Gen Tel & Elec	443	71⅛	69⅜	70⅝
Westinghouse	427	90¼	85⅝	88⅜
Univ Control	406	17¼	16	16⅛
Zenith Radio	329	104¾	99¼	100½
Elec & Mus Ind	317	7¼	7	7¼
Texas Inst	314	136⅝	126⅞	132
Gen Inst	296	23⅜	20¾	22⅝
Standard Coil	282	16⅛	14⅜	16⅛
Litton Ind	265	118¾	110½	114⅝
Gen Dynamics	255	49	46¾	47¼
El-Tronics	243	1⅝	1⅜	1½
Reeves Sndcrft	223	7⅞	7⅛	7⅜
Beckman Inst	214	54⅜	50⅜	52
Philco Corp	204	25¼	23⅝	24
Siegler Corp	193	27⅜	25¼	26⅛
Gen Transistor	190	35½	32½	34¼
Dynamics Corp	173	8⅞	8⅜	8½
Victoreen Inst	172	14⅜	13	13¾

The above figures represent sales of electronics stocks on the New York and American Stock Exchanges. Listings are prepared exclusively for ELECTRONICS by Ira Haupt & Co.

STOCK PRICE AVERAGES

(Standard & Poor's)	Sept. 9, 1959	Aug. 12, 1959	Change From One Year Ago
Electronic mfrs.	84.58	87.95	+43.9%
Radio & tv mfrs.	103.16	111.15	+82.11%
Broadcasters	91.89	99.29	+33.7%

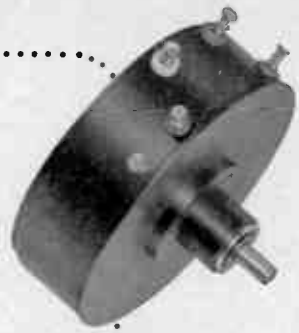
Helping to keep computers compact...

The space and weight saving characteristics of Gamewell Sinusoidal Potentiometers make them a popular choice for equipment employing sine-cosine operations. Far lighter and more compact than gears, cams, and other complicated mechanisms, they're widely used in analog computers, data converters, Tacan systems, and radar components. Wire wound card and double brushes produce sine-cosine functions with a smoothness and precision unobtainable by other resistive methods . . . ideal for low frequency sine wave generation.

Solve *your* prototype problems with Gamewell Precision Potentiometers. A wide range of linear and non-linear models including servo, precision, and trimmer types. Emphasis on "specials." Engineering assistance upon request. Write THE GAMEWELL COMPANY, Dept. 13E, Newton Upper Falls 64, Mass.

CONDENSED SPEC OF RVG-30XS-4POT

Resistance	16,000 ohms ± 5%
Conformity	1.0% peak to peak
Starting Torque	0.5 oz. in. max.
Angular Accuracy	±0.7°
Weight	2 oz. max.
Mechanical Rotation	Continuous
Electrical Rotation	360°
Nominal Life	350,000 cycles



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INTERNATIONAL RECTIFIER CORPORATION

RECTIFIER NEWS

644 Zener Diode Types Offer Advantages to Every Voltage Regulator Circuit

As compared to other voltage reference elements, the silicon diode regulator has a longer life expectancy because of its mechanical ruggedness. It does not deteriorate under storage nor age during its operating life. Small size and light weight make its use in airborne or portable equipment especially desirable from many standpoints.

International Rectifier Corporation now offers an extensive line of zener types numbering 644 in seven basic styles. From the miniature type rated at 750 milliwatts to the precision 1N430 reference element types, all are manufactured to meet the most rigid military requirements. *See how these all-welded, hermetically sealed diodes can improve your circuit design. . . .*

CIRCLE READER SERVICE CARD NO. 155

Miniature Voltage Reference Packs Maintain Voltage Regulation to within ± 0.01%!

REF-PAK MODEL 4RV8
Standard MIL Transformer Case

REF-PAK MODEL RV8-PC
Special Housing for insertion into printed circuit boards.

Designed around the highly stable 1N430 silicon reference element, these miniature reference supplies may be considered to be the solid state equivalent of the standard cell. A high degree of stability is attained by maintaining a precise constant current through the reference element, regardless of temperature or line voltage variations.

Ref-Paks will operate directly from an unregulated power source . . . maintain voltage regulation to within ± 0.01%! Output voltages of either 8.4 or 16.8 volts dc are available in 5 distinct types that allow operation from 28 or 115 volt dc, 400 and 60 cycle power supplies. Temperature coefficient of these devices is ± 0.001%/°C from −55° to +100°C.

For complete details ask for SR-401.

CIRCLE READER SERVICE CARD NO. 156

ZENIAC Provides a Shortcut to the Application of Silicon Zener Diodes

A flip of the Zeniac selector switch quickly tells you the exact diode required in complex breadboard circuitry. This unique innovation — the first semiconductor substitution box in history — has been designed specifically to aid system design groups by saving valuable lab time in the application of zener diodes.

Two units are available, each housing 11 diodes in voltage steps from 3.9 thru 27 volts. Model A Zeniac is rated at 1-watt; Model B is rated at 10-watts. Both are now in stock at your Authorized Distributor. Ask for details on this time saver . . .

CIRCLE READER SERVICE CARD NO. 157

Technical Service Provides XY Plot of Reverse Breakdown Characteristics of Each Diode in all Prototype Orders

To eliminate guesswork and tedious testing on your part, every zener diode sent on prototype orders will be accompanied by a specially plotted XY recording of its exact breakdown voltage point! This permanent record can come in mighty handy when it's time to match diodes or reorder to the same specs. This is just one of the many application engineering services we are prepared to extend to you at all times!

Write to the factory *for Bulletin SR-250-A, a four page technical article describing the characteristics of zener diodes, how to select them, and application data with circuit schematics.*

EXECUTIVE OFFICES: EL SEGUNDO, CALIFORNIA • PHONE OREGON 8-6281 • CABLE RECTUSA
BRANCH OFFICES: NEW YORK CITY AREA OFFICE: 132 E. 70th St., TRafalgar 9-3330 • NEW YORK STATE AREA OFFICE: 2366 James St., Syracuse N.Y., HOward 3-1441 • CHICAGO AREA OFFICE: 205 W. Wacker Dr., FRanklin 2-3888 • NEW ENGLAND AREA OFFICE: 17 Dunster St., Cambridge, Mass., UNiversity 4-6520 • PENNSYLVANIA AREA OFFICE: Suburban Square Bldg., Ardmore, Pa., Midway 9-1428 • MICHIGAN AREA OFFICE: 1799 Coolidge H'way, Berkley, Mich., Lincoln 9-1144 • IN CANADA: International Rectifier of Canada, Ltd., 1581 Bank St., Ottawa, Ontario, Regent 3-6880

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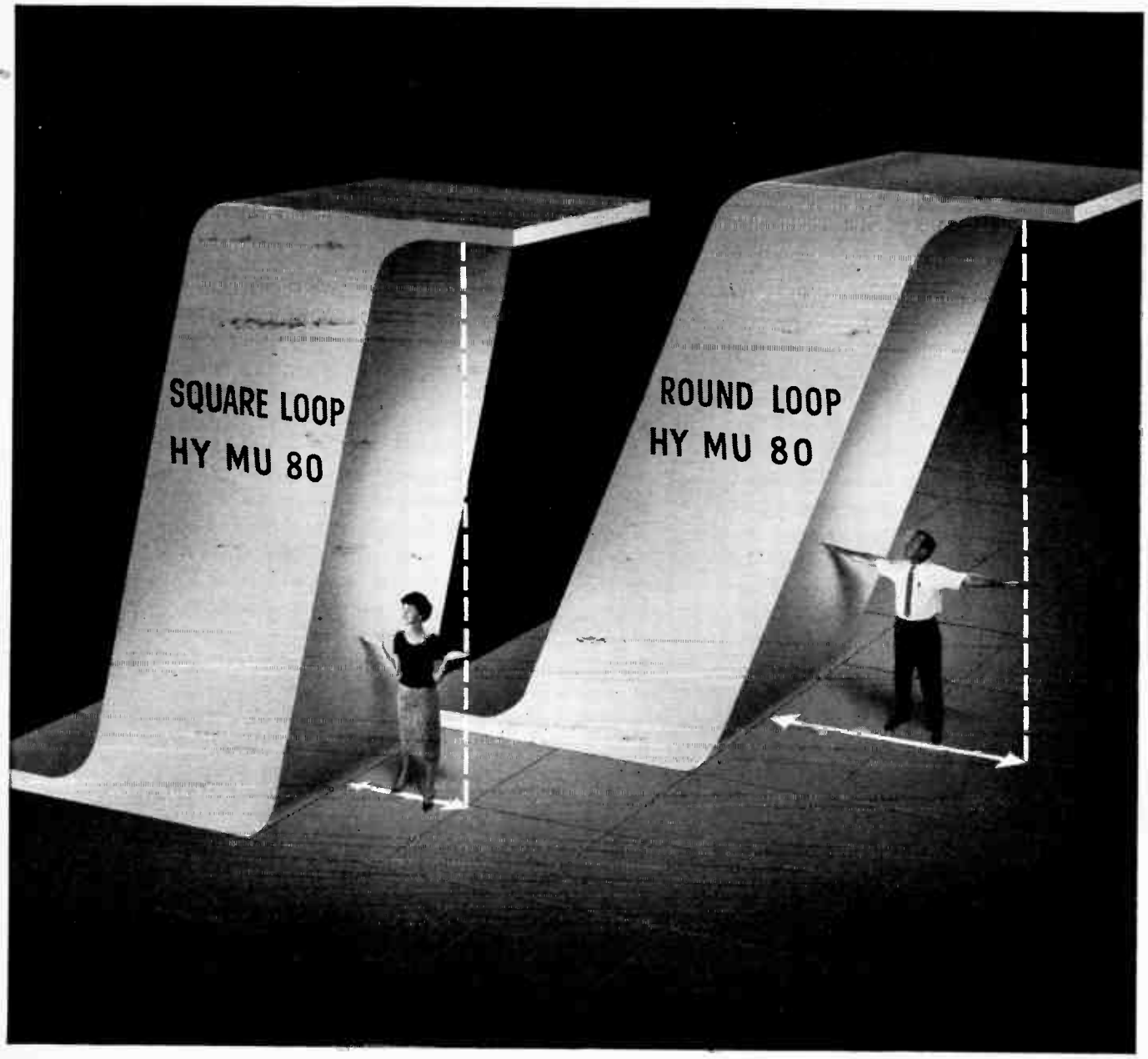


Vive la différence in Hy Mu 80!

For greater sensitivity—Magnetics, Inc. makes Round Hy Mu 80 for more output at low flux densities
For greater gain—Magnetics, Inc. makes Square Hy Mu 80 for more voltage amplification

There's an important difference in the two basic kinds of Hy Mu 80, Round Loop and Square Loop. By taking advantage of it, you design magnetic amplifiers with better performance and efficiency characteristics. We stock standard tape wound cores made of *both*, to be sold at non-premium prices. We want you to order the right kind.

Round Hy Mu 80 is demanded when flux densities are down around the 10 to 50-gauss level. Its high initial permeability results in great sensitivity. It also means fewer windings, thus smaller sizes. Combine higher inductance, great sensitivity and small size, and if you are a designer of devices like low level transformers or thermocouple amplifiers, then you want Round Hy Mu 80 tape cores.

On the other hand, if you design sensitive high gain magnetic amplifiers you need Square Hy Mu 80. The transfer curve is so linear and so nearly vertical that a minute change in input produces an extremely sharp response. When only a small bias supply is available, you get a lot more amplifier per dollar. Preamplifier designers are among our best customers.

So *vive la différence!* Order the right Hy Mu 80 for your needs. We'll supply either, and what's more, we'll supply them quickly. Want the full story? *Write Magnetics, Inc., Dept.* E-71, *Butler, Pennsylvania.*

MAGNETICS inc.

2N1069 2N1070

IGH POWER—LOW SATURATION RESISTANCE NPN SILICON TRANSISTORS

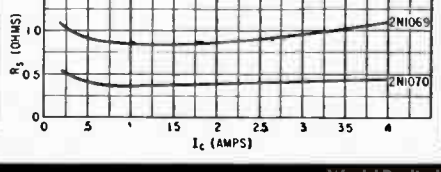
ilicon Transistor Corporation is now delivering diffused-junction, N silicon mesa transistors. These new high power—low saturation istance transistors operate in the temperature range of −65° C to 75° C for a wide variety of military and industrial applications where ak reliability and high temperature characteristics are required. Maxi- m saturation resistance for the 2N1070 is 0.67 ohms at a collector rent of 1.5 amps., the 2N1069 is 2 ohms maximum at the same current.

Applications: Since these STC transistors feature low saturation resistance they are ideally suited for switching applications as well as relay replacements and controls, solenoid actuators, power convertors, power switches, high level D.C. amplifiers, power supply regulators, and Class A and B power amplifiers.

For complete specifications, request STC Form 1953. Write also for engineering bulletins on STC's full line of silicon glass diodes.

RATINGS	
ower Dissipation	50 watts
CBO	60 volts
EBO	9 volts
CEO	45 volts
C	4 amperes

TYPICAL SATURATION RESISTANCE

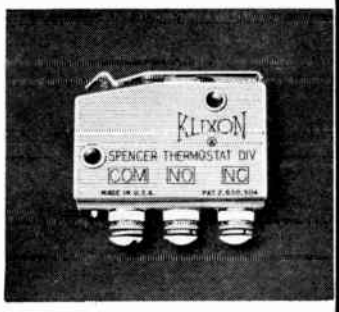


LICON TRANSISTOR CORPORATION, Carle Place, L. I., New York, Ploneer 2-4100

KLIXON®

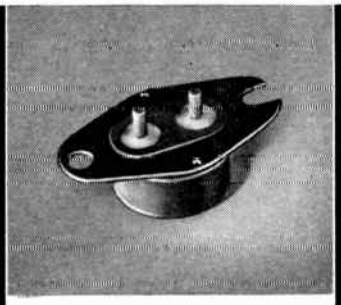
CIRCUIT BREAKERS, PRECISION THERMOSTATS, SWITCHES and OVERHEAT PROTECTORS

For Electronic, Radar and Radio Equipment, Ground Support Equipment, Missiles and Aircraft Controls



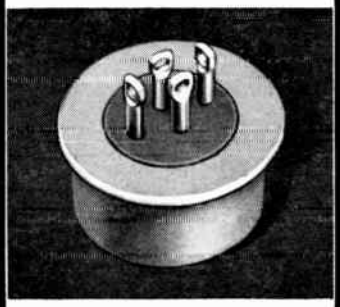
KLIXON KX-5 SERIES PRECISION SWITCHES

Hermetically sealed snap-acting limit switches. Seal uses metalized ceramic terminal inserts and metal diaphragm. Switching element, one-piece sine blade. Steel case withstands high impact and compression loads. High temperature resistance to 375°F. Vibration resistance to 25 g's, 0-2500 cps. Ratings to 10 amperes, 115 VAC or 30 VDC resistive. 25,000 cycles minimum life. Ambient temperatures range, −65°F to +375°F. Weight 1 oz. Variety of actuators available.



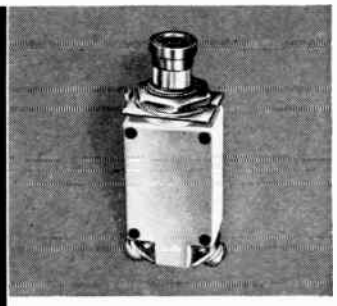
NEW KLIXON M1 PRECISION THERMOSTAT

Hermetically sealed, vibration resistant, snap action. Gold plated contacts for dry circuit applications. Conforms with MIL-E-5272A and MIL-T-5574A. Preset and non-adjustable. Temperature settings from −65°F to +400°F. High dielectric strength 1250 VAC. Ratings up to 7 amperes, 30 VAC/DC resistive; or 6 amperes, 125 VAC; or 3 amperes, 250 VAC. Weight 5 grams. Special high-reliability version with low differential (9°F) available.



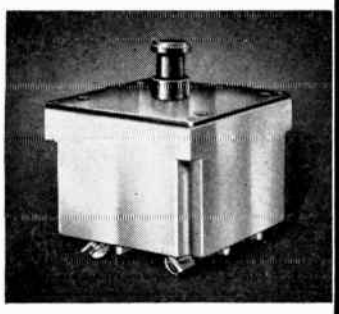
NEW KLIXON 2862 PRECISION THERMOSTAT

Positive temperature control for three-phase systems. Hermetically sealed, fixed temperature, snap action. Controls three phases simultaneously. Temperature settings from −65°F to +325°F. Minimum differential: 25°F. Rating 5 amperes, 120 VAC, 60/400 cycles. Variety of mounting brackets available.



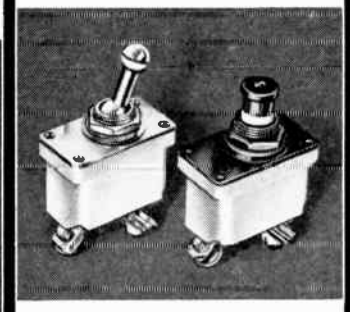
NEW KLIXON 7274 MICRO-MINIATURE CIRCUIT BREAKER

Simple push-pull, trip-free design. Available as shown SPST with 6/32 screw-type terminal or mounting to replace NAF-1357 front-mounted fuse. Also SPDT with N/O auxiliary contacts and 4 solder terminals. Exceptionally small — height 1.420", width 0.744", depth 0.562". Ratings ½ to 5 amperes. Ultimate trip @ 77°F, 115-145%. 200% trip, 2-15 seconds. Vibration resistance 10 g's, 10-500 cps. Shock resistance 25 g's. Weight only 0.9 oz.



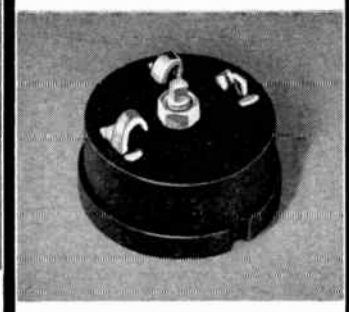
NEW KLIXON 06760 SIMULTRIP* CIRCUIT BREAKER

Thermal type, three phase. Interrupts high AC short circuits . . . trips quickly . . . provides simultaneous tripping of all three phases should any one phase become overloaded. Phases can be different ratings. Ratings 5 to 60 amperes. 120/208 VAC, 60/400 cycle systems and 220/440 VAC, 60/400 cycle systems. Weight 227 grams. Minimum AC rupture capacity 2500 amperes, 1 ϕ, 120 VAC, 400 cps. Ultimate trip @ 77°F, 105-130%. 200% trip, 10-65 seconds.
*Trade Mark



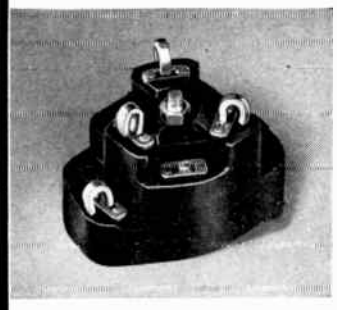
KLIXON 07270-07271 CIRCUIT BREAKERS

Two miniature breakers different only in actuators. Simple trip-free design about ⅓ the size of MS25005 and MS25017. Only three moving parts — actuator, slide and thermal disc. Ratings 3 to 35 amperes; weight 1.5 ozs. High rupture capacity 3500 amperes, 120 VAC, 400 cps; 4,000 amperes, 30 VDC.



KLIXON SINGLE-PHASE INHERENT OVERHEAT PROTECTORS

Protect transformers, solenoids, electric motors against excessive temperatures. Responsive to both temperature and current. These types are for single-phase inductive equipment with maximum continuous operating temperatures up to 225°C. Maximum rupture capacity is 750 amperes, 200 VAC, 400 cycle. Available in automatic and non-automatic reset types.



NEW KLIXON THREE-PHASE INHERENT OVERHEAT PROTECTORS

Designed to match the thermal and electrical characteristics of inductive equipment, they prevent protected components from reaching destructive temperatures without limiting useful output. For 3-phase equipment with maximum continuous operating temperatures up to 225°C. Maximum rupture capacity is 400 amperes, 200 V, 400 cycles. Available in open and hermetically-sealed construction in automatic and non-automatic reset types.

KLIXON Circuit Breakers, Precision Switches, Precision Thermostats and Overheat Protectors are small in size and light in weight; they respond quickly and with accurate repeat performance; they have ample capacity to handle a wide range of electrical loads; their calibrations stand up in the face of severe environmental conditions.

Competent Metals & Controls engineers at the factory and in the field will gladly make test applications of the KLIXON Line. Write for "KLIXON Controls for Electronic Equipment, Aircraft and Guided Missiles" Catalog.

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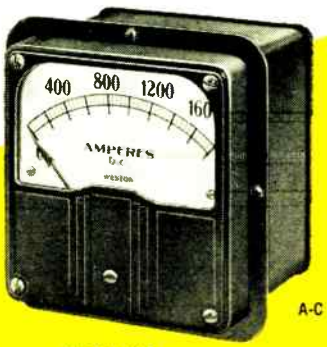
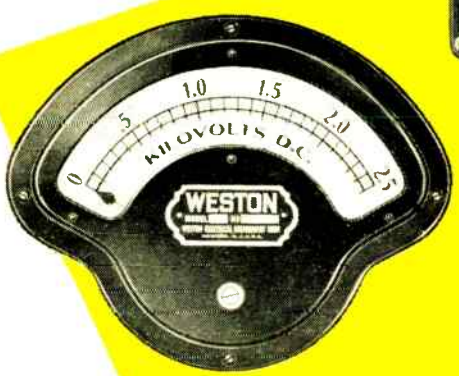
SPENCER PRODUCTS: Klixon® Inherent Overheat Motor Protectors • Motor Starting Relays • Thermostats • Precision Switches • Circuit Breakers

Why compromise on your panel or switchboard instrumentation?

SPECIFY WESTON: The finest instruments available . . . combining long-range economy, lasting quality



Model 921



Model 273

	Model 741 Group	Model 640 Group	Model 610 Group	Model 921 Group	Model 273	Model 271	Model 269	Model 267
A-C voltmeters	X	X	X	X				
A-C ammeters	X	X	X	X				
A-C milliammeters	X	X	X	X				
A-C rectifier-type instruments	X	X	X	X	X	X	X	
D-C voltmeters	X	X	X	X	X	X	X	X
D-C ammeters	X	X	X	X	X	X	X	X
D-C micro- and milliammeters	X	X	X	X	X	X	X	X
D-C millivoltmeters	X	X	X	X	X	X	X	X
Polyphase wattmeters-varmeters			X	X				
D-C & single-phase A-C wattmeters		X	X	X				
Single & polyphase power factor meters			X	X				
Frequency meters	X	X	X	X				
Thermo instruments	X	X	X	X				
Synchroscopes				X				

The widest range of SHAPES, TYPES and SIZES*

Model 271

Model 610

Model 643

Model 741

Over 70 years' leadership in electrical measurement . . . that's the tradition behind each of these instruments . . . the reason for the world-wide preference they've earned. You'll find just the model to meet your switchboard or panel needs in the Weston Catalog – including all versions of the famous instruments pictured on this page.

For specifications . . . information . . . or the address of your nearest distributor, contact your local Weston representative . . . or write to Weston Instruments, Division of Daystrom, Inc., Newark 12, N. J. *In Canada: Daystrom Ltd., 840 Caledonia Rd., Toronto 19, Ont. Export: Daystrom Int'l., 100 Empire St., Newark 12, N.J.*

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Instruments

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WORLD LEADER IN MEASUREMENT AND CONTROL

*Weston offers the broadest panel instrument coverage in the industry . . . in terms of shapes, scale lengths, ranges, accuracies, sensitivities and sizes.

New Statistical Facts Coming

WITH THE REVISED Standard Industrial Classification manual unlocking the floodgates, a new stream of electronics industry market statistics will soon be flowing.

Bureau of Census will issue its first preliminary industry report on the 1958 Census of Manufactures in December. All preliminary reports on electronics industry products will be issued between December and the following March, says Clarence Olsen of the Bureau's Industry Division.

Census industry reports, which include value of shipments, number of employees and establishments plus other statistics, are valued for their reliability. They are prepared from data reported to Census by all U. S. manufacturing firms.

Fills Barren Areas

The new Census of Manufactures will fill many statistical areas that have been nearly barren of factual market data since the preceding 1954 Census.

For instance, 1958 Census data on electrical measuring instruments will fall on electronics industry market planners like manna from heaven.

Also, the final 1958 industry reports, which will be issued between May and July of 1960, will supply our industry with more usable data than the 1954 Census. Reason: the final reports will also provide data based on the 1957 revised Standard Industrial Classification manual.

The 1957 revision created a number of new electronics industry statistical groups, including: Radio and TV receiving sets; Radio and TV transmitting-signalling apparatus; Radio and TV receiving tubes—except cathode ray; Cathode ray tubes; Transmitting-industrial electron tubes and Electronic components.

New Look

But this is only part of the story. Both the Bureau and other divisions of the Department of Commerce are looking at the electrical-electronics industry in a new light.

Bureau is becoming increasingly responsive to industry requests for a public source of statistical information in the approximately five-year intervals between issuance of major reports.

It hopes to help plug this five-year gap by adding more electrical-electronics industry surveys to its annual special survey program.

Several new electrical-electronic products may be introduced to the program with surveys of 1959 activities. There are good prospects that other products from our industry will be added in future years.

Other Plans

Also, conversations are now going on among Census, Business and Defense Services Administration, Electronic Production Resources Agency and industry trade associations on ways to provide the industry with more complete and more timely military and industrial electronics statistics.

Government is currently surveying electronic component shipments, backlogs through a joint survey by EPRA and BDSA. Plans have not yet jelled. But new components survey could turn out to be an expansion of the joint survey, or a new survey.

In addition, all government statistical centers have been knee-deep in eorts to penetrate the military electronic statistical barrier.

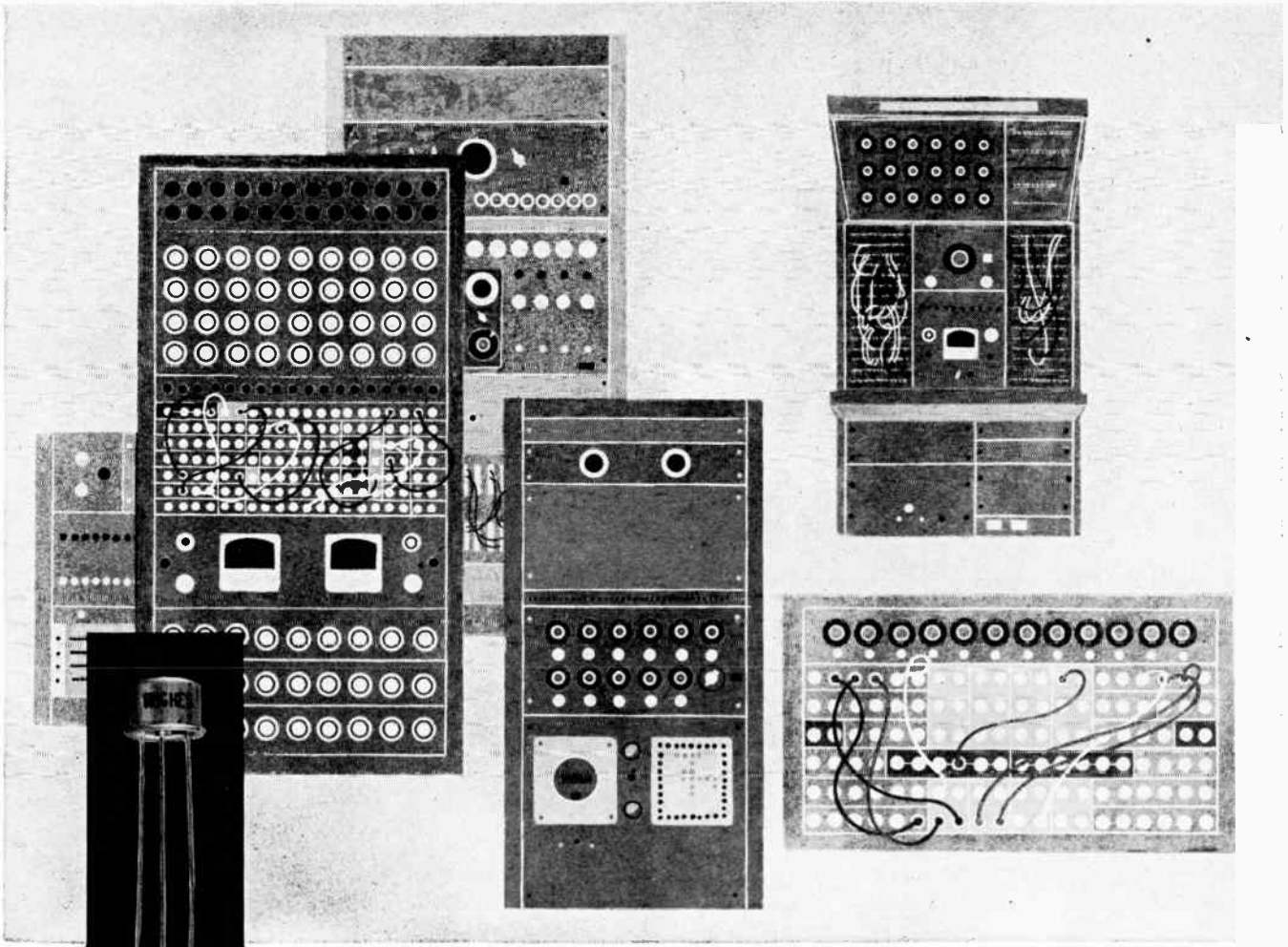
BDSA is putting finishing touches on its first survey of electronic end-equipment sales. This survey will include separate industrial and military sales totals.

EPRA, which just published a detailed report on military transistor requirements, hopes to follow up this effort with similar reports on other products.

FIGURES OF THE WEEK

LATEST WEEKLY PRODUCTION FIGURES

(Source: EIA)	Sept. 4, 1959	Aug. 7, 1959	Change From One Year Ago
Television sets	141,550	121,581	+25.27%
Radio sets, total	369,035	184,692	+34.39%
Auto sets	125,087	39,219	+36.35%



HIGH-SPEED COMPUTER SWITCHING TRANSISTORS

SILICON DDMT—Double Diffused Mesa Transistor . . . now available from Hughes to solve your high-speed switching problems. This new silicon PNP transistor, which operates at low and medium current levels, gives you a cut-off frequency greater than 50 megacycles. In addition, Beta—as a function of collector current—is flat over 80 per cent of the operating range.

Two other advantages: 1. This Hughes transistor offers you all the desirable characteristics inherent in the solid state diffusion technique. 2. The tiny flexible leads of its gold plated package may be soldered directly into circuits or used with standard plug-in sockets.

This new device, while designed primarily for computers, is also an excellent amplifier and oscillator, lending itself to an unusually broad range of applications.

As in all Hughes semiconductor devices, reliability has been specifically designed into this mesa transistor. They are manufactured in the new multi-million dollar Hughes Semiconductor facility . . . using the finest equipment and newest techniques.

Your inquiry regarding these transistors will be given prompt attention. Just write or call the Hughes sales office nearest you. They are located in:

Boston, 4 Federal Street; Woburn, Mass.; WEll s 3-4824
Minneapolis, 6121 Excelsior; Minneapolis 16, Minn.; WEst 9-0461
Newark, 80 Mulberry Street; Newark 2, N. J.; MArket 3-3520
San Francisco, 535 Middlefield Road; Palo Alto, Calif.; DA 6-7780
Syracuse, 224 Harrison Street; Syracuse 2, N. Y.; GRanite 1-0163
Chicago, 1515 N. Harlem Ave.; Oak Park, Ill.; NAtional 2-0283
Cincinnati, 816 Swifton Center; Cincinnati, Ohio; ELmhurst 1-5665
Philadelphia, 1 Bala Avenue; Bala-Cynwyd, Penn.; MOhawk 4-8365
Los Angeles, 690 N. Sepulveda; El Segundo, Calif.; OR 8-6125

Or write, Hughes Products, Marketing Department,
SEMICONDUCTOR DIVISION, NEWPORT BEACH, CALIFORNIA.
For export, write: Hughes International, Culver City, Calif.

SPECIFICATIONS: Absolute Maximum Ratings (25°C)

	2N1254	2N1255	2N1256	2N1257	2N1258	2N1219
BV_{CEO}	15V	15V	30V	30V	50V	50V
BV_{CBO}	15V	15V	30V	30V	50V	50V
BV_{EBO}	5V	5V	5V	5V	50V	3V
Power Dissipation	250 mw					
Ambient Temperature	−65°C + 175°C					

SEMICONDUCTOR DIVISION

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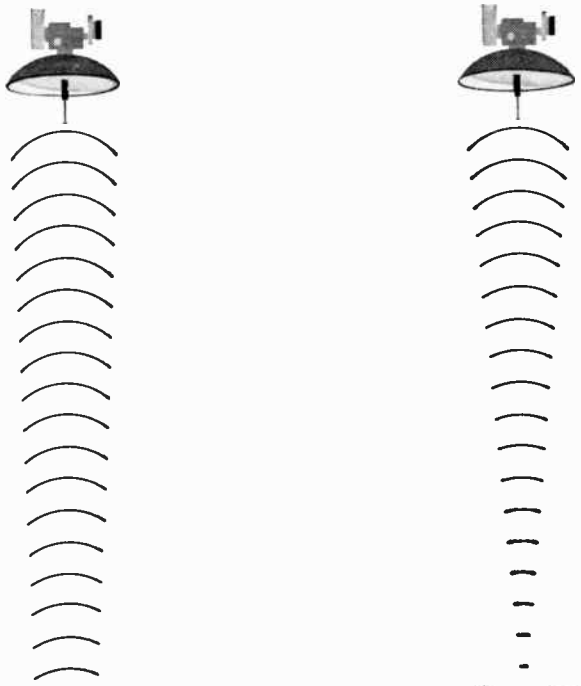
SEMICONDUCTOR DEVICES • STORAGE TUBES AND DEVICES • MICROWAVE TUBES • VACUUM TUBES AND COMPONENTS • CRYSTAL FILTERS • MEMO-SCOPE® OSCILLOSCOPES • INDUSTRIAL CONTROL SYSTEMS



DOUBLE YOUR RANGE!

WITH ONLY ONE CHANGE—ON X-BAND AND S-BAND MICROWAVE SYSTEMS

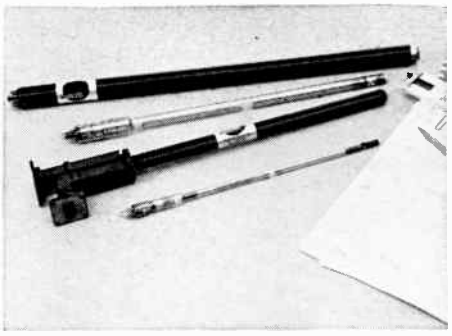
You can now double the effective range of your X-band or S-band microwave system applications with no change in power requirements, no change in antennas, no change in **other system equipment!**

How? By using Hughes PAX-1 or PAS-2B backward-wave amplifiers in your microwave systems you will achieve noise characteristics much lower than from any other traveling-wave tube. **The lower the noise level, the longer the effective range!**

Recent advances in electron gun design (resulting from noise phenomena studies conducted by Hughes R & D laboratories) make possible the extremely low noise characteristics of the Hughes PAX-1 and PAS-2B tubes.

In your microwave system applications, these amplifiers alone offer you advantages not **obtainable by any combination of other low-noise devices.**

Only one voltage to vary... Another important feature of the PAX-1 and PAS-2B backward-wave amplifiers is a narrow, electronically tunable passband covering the entire X-band or S-band spectrum. This feature automatically provides image rejection, excellent selectivity and anti-jamming capability. And, once the initial setup has been made, only **the tuning voltage needs to be varied for complete operation.**



SPECIFICATIONS:	PAX-1 (X-Band)	PAS-2B (S-Band)
Minimum noise figure	4.5 db	under 4.0 db
Gain	over 20 db	10-25 db
Tuning voltage	420-650 v	180-1150 v
Maximum voltage	1500 v	2750 v
Bandwidth	12 mc	11 mc
Input-output isolation	over 50 db	over 50 db
Filament power	6 w	10 w
Magnetic field	1300 gauss	1000 gauss
Saturation power output	0.2 mw	1 mw

Write now for detailed specifications on the PAX-1 and PAS-2B: HUGHES PRODUCTS, Electron Tube Division, International Airport Station, Los Angeles 45, Calif. For export information, write: HUGHES INTERNATIONAL, Culver City, Calif.

ELECTRON TUBE DIVISION

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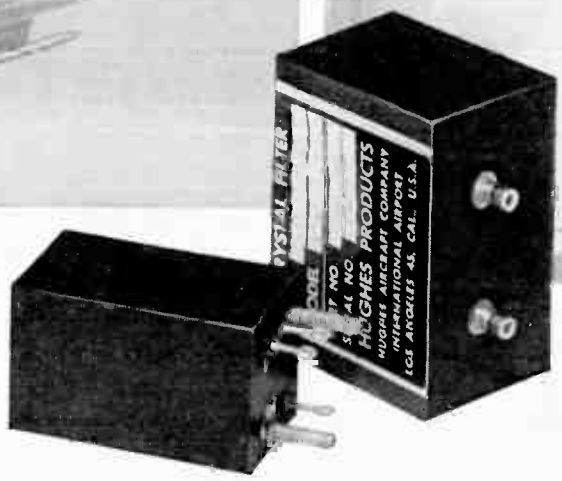


If you're looking for a high-performance crystal filter

At your service is a group of highly talented Hughes Crystal Filter engineers who specialize in solving difficult network problems. These men can design and produce a crystal filter to meet your most exacting requirements! In addition, Hughes offers you tremendous production capacity—over 10,000 filters per month of a single type.

With Hughes Crystal Filters you get:

Precise Selectivity—Eliminates cross talk between channels, makes new systems possible.

Small Size—Reduces overall equipment size, makes filter more reliable by eliminating air space, results in higher stress factor.

High Frequency—Saves circuit costs, eliminates the need for double conversion. Center frequencies 30 kc to 40 mc.

Low Passband Ripple—Eliminates errors in information, enables end equipment to be more precise.

Wide Temperature Stability—Provides flexibility of use, contributes to high reliability.

Low Insertion Loss—Enables system to operate on low signal level—thereby combating noise and cutting circuit costs.

To avail yourself of the Hughes applications engineering service, or for additional information concerning performance levels please write: HUGHES PRODUCTS, *Industrial Systems Division, Marketing Dept., International Airport Station, Los Angeles 45, California. For Export, write: Hughes International, Culver City, California.*

See Crystal Filters and other Hughes Products at WESCON: Booths 3012-18.

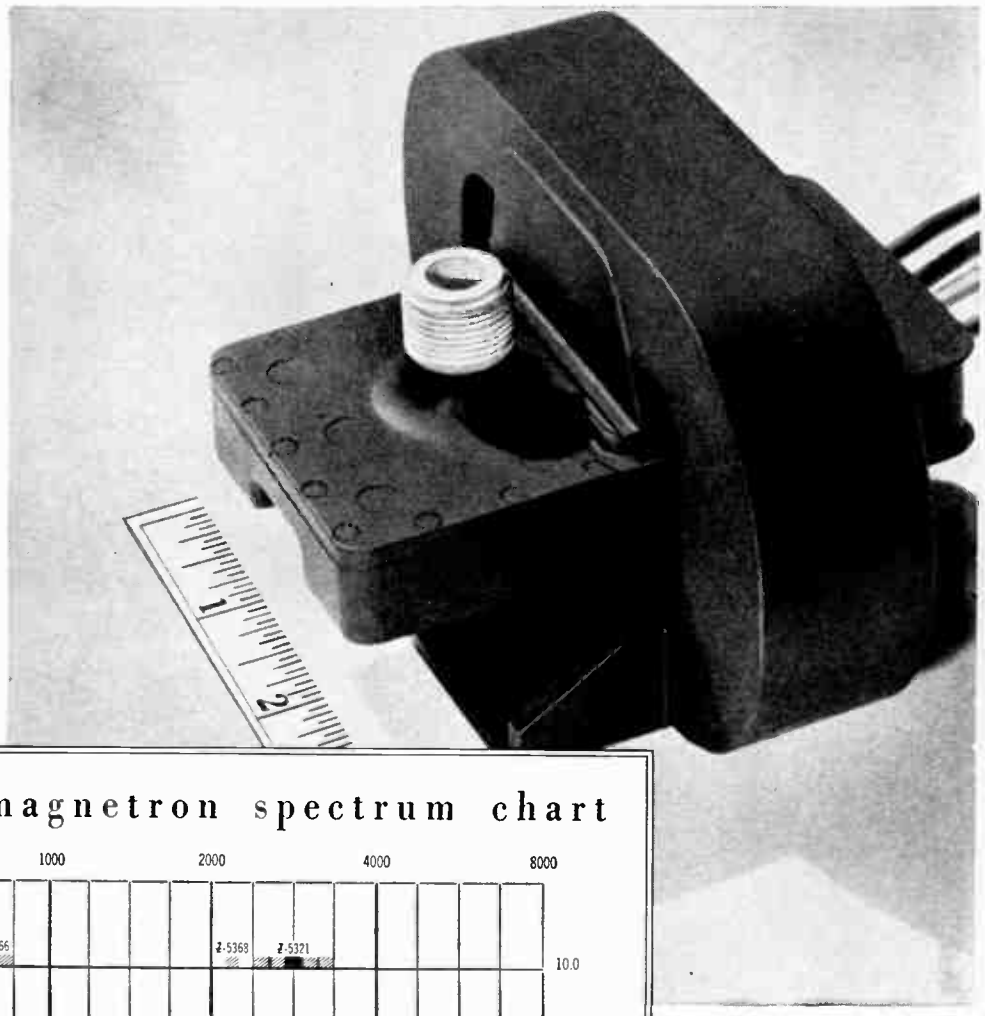
Creating a new world with ELECTRONICS

HUGHES PRODUCTS

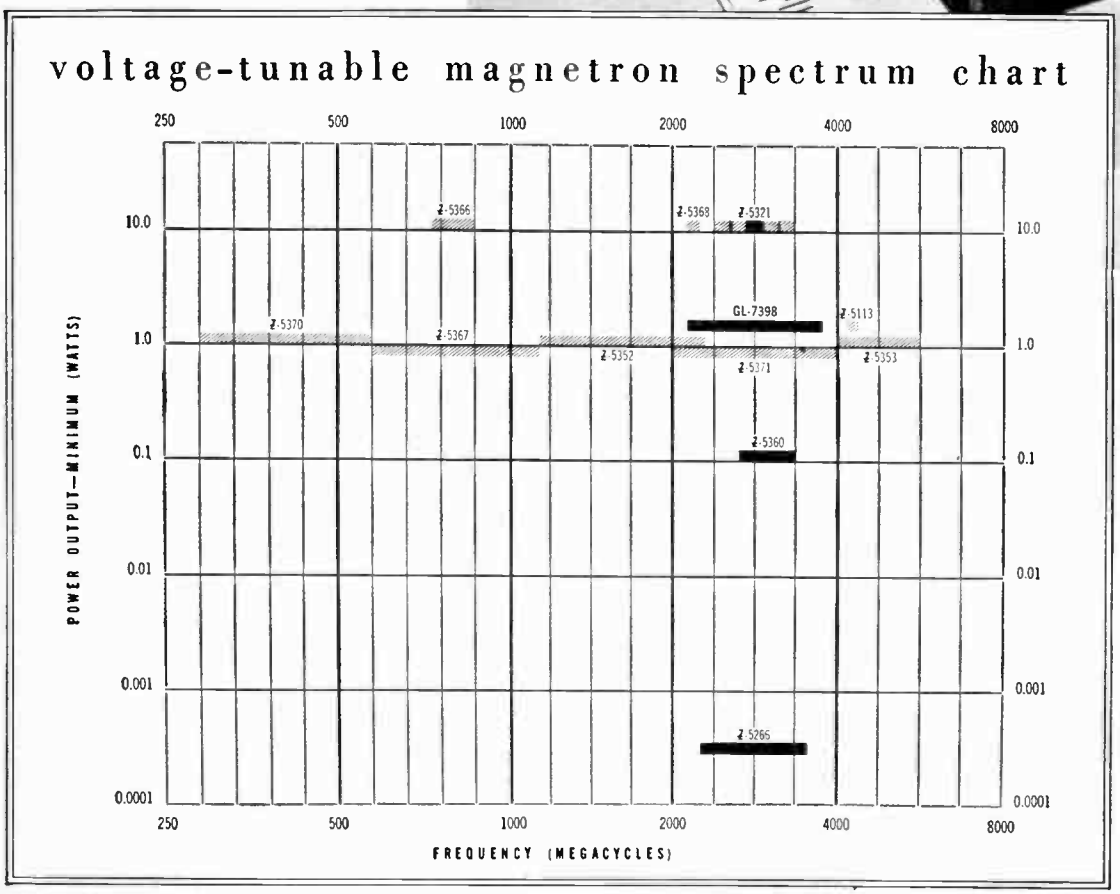
SEMICONDUCTOR DEVICES · STORAGE TUBES AND DEVICES · MICROWAVE TUBES · VACUUM TUBES AND COMPONENTS · CRYSTAL FILTERS · MEMO-SCOPE® OSCILLOSCOPES · INDUSTRIAL CONTROL SYSTEMS

GENERAL ELECTRIC GL-7398* VOLUME PRODUCTION, AVAILABLE

**formerly designated Z-5300*



Voltage-tunable magnetrons now available are indicated by solid areas. Other developments are shown by cross-hatched areas.
▼



VOLTAGE-TUNABLE MAGNETRON IN FOR IMMEDIATE DELIVERY!

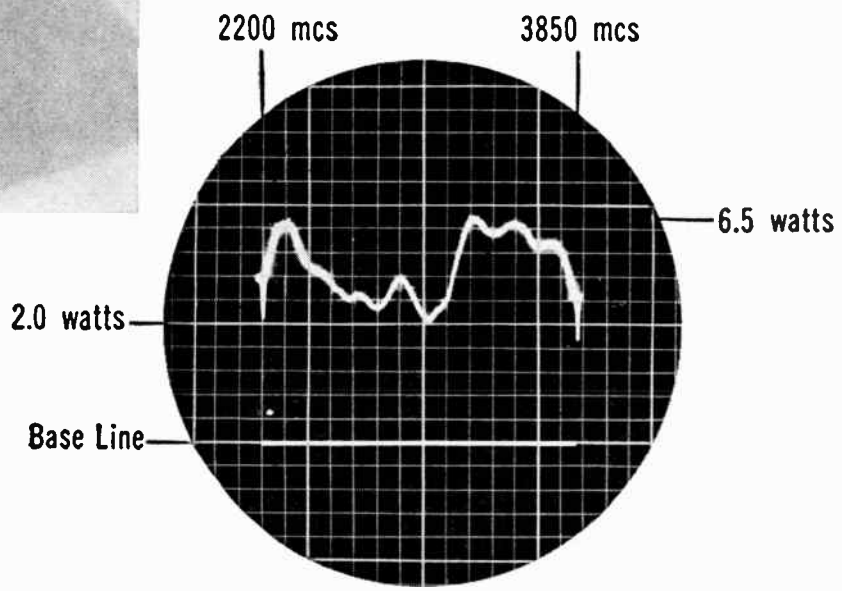
The General Electric GL-7398 voltage-tunable magnetron, a complete RF power source ideal for FM modulation, is now in volume production and available for immediate delivery. Moreover, samples are currently available or can be developed by use of proved technology to meet any need within the frequencies charted on the opposite page. The GL-7398 is designed for use in many applications, such as:

- FM telemetering or video transmission
- Beacon transmitters
- Local oscillators in electronically tunable radars
- Drivers in pulse-to-pulse frequency-shift radars
- FM altimeters
- Broad-band signal generators
- Countermeasure transmitters
- Drivers for countermeasure amplifiers

Output frequency can be varied linearly over a range of nearly 2 to 1 by sweeping the anode voltage. Power output is relatively flat at a minimum of 2 watts. The GL-7398 is a rugged, compact, packaged unit with these characteristics:

Anode voltage at 3 kmc	— 1250 volts
Anode current	— 10-20 ma
Frequency range	— 2200-3850 mcs
Tuning rate	— approx. 3 mcs/volt
FM rate	— 10 mcs or higher
Weight	— 3.1 lbs.

By use of internal narrow-band circuits, a variation (Z-5321) is available which gives a minimum of 10 watts power over a 200 mc bandwidth at a factory-predetermined centerpoint in the 2 to 4 kmc band. Other variations with built-in attenuators for local oscillator applications can be supplied (Z-5360 and Z-5266). *Power Tube Department, General Electric Company, Schenectady, New York.*



◀ Typical power – frequency of the GL-7398 shows power constant over the full band to within plus-or-minus 3 db.

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- practical product information—regularly
- helpful RCA technical assistance
- a specialist who understands your problems and electronic needs

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Electron Tube Division
Harrison, N. J.

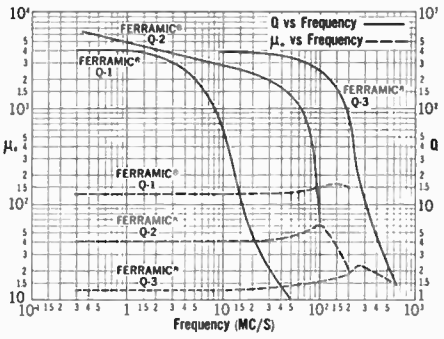
For the name of your nearest RCA Industrial Tube Distributor call Western Union by 'phone and ask for Operator 25.

Only GENERAL CERAMICS offers a complete line of

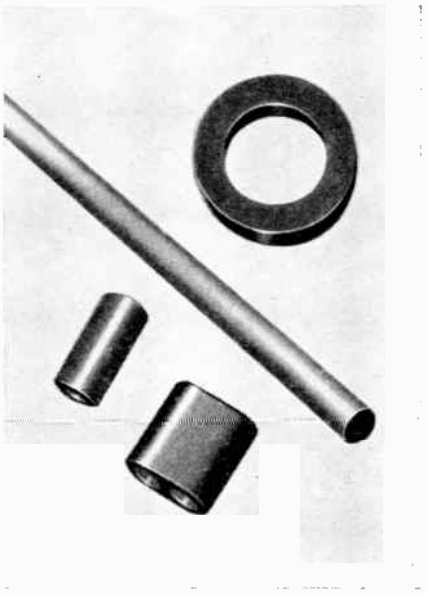
HIGH FREQUENCY FERRITE CORES

Make G-C your single source for a complete line of H-F ferrites ranging in frequency from 300 kc to 220 mc.

Ferramic® Q-1, Q-2 and Q-3 materials, developed and introduced by G-C, feature exceptionally low losses, temperature stability and high permeability. Whether your ferrite requirement is for the commercial entertainment industry, military, ground or air borne communication equipment or industrial electronic applications, G-C will meet your needs with the broadest line of high frequency ferrite materials and in the shapes you require.



This curve demonstrates the exceptional qualities of G.C's "Q" family of materials – high permeability and low loss.

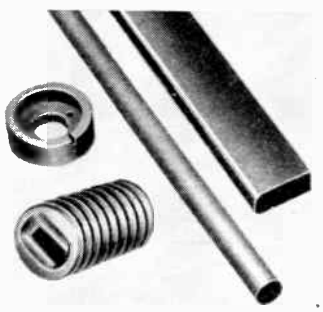


Q-1 Material

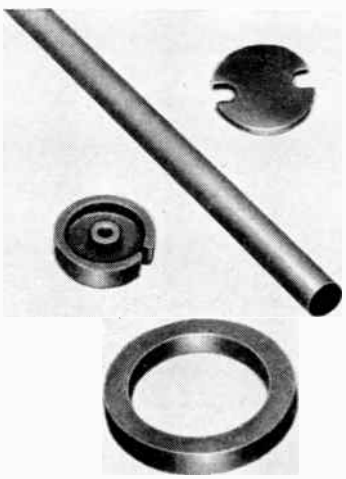
Ideally suited for IF transformers at 455 kc and antenna cores from 500 kc to 1700 kc.

Magnetic properties include: Initial permeability at 1 mc/sec. – 125; Maximum permeability – 400; Saturation flux density – 3300 gauss; residual mag. – 1800 gauss; coercive force – 2.1 oersted; temperature coefficient of initial permeability – .10%/°C max; Curie point – 350°C; vol. resistivity – high; loss factor at 1 mcs/sec. – .000020; loss factor at 5 mcs/sec. – .000050.

Standard Ferramic parts in various sizes and shapes offer a dependable, quick solution to design problems. Custom parts can be produced to your specifications. Contact General Ceramics' engineering advisory service. Our staff is ready to discuss your problems and make recommendations.



Q-2 Material



This material produces excellent results in TV receiver IF applications at 45 mc; and FM radio applications at 10.7 mc.

Magnetic properties include: Initial permeability at 1 mc/sec. – 40; Maximum permeability – 115; Saturation flux density – 2400 gauss; residual mag. – 750 gauss; coercive force – 4.7 oersted; temperature coefficient of initial permeability – 0.10%/°C max; Curie point – 450°C; vol. resistivity – high loss factor at 10.0 mc/sec. – 0.000085; loss factor at 50.0 mc/sec. – 0.000017.

Q-3 Material

The exceptionally high Q, excellent temperature stability and high permeability of Q-3 ideally suits it for applications in the 88 mc–108mc FM band and television RF frequencies from 50 mc–216 mc.

Preliminary specifications include: Initial permeability μ_o – 14; Maximum permeability μ_{max} – 42; Saturation flux density B_s – 2600 gauss; Residual magnetism B_r – 1470 gauss; Coercive Force – 21 oersted; Q at 100 mc – 250; Q at 150 mc – 150; Q at 200 mc – 70; Resistivity high; Curie point 330°C; Temperature coefficient of μ_o – .09%/°C max.

A New 16-page
FERRITE PARTS CATALOG

is available to engineers by request on company letterhead. It contains complete engineering data on stock parts and materials. When requesting your copy, please address Dept. E.

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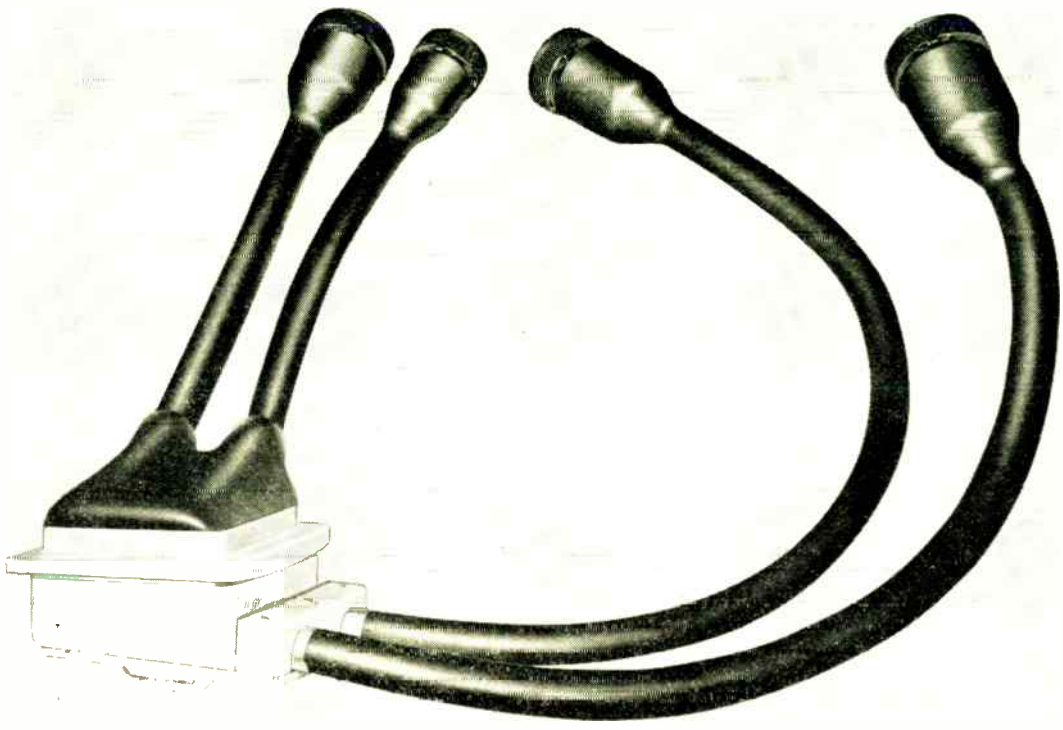
CANNON PLUG/HARNESS SYSTEMS



SINGLE RESPONSIBILITY FOR PERFORMANCE OF PLUG/HARNESS SYSTEMS...RELIABILITY GUARANTEED!

■ **CANNON PLUG/HARNESS SYSTEMS** are designed and manufactured under rigid, quality-controlled conditions in a separate, highly specialized facility completely equipped to handle all phases of design, development and manufacture. As a single source supplier for both plugs and harness assemblies, Cannon can assume complete responsibility for the reliability of the "Cannon Plug/Harness System" as a whole.

■ **COMPLETE TESTING FACILITIES:** Extensive testing equipment is also available to duplicate environmental conditions. These include vibration tests, temperature cycling tests, and heat flux tests duplicating heat re-entry conditions. Each system is 100% tested for continuity and for high potential and insulation resistance, shorts or grounds as well as humidity, VSWR, contact retention, etc. Certified test reports are available.

■ **SPECIAL DESIGN SERVICES:** Because Cannon is a single source supplier of the plugs and completes the termination, it is possible to select and recommend cables and termination techniques designed to custom-match the proper plug for the assembly. The complete assembly can thus be manufactured and tested under conditions prohibited to single-source suppliers.

■ **FASTER DELIVERY—NO COST PYRAMIDING:** A special, separate facility devoted to umbilical and harnessing production offers the most up-to-date production techniques to provide the industry's fastest delivery—plus no pyramiding of costs. Customers draw on Cannon's capabilities as the world's largest exclusive manufacturer of electrical plugs.

■ **FIELD TECHNICAL ASSISTANCE:** Experienced specialized sales engineers are available to discuss and assist customers in the technical aspects of plug-harness system requirements prior to manufacture and after installation in the field.

FOR FURTHER INFORMATION on Cannon Plug/Harness Systems write for Cannon Catalog HC-1— Cannon Electric Company, 3208 Humboldt Street, Los Angeles 31, Calif. Please refer to Department 120

CANNON ELECTRIC COMPANY —Factories in Los Angeles, Santa Ana, Salem, Toronto, London, Paris, Melbourne and Tokyo.

Distributors and Representatives in principal cities of the world.

CANNON PLUGS

Picture Flying Arrives

Integrated instrumentation systems using contact analog display promise safe all-weather flying for both fixed and rotary-wing aircraft

By WILLIAM E. BUSHOR

DALLAS, TEX.—Problems of presenting flight data to aircraft pilots are slowly but surely being solved. Recent advances were shown at the Army-Navy Instrumentation Program (ANIP) symposium held here last month. (See ELECTRONICS, p. 21, Sept. 18).

Helicopters

Demonstrations (see photo) of a contact analog system for instrument flying were given by Bell using their experimental RH-1 helicopter. A picture of the external world is presented to the pilot on a trichroic combining glass developed by North American's Autonetics division. The glass acts as a filter capable of reflecting one color while permitting others to pass through. The image projected on the trichroic glass is formed by an optomechanical generator designed by Bell.

The pattern is continuously varied by altitude signals from Bendix-Pacific's sonic altimeter; roll, pitch and heading signals from conventional vertical and directional gyros; and velocity signals from Ryan's Doppler radar. All these motions are shown as an integrated picture. Thus the pilot can judge attitude, altitude, ground speed and compass heading.

During a demonstration flight in the RH-I, I was able at all times to orient myself without reference to the outside world. Although judgment of ground speed was somewhat difficult, experienced helicopter pilots have flown and landed blind. One item needing further development is the altitude display—I found it extremely difficult to detect changes in vertical position of the aircraft.

Bell also displayed the RH-2 helicopter used as a research tool for evaluating performance of new instruments, controls and systems. A forward-looking obstacle radar system built by DuMont was shown installed in the RH-2. This system is a pulsed radar in the millimeter wavelength region which permits flight under zero-zero weather conditions at altitudes as low as 20 ft. I noticed that the radar was able to detect with good resolution close-in objects, such as other helicopters parked immediately in front. A narrow beam-width and nearly hemispherical field of view are required.

Author tries contact analog flying. Special glasses make screen image more distinct

Sensors

A new technique for air-speed measurement using radar and acoustics was shown by Midwest Research Institute. The system, unlike the conventional pitot tube, will be able to reach out beyond disturbed air mass produced by helicopter rotary wings. An acoustic wave and a radar beam are sent out. The radar beam is reflected by the acoustic wave; the frequency of the electromagnetic energy returned is automatically interpreted to give the pilot an instantaneous, accurate reading of air-speed. This technique also has meteorological applications.

Displays

Avion division of ACF described a device which automatically correlates information fed into it by navigation computers and instruments, and presents a tv picture in the form of a map of the terrain below the plane. An image of the plane projected over the map corresponds to the exact position of the aircraft.

Another unit shown was a ground-plane generator built by DuMont. Its crt display simulates the earth's surface by coordinate grid lines of uniform spacing. Sys-

tem contains high-speed analog computers capable of solving the equations required to describe the six kinds of helicopter motion: roll, pitch, yaw, change in altitude and translation in two directions relative to the earth. The pattern presented moves with the aircraft.

The radar data converter system developed by DuMont converts radar signals into tv-like displays and allows pilots to perceive depth of surrounding space outside aircraft. System receives antenna pointing angles and target range from a special radar system. This information is stored in two electrostatic storage tubes alternately storing, reading out and erasing on successive antenna scans. Readout is accomplished by tv scan at standard EIA rates. Display appears as standard lap-dissolved picture where the output of one storage tube is dissolved into the output of the other. Apparent target range information is provided through a process of intensity coding of the targets; close targets are brightest; brightness decreases as range increases.

Supporting Research

Varo Manufacturing is exerting research efforts towards developing ultimate microcircuits through optimum utilization of electrical, magnetic and other properties of matter, and through elimination of all superfluous nonfunctional materials. Varo is also striving to obtain a high degree of reliability by reducing process contamination, eliminating mechanical junctions and removing human factors in fabrication and assembly.

Laboratory for Electronics is studying micromagnetic properties of vacuum-evaporated thin films and the dependence of these properties on other controllable or measureable characteristics. Practical objective is a new class of storage and display devices which depend on the detailed properties of domain walls and their motion. Such devices are expected to be extremely compact, rugged and simple.

Servomechanisms, Inc., is researching thermoelectric materials with relatively high conversion effi-

(Continued on p 43)

AER -O- COM

DEFINITELY DEPENDABLE!

Aerocom's Dual Automatic Radio Beacon

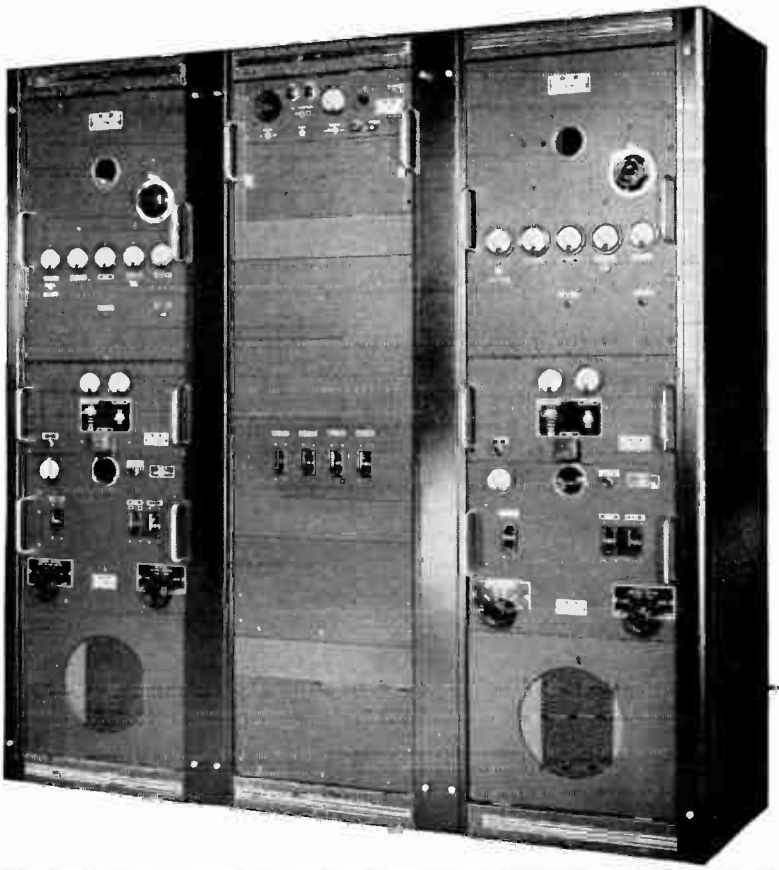
Reliability is built into every part of this dual 1000-watt aerophare unit. Ruggedly constructed and conservatively rated, it provides trouble-free unattended service, and at truly low operating and maintenance cost. It operates in the frequency range 200-415 kcs, using plug-in crystal for desired frequency.

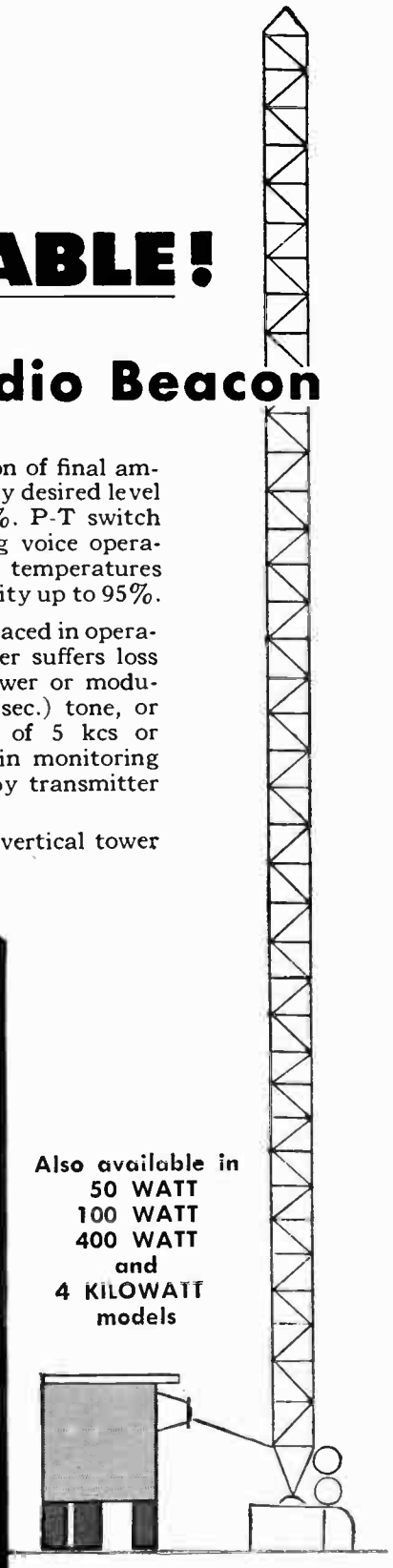
Uses single phase power supply, nominal 220 volts, 50 or 60 cycles. Consists of two 1 kw transmitters with 2 keyers, automatic transfer unit and weatherproof antenna tuner. Each transmitter housed in separate fan ventilated rack cabinet, with controls in center rack cabinet.

Nominal carrier power is 1000 watts. High level plate modulation of final amplifier is used, providing any desired level of modulation up to 100%. P-T switch interrupts tone, permitting voice operation. Operates in ambient temperatures from –35°C to 55°C, humidity up to 95%.

Standby transmitter is placed in operation when main transmitter suffers loss (or low level) of carrier power or modulation, or continuous (30 sec.) tone, or carrier frequency change of 5 kcs or more. Audible indication in monitoring receiver tells when standby transmitter is in operation.

Antenna may be either vertical tower or symmetrical T type.





Also available in
50 WATT
100 WATT
400 WATT
and
4 KILOWATT
models

A-101

AER -O- COM

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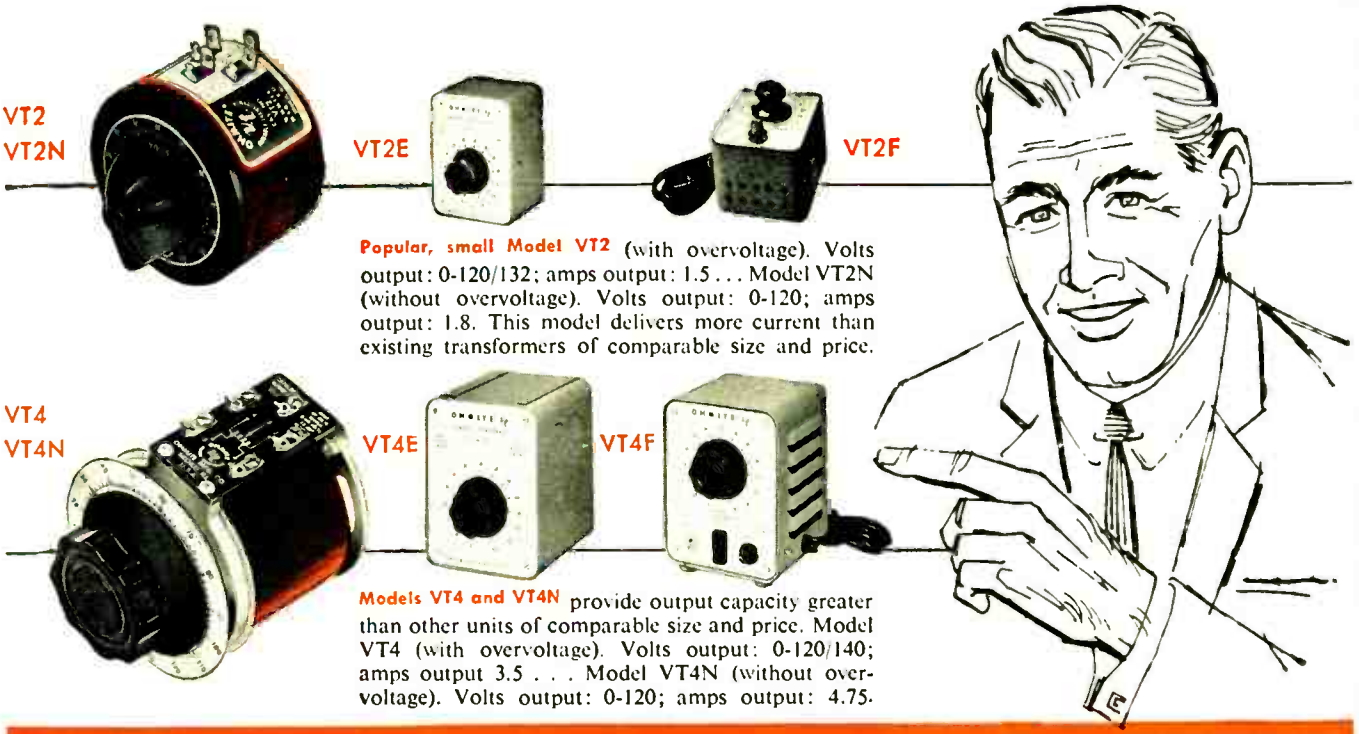


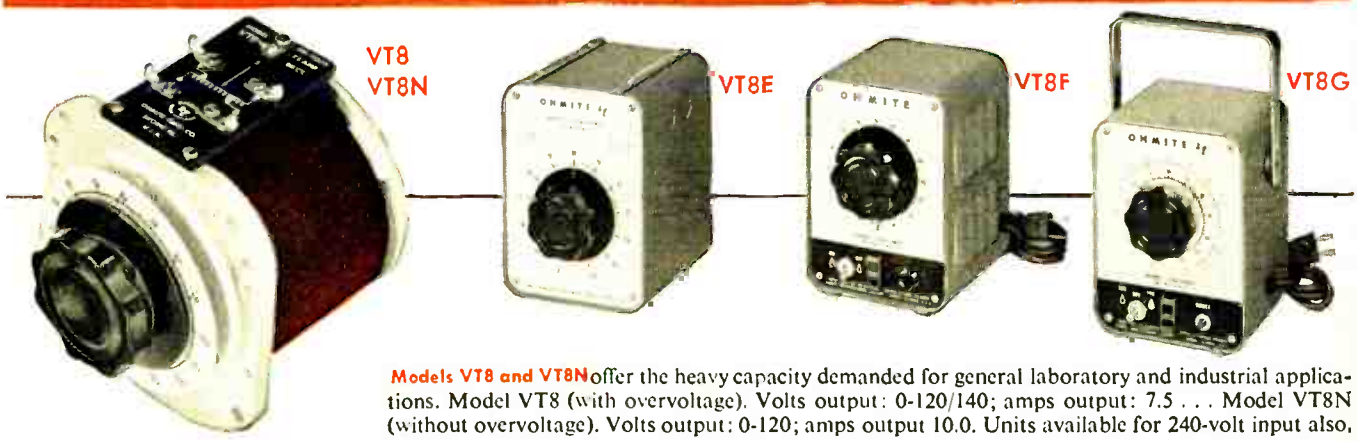
Popular, small Model VT2 (with overvoltage). Volts output: 0-120/132; amps output: 1.5 . . . Model VT2N (without overvoltage). Volts output: 0-120; amps output: 1.8. This model delivers more current than existing transformers of comparable size and price.

Models VT4 and VT4N provide output capacity greater than other units of comparable size and price. Model VT4 (with overvoltage). Volts output: 0-120/140; amps output 3.5 . . . Model VT4N (without overvoltage). Volts output: 0-120; amps output: 4.75.

OHMITE®

VARIABLE TRANSFORMERS

Complete Line Now Available from Stock



Models VT8 and VT8N offer the heavy capacity demanded for general laboratory and industrial applications. Model VT8 (with overvoltage). Volts output: 0-120/140; amps output: 7.5 . . . Model VT8N (without overvoltage). Volts output: 0-120; amps output 10.0. Units available for 240-volt input also.

Now you can get *fast delivery from stock* on 35 different models of Ohmite variable transformers. This newly expanded selection covers a high percentage of industrial needs. In it you will find single and three-phase units, two and three-in-tandem assemblies (not shown above), plus a variety of other cased and uncased models.

Ohmite "v.t." variable transformers combine fresh thinking in design with traditional Ohmite quality. For example, positive current transfer is achieved with direct brush to slip-ring, pig-tailed connection. Adjustable shafts on sizes VT4 and VT8 extend either to the brush or the base side. These two models also are *interchangeable* with competitive makes of comparable ratings. The "N" types in all three models provide additional current without overvoltage. The next time you need variable transformers, select from the line with advanced design—Ohmite.

Write for NEW Stock Catalog 30.

OHMITE® QUALITY Components

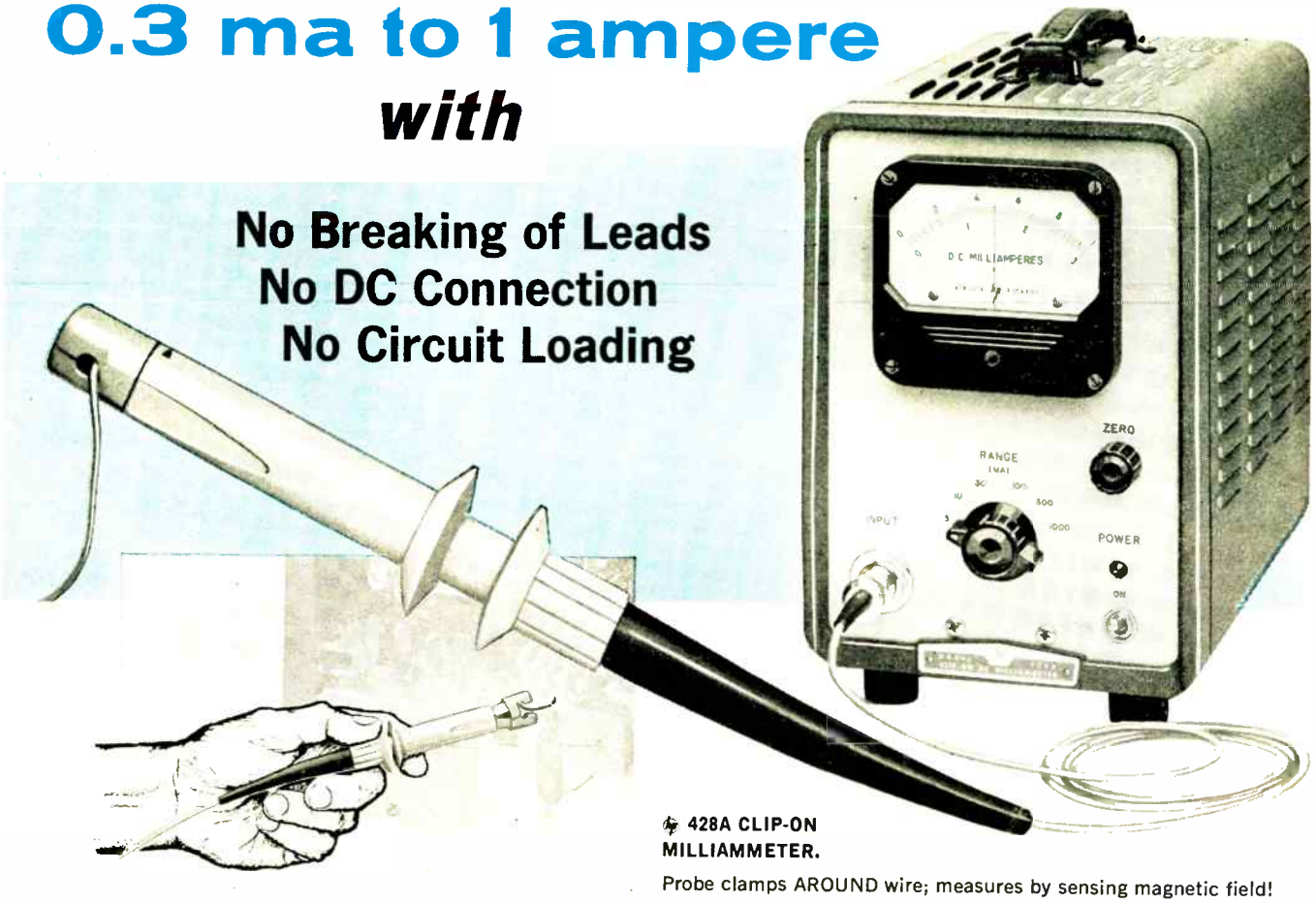
OHMITE MANUFACTURING COMPANY

3610 Howard Street, Skokie, Illinois

RHEOSTATS RESISTORS RELAYS
TAP SWITCHES TANTALUM CAPACITORS DIODES
VARIABLE TRANSFORMERS R. F. CHOKES

Measure dc currents
0.3 ma to 1 ampere
with

No Breaking of Leads
No DC Connection
No Circuit Loading



hp 428A CLIP-ON MILLIAMMETER.

Probe clamps AROUND wire; measures by sensing magnetic field!

Think of the measuring convenience, time saved and accuracy gained when you don't have to break into a circuit, solder on a connection, or worry about probe loading.

With the hp 428A Milliammeter and its new probe, you literally "*clamp around*" and read! You get maximum accuracy because there is no effective circuit loading from the 428A's dc probe. The instrument easily measures dc currents in the presence of ac. And insulation is more than adequate to insure safe measurements at all normal voltage levels.

For extremely low current level measurement, sensitivity can be increased by looping the conductor through the "jaws" of the 428A probe two or more times.

Brief specifications are given here; for complete details and demonstration *on your bench*, call your hp representative or write direct.

Specifications

Current Range: Less than 0.3 ma to 1 amp, 6 ranges. Full scale readings from 3 ma to 1 amp: 3 ma, 10 ma, 30 ma, 100 ma, 300 ma, 1 amp.

Accuracy: ± 3% ± 0.1 ma.

Probe Inductance: Less than 0.5 μh maximum.

Probe Induced Voltage: Less than 15 mv peak.

Effects of ac in circuit: Ac with peak value less than full scale affects accuracy less than 2% at frequencies different from the carrier (40 KC) and its harmonics.

Power: 115/230 v ± 10%, 50-60 cps, 70 watts.

Size: Cabinet mount, 7½" wide, 11½" high, 14¼" deep. Weight 19 pounds. Rack mount, 19" wide, 7" high, 12½" deep. Weight 24 pounds.

Probe Tip Size: Approximately ⅝" x 7/16". Wire aperture diameter 3/16".

Price: (Cabinet) $475.00; (Rack) $480.00.

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

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6058

Test the new hp 405A DC Digital Voltmeter

Beacon Extends Radar Range

First radar beacon in FAA's plan for positive airways control goes into New York area

IMPORTANT ADVANCE in positive air-traffic control was registered earlier this month with the dedication in New York of Federal Aviation Agency's air-traffic control radar beacon system.

First four beacons, implementing already-installed long-range and airport-surveillance radars, went into the ever-problematical New York complex of airports—one each at Newark, LaGuardia and New York International (Idlewild), and the fourth at the New York Air Route Traffic Control Center, also at Idlewild.

These four cost substantially more than the quarter-million-dollar price tag to be put on the production models of the beacon. The higher initial costs paid for a lot of test, evaluation and R&D, including development of a "defruiter" to keep the clutter from other beacons (called fruit) off the scopes. Airborne Instruments Laboratory division of Cutler-Hammer worked with FAA staff in the testing, evaluation and R&D.

Coherent Defruiter

The defruiter developed by AIL is a coherence device. The transponder returns a four-bit answer upon interrogation from the ground; the four bits are bracketed by spacing pulses. The bracket pulses are compared against a stored record of the transmitted interrogation pulse. If successive bracket pulses do not match successive interrogation pulses, the response is junked. If they do match, a blip is artificially prepared for the ppi display.

Since there are relatively few transponder-equipped planes flying (aside from military craft), and since many general-aviation craft may never be properly equipped, the system also presents primary radar returns. The primary return signal is delayed suitably to match the delay introduced by the transponder and the two sets of returns are superimposed on a common ppi display.

Secondary returns (beacon signals) are larger and clearer than primary returns from the same distance. Further, the 63 codes permitted by the four-bit answer can be used to communicate information—altitude, identification, position, states of emergency—as the need for this information becomes more clearly established.

Experience to date indicates that range of airport surveillance radars can be extended from 30 to 50 nautical miles by the beacon, and range of terminal-area radars can be extended from 90 to 120 nautical miles at 10,000 ft. The beacon is a lower L-band system.

Joseph Tippets, who runs FAA's Bureau of Facilities, said that his bureau will spend some $150-to-$200-million annually during the next few years for buying new control gear—"principally electronic gear." By the end of fiscal 1961, FAA will have spent upwards of $1 billion for new facilities, he added, pointing out that by then, spending for sophisticated air-ground communications and navigation aids will have only begun.

Radar beacon systems will be added to all long-range radars (whether FAA's or USAF's) which cover high-altitude flights; they will be working at the 13 air-route control centers before the end of this year. Then, as a second priority, they will be installed at the 180-odd terminal radar locations.

This will mean about 250 beacon installations for FAA, which adds up to about $70 million for ground stations alone. Airborne transponders cost about $2,000, and there doesn't seem to be much chance, ELECTRONICS learned, that the price can be substantially reduced.

Few commercial craft are presently equipped with the needed airborne transponder. Eastern Airlines has outfitted its fleet, and a few other flag craft are outfitted, for a total of about 200 transponders thus far. The 600 transponders now on order will outfit about a third of the carrier fleet. New commercial craft will come from factory with transponders installed.

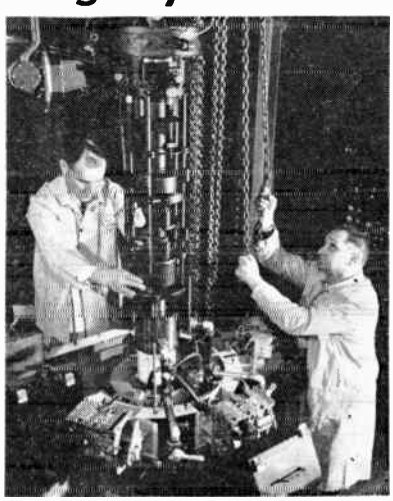
Picture Flying . . .

(Continued from p 39)

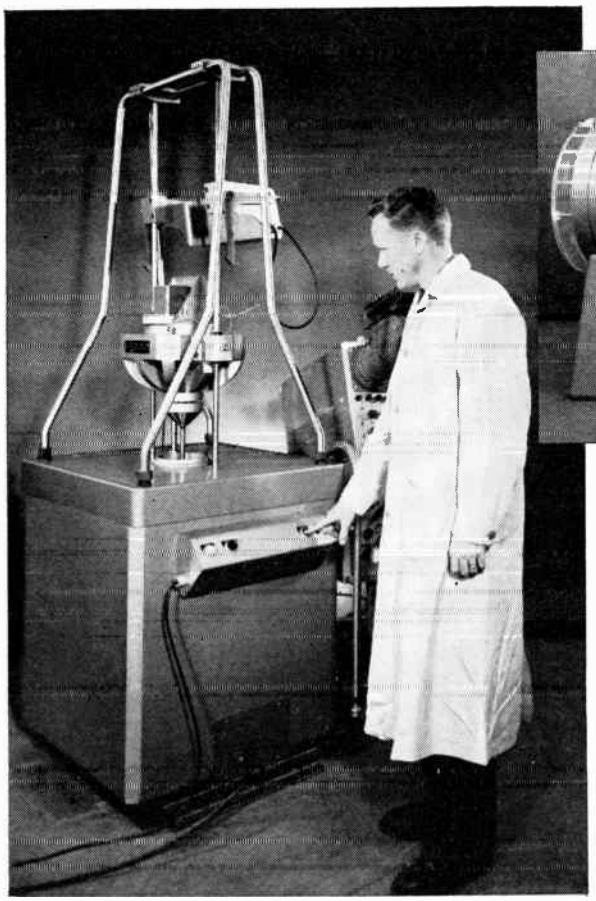
ciency. Much effort is directed toward obtaining materials capable of retaining thermoelectric properties at very high temperature. Also being studied is the use of magnetic domain interaction in thin evaporated films as an approach to digital logic and memory elements. Success of such studies should do much to miniaturize digital circuits and increase their reliability.

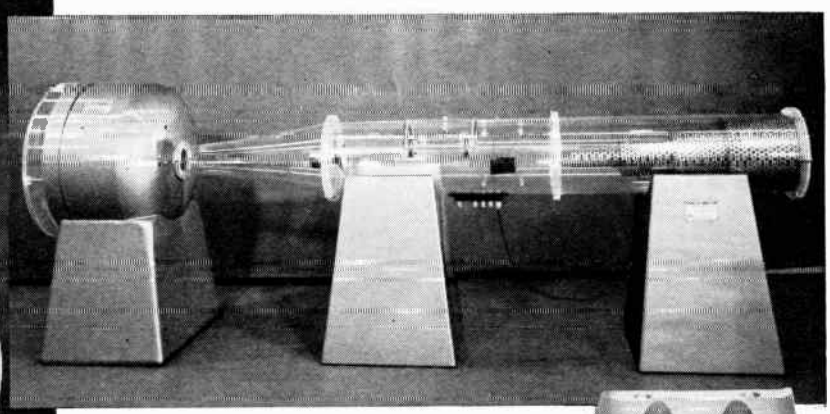
An ANIP research team made up of Douglas Aircraft, Servomechanisms, Varo and Litton is developing the RV-2 airborne digital computer, which will use principles of magnetic-domain interaction. This computer is scheduled for completion in approximately two years.

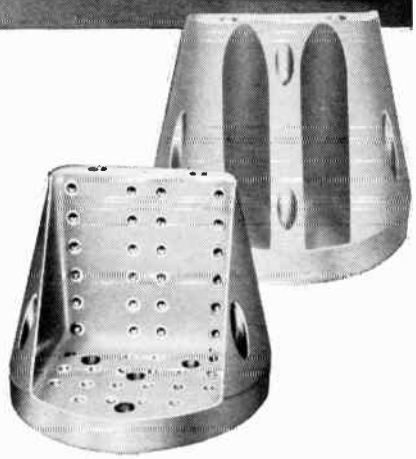
King Klystron



Multi-million watt klystron is being placed in new Sage radar system. The tube, developed jointly by GE and the Air Research and Development Command's Rome Air Development Center, will produce hundreds of times more power than the radar used to beam pulses to moon and back in 1946







(left) **Shock Machine** SM-010, with shock pulses up to 1000 g's, meets rigid specifications of WS-107A-2 Environmental Test Requirements for ballistic missile components.

(above) **Acoustic Noise Generator** AG-012, producing up to 163 db of random noise, can be used singly or in systems with other speakers to meet specific testing requirements.

(right) **Environmental Test Fixture** (two views shown) is compact and versatile. Handles several specimens along three mutually perpendicular axes. Mounts on standard vibration exciters, centrifuges and shock machines.

NOW AVAILABLE...

USE-PROVEN ENVIRONMENTAL TEST EQUIPMENT

Avco test equipment meets severe environmental testing requirements of ballistic missile program

SHOCK TESTING. Shock Test Machine SM-010, first in a series of Avco-developed and use-proven shock test machines, answers broad categories of testing requirements.

- Produces shock pulses up to 1000 g's
- Handles specimen loads up to 100 pounds
- Provides sawtooth, quarter-sine, half-sine, square and triangular pulses
- Designed to permit easy duplication of particular shock pulse for repetitive testing
- Use-proven in qualification testing of electronic and electromechanical units for major missile program
- Occupies less than four square feet of floor space
- Incorporates operator safety features
- Shock pulses easily modified by changing lead pellet or rubber pad decelerators
- Provides capability of recycling for life testing

ENVIRONMENTAL TEST FIXTURE. This new unit was designed for general environmental lab use and has several advantages over the conventional unit.

- Mounts on vibration exciters, acceleration and shock test machines
- Permits simultaneous testing of several small components in three planes
- Both fixtures available in beryllium to meet more stringent requirements
- Virtually resonance-free up to 2000 cycles
- Two sizes available: TF-006-1 (specimen size—6 x 6 x 4½ inches) handles specimens up to 6 pounds; TF-025-1 (specimen size—12 x 12 x 9½ inches) handles specimens up to 25 pounds

ACOUSTIC NOISE TESTING SYSTEMS. Avco has pioneered in the development of these systems, featuring the Avco Acoustic Noise Generator AG-012.

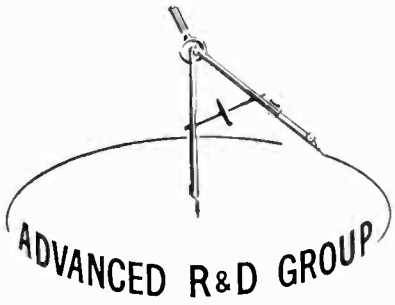
- First noise generator to duplicate random noise of rocket engine firing
- Produces up to 160±3 db of random noise into a 4-inch progressive wave tube, thereby providing most powerful single electrodynamic loudspeaker available
- Peak single frequency of 170 db at 200 cycles per second
- Adaptors available for changing to 4-, 6-, 12-, 18-inch plane wave tubes in minutes
- Single electrodynamic loudspeaker offers maintenance advantages over multispeaker systems
- Designed for operation with existing vibration amplifiers—no additional capital equipment required
- Single Avco Noise Generator permits tests formerly requiring up to 50 speakers
- Single Avco AG-012 becomes heart of complete noise testing system
- Designed for progressive wave and reverberant chamber testing
- Frequency range from 20 to 2400 cps

Avco's line of Environmental Test Equipment is fully represented by local agents throughout the continental United States and the world. For further information write: *Products and Services Department, Research and Advanced Development Division, Avco Corporation, Wilmington, Mass.*

AVCO
Research & Advanced Development division

How far can an engineer go at AC?

SPECIAL EDUCATION PROGRAMS DEVELOP CAREERS



AC's instrumentation projects offer you a bright future of growth and job satisfaction, if you qualify. You can work on the AChiever inertial guidance system or many other electromechanical, optical and infra-red devices. The finest "in house" training programs are available to you. And AC's new R & D group assures a position of leadership in space age developments.

Three advanced education programs can help you enhance your professional status. AC offers them in addition to their educational assistance programs for men who wish to study for advanced degrees in nearby universities.

Program A—for recent graduate engineers—gives you a solid foundation in the theory and application of inertial guidance systems and servomechanisms.

Program B—for experienced engineers—consists of upgrading studies in inertial guidance, servomechanisms, environmental problems, engineering math and physics, plus advanced state-of-the-art courses.

Program C—for all engineering supervisors—involves management training developed by a team of AC executives and University of Chicago industrial relations experts.

AC's new R & D Group is devoted to the Research and Development of advanced systems and components. Current programs include many vital projects: interplanetary navigation and guidance; digital computer development; advanced inertial sensors; passive electromagnetic detection, surveillance and navigation systems; guidance systems for ballistic missiles, space vehicles and aircraft.

If you are a graduate engineer in the electronics, electrical or mechanical fields, or if you have an advanced degree in mathematics or physics, you should talk with the people at AC. Write the Director of Scientific and Professional Employment, Mr. Robert Allen, Oak Creek Plant, Box 746, South Milwaukee, Wisconsin.

INERTIAL GUIDANCE SYSTEMS • AFTERBURNER FUEL CONTROLS
BOMBING NAVIGATIONAL COMPUTERS • GUN-BOMB-ROCKET SIGHTS
GYRO-ACCELEROMETERS • GYROSCOPES • SPEED SENSITIVE SWITCHES
SPEED SENSORS • TORQUEMETERS • VIBACALL • SKYPHONE

AC SPARK PLUG ❀ THE ELECTRONICS DIVISION OF GENERAL MOTORS

Magnetic Ink Sorts

New electronic data processing system designed for banks does not use magnetic tape

Punched Mylar tape stores instructions

PAOLI, PA.—This month Burroughs started accepting orders for its Visible Record Computer (VRC), an electronic data processing system that reads magnetic ink characters imprinted on bank checks, posts and totals customer ledgers without the intermediate step of putting the data on magnetic tape.

The company reports 10 systems on order. They sell for $217,400, rent for $3,975 monthly. Production is just starting at Burroughs' Plymouth, Mich., plant. First deliveries are slated for early 1961.

Applications

The system is designed to handle checking accounts, or as bankers say: demand deposits. In addition it is expected to find use in savings accounts, mortgage and installment loan work.

The manufacturer says the system will pay for itself in a bank having 10,000 accounts. Reportedly life insurance companies and stores with heavy retail charge account business are also interested.

The VRC fills out the Burroughs line of automatic data processing equipment for banks: mechanical bookkeeping machines for very small operations, semiautomatic Sensitronic machines for larger operations, then the VRC and, finally, for large establishments, a magnetic-tape record computer (TRC).

How VRC Works

Magnetic ink characters in the so-called MICR (Magnetic Ink Character Recognition) format adopted last year by the American Bankers Association automation committee are imprinted on checks by Burroughs subsidiary Todd. Blank checks are imprinted by a manual off-line imprinter at the

Checks

bank. Magnetic heads (one for each digit) on a rotating drum sense the character. The signals are stored in delay lines and compared with character waveforms for recognition.

The computer portion of the system can perform 4,000 arithmetic operations a minute. The programming units are controlled by instructions punched into Mylar tape; 2,500 steps are available. The output printer has 160 character positions, prints 200 lines a minute. The printer is electronically controlled with a plugboard on console to select format.

The unit uses 5,500 transistors of the medium-speed switching and audio power types; 50,000 other electronic components; and 75,000 mechanical parts. Basic circuits are laid out on some 1,000 printed circuit cards. Wire-wrap joints are used throughout for interconnection.

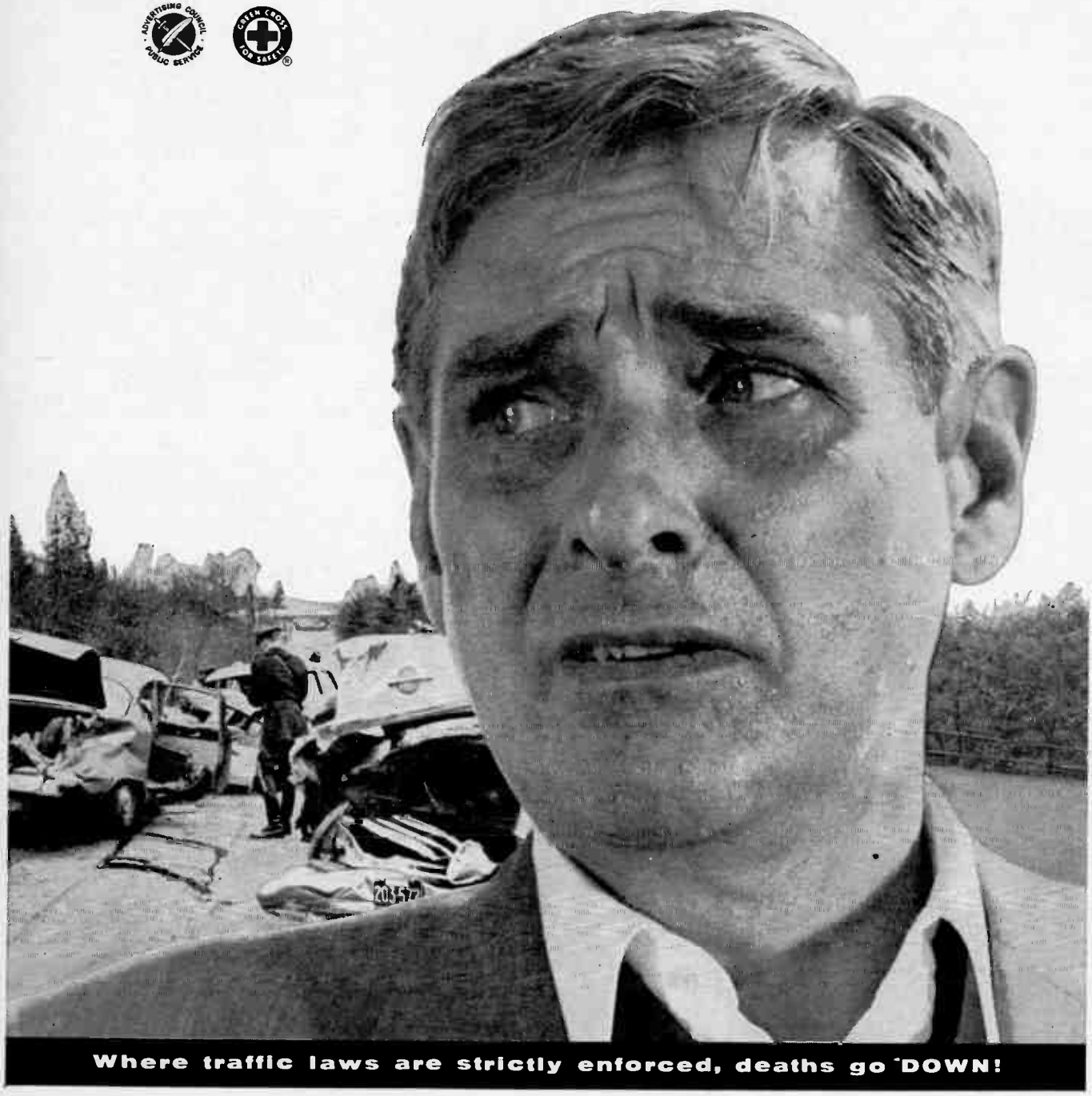
Maintenance is facilitated by a panel showing the condition of all binary circuits. Dials permit manual set-up of the computer and step-by-step operation for maintenance or troubleshooting. The Mylar tape program units are plugable to add flexibility to the computer. The system reportedly took 100 engineer-years, cost $5 million to develop.

Tests Guidance

Test console and rate table, built by Amelco, Inc. for Douglas, makes all dynamic measurements necessary to evaluate the Inertial Guidance Flight Controller prior to its installation in the Thor IRBM

"I wish I could have done something to help . . ."

You can do something about traffic accidents! Drive safely yourself—obey the law. Sure. But you can do a lot *more!* Traffic accidents affect *everybody.* Reducing them is a community problem. Its solution calls for systematic, organized effort and cooperation with public officials—for teamwork and leadership. Here is where *you* can help. Join with others who are working actively to promote safe driving and secure strict enforcement of all traffic laws. Make your influence count. *Support your local Safety Council!*



Published in an effort to save lives in cooperation with the National Safety Council and The Advertising Council.

Simplified, Accurate Broadband Measurements

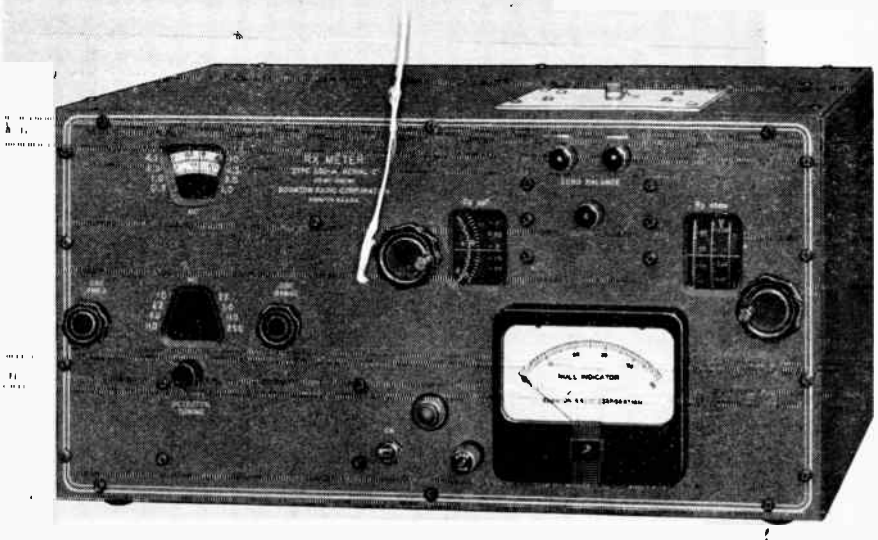
Frequency Range 500 KC to 250 MC

The integral design of this RF bridge eliminates difficulties from leakage, hand effects or improper matching that can occur when several units must be interconnected to make measurements. Integrated within the 250-A are an accurate, continuously tuned RF oscillator, high frequency bridge, amplifier-detector and null indicating meter. Connections to the unknown impedance are arranged for practically zero lead length. Equivalent parallel resistance and capacitance are read directly from the calibrated dials over the entire range.

Typical Applications

The RX meter provides a quick accurate means of measuring the RF resistance and reactance of a wide variety of materials, components and circuits. Measurements can also be made of the dynamic parameters of transistors, vacuum tubes and diodes under selected conditions of D.C. bias and operating levels. Measurements of antennas and antenna systems are readily convertible to series equivalents or VSWR. Transmission line characteristic impedance, attenuation and velocity of propagation are easily determined.

BRC Type 250-A RX Meter... Complete, Integrated, Self-contained— No External Units Required



Specifications

Frequency Range: 500 KC to 250 MC

Frequency Accuracy: ±1%

Resistance Range (Rp): 15 to 100,000 ohms (28" scale length)

Resistance Accuracy: $\pm\left[2+\frac{F^*}{200}+\frac{R^*}{5000}+\frac{Q^*}{20}\right]\% + 0.2\ \Omega$

*F = frequency (MC); R = RX Meter Rp reading (Ω);
$Q = \frac{R}{\omega C \times 10^{-12}}$, where C = RX Meter Cp reading (μμf)

Resistance Calibration: Increments of approx. 3% throughout most of range.

Capacitance Range (Cp): 0 to 20 μμf (0.1 μμf increments)

Capacitance Accuracy: ± (0.5 + 0.5F²* C* x 10⁻⁵)% ± 0.15 μμf
*F = frequency (MC); C = RX Meter Cp reading (μμf)

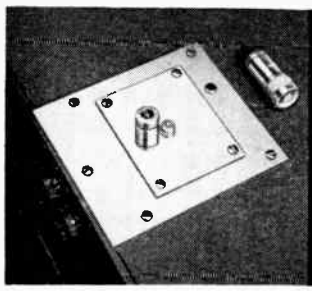
Capacitance Calibration: 0.1 μμf increments.

Inductance Range (Lp): .001 μh to 100 mh

Inductance Accuracy: Basic accuracy is capacitance accuracy given above.

Test Voltage: 0 volts D.C. (50 ma permissible thru unknown terminals)
0.1 to 0.5 volts RF (conveniently reducible to 20 mv)

Price: $1525.00 F.O.B. Boonton, N. J.



CO-AX ADAPTER KIT TYPE 515-A
Permits connection to the RX Meter bridge circuit of any coaxial transmission line or fixture fitted with a type "N" male connector.
PRICE: $38.50 FOB Boonton, N. J.

25th ANNIVERSARY

Precision Electronic Instruments since 1934

BOONTON RADIO CORPORATION
BOONTON, NEW JERSEY, U.S.A.

Prices cut another 20% on

Mass production of SCR's is now a reality. The experience, skill and manufacturing knowhow of General Electric's SCR production line is your assurance of dependable quality-controlled SCR's —an assurance unmatched by any other manufacturer.

WHAT THE SCR DOES

The SCR is a miniature semiconductor device that blocks positive forward voltage in its "off" or nonconducting state. However, by applying a small signal to the gate terminal it switches rapidly to a conducting state and acts like a single junction silicon rectifier. It is completely static, arcless and fast. It is almost 100% efficient. It contains no mechanisms subject to wear. As a result, the SCR can switch and control power either faster, more safely, less expensively or more reliably than the many devices it replaces: circuit breaker, relay, thyratron, magnetic amplifier, rotating amplifier and many others. Among the many hundreds of circuit designs are these:

Superior d-c motor operation from an a-c source. Eliminates motor generator sets, tubes or magnetic amplifiers to provide controlled d-c. Replaces mechanical speed and direction changers.

Superior a-c generation from a variable d-c source. First really practical method of using static inverters with ratings of several kilowatts.

Simpler conversion to high frequency. SCR converters are small and efficient. Extends use of high frequency power where desirable, as in fluorescent lighting systems.

Pulse modulators. Compact, yet rugged replacement for hydrogen thyratrons in radar and beacon modulators.

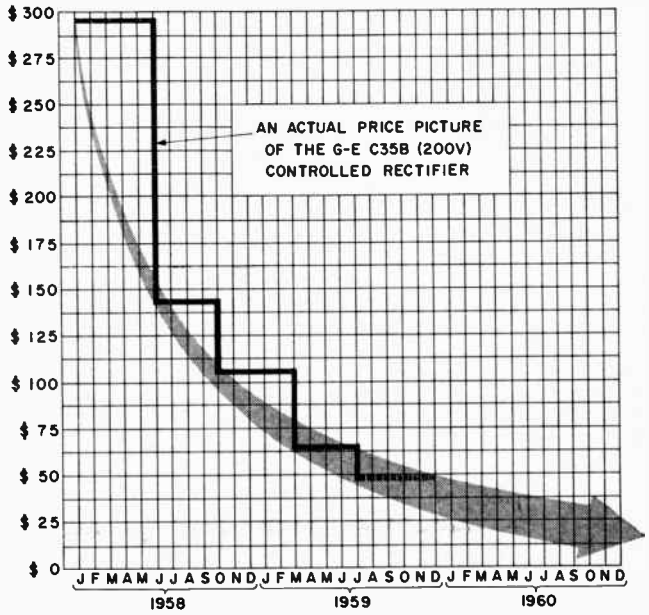
D-c regulation. Control large blocks of voltage with small losses by pulse width modulation. Eliminate bulky rheostats and adjustable d-c generators.

Other applications: Battery charging regulator, transient voltage protection, dynamic braking, constant current supply, static switching, regulated power supply, d-c to d-c conversion, temperature control.

silicon controlled rectifier

First test data revealed, new circuits developed, customer designs move into manufacturing stage

Prices again have been reduced an average of twenty percent on General Electric's Silicon Controlled Rectifier, providing greater values to users. These new prices have been made possible through expanding production and lower manufacturing costs.



GENERAL ELECTRIC
CONTROLLED RECTIFIER PRICE TREND

TESTS AND FIELD REPORTS PROVE RELIABILITY

Reliability of General Electric SCR's has been steadily improved over two years of manufacturing experience. Typical test results point to the reliability achieved to date.

98% survival after 1000 hours of storage at 125°.

97% survival after 1000 hours of operation at maximum ratings at 125°C.

No thermal fatigue failures after 30,000 cycles from 20°C to 135°C and return.

Less than one percent failures experienced by customers (many of which were traced to misapplication).

SCR NOW BEING USED BY MANY COMPANIES

The evaluation stage is passing rapidly into the application stage. Many products incorporating the SCR are being marketed, for the applications are proved, circuits refined and quantity production is a reality. These are just a few of the many cases where an SCR is now doing a job more efficiently, less expensively, faster or more reliably than previous designs:

Power supplies incorporating transient voltage protection (for computers).

Radar modulator.

Static switch to replace mechanical relay for aircraft.

Three phase inverter.

Stage lighting lamp dimming.

Regulated power supply.

Battery charging regulator.

Constant current supply for a magnetic yoke.

SEND FOR DESIGN INFORMATION

Detailed application notes and article reprints are available for the guidance of designers. Your General Electric Semiconductor Sales Representative will be pleased to provide you with complete details. Or write to Section **S2599**, Semiconductor Products Dept., General Electric Company, Electronics Park, Syracuse, New York. Many local G-E Semiconductor Distributors also stock General Electric SCR units for fast delivery at factory-low prices.

MAXIMUM ALLOWABLE RATINGS (Resistive or Inductive Load)

	C35U	C35F	C35A	C35G	C35B	C35H	C35C	C35D
Continuous Peak Inverse Voltage (PIV)	25	50	100	150	200	250	300	400 volts
Transient Peak Inverse Voltage (Non-Recurrent<5 millisec.)	35	75	150	225	300	350	400	500 volts
RMS Voltage (V_{RMS}), Sinusoidal	17.5	35	70	105	140	175	210	280 volts
Average Forward Current (I_F)	Up to 16 amperes							
Peak One Cycle Surge Current (I_{surge})	150 amperes							
Peak Gate Power	5 watts							
Average Gate Power	0.5 watts							
Peak Gate Current (I_G)	2 amperes							
Peak Gate Voltage (V_G) (forward)	10 volts							
Storage Temperature	−65°C to +150°C							
Operating Temperature	−65°C to +125°C							

	C35U	C35F	C35A	C35G	C35B	C35H	C35C	C35D
CHARACTERISTICS (At Maximum Ratings)								
Minimum Forward Breakover Voltage (V_{BO})	25	50	100	150	200	250	300	400 volts
Maximum Reverse (I_R) or Forward (I_S) Leakage Current (Full Cycle Average)	6.5	6.5	6.5	6.5	6.0	5.5	5.0	4.0 ma
Maximum Forward Voltage ($V_{F\ AVG}$)	0.86 volts (Full Cycle Average)							
Maximum Gate Current To Fire (I_{GF})	25 ma							
Maximum Gate Voltage To Fire (V_{GF})	3 volts							
Typical Gate Current To Fire (I_{GF})	10 ma at +1.5 volts (Gate to Cathode Voltage)							

C-35 Series—lower cost series with ratings similar to above, but for use up to 100°C maximum, with forward current ratings up to 10 amperes.
ZJ-50 Series—a high-current series now in development, and available on a prototype-sample basis.

GENERAL ELECTRIC

Semiconductor Products Department

why should you consider going to work for Collins Radio?

You shouldn't if your present job is good enough. If it offers you enough individual expression, enough satisfaction, enough variety, enough incentive. And, yes, enough salary. But perhaps something is lacking. Perhaps you should consider Collins.

Collins has been the creative leader in electronics for over 25 years. The reason for this leadership is a continuous emphasis on advanced research and development. The results are impressive steps forward in communication and navigation. Collins was first to develop the radio sextant. Collins was first to bounce radio signals off the moon. Collins pioneered the development of single sideband communication, and is currently setting up the SAC global communication system.

Collins offers outstanding opportunities for professional advancement. Each engineer becomes a valuable specialist, or obtains the broad experience necesssary for technical administration. And engineers are viewed as Collins' most important source of administrative leaders. In addition, Collins Radio offers you the advantages of your choice of location and project assignment.

If you are an engineer with a degree in EE, ME or Physics, Collins invites you to consider applying your talent and experience toward advancing your career in one of the following areas: With Collins in Dallas — circuit design, radar, microwave and carrier, telephone transmisssion, missile and satellite tracking and communication, airborne communication and navigation systems. With Collins in Cedar Rapids — gyro controls, navigation and guidance systems, circuit design, vibrations. With Collins in Burbank — digital communication system transistorized circuit design, component engineering, test equipment design, reliability engineering, system design, and group project administration. U. S. citizenship is required.

Choose your climate and send your resume and home phone number in complete confidence to one of the following:

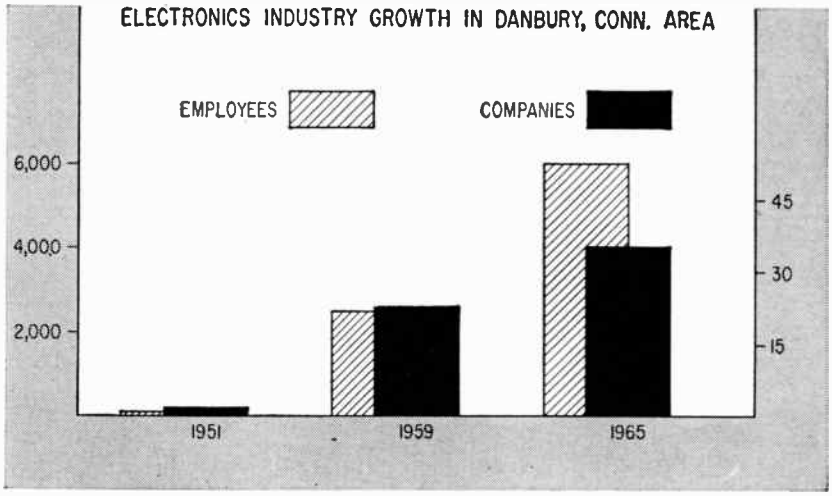
L. R. Nuss, Collins Radio Company, 855 35th St., N.E., Cedar Rapids, Iowa;

B. E. Jeffries, Collins Radio Company, 1930 Hi-Line Dr., Dallas 7, Texas; or

R. J. Olsen, Collins Radio Company, 2700 W. Olive Ave., Burbank, California.

COLLINS

COLLINS RADIO COMPANY • CEDAR RAPIDS, IOWA • DALLAS, TEXAS • BURBANK, CALIFORNIA



'Dead' Town Comes to Life

Electronics industry plays a major role as Danbury, Conn., starts booming once more

DANBURY, CONN.—This is the town that died twice.

This is the town the electronics industry, more than any other, is bringing back to life—for good.

The hat industry's departure decades ago killed the town. The town crept back slowly, only to be flattened again by the Connecticut floods of 1955. Today the area is booming. Here is the part electronics has played:

In 1951 two electronics firms here employed 100 persons. Today there are 23 plants and 2,500 workers. And the prediction for 1965 is this: 35 electronics companies hiring 6,000 men and women.

Land, Men Aplenty

Danbury has used no tax gimmicks, no stunts. It has attracted nearly 100 companies to its area in the last six years by pointing out its prime assets: available land and skilled manpower which works best under pressure.

Sixty miles from New York City, Danbury is the 13th largest city in the state, has an area population of 85,000.

"Danbury and the 14 smaller communities in its area cover 474 square miles," says Richard C. Gram, manager of the city's chamber of commerce. "And we have several thousand acres left for new companies to build on."

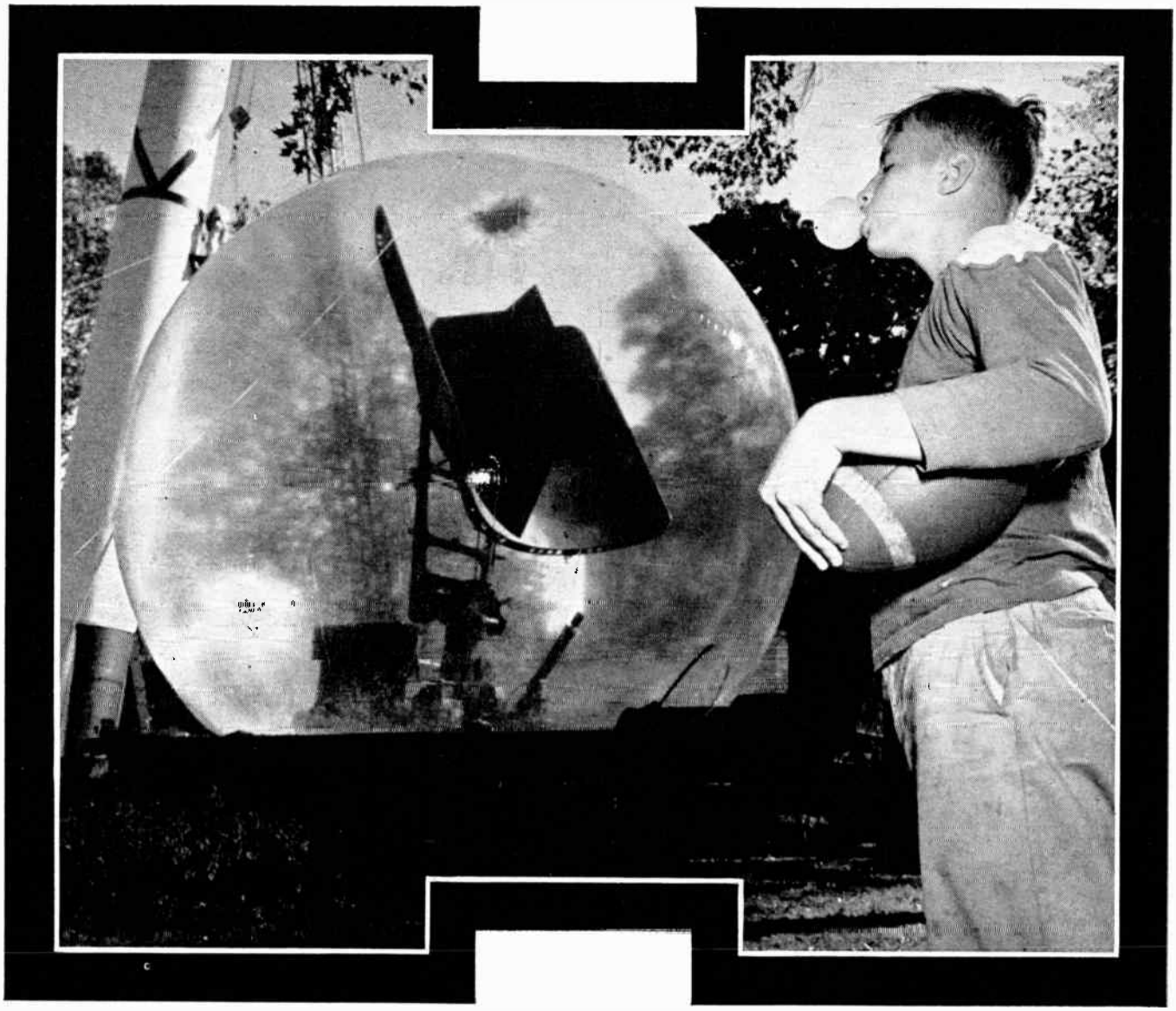
Of seven companies to pick the Danbury area in the past three months, five are in the electronics industry. By the end of next year, electronics firms expect to hire 1,000 more persons. Our industry now accounts for 25 percent of the area's 11,000-man labor force.

Company growth rates have been amazing. Data-Control Systems, Inc., went from four to 250 workers in six months. National Semi-Conductor Corp., just starting with 50 workers, expects to be hiring 500 shortly. Consolidated Controls Corp. expanded its facilities 75 percent in nine months.

Electronics companies in the greater Danbury area include:

Reeves Soundcraft Corp.; Sperry Products, Inc.; Electronic Fittings Corp.; Kanthal Corp.; National Semi-Conductor Corp.; Rapid Electric Corp.; Waltham Precision Instrument Co.; American Radionic Co., Inc.; Boesch Mfg. Co.; Brown Engine Products; Colin Campbell Co., Inc.; Danbury-Knudsen, Inc. div. of Amphenol-Borg Electronics Corp.; Data-Controls Systems; K-V Transformer Corp.; Republic Foil & Metal Mills; Viking Wire Co.; Pyno Moulding Corp.; Winchester Electronics, Inc.; Plastic Molding Corp.; Brandstrom Electric Co.; Berkshire Transformer Corp; Consolidated Controls Corp; Mosler Research Products, Inc.

A new dimension in



bubble blowing

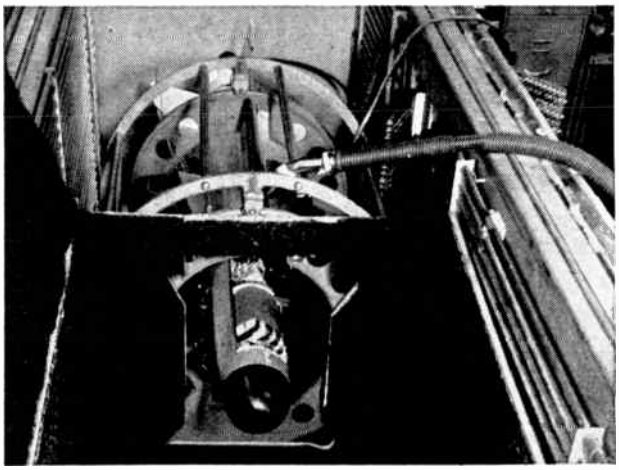
This plastic bubble protects the antenna of a radically new aerial three-dimensional radar defense system.

Sensitive to the inadequacies of conventional radar systems, engineers at Hughes in Fullerton devised a radar antenna whose pointing direction is made sensitive to the frequency of the electromagnetic energy applied to the antenna. This advanced technique allows simultaneous detection of range, bearing and altitude...with a single antenna.

Hughes engineers combined this radar antenna with "vest-pocket sized" data processors to co-ordinate antiaircraft missile firing. These unique data processing systems provide:

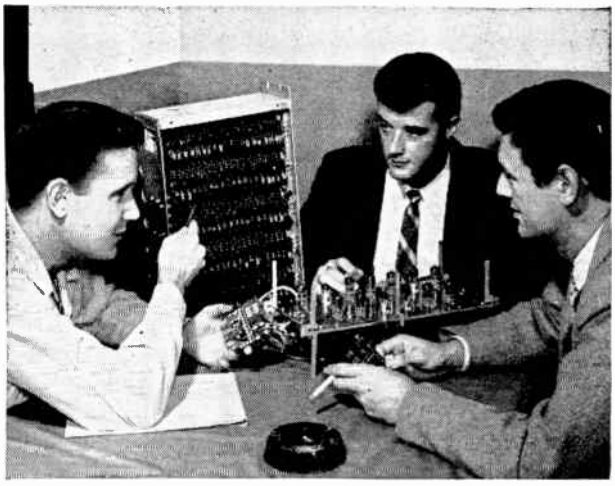
1. Speed—Complex electronic missile firing data was designed to travel through the system in milliseconds, assuring "up-to-date" pinpoint positioning of hostile aircraft.
2. Mobility—Hughes engineers "ruggedized" and miniaturized the system so that it could be mounted into standard army trucks which could be deployed to meet almost any combat problem—even in rugged terrain.
3. Reliability — By using digital data transmission techniques, Hughes engineers have greatly reduced any possibility of error.

Result: the most advanced electronics defense system in operation!



Falcon air-to-air guided missiles, shown in an environmental strato chamber are being developed and manufactured by Hughes engineers in Tucson, Arizona.

Reliability of the advanced Hughes systems can be insured only with the equally advanced test equipment designed by Hughes El Segundo engineers.



Other Hughes projects provide similarly stimulating outlets for creative talents. Current areas of Research and Development include advanced airborne electronics systems, advanced data processing systems, electronic display systems, molecular electronics, space vehicles, nuclear electronics, electroluminescence, ballistic missiles...and many more. Hughes Products, the commercial activity of Hughes, has assignments open for imaginative engineers to perform research in semiconductor materials and electron tubes.

Whatever your field of interest, you'll find Hughes diversity of advanced projects makes Hughes an ideal place for you to grow... both professionally and personally.

Newly instituted programs at Hughes have created immediate openings for engineers experienced in the following areas:

Infrared	Thin Films
Plasma Physics	Microwave Tubes
Digital Computers	Circuit Design & Evaluation
Field Engineering	Systems Design & Analysis
Quartz Crystal Filters	Logical Design
Communications	Semiconductor Circuit Des.

Write in confidence to Mr. Mike Welds
Hughes General Offices, Bldg. 6-D9, Culver City, Calif.

HUGHES

The West's leader in advanced ELECTRONICS

HUGHES AIRCRAFT COMPANY
Culver City, El Segundo, Fullerton, Newport Beach, Malibu and Los Angeles, California
Tucson, Arizona

MEETINGS AHEAD

Sept. 28-30: Telemetering, National Symposium, PGTRC of IRE, Civic Auditorium & Whitcomb Hotel, San Francisco.

Sept. 30-Oct. 1: Industrial Electronics Symposium, PGIE of IRE, AIEE, Mellon Inst., Pittsburgh, Pa.

Oct. 5-7: Communications Symposium, National Conf., PGCS of IRE, Hotel Utica, Utica, N. Y.

Oct. 5-9: Society of Motion Picture & Television Engineers, Annual Convention, Statler-Hilton Hotel, New York City.

Oct. 5-9: Audio Engineering Society, Convention and Exhibit, Hotel New Yorker, New York City.

Oct. 6-7: Value Engineering, EIA, Engineering Dept., Univ. of Penn. Museum Auditorium, Philadelphia.

Oct. 6-8: Radio-Interference Reduction, Annual, Armour Research Foundation of Illinois Institute of Tech., Chicago.

Oct. 6-9: High-Temperature Technology, International Symposium, Asilomar Conf. Grounds, Stanford Research Inst., Asilomar, Calif.

Oct. 7-9: Canadian IRE Convention, Automotive Building, Exhibition Park, Toronto, Canada.

Oct. 7-9: Vacuum Technology, National Symposium, Sheraton Hotel, Philadelphia.

Oct. 11-16: American Institute of Electrical Engineers, Fall General Meeting, Hotel Morrison, Chicago.

Oct. 12-14: National Electronics Conference, AIEE, EIA, IRE, SMPTE, Hotel Sherman, Chicago.

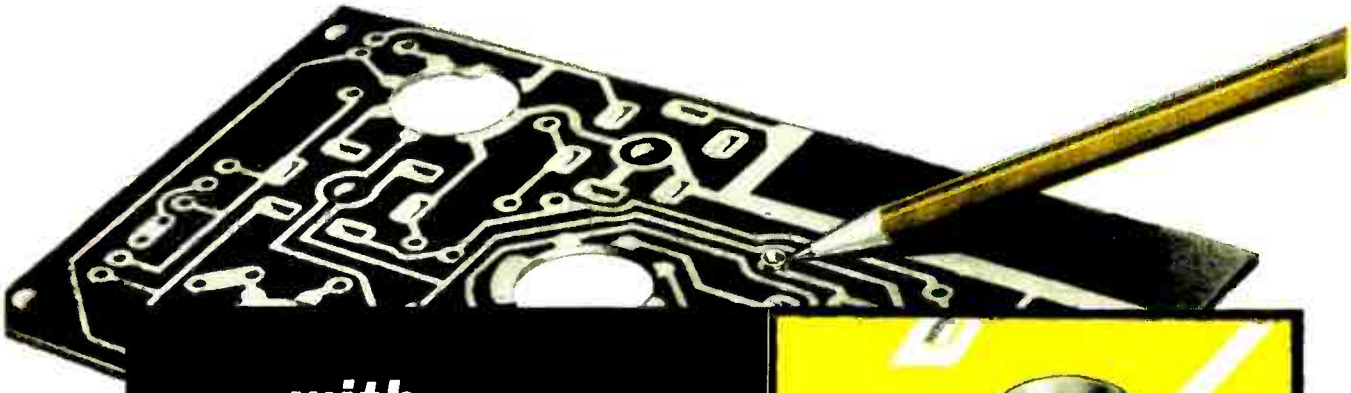
Oct. 12-16: Acronautics and Space Administration Inspection, NASA, Langley Research Center, Norfolk, Va.

Oct. 19-21: National Academy of Sciences, Research Council, URSI-IRE Fall Meeting, El Cortez Hotel, San Diego, Calif.

Mar. 21-24, 1960: Institute of Radio Engineers, National Convention, Coliseum & Waldorf-Astoria Hotel, New York City.

There's more news in ON the MARKET, PLANTS and PEOPLE and other departments beginning on p. 104.

RELIABLE CONNECTIONS

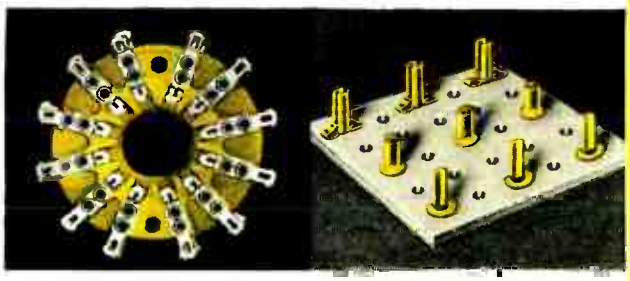


...with LOW COST EYELETS

NEW FUNNEL FLANGE eyelets designed especially as connectors for PW boards. Solves two-sided circuitry and solder problems. Speeds insertion. Are fed and set automatically on United Machines.

Eyelets give you unlimited opportunities for savings as connectors, fasteners, terminals, bushings, contacts for switches and hundreds of similar applications. Only with United Eyelets do you have such a wide choice of standardized sizes, special designs for cutting costs on unusual production problems, combined with a comprehensive line of the most versatile eyelet setting machines available.

In no other way can you get the flexibility obtainable with eyelets at comparable installed costs. Call or write us today for more information. Our national sales and service organization is ready to help with your most challenging problem.



NEW MINIATURIZED EYELETS as connectors and fasteners for low cost, high speed insertion in components, PW boards, miniature equipment. Designed for high speed automatic feeding with United Machines. Copper or brass.

CUT COSTS WITH SHEARED EYELETS as stand-off terminals. Set as many as 3000 terminals per hour. Cuts soldering time too.

Simultaneous multiple eyeleting from either or both sides of machine. Typical six eyelet application illustrated. 50 years' experience is your assurance of complete dependability.

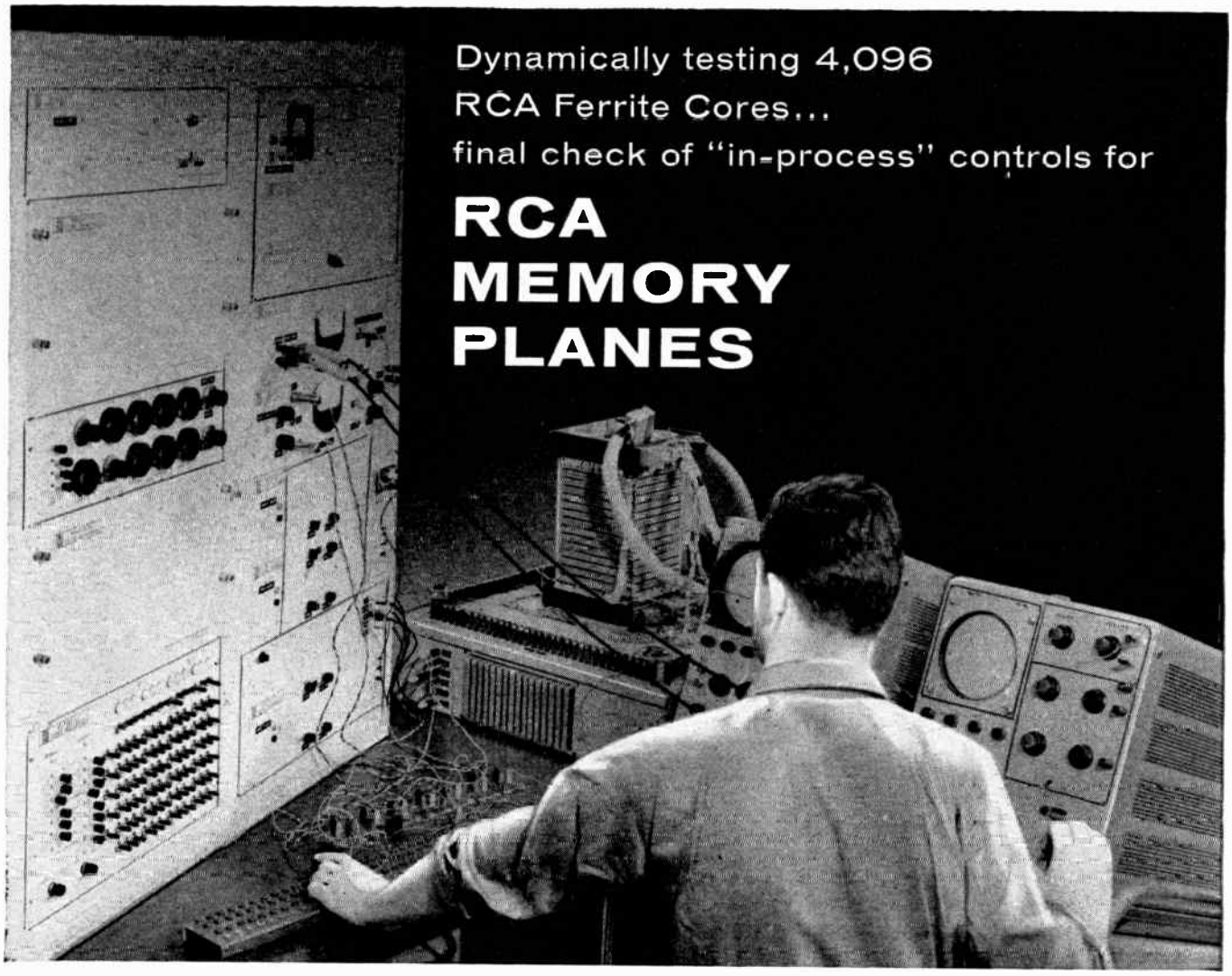
Simplify design, purchasing, inventory, and production. Decide the hole size and grip, and set the calculator to find the exact eyelet you need. Send for your free copy today!

NEW EYELET SELECTOR — FREE

United

UNITED SHOE MACHINERY CORPORATION
Boston 7, Massachusetts • LIberty 2-9100

Branches: Atlanta, Ga. • Chicago, Ill. • Cincinnati, Cleveland, Columbus, Ohio • Dallas, Texas • Harrisburg, Pa. • Johnsan City, N. Y. • Las Angeles, Calif. Lynchburg, Va. • Milwaukee, Wisc. • Nashville, Tenn. • New York, N. Y. • Philadelphia, Pa. • Rochester, N. Y. • St. Louis, Mo.



Unique memory plane and stack tester dynamically tests every RCA core in every RCA plane while the entire stack is being driven ... assures extremely high uniformity from core to core.

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This testing procedure is another example of "in-process" controls employed by RCA in every stage from the selection of raw materials to the inspection of finished product. For Ferrite Cores, Planes, and Stacks to meet your most rigid specifications, contact your local RCA Field Representative. For technical data, write RCA Commercial Engineering, Section I-19-NN-4, Somerville, New Jersey.

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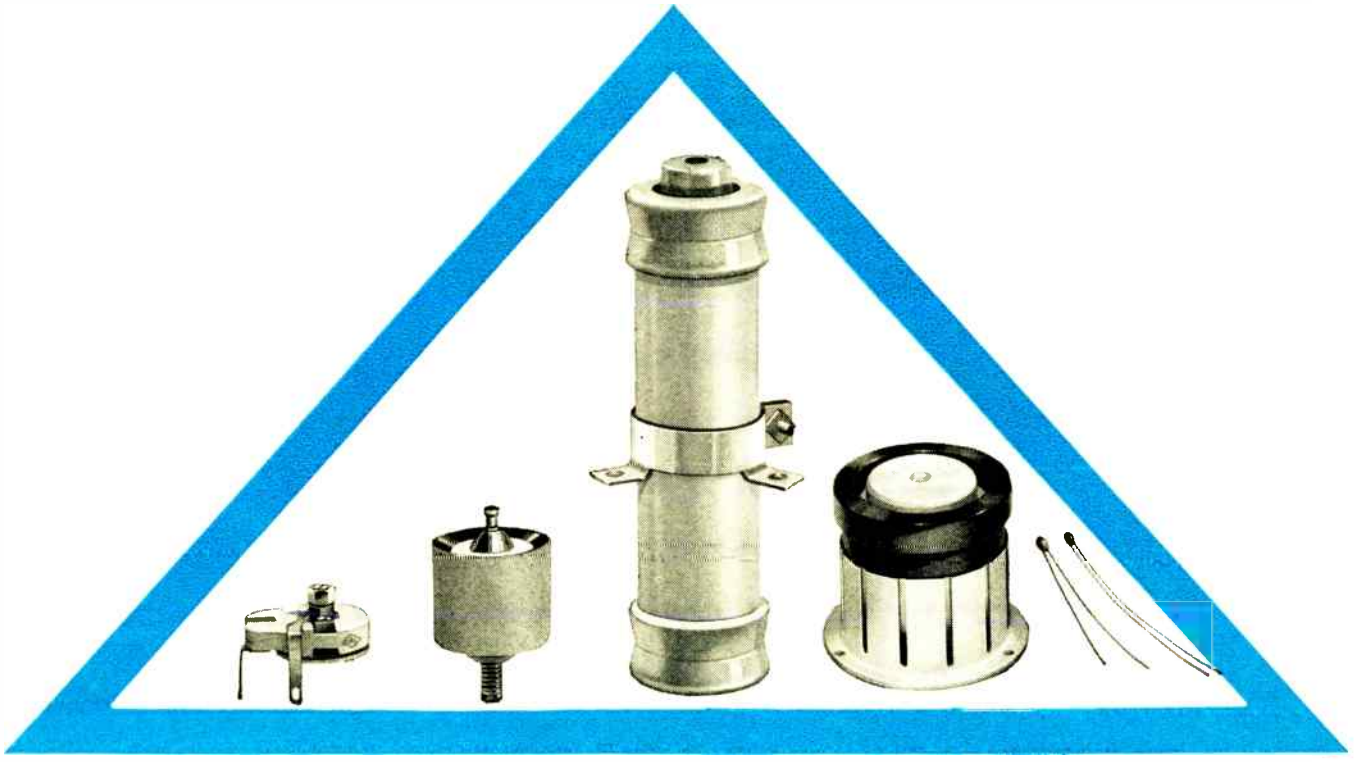

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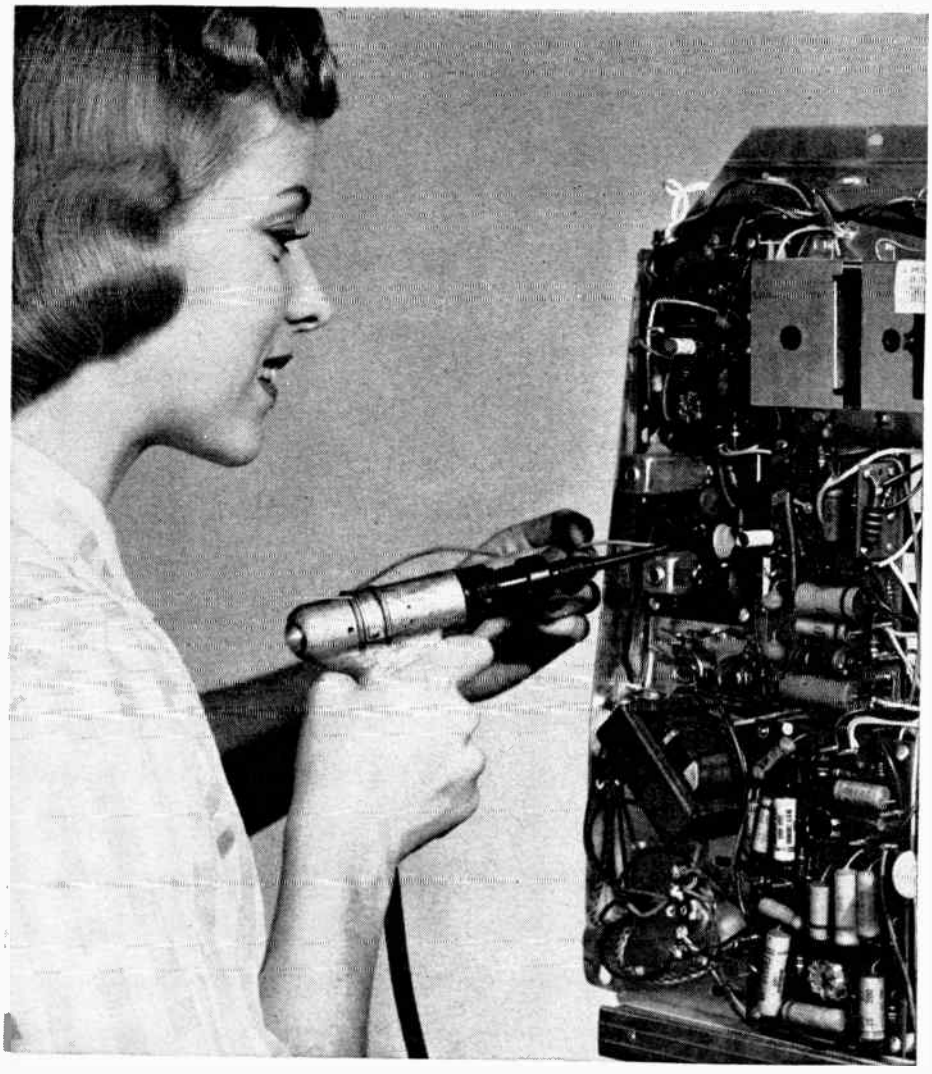

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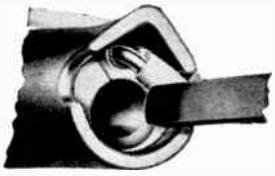

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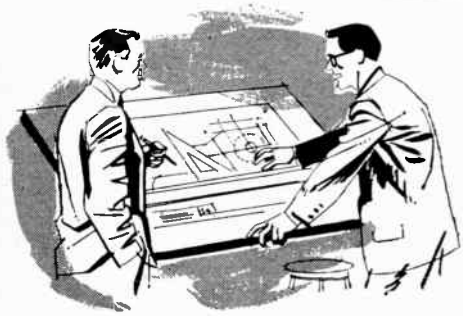

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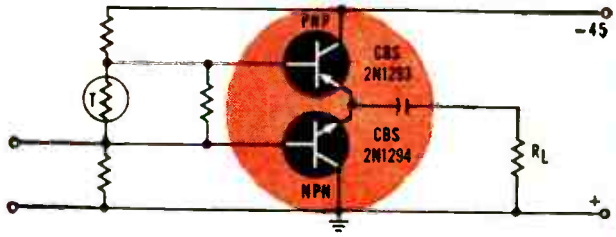

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2N326	7	35	35†	30	8	**2N1291**
2N1292	20	35	30#	30	3	**2N1291**
2N1294	20	60	45#	30	3	**2N1293**
2N1296	20	80	60#	30	3	**2N1295**
2N1298	20	100	80#	30	3	**2N1297**

All types have: Max. collector current, 3 amps; storage temperature, −65 to +85°C. *25°C base mounting temperature. ‡Polarity: NPN positive, PNP negative. †I_{CES} = 1 ma max. #I_{CES} = 10 ma.

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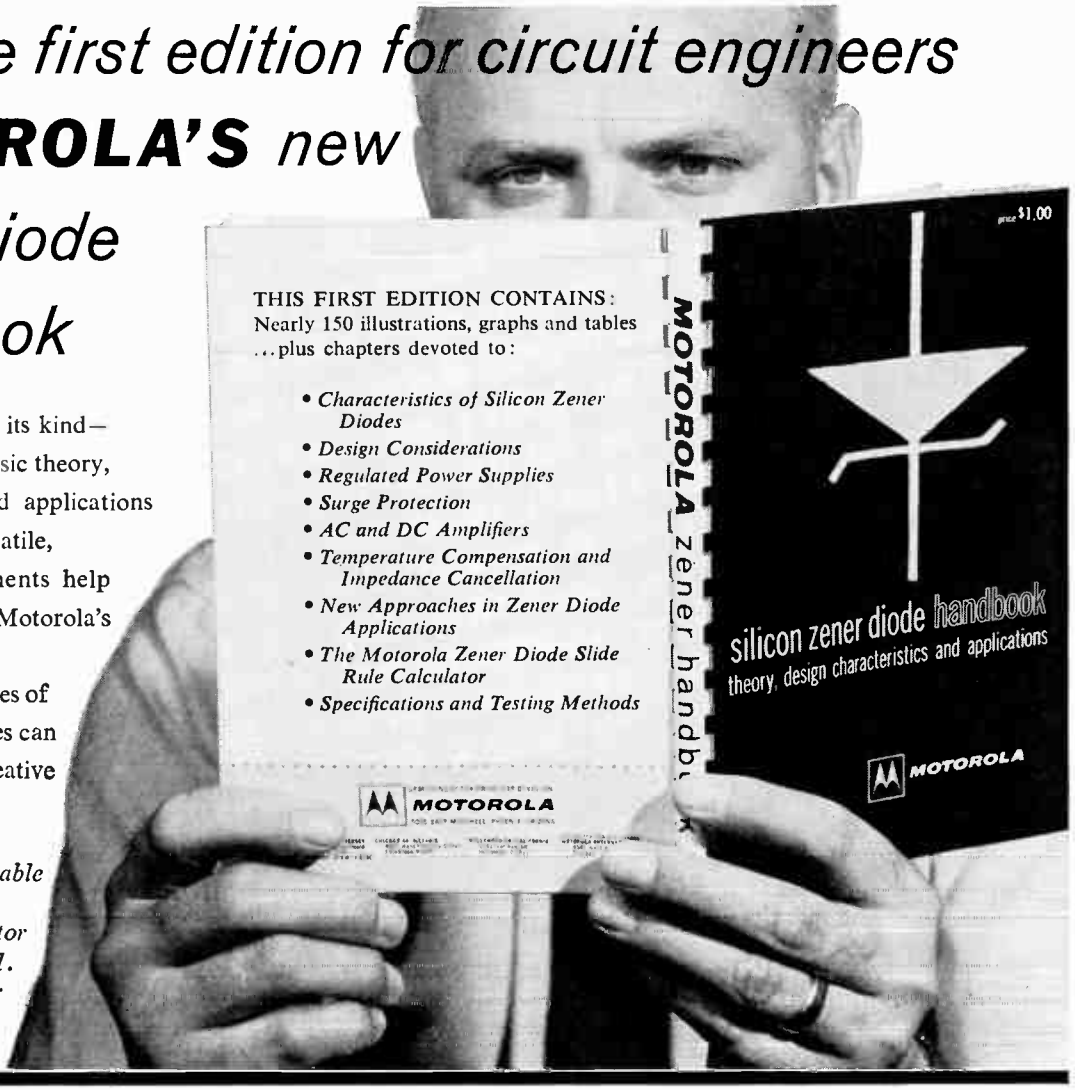

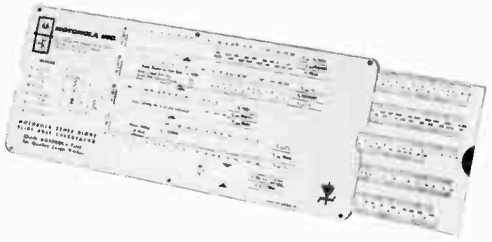

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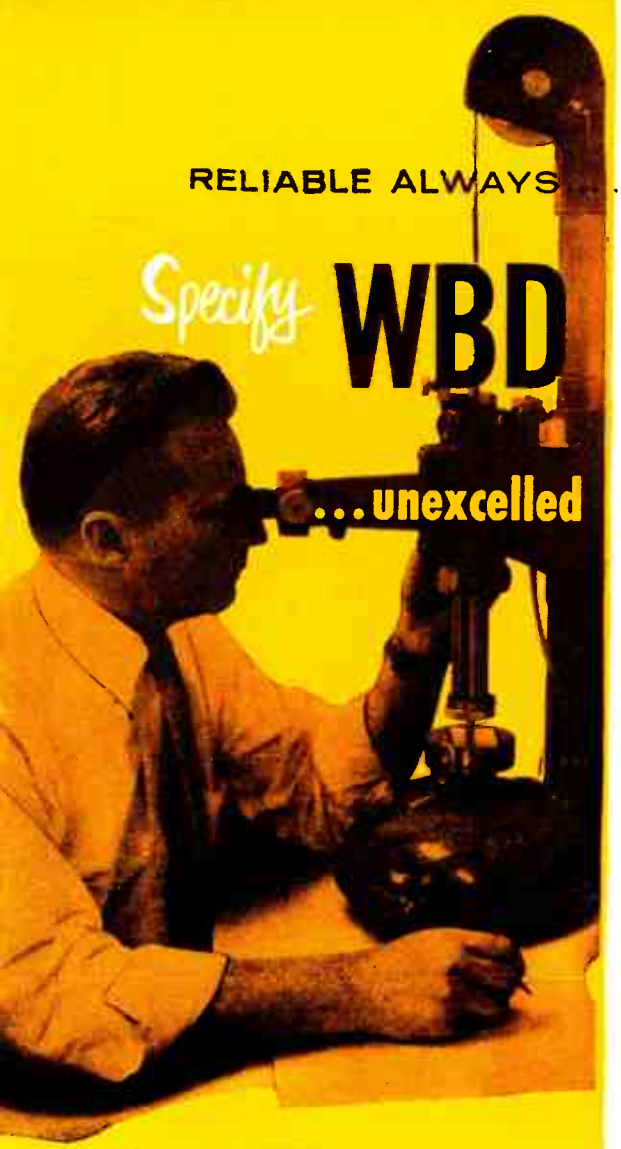

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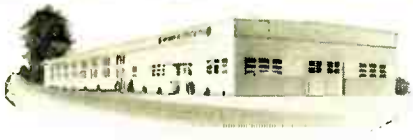

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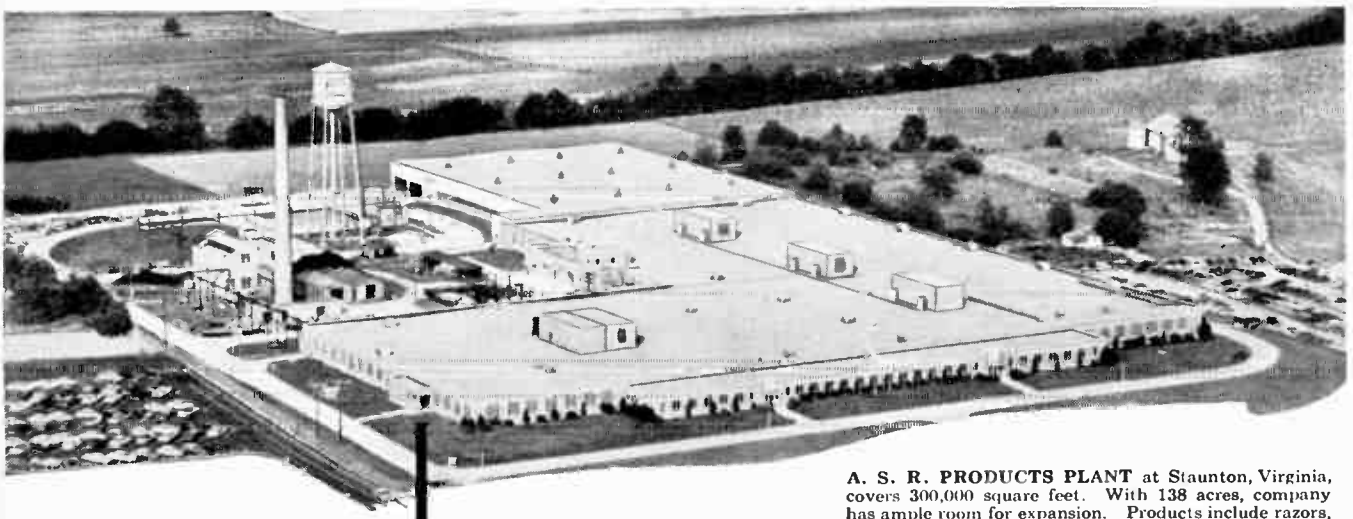

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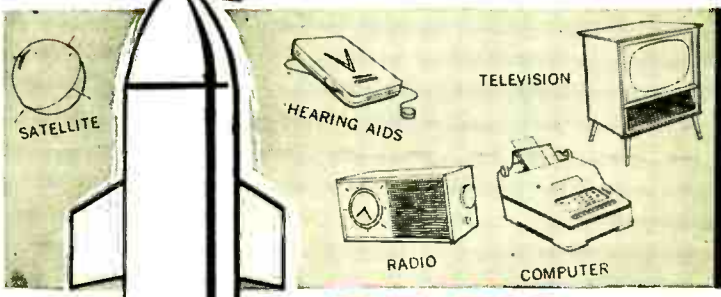

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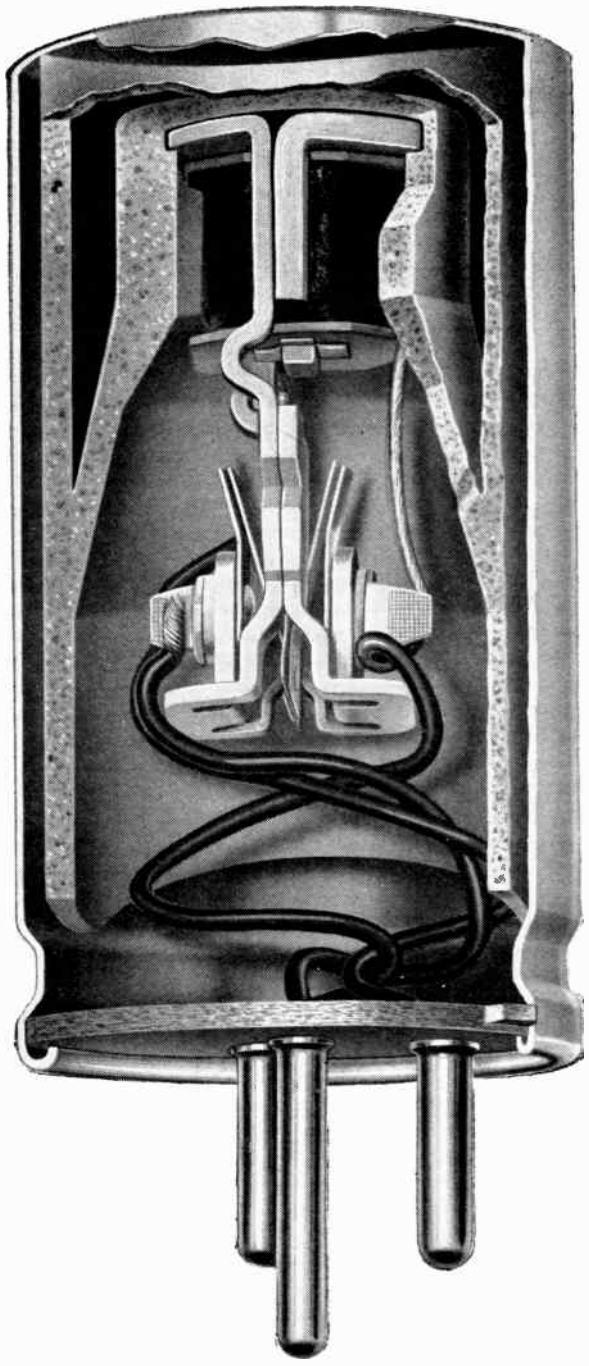

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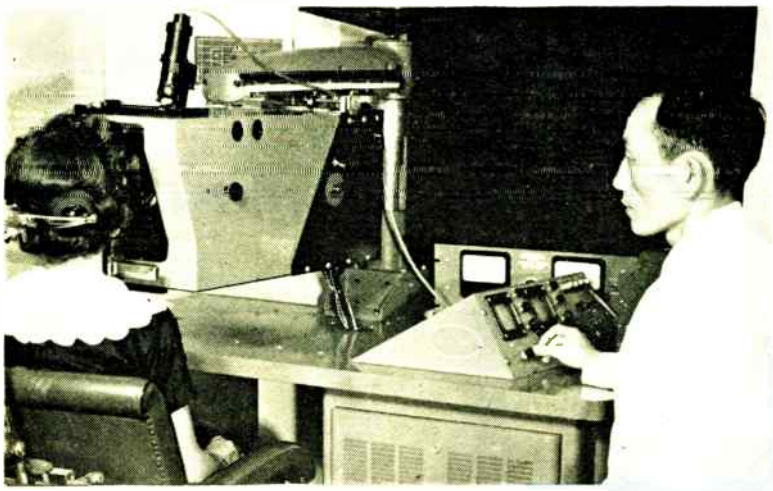


FRONT COVER — Shows pupillograph observing the pupillary action of a patient

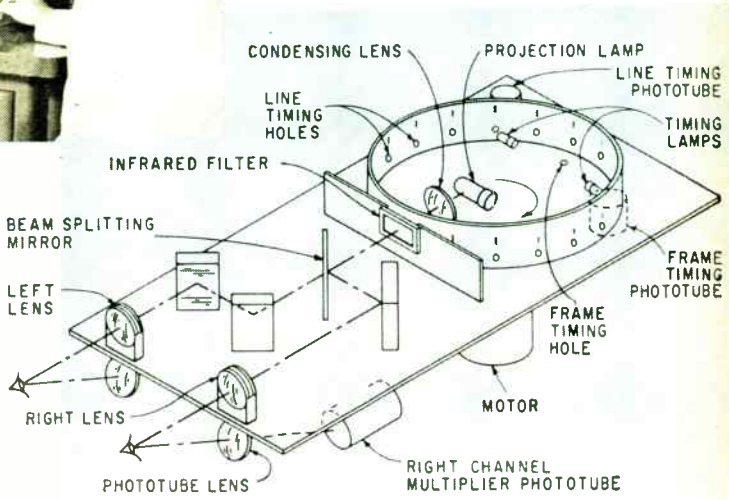


FIG. 1—Basic optical system without stimulation lamp uses a 500-w projection lamp operated at 90 percent of rated voltage to prolong its life

Recording Pupil Changes For Clinical Diagnosis

Movements of the pupil of the eye are accurately measured by electronic pupillograph. Device uses phototube to eliminate delays in obtaining data. Its direct writing feature makes it particularly valuable for clinical use

By GEORGE W. KING, General Precision Laboratory, Pleasantville, New York

AN ELECTRONIC PUPILLOGRAPH designed for clinical use in the recording and analysis of movements of the pupil of the eye has been developed. The measurement of these pupillary changes provides valuable information about the condition of the brain stem. Earlier pupillographs have involved complex, time-consuming operations making them unsuitable for clinical applications.

This instrument incorporates accuracy with its direct-writing capability. It can plot pupillary diameters with a maximum error of 1 percent of full scale. The visible energy required at the patient's eye is so low that his dark adaption is not disturbed.

A scanning unit, amplifier-detector, and recorder are the pupillograph's three major components. The scanning unit is a flying-spot device in which a rotating drum with slits in its periphery is used for scanning the eyes and providing timing pulses for a cathode-ray tube monitor. In the amplifier-detector unit, the signals resulting from scanning the two eyes are amplified and converted to d-c analog voltages proportional to pupil diameter. These voltages are

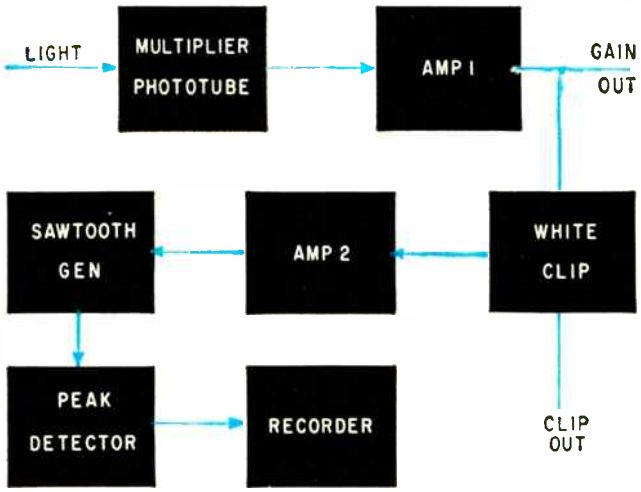


FIG. 2—Block diagram of single channel of two-channel measuring system shows provision for observing the waveform either before or after clipping

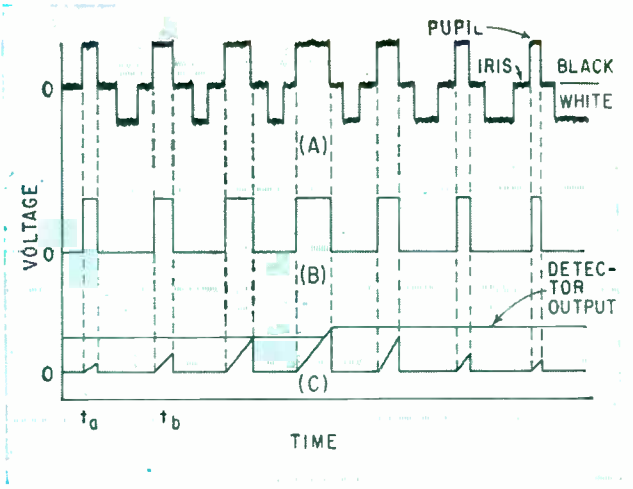


FIG. 3—Voltage waveforms show phototube output (A), phototube output clipped and amplified (B), and the sawtooth and detector output (C). Time lapse between t_a and t_b is 1.67 milliseconds

recorded as a function of time by two recorders. Power supplies and operating controls are in the desk which houses the amplifier-detector unit and supports the scanning unit.

SCANNING UNIT—Scanning of the 20-line, 30-frames- per-second raster is accomplished by slits in the periphery of a 10-in. diameter drum driven by a synchronous motor at 1,800 rpm. The scanned area is about 1½ in. wide by ¾ in. high at the drum, and each scanning slit is 0.060 in. high and 0.015 in. wide. The scanned area is evenly illuminated by a 500-watt projection lamp and f/2 condensing system mounted inside the scanning drum as shown in Fig. 1. The scanning slits are imaged by two high quality 3-in. focal length f/2.3 lenses onto the irises of the patient. Optical reduction makes the scanned area about 14 by 7 mm at the iris. The optical path is split by a half-silvered mirror so there can be no geometrical dissimilarity in the scanning of the two eyes.

A Wratten infrared transmitting filter is placed ahead of the beam-splitting mirror so the scanning energy is essentially invisible to a dark-adapted patient. The mirror and lens for the right eye are mounted to provide adjustment of interpupillary distance and to accommodate different elevations of right and left eye. The entire scanning unit is mounted on a crane which allows adjustment for the height of the seated patient and for optical focus.

Energy reflected from the scanned area of the patient's eyes is almost entirely diffused. A portion of this energy is picked up by an infrared-sensitive phototube through a simple lens. This lens roughly focuses the scanned area of the eye on the photocathode of the proper phototube and prevents interference from the opposite channel. The pickup lens is located below the optical axis of the scanning system to make sure mirror-like reflections from the surface of the cornea occur below the elevation of the scanning line which most nearly covers the horizontal diameter of the pupil.

The upper part of the scanner has dual reflective optical paths for each eye, which are used for insertion of the optical stimulation signals and for providing a red light for fixation of the gaze at a distance of 36 in.

CIRCUIT OPERATION—The system consists of two identical channels; a block diagram of one is shown in Fig. 2. The voltage waveforms are drawn in Fig. 3. The video signal is amplified by a direct coupled stage, V_1 in Fig. 4. The white portion of the phototube output (waveform A) is clipped by V_{2A} and amplified by a cathode follower for transmission to the amplifier and detector chassis.

Diode D_1 and its associated resistors reduce the gain of the signal channel for signals representing regions somewhat lighter than the iris. This nonlinear load and the reverse-connected diode V_{2B} prevent any large transient signals from the whites of the eyes from causing false back impulses by capacitance coupling across V_{2A}. Gain for the signal channel is controlled by changing the supply voltage for the dynodes of the multiplier phototube.

AMPLIFIER-DETECTOR UNIT—The amplifier-detector contains two identical measuring channels, each of which has wave shaping and detector circuits. Each channel produces an output voltage proportional to the diameter of the pupils by peak detection of sawtooth voltages whose amplitudes are proportional to the time required for the scanning spot to move across the pupil of the eye.

The signal from the pupil is amplified and clipped both top and bottom by V_3 which drives the switch or gate tube, V_{4A}. Tube V_5 sets the potentials in the sawtooth generator circuit during the time when the scanning spot is at any point other than the pupil. While the spot is traversing a pupil, V_{4A} is cutoff, and the grid potential of V_{4B} rises linearly. The charging current for C_1 is constant because the top of the charging resistor, is bootstrapped by capacitance coupling to the cathode of V_{4B}. Cathode follower V_5 also provides a low-impedance source to drive the

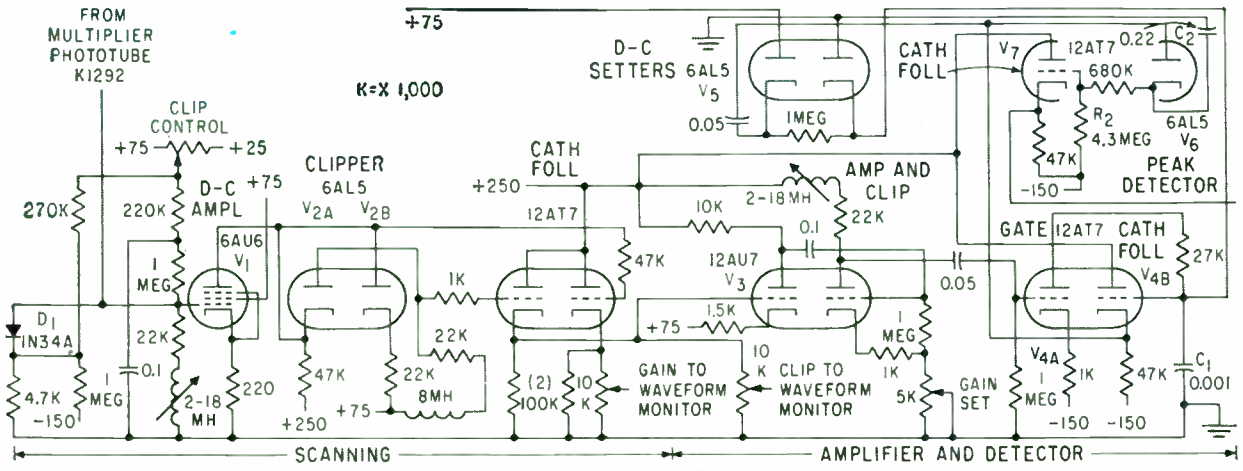


FIG. 4—Circuit diagram of complete system includes the scanning unit and amplifier and detector. Tubes V_{1A}, V_{1B}, and V_5 form a sawtooth generator

peak detector, V_6, and its associated R-C load.

As shown in Fig. 3, these circuits respond to the largest black interval during a given period of time. The detector discharge time constant is chosen so the output voltage can decrease about three times as fast as required to follow the maximum rate of change of pupillary diameter. Rate of decrease of the analog voltage at the detector output is almost independent of pupillary diameter because the energy storage capacitor C_2 is discharged at an essentially constant rate through a high resistance R_2 returned to a large negative voltage.

Excellent linearity of response is obtained by the use of bootstrapped sawtooth generators to drive the detectors. The bandwidth of the signal channels up to the sawtooth generators is about 300 kc, which provides a rise time of about 2 μsecs, which is less than one fifth that required by the scanning slit to move a distance equal to its own width.

Signal-to-noise ratio is adequate for consistent recording of all except albino eyes. Cathode follower power amplifier V_7 provides a low impedance source to drive the output attenuator which reduces the 5 v/mm pupil diameter analog signal to a level appropriate to drive the recorder. The high signal levels in the detector and output circuits ensure that the effect of changes in heater voltage is negligible.

MONITORING CHANNELS — Three-inch cathode-ray tube displays are provided for each channel to facilitate optical adjustments and setting of channel gain and clipping controls. These displays receive timebase signals from sawtooth generators controlled by auxiliary vacuum phototubes in the scanner unit. The cathode-ray tubes display a picture of the eye being scanned when S_1 in Fig. 5 is in position 1, or the waveform in the measuring channel at position 2, or the signal before the white portion is clipped, position 3.

The two potentiometer-type recorders are mounted in a small cabinet which also provides room for spare parts storage. The paper for both recorders is driven by a single synchronous motor through a common chain and sprocket so that positive time relationship between channels is maintained. Paper speed is one inch per second and the pupillary diameter scale is 8.3 mm per 5 in. Linearity error for the recorders is less than 1 percent. Hysteresis and dead time do not exceed $\frac{1}{2}$ percent of full scale deflection. Full-scale response occurs in less than one second.

When properly calibrated, the device gives readings with an accuracy of ± 0.1 mm. Short time stability of calibration after a few minutes warm up is such that the drift is less than ± 0.05 millimeters during an eight-hour day.

Basic research in these pupillography techniques has been done by Otto Lowenstein, M. D., and Irene E. Lowenfeld, Ph. D. at the Department of Opthalmology (Laboratory of Pupillography), Columbia University College of Physicians and Surgeons, and the Institute of Opthalmology, Presbyterian Hospital, New York, N. Y. This device was designed for their laboratory under grants from the Harriman Fund and the U. S. Public Health Service.

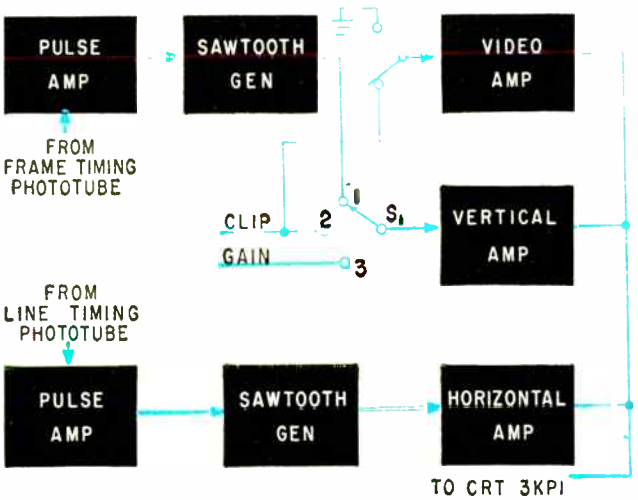


FIG. 5—Block diagram of single channel of two-channel monitoring system shows switch for observing clip and gain as well as a picture of the scanned eye in switch position 1

Designing Highly Stable Transistor Power Supplies

Summary of design techniques used in making extremely stable low-voltage power supplies for transistor circuits. Final circuit described has overall stability of plus or minus 250 microvolts and overall drift of less than 40 microvolts per hour

By **E. BALDINGER and W. CZAJA,** Institute of Applied Physics, University of Basle, Switzerland

CONVENTIONAL TRANSISTOR-STABILIZED power supplies use either shunt or series regulation. If the rectifiers and line transformer are suitably designed, the shunt-type circuit cannot be damaged by short circuits at the output terminals. The rectifier of the shunt-type circuit may be designed to have high efficiency and low cost since it operates at constant load. With no load, a high collector dissipation may occur within the shunt transistor. This may be prevented by using a suitable collector resistor which in no way influences the properties of the device. The low overall efficiency (approximately 40-percent) is a disadvantage.

In the series regulator, additional circuits must be used to prevent overload or damage to the series transistor. The control range at high voltage is limited by the maximum ratings of the series transistor as the absolute values of voltage variations increase with increasing input voltages. For a variable load, the rectifier internal resistance makes an important contribution to the input voltage variations that have to be controlled.

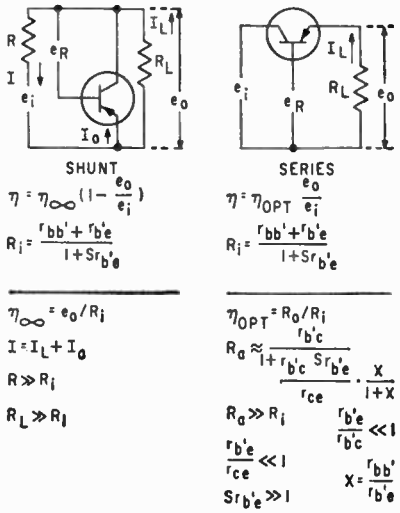


FIG. 1—The two principal stabilizing circuits, shunt (left) and series (right)

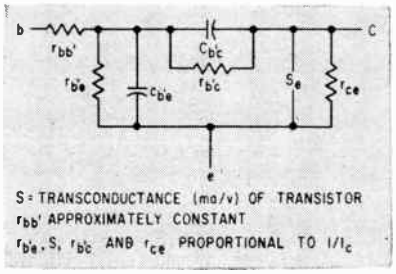


FIG. 2—Hybrid π transistor equivalent

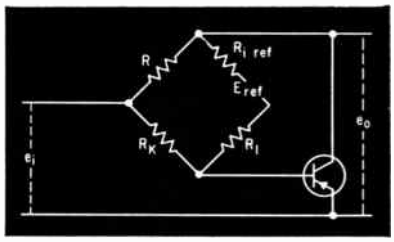


FIG. 3—Compensation of a shunt-type power supply

The circuits to be described show methods of improving circuit performance so that highly stable power supplies having an overall stability of ± 250 μv and overall drift of less than 40 μv/hour at outputs up to 17 volts can be designed.

Basic Circuits

Basic series and shunt regulating circuits are shown in Fig. 1. The stabilization factor η is defined as the relative change in input voltage e_i to the change in output voltage e_o produced.

The expressions for the stabilization factor η and the internal re-

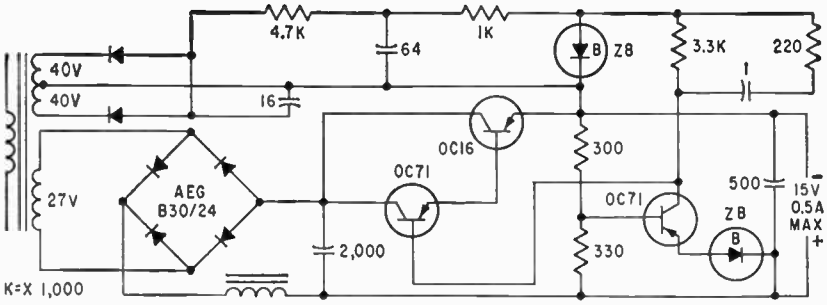
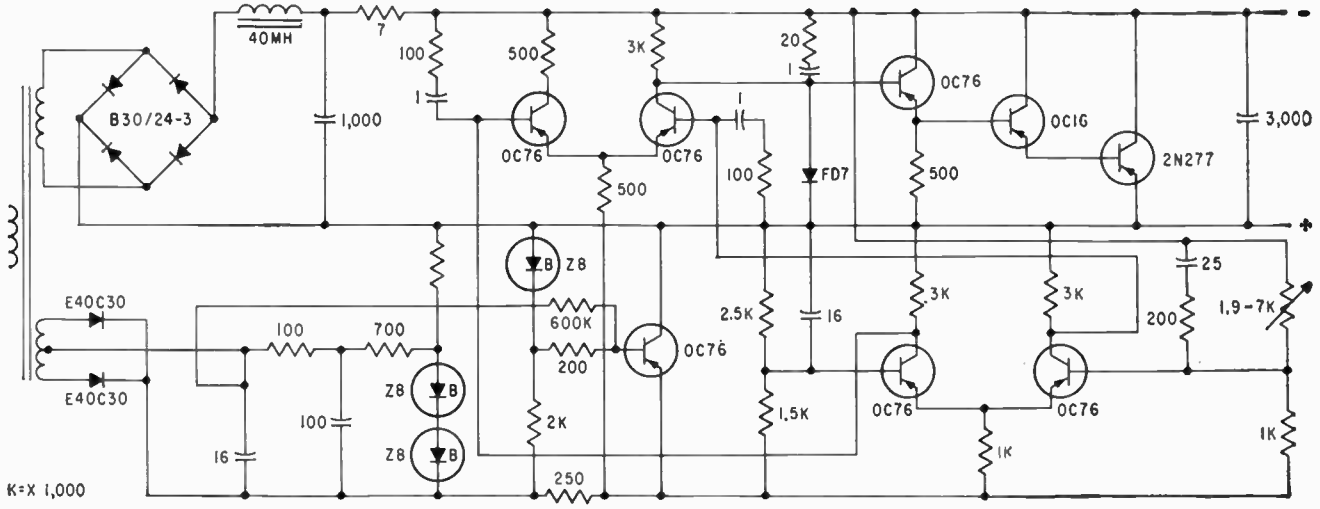


FIG. 4—Series stobilized power supply

FIG. 5—Shunt-type, short-circuit-proof, general-purpose power supply



sistance R_i using small-signal parameters[1] are also shown in Fig. 1. The expressions are accurate under the following assumptions: small signal behavior of circuit; slow variations from equilibrium; and $r_{bb'}$ includes the internal resistance of the reference voltage source. Improved accuracy can be obtained by taking into consideration the approximate working point (collector current) dependence of the small signal parameters (see Fig. 2) and the internal resistance of the supply source. Modifications of the above expressions are published elsewhere[2].

Zener diodes may be used as reference elements instead of dry cells or similar devices. Cascading of an unstabilized power supply with a stabilized one may be used when high output voltages at high load currents are to be stabilized. The stability of cascaded supplies can be improved by driving the transformer of the unstabilized source with a servo motor to achieve optimum operating conditions for the stabilized supply.

The two basic means of improving the stabilization factor η or lowering the internal resistance R_i, or both, are by compensation or by preamplification.

Compensation

Figure 3 shows a simple method of improving the stabilization factor η of a shunt-type power supply. For exact compensation, the condition $R_{i\ ref} + R_1/R_1 > 1$ must hold[2]. Exact compensation ($e_o = 0$, or $\eta = \infty$) is possible for only one load current value. The load current dependence of the output voltage may also be compensated, but this may be considered as compensation of R_i. Devices with a negative R_i can be realized this way.

Preamplification

By inserting a preamplifier with an amplification factor of A between the base of the transistor and the reference voltage shown in Fig. 1, both η and R_i can be improved. The stabilization factor η is multiplied by A and the internal resistance R_i is divided by A.

Stabilized power supplies with preamplifiers are complicated feedback systems and means must be provided to insure system stability for all load conditions. In most cases it is necessary to limit the frequency response by shunting one or more of the amplifier stages collector resistances with series R-C circuits and by employing a large output capacitor. Electrolytic capacitors are used because their high losses at high frequencies produce a suitable damping of unwanted oscillations produced by abrupt changes in the load.

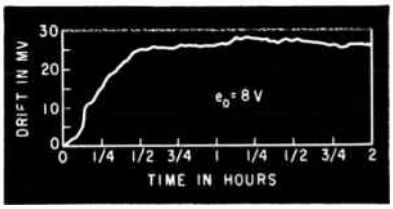


FIG. 6—Output voltage drift for the first two hours of operotion for circuit of Fig. 5

Comparison

The circuit with compensation is assumed to have a stabilization factor η_1 and the one with preamplification is assumed to have a stabilization factor η_2 equal to η_1. With $R_i/R << 1$ and $R_i/R_k << 1$, then the variations with load current of η_1 and η_2 are expressed as:

$$\frac{\delta\eta_1}{\delta I_L} \Big/ \frac{\delta\eta_2}{\delta I_L} = A\left(1 + \frac{R}{R_K}\right)$$

This equation shows that η_2 is about a factor A more insensitive to load current variations than η_1. This, and the fact that in compensated stabilizing circuits η is sensitive to transistor aging, show that a circuit should only be compensated in such a way as to improve η by about a factor of five.

Temperature

The temperature coefficient of the output voltage of the two circuits shown in Fig. 1 is small. The emitter junction voltage for constant collector current varies linearly with the absolute temperature with a slope of about −2 to −3 mv/degree C. This slope is a property only of the bulk material and depends strongly on the doping ratio. In the case where preamplification is used to improve η and R_i, the temperature coefficient is mainly determined by the temperature coefficient of the amplifier and of the reference voltage. The contribution of the amplifier is kept small, especially when symmetrical amplifier stages are used.

Stabilized Supplies

The series stabilizing circuit shown in Fig. 4 is of the Middlebroock type[5]. This supply is designed for constant output voltage and moderately variable load. This supply has an output of 15 v, an internal resistance of 0.1 ohm, a temperature coefficient of 1 mv/degree C, a ripple voltage of 4 mv peak to peak and a maximum current of 0.5 amp.

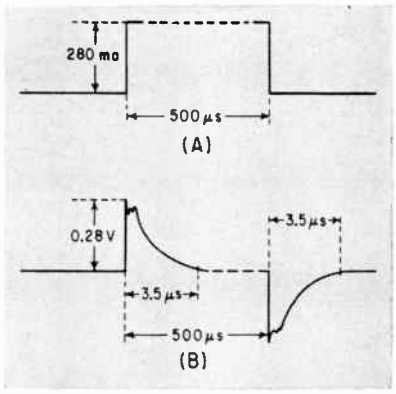


FIG. 7—When a current step (A) is applied to the output terminals of circuit of Fig. 5, the response is as shown in (B)

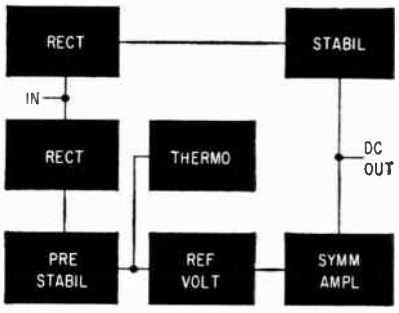


FIG. 8—Improved power supply showing temperature-controller coupling

A short-circuit-proof, general-purpose power supply is shown in Fig. 5. This supply has an output variable from 1 to 17 v, an internal resistance of 0.0005 ohm, a ripple voltage of 1 mv peak to peak and a maximum current of 2.5 amp at 1 v and 0.8 amp at 17 v. After the first two hours of operation the output drift is negligible as shown in Fig. 6. One unit was initially set at 10 v and after one year of continuous operation had a drift of 130 mv. Figure 7 shows the output after the application of a square wave.

The limiting factors for η and R_i are variation of the reference voltage and temperature variations within the device. The circuit of Fig. 5 can be improved by improving the reference source and using a transistorized thermostat for controlling the reference voltage source and preamplifier. A block diagram is shown in Fig. 8.

Temperature Control

The temperature dependence of the operating point of a low-power transistor is used to drive a power transistor which in turn controls the temperature controller' shown in the improved stabilization circuit of Fig. 9. Fixing the base voltage of temperature-sensing transistor Q_1 produces a more stable circuit over long periods of time than fixing the base current. A low-imped-

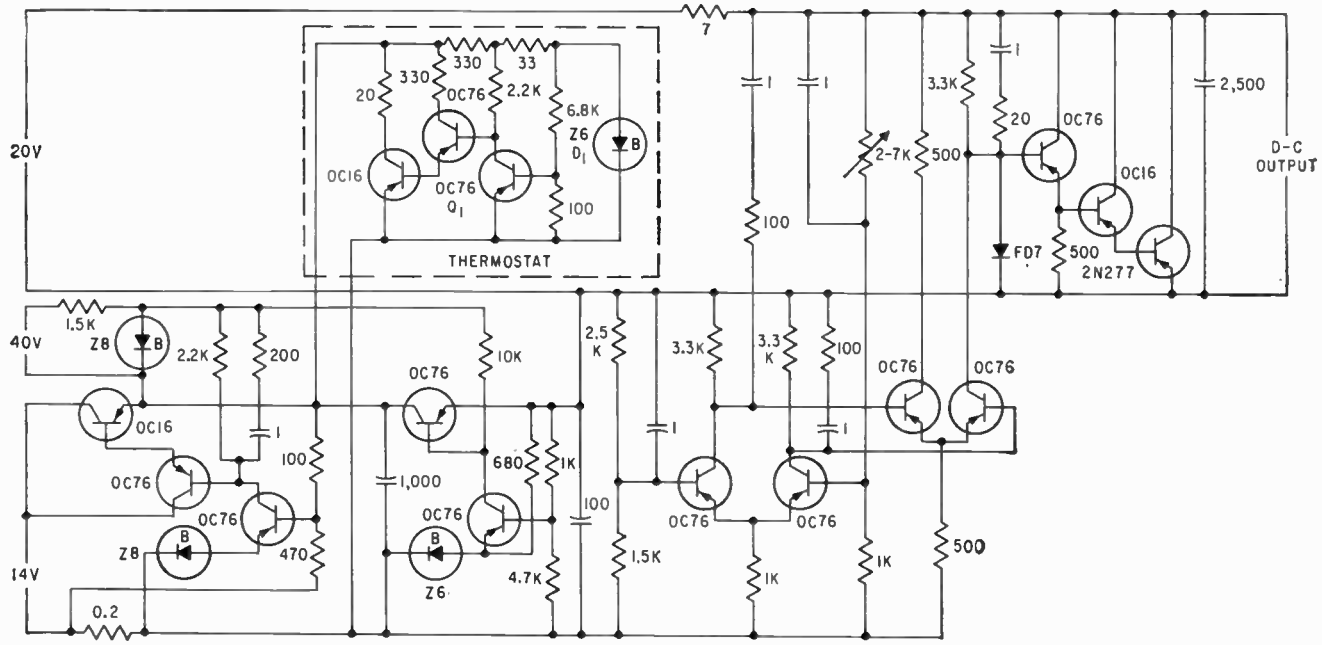


FIG. 9—Improved stabilized power supply uses temperature-control circuit for better regulation

ance input was provided for the first stage. Zener diode D_1, together with compensation, prevents variation of the controlled chamber temperature due to variations of supply voltages. The internal temperature may be varied by changing the operating point of the temperature-sensing transistor. The temperature control device used in Fig. 9 has a controlled temperature of approximately 40 degrees C. A temperature stabilization ratio of $\Delta T_{ambient}/\Delta T_{inside} \approx 40$ to 50 has been achieved. The overall drift of the controlled temperature of 40 C over a period of one year is 0.4 C. Conventional carbon resistors were used and no selection was made of the transistor. The circuit shown in Fig. 9 has a variable output between 1 and 17 v, an internal resistance of 1.7×10^{-1} ohm at d-c and less than 0.05 ohm at 500 kc, a temperature coefficient of 0.1 mv/degree C and a ripple voltage of 0.1 mv peak to peak maximum.

After turning on, 4 to 5 hours are required until equilibrium temperature is reached. From that time, the overall drift over a 15 hour period was 36 μv/hour at an output of 6 v.

The circuit shown in Fig. 9 is basically the same as that shown in Fig. 5 with a different reference source. A prestabilizer controls the temperature controller as well as a stabilizing circuit which serves as the voltage reference source.

Characteristics

Figure 10 shows the power supply output voltage plotted against input line voltage changes and loading. The major part of the short-term fluctuations is due to small temperature differences (0.05 C or less) within the thermostat.

Figure 11 shows the stabilized power supply compared with a lead-acid storage battery. Both the power supply and the battery were loaded. The long time period which the battery needs to establish equilibrium after load removal is typical.

The lead-acid storage battery has a time contant of about $\frac{1}{4}$ to $\frac{1}{2}$ hour resulting from the time required for diffusion of the chemical reaction products between the plates until equilibrium is reached.

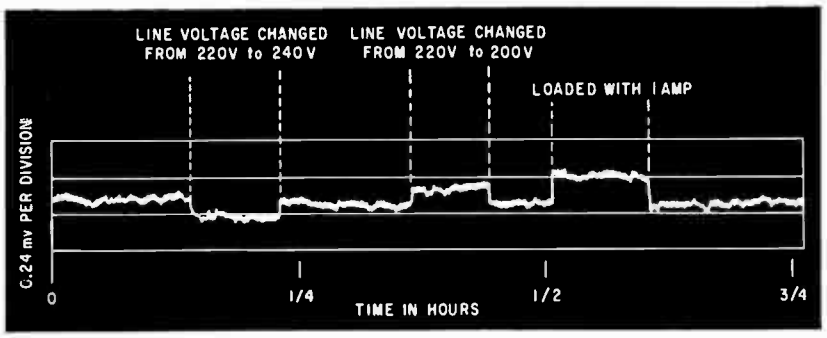


FIG. 10—Output characteristics of improved stabilized power supply

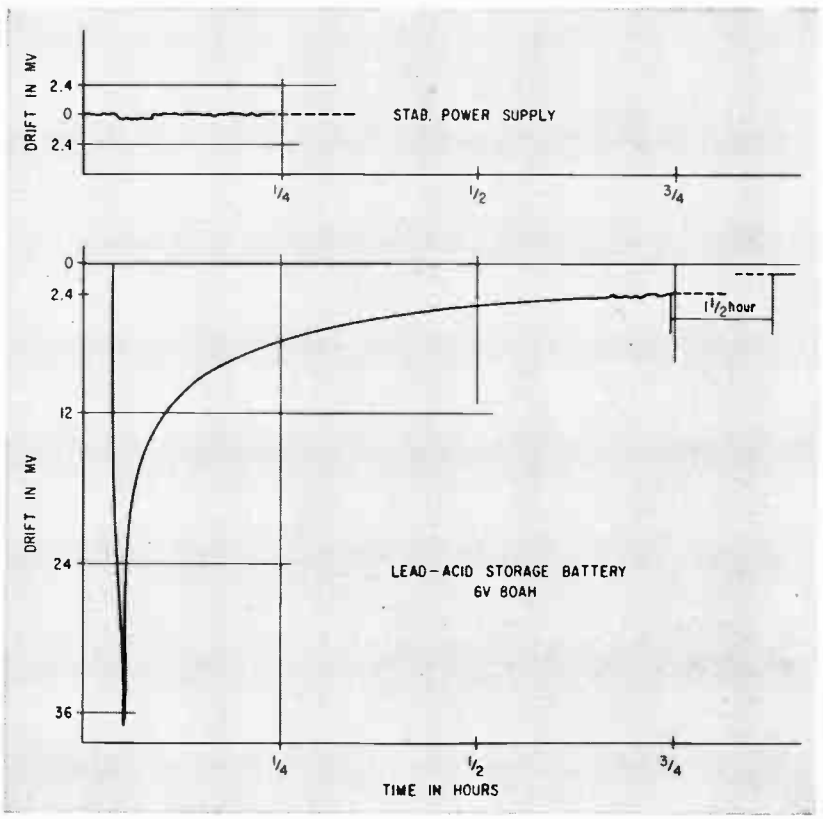


FIG. 11—Output characteristics of improved power supply compared with lead-acid battery (both 6 v)

During the preparation of this article, an American voltage reference (see last entry in Bibliography) was called to the authors attention.

This device has excellent stability and temperature coefficient, the output voltage is practically constant but the output current is much smaller having a maximum of 100 milliamperes.

There are a number of applications for this highly-stable power supply where up to the present, only lead-acid batteries connected in parallel with a power supply of poor regulation have been used.

Further consideration of the above described circuits show that this highly-stable power supply can be improved still further.

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(2) E. Baldinger and W. Czaja, *ZAMP*, 9, p 1, 1958.
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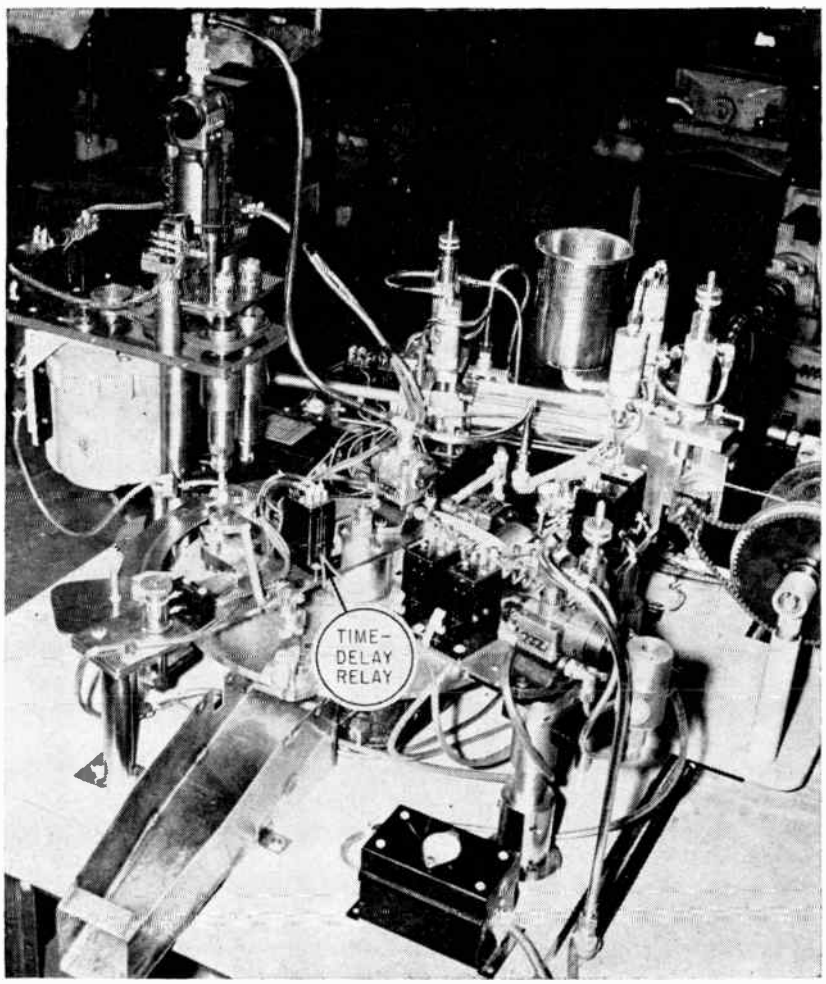
Here's a time delay relay that is adjustable. It can replace synchronous timers in industrial control circuits. Accurate relay has instant recycling

By **LEON SZMAUZ and HAL BAKES,** Engineering Dept., Heinemann Electric Company, Trenton, New Jersey

Transistor Time Delay

AN ADJUSTABLE time delay relay using transistors has been developed for use in various industrial or other processes. Advantages of the relay are timing repeatability and instant recycling. These factors provide for maximum speed in automatic operations and cut production time.

One application of the relay is automatic cycling, where the relay can be used to endurance test other relays and contactors. In other applications the relay can be used to replace synchronous timers, with a consequent saving in space, weight and cost. Delay periods between 1.5 sec and 30 sec are possible. The photograph shows a number of the relays used in an automation setup where a small brass tube goes through the operations of spinning, fluxing, placing solder and brazing. A considerable saving is effected since these operations previously required much handling and personal judgment.



A number of the transistorized time delay relays are used to control a movable table for automatically processing a small brass tube

Basic Operation

In a typical application, the user connects 12 volts d-c to the input with an external switch. The circuit is shown in Fig. 1. As soon as switch S closes, transistor Q_1 conducts, charging capacitor C_1 through the normally closed contacts of K_1. Charging rate is controlled by variable resistor R_p. To simplify analysis, other charging resistances will not be considered. Transistor Q_2 is cut off by the action of Q_1 and relay K_1 is held deenergized. When the current in the R_pC_1 network has dropped to approximately 37 percent of its maximum, Q_2 acts as a switch to connect K_1 across the supply. This actuates the relay which remains closed until the supply voltage is broken.

An extra set of contacts on the relay connects R_d across C_1, thus discharging the capacitor preparation for the next cycle. When the 12-volt supply is broken, the circuit is instantly ready for another time

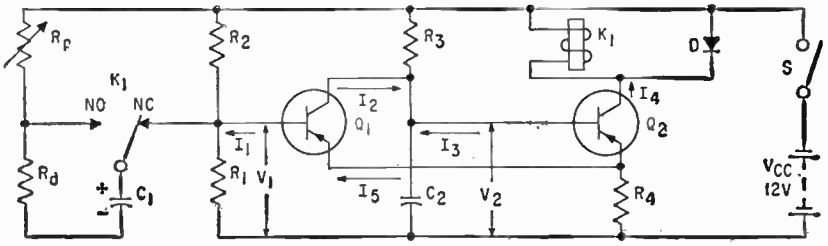


FIG. 1—Time delay begins when S is closed. Charging current of C_1 through R_p and Q_1 controls the circuit. Transistor Q_2 is held cut off until C_1 charges to the time-delay-setting voltage

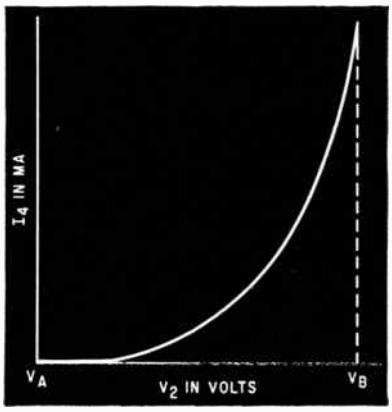


FIG. 2—Relay current is a function of V_2. Relay turn-on point occurs between V_A and V_B

for Industrial Control

delay cycle.

The circuit consists of two directly coupled alloy-junction, germanium transistors. Since Q_1 (Fig. 1) serves as a driver and Q_2 as a switch, the collector saturation voltage of Q_1 must be lower than its base to emitter drop. That is, when Q_1 is saturated, voltage V_2 must be sufficiently low that Q_2 is effectively cut off.

Because of direct coupling, the collector voltage of Q_1 is the same as the base voltage of Q_2, as can be seen in Fig. 1. By varying the collector voltage of Q_1, the bias voltage

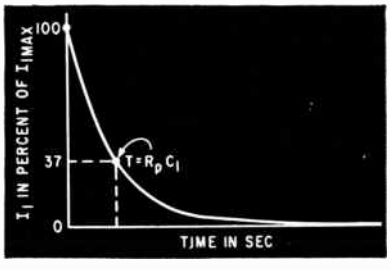


FIG. 3—Charging current of C_1 and thus base current of Q_1 follows typical exponential curve

of Q_2 will vary from V_A to V_B, as shown in Fig. 2. If V_A is the voltage just below or equal to the base cutoff bias, and V_B is the forward bias at saturation, Q_2 will switch the relay ON at some intermediate voltage.

The relay coil and the supply voltage are chosen to give rated relay current $I_4 = V_{cc}/R_L$, where R_L is the d-c resistance of the relay.

Resistor R_3 is determined from saturation conditions. When Q_2 is saturated, maximum current is flowing through the relay. Under these conditions, Q_1 is not conducting since its base current has fallen to zero (except for a small bias current) because C_1 is not in the circuit. The maximum collector current of Q_2 is $I_4 = \beta I_3 = V_{cc}/R_L$. But the maximum value I_3 can have is V_{cc}/R_3. From these equations it can easily be shown that R_3 must be less than βR_L if I_4 is to reach a specified value.

Timing Circuit

The simplified timing circuit consists of R_p in series with C_1. The time delay period begins when external switch S is closed. A charging current begins to flow into C_1 and into the base circuit of Q_1. Transistor Q_1 conducts and holds the base to emitter voltage of Q_2 to a low value. As C_1 charges, the current through Q_1 decreases and the base voltage of Q_2 rises.

Base current of Q_1, ignoring bias current, is given by $I_1 = (V_{cc}/R_p)\ \epsilon^{-t/RpC1}$. The initial base current is $I_{max} = V_{cc}/R_p$. This value of current is much greater than that needed to hold Q_2 at cutoff. Base current I_1 will decrease exponentially as shown in Fig. 3. For fast switching and good timing accuracy, it is desirable that Q_2 turn-on conditions be reached while I_1 is still changing rapidly. This condition is met when the time delay period is approximately equal to the time constant of the network, or $T \cong R_pC_1$.

Because of the variation of parameters of production lot transistors, some experimentation with component values may be required if the best performance of the circuit is to be obtained. The circuit of Fig. 1 is stabilized against minor temperature changes. Thus, for the condition $R_2 >> R_1 >> R_4$, the current through R_2 is essentially constant for a given supply voltage. When the emitter current of Q_1 increases because of an increase in temperature, the voltage across R_1 and R_4 increases. The current through R_1 is therefore larger since the voltage drop across it is larger. Since the current through R_2 is constant, base current I_1 must decrease. The decrease in I_1 will then act to decrease I_2 and I_5.

If wide temperature swings are expected, compensation can be obtained with nonlinear elements and temperature sensitive resistors.

A diode is placed across the relay coil to prevent inductive transients which would otherwise appear when switch S is opened. Capacitor C_2 at the base of Q_2 acts as a low pass filter and keeps any sudden changes from being applied to Q_2 and thus accidentally triggering the relay.

Resistor R_d has a low value and is used to discharge C_1 as soon as the relay operates, thus readying the circuit for the next operation.

For appreciable time delays, electrolytic capacitors have to be used. Tantalum electrolytics should be used since they are more stable than the aluminum type.

Electronic Commutators in

Variety of sampling speeds and signal capacities are covered by production models of electronic commutators. Here is a listing of representative types

MULTIPLEX TELEMETERING systems of the time-division type require at least two commutators: one at the transmitter to sample the data to be transmitted and another at the receiver to decommutate the data so it can be displayed.

Most of the electronic commutators listed here can be used for pam/f-m, pdm/f-m or pdm/p-m time-sharing systems. An extremely large number of commutating systems is conceivable, but most practical telemetering needs can be met with a few simple methods.

Most commonly-used systems are included in the Inter-Range Instrumentation Group (IRIG) recommendation.[1,2] A survey of telemetering methods, equipment and applications, which includes a glossary of terms, is also referenced.[3]

MODULATION METHODS—Pulse duration modulation systems (pdm) are suitable when all the measured parameters are changing slowly and time-sharing is feasible. Each time the output of the transducer is sampled, a pulse of duration proportional to the value of the sample is generated. These pulses then serve to modulate the radio-frequency transmitter.

Pulse amplitude modulation systems (pam) are also useful when the parameters are slowly changing. A pulse of amplitude proportional to the sample value is generated as a subcarrier and, again, modulates the r-f transmitter.

Table I—Typical Specifications for an Electronic Commutator

Characteristic	Specification
Duty Cycle	50 percent
Number of Channels	45
Sampling Speed	900 samples per second
Input Signal	0 to 5 volts
Output Signal	6 volts peak-to-peak
Output Load	1 megohm
Accuracy	1 percent
Linearity	0.25 percent of full-scale from best straight line
Crosstalk	0.1 percent of full-scale range
Noise	0.01 percent of full-scale range
Dimensions and Weight	5×3×4 inches, 2.5 pounds

Key to Manufacturers

ARN	Arnoux Corp.
ASC	Applied Science Corp. of Princeton
BUR	Burroughs Corp., Electronic Tube Division
EMR	Electro-Mechanical Research, Inc.
GDI	General Devices, Inc.
PBL	Packard Bell Co.
TEL	Telechrome Manufacturing Corp.

COMMUTATOR OPERATION — A typical electronic commutator has a master oscillator which drives a broken ring binary counter. The counter, in turn, sequentially drives diode gate matrixes. The diode gates are opened and closed each time a pulse is received from the master oscillator through the counter.

The level of the signals is raised 10:1 by d-c amplifiers. After gating, the common output signal is further amplified by a factor of 10. Frame synchronization is provided once for each complete ring sequence.

The commutator is housed in a small package and can be used for missile applications. External power and signal connections are made through a flush-mounted connector. Silicon diodes, transistors, or both, are used for all circuits. Modular construction may be employed.

Specifications for this typical unit might be as shown in Table I. Actual specifications for several of the commercially-available electronic commutators are given in Table II.

The list is not intended to be all-inclusive. In addition to solid-state types, beam-switching tube types are made.

Among the advantages of electronic commutators are, generally, high operating speed, low power consumption for a given application and long life due to the absence of moving parts.

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Multiplex Telemetering

By ARTHUR S. KRAMER, Senior Technical Specialist, Allen B. DuMont Laboratories, East Paterson, N. J.

Table II—Characteristics and Suggested Applications of Some Typical Electronic Commutators

Mfgr Model	Duty Cycle	Channels	Samples	Input (*IN*) and Output (*OUT*) Characteristics	Accuracy (*A*), Linearity (*L*), Crosstalk (*C*), or Noise (*N*)	Suggested Applications
DIODE-TRANSISTOR TYPES						
ARN Series pam 30	50 ±5%	30	900 per sec	*IN*: 0–5 v full scale, 0–25 K source impedance with filtering *OUT*: into any subcarrier osc with source impedance of 500 K ±50 K	*L*: within ±0.1% of full-scale range (fsr) *C*: 0.01 % of fsr: *N*: peak-to-peak, <0.01% fsr	pam telemetering
ARN Series pdm 90	45 ±5%	90	900 per sec	*IN*: same as PAM 30 *OUT*: 5-v input signal gives output pulse train of 6–6.5-v peak-to-peak amplitude	*L*, *N*: same as PAM 30 *C*: <0.1% of fsr	pdm/f-m or pdm/p-m telemetering
ASC EC-5800	50%	90	0–1,000 per sec	*IN*: −2.5 v to +2.5 v and 0–5 v signal amplitude *OUT*: recommended load impedance 10 Meg	*A*: 1% or better *L*: ±0.25% C: 1 mv N: 1 mv	pam and pdm telemetering
GDI Hi-Lo Level	10 to 90%	Lo 6 Hi 10	to 10,000 per sec	*IN*: Lo, ±5 mv fs; Hi, ±5 v fs; input impedance >50 K *OUT*: Hi, >50 K impedance	*A*: Lo, 0.5%; Hi, 0.1% *L*: Lo, 0.2%; Hi, 0.1% *C*: Lo, 80 db down; Hi, <0.1% *N*: Lo, 30 μv; Hi, 1 mv	digital data logging
TEL 1480-A		45	900 per sec	*IN*: 2 sync chan; 43 chan, 0–5 v-dc; input impedance, ½ load impedance +10 K *OUT*: output impedance, source impedance +10 K	*L*: ±0.5% of 5-v fs *C*: <0.1% of full amplitude	pdm/f-m or pdm/p-m telemetering
TEL 1481-A		45	900 per sec	*IN*: 33 chan, 0–5 v-dc unbalanced; 10 chan, 0–50 mv bal or unbal input impedance, 1 Meg on high level, 20 K on low level channels *OUT*: output impedance, 20 K	*L*: ±2% *C*: <0.2% of full amplitude	pdm/f-m or pdm/p-m telemetering
OTHER ELECTRONIC TYPES						
EMR 99B	100%	up to 98	75–20,000 per sec	*IN*: 0–5 v signals, 285 K impedance *OUT*: output load 1 Meg or greater	*A*: better than 50 mv *L* < 0-03% of fs between end points *C*: <0.01% of fs	silicon diode switch: pdm and pam telemetering
GDI Electrocom	0 to 100%	4–100 per pole	to 10,000 per sec	*IN*: acts like constant current generator of 10–15 μ amp during sampling time *OUT*: emitter follower supplied	*A*: 0.25% *L*: better than 0.1% into 250 K load *C*: <0.1% fs *N*: <1 mv	silicon diode switch: light, low power telemetering
PBL Model EC		2 to 1,008	18,000–25,000 per sec	*IN*: voltage input ranges to ±8 v max; impedance 50 K *OUT*: ±10 v max at 5 ohm max impedance	*A*: ±0.02% *L*: 0.02% *N*: ±2 mv max	transistor type: pdm/fm or pdm/pm telemetering
BUR Beamplexer		10	10 inputs to 100 kc	*IN*: signals to 200 v accepted, min pulse width +0.1 μsec *OUT*: signal pulses of 1.4 μsec, 20 v, + polarity	*C*: 0.5 v peak-to-peak max at 1 mc *N*: 0.4 v peak-to-peak max in channel	tube type: telemetering, neurology, vibration analysis

Realistic Simulation

Ultrasonic delay line and 30-mc Gaussian noise source are used to simulate actual clutter received during a number of consecutive sweeps

AUTHENTIC SIMULATION of radar echoes from wooded terrain and meteorological phenomena has been hampered by the difficulty of reproducing the particular statistical and spectral properties of reflections from this class of extended targets. The device to be described generates sweeps of Rayleigh-distributed clutter having video bandwidth in range, but only audio or subaudio bandwidth at constant range as a function of time. The audio fluctuation rate of the video at constant range duplicates the high correlation in real clutter amplitudes received during a number of consecutive sweeps differentiating such signals from ordinary noise. The key components in the clutter simulator are an ultrasonic delay line memory and a 30-mc Gaussian noise source.

Here it will be assumed that the statistical characteristics of clutter echoes are not affected by clutter range. Variations in the rms strength of reflections from extended targets as a function of azimuth and range can be simulated by gain-programmed amplifiers. Ground clutter video originating from a piece of homogeneous terrain assumed to consist of random scatterers only which is being scanned by a ground-based search radar may be characterized as follows. The clutter video as a function of range has a Rayleigh amplitude distribution whose fluctuation spectrum is approximately determined by the i-f and video circuits of the radar. The clutter video at constant range and azimuth is also Rayleigh distributed as a function of time. In the case of an S-band radar this ground clutter fluctuation spectrum typically has half-power frequencies between 1 and 6 cps. The shapes of the frequency spectra have been determined experimentally.[1, 2]

The effect of the scanning radar antenna is to slightly widen the spectrum discussed above.

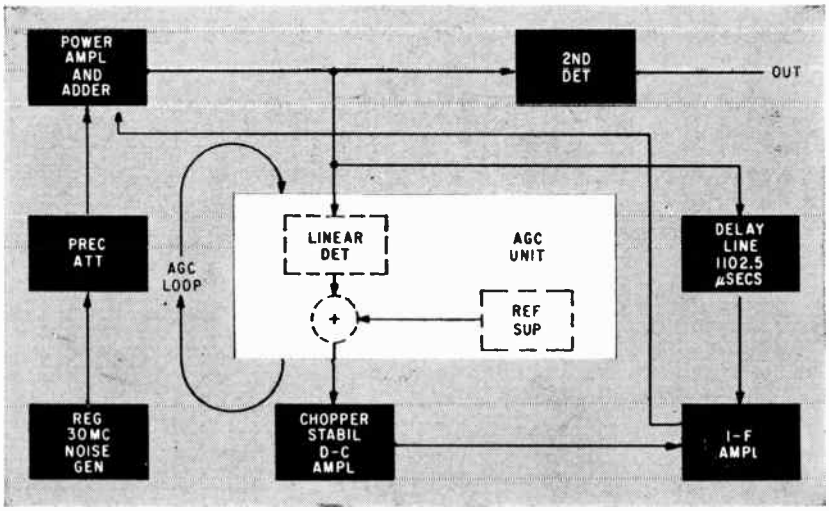

FIG. 1—Delay line exactly equal to interpulse period of radar used. Agc loop maintains output level constant

Clutter Simulator

A simplified block diagram of a clutter simulator capable of generating realistic clutter video is shown in Fig. 1. The time delay is exactly equal to the interpulse period of the radar. The 30-mc Gaussian noise generator has a bandwidth comparable to that of the i-f bandwidth of the radar receiver whose clutter output is to be simulated. The gain α of the delay loop made up of delay line and i-f amplifier is less than unity.

The second detector is assumed to be linear. Its characteristics may be chosen to match those of the video detector in an actual radar. A long time-constant automatic gain control loop is provided to make the system amplitude stable and to keep the rms input to the ultrasonic delay line constant, thus fixing the value of α for each rms voltage level of the added 30-mc noise. The envelope of the 30-mc signal appearing at the input to the delay line constitutes the simulated clutter video.

Amplitude Correlations

The correlation in the clutter amplitudes received during a number of consecutive range sweeps is determined by the loop gain α. If no 30-mc noise is added to the signal circulating in the loop the loop gain will be unity and perfect correlation at fixed range will result. The fluctuation rate of the clutter signal in range is determined primarily by the frequency characteristic of the 30-mc Gaussian noise generator. Thus a signal with the statistical properties of ideal clutter is obtained.

The internal noise produced by a high-gain amplifier is used as the random signal source in the regulated 30 mc Gaussian noise generator. The noise voltage is regulated before it is transformer-coupled to the unit's output. There it is passed through a calibrated precision attenuator and then added to the signal circulating in the delay-line

# of Radar Clutter

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storage loop. The physical addition takes place in the power amplifier used to drive the low impedance presented by the inputs of the delay line, the agc unit, and the output unit. The signal present at the output of the power amplifier is then delayed by an ultrasonic delay line. The i-f amplifier is of high quality. The agc unit contains a buffer amplifier, a linear detector of the average of the half-wave rectified signal and a circuit for comparison of the detector output with an internally-generated reference voltage. The chopper stabilized d-c amplifier raises the level of the error signal output.

Noise Generator

The noise generator uses a high gain i-f amplifier as the noise source. With the input terminal of this amplifier shorted, the output signal consists of internal noise enhanced by the gain of the amplifier. Noise generated in this manner has a Gaussian amplitude probability distribution with a frequency spectrum determined by the transfer function of the unit.

The i-f amplifier has the following characteristics: gain variable to 120 db, center frequency of 30 mc, half power bandwidth of 2 mc and an output impedance of 50 ohms. In its application in the clutter simulator, the i-f strip gain control is operated in the region which results in the greatest percentage variation in the output noise for a small change in the gain control voltage, the region being from −4.0 to −1.4 volts d-c. The noise available at the output terminal of the noise generator has a bandwidth of 1/2 mc and may be varied from 0.3 to 2.0 volts, rms. A plot of the rms value of the generator's output noise as a function of the gain control bias is shown in Fig. 2.

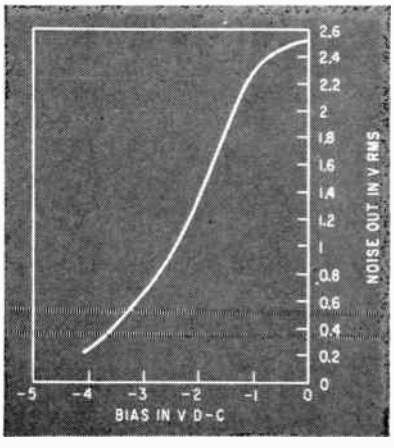


FIG. 2—Regulated 30-mc Gaussian noise generator output level plotted against gain control output bias

The noise output is stabilized by a feedback circuit having a loop gain of approximately 34 db. The 3-db corner of the control loop is at 1 cps.

The capacitive load present at the output is driven by a buffer amplifier. This amplifier and output transformer have a gain of −2 db and a half-power bandwidth of 0.5 mc. The output is taken through a transformer designed to work into a 50-ohm load.

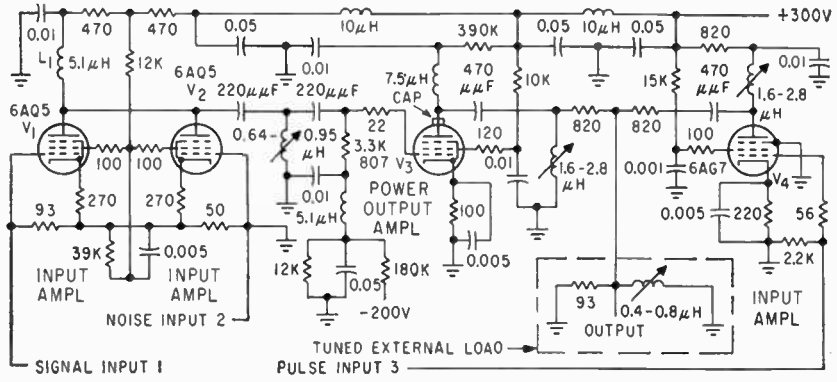


FIG. 3—Power amplifier and adder accepts delay line output and noise. Other input is for synchronizing pulse

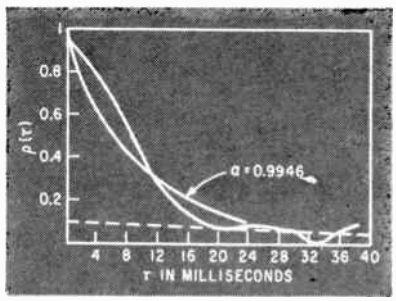


FIG. 4—Typical correlation function of real clutter compared with correlation function obtained by simulation

Power Amplifier

The power amplifier and adder whose schematic diagram appears in Fig. 3 is used to drive the delay line. Its inputs are the amplified version of the delay line output signal and narrow-band Gaussian noise. These signals are added in the common plate load of V_1 and V_2 and amplified by V_3. The tuned circuits at the plate of tubes V_1, V_2 and V_3 in addition to the tuned input to the delay line form a staggered Butterworth triple which is centered at 30 mc and has a half-power bandwidth of 2.75 mc. The overall gain of this unit is 0.92 for either input channel.

A third channel is included in this unit for addition of a pulse to the information entering the delay line. This pulse is used to provide a precise means for synchronizing to the repetition frequency of the clutter simulator. The pulse chan-

nel has a gain of 0.45, a center frequency of 35 mc and a half-power bandwidth of 6 mc.

The maximum undistorted voltage that the power amplifier can drive into the load represented by the input impedances of the delay line, the agc unit and the output unit is 8.4 volts peak-to-peak.

Ultrasonic Delay Line

The ultrasonic delay line uses a solid quartz delay medium. This line has a center frequency of 30 mc, an electrical half-power bandwidth of 10 mc and an acoustic half-power bandwidth 14.3 mc wide. Its delay time is about 1,000 microseconds. Its insertion loss (attenuation) with the 93-ohm terminations used is approximately 70 db. The spurious signal level is at least 50 db below that of the main signal.

I-F Amplifier

The clutter video at the output of the delay line must be amplified to restore its rms voltage to approximately the same value it had at the input to the delay line. A 2 mc commercial i-f amplifier centered at 30 mc provides the necessary voltage amplification. The gain of the amplifier can be varied to a maximum of 120 db.

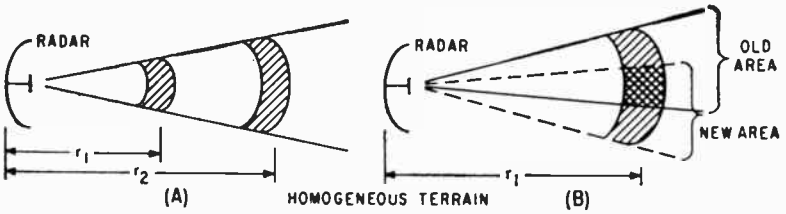
AGC Unit

The function of the agc loop is to regulate the input voltage to the delay line.

The agc unit consists of a single stage of amplification followed by a linear envelope detector whose output is averaged. The frequency response of the post-detection filter is 3 db down at 1 cps. The signal at the output of the filter is compared with a reference voltage, and their difference is fed to a d-c amplifier.

The delay line input is fixed at a level determined by the value to which the reference voltage is set. Any drift in the rms level at the delay line input results in a change in the i-f amplifier gain in the direction which will return it to its initial value. However, any drift in the gain of the agc unit itself will cause the delay line input to drift from the desired level. For this reason, the agc amplifier is operated with an unbypassed cath-

Properties of Real Clutter



In general, a search radar echo is caused by reflections from all the targets illuminated by the radar antenna. The term target area is used to denote the radar coverage at a fixed range. For a ground-based installation, it is defined by the antenna beamwidth, one-half the radar pulse length and the vertical coverage of the beam. An echo from an extended target covering a region much larger than the target area is called clutter. Clutter from meteorological phenomena or ground vegetation exhibits fluctuations which are due to the motion of many reflectors within the target area. At S-band, for instance, the radar wavelength is 10 cm and a piece of terrain appears to the radar as an assembly of many individual targets. Due to wind, such reflectors as small branches and other forms of vegetation move slightly and change their distances from the radar antenna. Echoes from the various portions of the target area reenforce or cancel by wave interference. If the resultant echo is due to contributions from random scatterers only, its phase has a uniform probability distribution from zero to 2π radians while the amplitude of the fluctuating echo possesses a Rayleigh distribution. The power spectrum which characterizes the rate of fluctuation has been measured under a variety of conditions. To investigate the properties of clutter echoes, it is appropriate to consider two separate cases: pulse-to-pulse clutter fluctuations at constant range, and fluctuations which occur within a single sweep as a function of range.

Pulse-to-pulse clutter fluctuations at constant range can be studied most conveniently by stopping the search radar antenna and by recording range-gated clutter video. Under these conditions attention can be focused on radar echoes originating from a specific target area. Using this setup the amplitudes of precipitation echoes have been found to follow the Rayleigh distribution, and some indications of their power frequency spectra have appeared in the literature.[2, 8]

So far, the radar antenna was held stationary and clutter echo amplitudes originating from a typical range element were observed from pulse-to-pulse. Figure A illustrates two range elements, one of which might be under observation. If the antenna rotates, the terrain illuminated by successive pulses will not be quite the same and this situation is depicted in Fig. B. The echo contribution from the incremental portion of new area which has come under surveillance because of antenna rotation between main bangs is statistically independent of the reflections from the old area. The overall effect is one of decorrelation of pulse-to-pulse clutter amplitudes at constant range. A one-degree radar antenna scanning a field of fixed, randomly-oriented scatterers at 6 rpm gives rise to clutter video having a fluctuation spectrum approximately 10 cps wide. The experimental frequency spectra of clutter echoes from random scatterers (chaff, rain, snow, some types of vegetation) have been found roughly similar in shape, resembling error curves centered at the origin.[3, 8]

As mentioned previously, the second kind of clutter fluctuations to be considered are those which occur within a single sweep as a function of range. At any instant during a range sweep the signals received by the radar antenna originate from a patch of land of radial dimension r = (transmitter pulse length) (velocity of light)/2

If the transmitter pulse length is designated by τ, it should be clear that echoes from a completely new target patch will be received every τ seconds. Based on the assumption that the terrain acts like an assembly of random scatterers, echoes received from distinctly different patches of land will be statistically independent. Taking into account transmitter pulse shape, radar i-f and video bandwidths, the exact clutter fluctuation spectrum can be calculated. For most practical radars, it will be determined substantially by the radar receiver low-pass video characteristic, provided that the product of radar i-f bandwidth times pulse length equals approximately unity and that the video bandwidth of the radar is matched to the i-f bandwidth.

ode resistor, thus introducing negative feedback to improve the stability of the unit.

The gain of the agc unit is 17.5 volts d-c/v rms of Gaussian noise. The output is linear to 30 volts d-c, which is well above the operating level of the unit in the clutter simulator.

D-C Amplifier

This unit amplifies the error voltage produced at the output of the agc unit. The amplified error signal is used to control the gain of the i-f amplifier. The d-c amplifier is chopper-stabilized and has a gain which is variable in discrete steps from 0 to 1,000. The 3-db passband is greater than 30 kc for all gain ranges. The maximum linear output is greater than ± 30 volts for 1,000-ohm output termination. The equivalent input noise of the amplifier is 10 μv peak-to-peak. A line voltage variation of ± 10 percent caused an equivalent drift of 12.5 μv.

Second Detector

The output consists of a stage of amplification with cathode feedback, followed by a positive peak detector and a 1 mc wide low-pass filter. The envelope output is taken from a cathode follower through a 30-mc rejection filter. In addition, an i-f output is available at the cathode of the amplifier. The gain from input to cathode follower output of the unit is 4.6 v video/volt rms of Gaussian noise. The half-power bandwidth is 4 mc centered around 30 mc. The output is linear to a voltage well above the maximum at which the unit will be operated.

Performance

A typical experimentally obtained normalized autocorrelation function of clutter power at constant range and azimuth appears in Fig. 4[1].

The slight rounding or decorrelation of the function for τ approaching zero is due to the presence of receiver noise in the radar output.[1] A possible reason for the departure from asymptotic behavior as τ approaches infinity has been explained as being due to a slow temporal change in the average power received by the radar.[1]

The autocorrelation function of the simulated clutter video at a constant range as a function of time is

$$\overline{r(t)r(t+\tau)} \cong \frac{\pi}{2}\sigma^2\left[1+\frac{\alpha^{\frac{2\tau}{T}}}{4}\right] \quad (1)$$

where σ^2 = the mean square voltage input to the detector; α = the storage loop gain; τ = time variable; and T = radar interpulse period or delay of ultrasonic line.

The autocorrelation function of the clutter output power is

$$\overline{r^2(t)r^2(t+\tau)} \cong 4\sigma^2\left[1+\alpha^{\frac{2\tau}{T}}\right] \quad (2)$$

It is seen that the part of Eq. 2 which is a function of τ is exponential in nature and Fig. 4 shows how it (after proper normalization) approximates the experimental data. If a delay line of length 1,000 μsec is used in the clutter simulator a loop gain α of 0.9946 is required for this approximation. Substitution of this α into Eq. 2 yields a bandwidth of 1.6 cps. The experimental data having this very low fluctuation rate at constant range was obtained by maintaining azimuth constant. Using the existing clutter simulation equipment α's $\leq$ 0.98 ($f_{1/2}$ = 6 cps) can be obtained reliably.

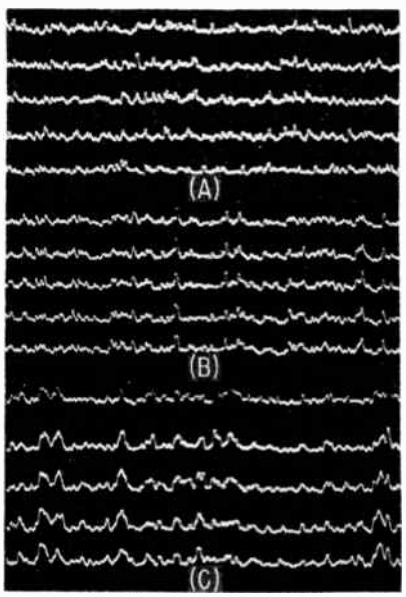


FIG. 5—Simulated clutter for a loop gain of 0.61 shown in (A), loop gain of 0.917 shown in (B) and loop gain of 0.98 shown in (C)

Various values of storage loop gain (α) permit simulation of clutter from meteorological phenomena such as rain or snow or chaff, as well as most ground clutter situations involving a scanning radar and antenna.

Figure 5 shows the video output waveform for various values of α. Each sweep shown is 500 μsecs long. The pulse repetition interval (T) is 1,000 μsecs. In order to display the correlation of the simulator output video at constant range as a function of time, a d-c voltage changing by a fixed increment every T (or 10 T) seconds was added to the simulated clutter video. This permitted the observation and photographing of successive sweeps (or every tenth sweep) on a standard oscilloscope. By employing this display method to photograph the output, signals from the same range are directly below one another on the oscillograms. Therefore, each photo shows the variation of the clutter video as a function of range in the horizontal direction and as a function of time at constant range in the vertical direction.

The oscillogram in Fig. 5A was taken at α = 0.61. The traces are consecutive sweeps of the simulator's video output, each trace containing approximately one-half of the sweep whose total length is 1,000 μsec. A correlation at a constant range is just noticeable. In Fig. 5B, the loop gain of 0.917 results in a highly correlated signal. At a loop gain of 0.98 no decorrelation is noticeable from sweep to sweep. This is to be expected since the fluctuation rate at this α is 6 cps while the interval between successive sweeps is 1 millisecond.

Figure 5C shows every tenth sweep of the simulator's video output with α = 0.98. Little decorrelation in the video at constant range as a function of time can be observed.

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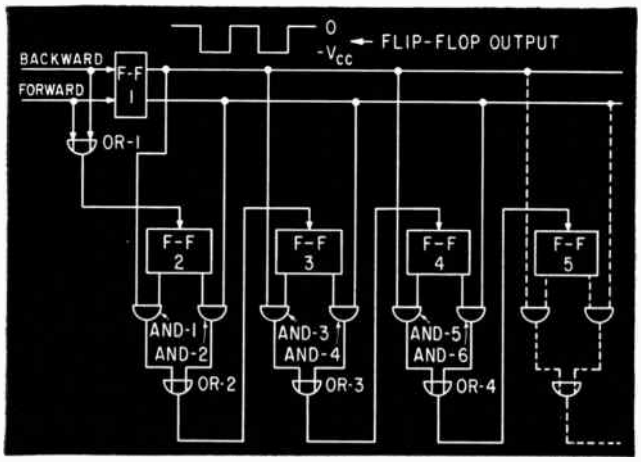
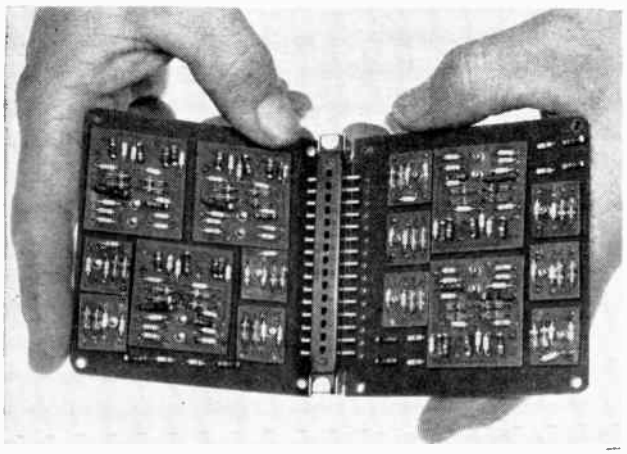


FIG. 1—Counter is broken down to basic building blocks. Dotted lines show how additional stages can be added



Use of submodules is shown in construction of counter. Larger printed boards are flip-flops, smaller boards are gates

Binary Circuits Count

BINARY COUNTERS generally consist of a number of stages of bistable storage elements whose purpose it is to count an incoming pulse train. This counting process is accomplished by cascading these devices so that two pulses applied to each stage result in a single output pulse which triggers the following stage. These bistable storage elements form a register; the number of pulses applied as an input appears as a binary representation in the states of the storage elements.

A counter of the type described above is capable of counting or adding a number of incoming pulses. This article describes the logic as well as the actual working circuits of a counter that is capable of adding and subtracting pulses at the control of the appropriate logic circuits.

This reversible binary counter[1] has been assembled using extremely small digital building blocks. The complete reversible counter fits on to a single plug-in unit 3.25 x 3.8 x 0.75 in. which includes the plug-in connector.

In explaining the theory of operation, the following definitions are used.

Input pulses applied to the forward and backward lines are of positive polarity. The ZERO state of a flip-flop is defined as *0 1*; the ONE state as *1 0*.

Transistors of the *pnp* type are used and the output from a flip-flop is as shown in Fig. 1.

ZERO state of a transistor is defined as the non-conducting state in which the collector is approximately $-V_{cc}$, the ONE state as the conducting state in which the collector is at approximately zero volts.

An output pulse of the proper polarity to trigger the following stage occurs only when the flip-flop changes from the ONE state to the ZERO state.

Finally, the flip-flops used in these circuits are operated in a saturation mode to provide maximum stability as well as independence from transistor parameters and selection.

Theory of Operation

The logic diagram for a four-stage reversible binary counter is shown in Fig. 1. It is understood that counters with any number of stages can be made; the method of assembly being simple repetitions of the four stages used here.

When this logic diagram is broken down to its submodule approach it becomes apparent that the reversible binary counter can be reduced to five flip-flops, six AND gates and four OR gates. Flip-flop 1 is the control or setting flip-flop which is operated in a set-reset manner. Flip-flops 2 to 5 comprise the storage register.

The reset switch shown in Fig. 2 is used to put the storage register in the ZERO state. Assume that flip-flops 2 through 5 are all in the ZERO state, *0 1*. Then, if an input pulse is applied to the forward bus, flip-flop 1 is cut off and the forward bus line is at $-V_{cc}$. The same input pulse is also routed through OR-1 to trigger flip-flop 2 and change its state to *1 0*.

Since the right-hand side of flip-flop 2 has changed state in the direction from *1* to *0*, an output pulse would have been routed through AND-1 but for the fact that the second input to AND-1 is tied to the backward bus which is at ground potential. One input to AND-2 is tied to the forward bus which is at $-V_{cc}$, but since the left hand side of flip-flop 2 changed state from *0* to *1* no output is forthcoming from this gate. The counter has received one input pulse and this information is stored as 0001 in flip-flops 2 through 5.

Indicator

The least significant digit is stored in flip-flop 2 and since this stage is in the ONE state the indicator lamp associated with it lights up to show its condition.

When the flip-flop output is zero Q_5 is nonconducting and the voltage at its collecter is −45. Therefore, the voltage across the neon lamp is 40 v, which is insufficient to break

Transistorized binary counter uses small digital building blocks to perform adding and subtracting functions. Technique of using digital building blocks can be applied to other applications

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Backwards or Forwards

down the neon. When the flip-flop is at −12 v, Q_3 conducts heavily and the voltage at its collector is essentially zero. The voltage across the lamp is thereby increased to 85 v which is sufficient to break down the neon and light the bulb.

Now assume that another input pulse is applied to the forward line. Although this pulse does not change the state of the control flip-flop, it serves to trigger flip-flop 2, which reverses its state to *0 1*.

This change of state applies two negative voltages to D_1 and D_2 of AND-2, cutting off transistor Q_7 and causing its emitter to drop to $-V_{cc}$. This negative voltage is transmitted through diode D_3 of OR-2, inverted and the resultant positive pulse used to trigger flip-flop 3. This changes the state of flip-flop 3 to *1 0*. The count is now stored as 0010 in the storage register.

Assume now that a pulse is applied to the backward bus line. This pulse causes the control flip-flop (flip-flop 1) to change state, causing the backward line to assume $-V_{cc}$. The same input pulse triggers flip-flop 2 reversing it to the *1 0* state. This change of state permits a pulse output to get through the AND-1 gate thereby triggering flip-flop 3 back to the *0 1* state.

The register now displays the total count as 0001 and has, therefore, shown that it can cycle in a forward direction as well as in a backward direction.

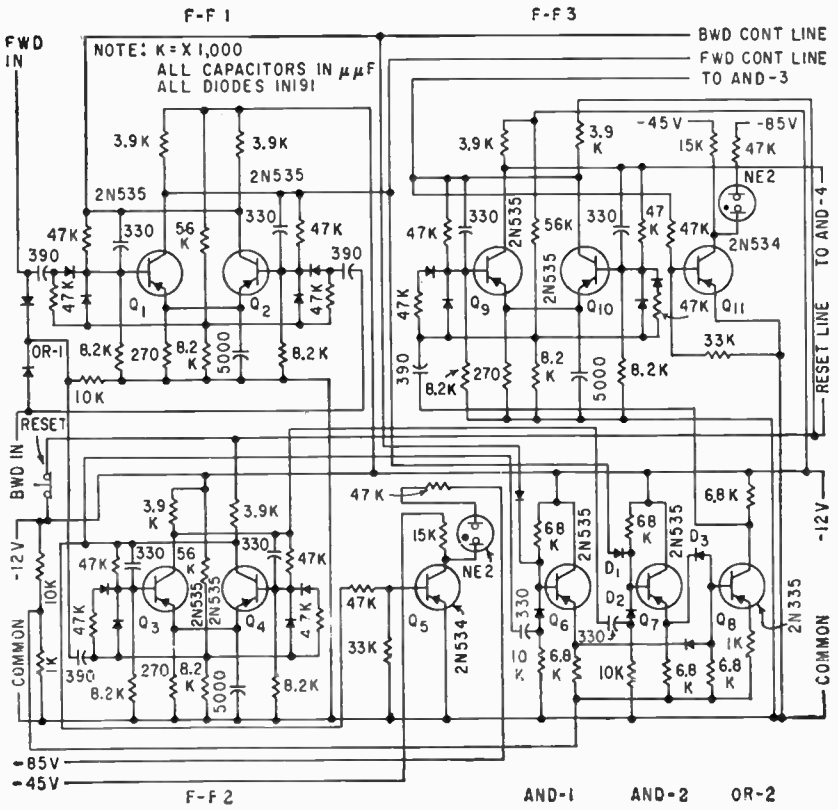

FIG. 2—Flip-flops used in counter are identicol. Input voltages to flip-flops depend upon circuit function

Modular Design

The plug-in module described is a separately packaged function which may be subdivided into individual submodules or digital building blocks. These fully engineered and tested building blocks can then be used to assemble the particular counter in a minimum of time and at the lowest possible cost.

REFERENCE

(1) R. L. Trent, A Transistor Reversible Binary Counter, *Proc of NEC*, 8, p 346.

Unusual Applications for Conventional Synchros

In addition to their regular use as an angular data link between remote points, standard synchros can be used for several other functions. Low frequency generators and linear induction potentiometers are just two examples

By **DAVID J. SALONIMER,** Missile Electronics Laboratory, Redstone Arsenal, Huntsville, Ala.

SEVERAL UNUSUAL USES for synchros have evolved in the development of test equipment in the Army missile program. Among these new ways to use synchros are as a difference frequency generator and as a direct reading frequency deviation meter.

Synchro control transformers, transmitters and repeaters are similar in construction but have significant differences. All three types have single winding rotors and three winding stators. The stators are wound as a three phase, Y-connected a-c machine but only single phase excitation is used. The main differences are in the rotors.

The rotor of a control transformer is cylindrical while the rotors of transmitters and repeaters have salient poles. Repeaters have a further difference in that they have damping or antihunt provisions. Synchro differentials are similar to control transformers in construction but the rotor is wound as a three phase, Y-connected machine.

Servo Loop

A typical control loop, as shown in Fig. 1A, might use a synchro transmitter as an error-sensing pickup. With a synchro control transformer linked electrically with the transmitter, the error signal is introduced into the control loop. The servo motor positions the load and the control transmitter until the error signal is minimum. A servo of this type is analogous to a highly precise, flexible shaft. The accuracy and precision of such loops are determined largely by the characteristics of the synchros.

With a differential synchro placed in the loop as shown in Fig. 1B, the output position becomes a function of two angles, ϕ_i and ϕ_D. The output is the sum or difference of the two inputs.

Because of their precise construction, low cost and special characteristics, synchros can be used in several applications unrelated to their principal uses.

Low Frequency Generator

A practical low frequency generator is shown in Fig. 2A. A low-speed motor is used to drive a synchro at the output frequency

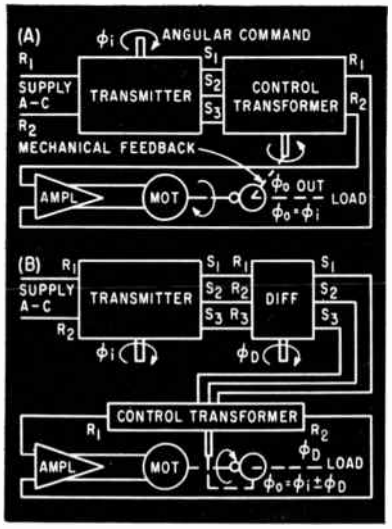

FIG. 1—Common type servo using two synchros to develop the error signal (A). Servo loop with differential performs a computer operation summing the two input angles θ_i and θ_D (B)

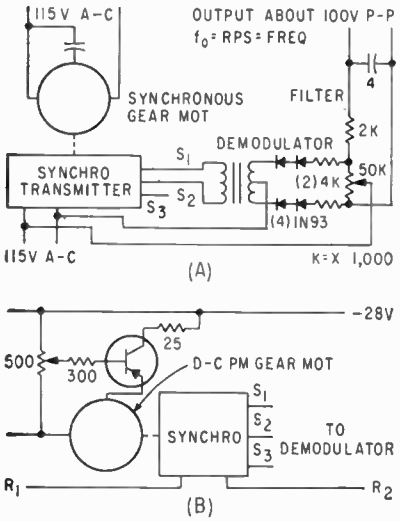

FIG. 2—Low-frequency sine-wave generator (A). Adjustable frequency generator using permanent magnet motor (B). A fixed speed motor and a variable transmission can also be used for drive

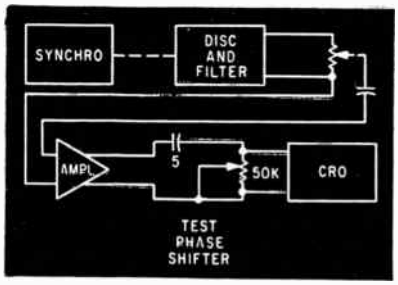

FIG. 3—Phase shift circuit and scope are used to measure distortion

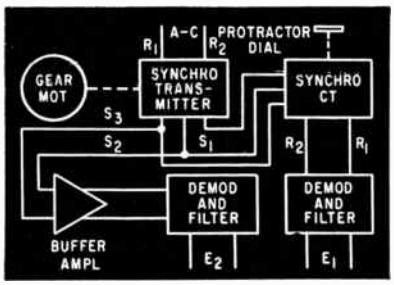

FIG. 4—Phase of voltage E_1 is adjustable with respect to E_2

Engineer tests the wave shape, frequency and distortion of an experimental low-frequency sine-wave generator

desired. The output of the synchro is a suppressed carrier signal which is amplitude modulated at the frequency of synchro rotation. When this signal is phase demodulated and filtered, the output becomes a sine wave at the same frequency as the synchro shaft rotation in rps.

Only one stator phase is needed to pick up the low frequency signal and it is not important whether the synchro is a transmitter, control transformer, repeater or resolver. A resolver, however, is built as a two phase a-c machine and it may be used as a low-frequency generator with two outputs shifted from each other by ninety degrees. A separate phase sensitive demodulator will be required for each output. If a transmitter, or other synchro with a three winding stator is used, three signals are available with 120 degrees phase shift between them.

There is no lower limit to the frequency generated and variable frequency generators are readily made as shown in Fig. 2B. The upper frequency limit depends on the allowable percentage of ripple and the high speed characteristics of the synchro brushes.

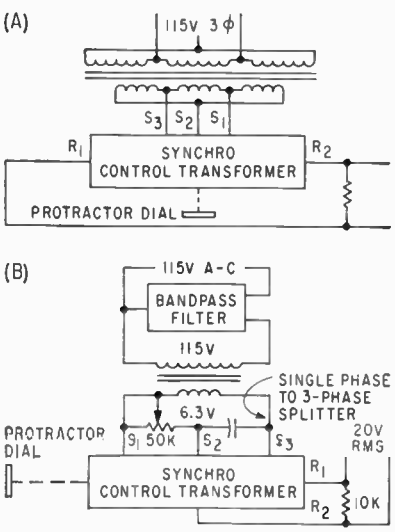

FIG. 5—A syncho control transformer is used to shift the phase of the carrier signal. Three-phase source should be balanced and have little distortion (A). Single phase to 3 phase splitting network (B)

Low Frequency Distortion

Some applications require a low-frequency signal with a minimum amount of distortion. The most common causes of distortion are: misalignment of motor and synchro shafts; excessive phase shift of the carrier before demodulation; inadequate reference signal amplitude; circuits using nonpolarized tantalum capacitors with unequal forward and reverse capacitance; and an output amplifier used to increase the voltage or lower the output impedance.

A simple test to reveal distortion in a low-frequency wave can be made with a capacitor, potentiometer and oscilloscope. The arrangement is shown in Fig. 3. If there is little distortion in the wave, the oscilloscope pattern will be a smooth sinusoid for any setting of the potentiometer. But even a little distortion, imperceptible in the full output, will show up as a lump or spike at some point on the wave as the time constant of the R-C high-pass filter is varied. Only a pure sine wave will remain smooth throughout the full filter range.

Using two synchros, such as a transmitter and control transformer as shown in Fig. 4, two signals of variable relative phase relation can be produced. The position of the rotor of the stationary synchro controls the phase shift.

A protractor dial on this synchro can be used to read the phase shift. The slowly rotating single phase field produced by the driven rotor will be established in the stator of the dial synchro and the position of its rotor, used here as a pickoff, will determine the phase relation of its output to that of one of the driven synchro field windings. This winding must not be loaded appreciably or distortion of the output waveform will result. A high input impedance buffer amplifier is desirable for isolation.

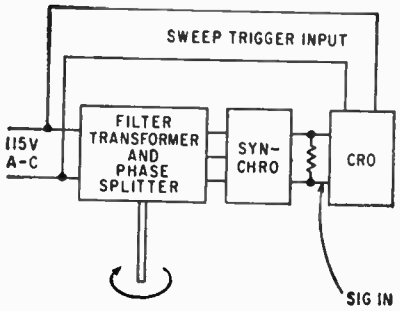

FIG. 6—Method of adjusting phase splitter for optimum phase shift linearity. See Fig. 5 also

Carrier Frequency

Because a control transformer has a well balanced three phase, Y-connected stator, it can be used as a carrier phase shifter. If a uniform rotating magnetic field is established in the synchro stator, a sinusoidal wave at the frequency of the rotating magnetic field is developed at the rotor terminals. Advancing the rotor in the same direction as the rotating field, with reference to a fixed position, provides a rotor signal whose phase position lags the reference. An opposite angular displacement produces lead. Fig. 5A shows an arrangement using a three-phase source.

If three-phase power is not available, or if because of unequal external loading the signal source would produce a distorted or non-uniform rotating magnetic field, a single-phase to three-phase splitting network can be incorporated. Fig. 5B shows such a network adapted to a synchro. Three points must be observed. First, the synchro must have a cylindrical rotor, not salient poles. Control transformers, resolvers or differentials are suitable but transmitters and repeaters are not. The salient poles distort the magnetic field, resulting in a distorted output.

Second, the rotating magnetic field must be of uniform amplitude throughout the entire cycle. Hence the power source wave form must not be significantly distorted. A good band pass filter will aid greatly in achieving a precise unit.

Thirdly, only light loading of the rotor circuits can be permitted if an undistorted output waveform is to be attained.

Final adjustment of the phase splitter is a trial and error procedure, since no two synchros are exactly alike. Optimum values of resistance and capacitance are easily determined while testing the unit for linearity. Fig. 6 shows a method of testing using a triggered oscilloscope. When the synchro shaft is spun with the fingers, the wave on the oscilloscope screen shifts right or left corresponding to the angle and direction of rotor movement. Resistance and capacitance are adjusted until the wave appears to shift smoothly and the amplitude of the wave remains constant as the shaft is rotated.

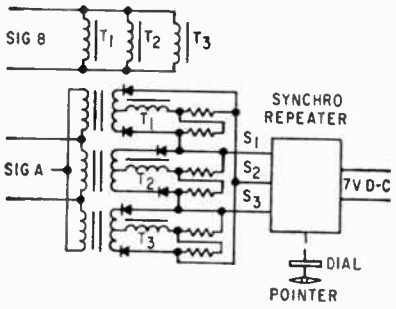

FIG. 8—Frequency deviation meter measures errors of ± 4 cps

Difference Frequency Generator

Rotating the synchro of the phase shifter just described will produce a signal differing in frequency from the carrier by the speed of rotation in rps. A generator of this type, when driven from a precision variable speed source, is useful in testing the compensation circuits of a-c servos. A secondary frequency standard and amplifier may be used for the supply signal. With proper gearing, frequencies near the carrier may be generated with extremely high resolution.

The output of a synchro can be made a linear function of shaft position if the output wave of the phase shifter described above is shaped into a square wave and applied to a phase detector in which the reference signal is a square wave. The linearity of the d-c output will depend largely on the flatness of the horizontal portion of the two square waves and the linearity of the phase shifter itself. Fig. 7 is a block diagram of this scheme. Good linearity can be achieved through a range of more than plus or minus 80 degrees.

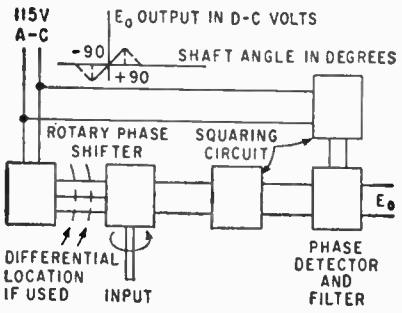

FIG. 7—Linear induction potentiometer has output linear to ± 80 degrees

Frequency Deviation Indicator

A high impedance synchro repeater and a three phase detector can be used to indicate a small difference in frequency or phase shift between two sources. Readout is by a pointer which rotates at the difference frequency of the two sources. See Fig. 8.

A three-phase signal from one source is phase demodulated by a single phase signal from the second source. The output of the three-phase demodulator is a three-phase signal at the difference frequency and is applied to the synchro stator. A small d-c current in the synchro rotor windings causes the rotor to align itself with the rotating stator field. The time in seconds for one revolution of the pointer is the reciprocal of the difference frequency. If no difference exists, the pointer measures the phase difference of the two signals.

Many Varieties

The repeater will turn a small torque potentiometer and the time integral of the deviation can be recorded. The technique is well suited to testing inverters for reaction to shock loads. Frequency deviations up to 3 or 4 cps and phase shift within plus or minus 1 or 2 degrees can be measured.

Many varieties of test and computation apparatus may be devised with these techniques. High quality precision synchros are in abundant supply and are relatively inexpensive. They have a high order of reliability, high sensitivity, low noise and light torque. The variety of secondary applications make synchros one of the designer's most versatile components.

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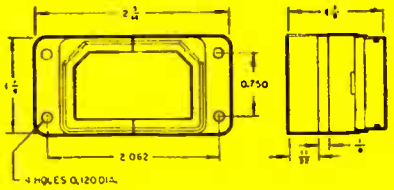

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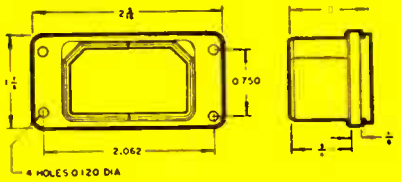

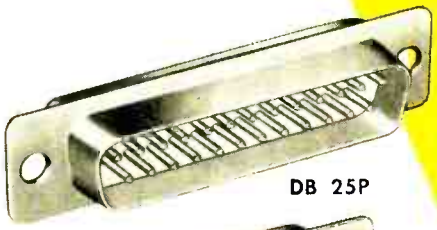

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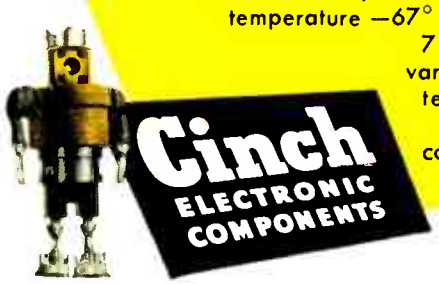

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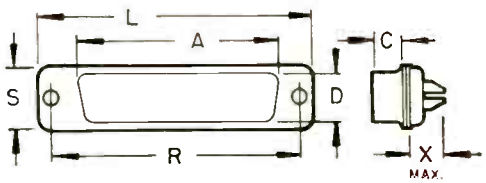

size	A	C	D	L	R	S	X	weight
DA-15P	1 1/64	15/64	23/64	1 17/32	1.312	31/64	5/16	.013
DA-15S	31/32	15/64	5/16	1 17/32	1.312	31/64	5/16	.014
DB-25P	1 9/16	15/64	23/64	2 3/64	1.852	31/64	5/16	.023
DB-25S	1 33/64	15/64	5/16	2 3/64	1.852	31/64	5/16	.031
DC-37P	2 13/64	15/64	23/64	2 23/32	2.500	31/64	5/16	.035
DC-37S	2 11/64	15/64	5/16	2 23/32	2.500	31/64	5/16	.035
DD-50P	2 7/64	15/64	1 5/32	2 5/8	2.406	39/64	5/16	.035
DD-50S	2 5/64	15/64	2 7/64	2 5/8	2.406	39/64	5/16	.040
DE-9P	45/64	15/64	23/64	1 13/64	.984	31/64	5/16	.011
DE-9S	41/64	15/64	5/16	1 13/64	.984	31/64	5/16	.012

FRACTIONS ±1/64 Tolerance DECIMALS ±0.005 Tolerance

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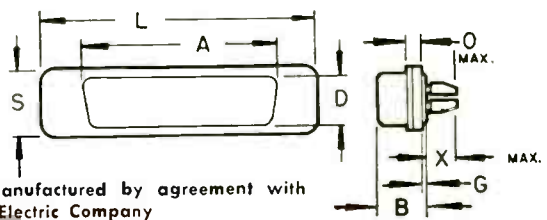
DAH-15P-002	1 1/64	23/64	3/32	23/64	1/32	1 35/64	1/2	15/64	0.021
DBH-25P-001	1 9/16	23/64	3/32	23/64	1/32	2 3/32	1/2	5/32	0.027
DBH-25P-002	1 9/16	23/64	3/32	23/64	1/32	2 3/32	1/2	15/64	0.027
DCH-37P-001	2 13/64	23/64	3/32	23/64	1/32	2 47/64	1/2	5/32	0.037
DCH-37P-002	2 13/64	23/64	3/32	23/64	1/32	2 47/64	1/2	15/64	0.037
DDH-50P-001	2 7/64	23/64	3/32	1 5/32	1/32	2 41/64	39/64	5/32	0.041
DDH-50P-002	2 7/64	23/64	3/32	1 5/32	1/32	2 41/64	39/64	15/64	0.041

Variation in final dash number indicates type of contact terminal. —001 = eyelet type; —002 = solder pot type.

FRACTIONS ±1/64 Tolerance DECIMALS ±0.005 Tolerance



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Antenna accupies entire left temple piece while radia accupies ather temple piece

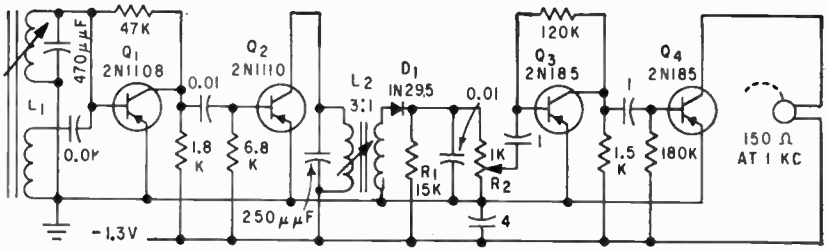

FIG. 1—Ferrite antenna has Q af 250. Base bias resistars in each stage are adjusted to give 0.5 ma callectar current

Transistor Eyeglass Radio

Sensitive single-channel radio constructed in hearing aid eyeglass frame uses four transistors in tuned radio frequency circuit

By **HARRY F. COOKE,** Semiconductor Components Div., Texas Instruments Inc., Dallas, Texas

AUDIO MINIATURIZATION TECHNIQUES have been commercially used in the creation of hearing-aid eyeglasses. The eyeglass radio described in this article is a further extension of this idea.

Since a superheterodyne receiver is unnecessarily complex for single-channel operation and a regenerative detector is marginal on sensitivity and stability, a trf circuit, Fig. 1, was selected.

Circuit

The ferrite-core antenna has a high permeability which affords an effective area much greater than the actual size of the antenna. In the interests of sensitivity, the entire space within one temple piece is devoted to the antenna.

To obtain a reasonable r-f gain with a power supply consisting of a single 1.3 v mercury cell, grown-diffused transistors are used. These transistors have an h_{fe} (common emitter forward current gain) of 30 db at 455 kc. With fixed emitter current, the collector voltage may be dropped as low as 0.9 v without a serious loss in gain. The transistors were specially packaged in small diode cans.

For selectivity, a minimum of two tuned circuits are necessary with the antenna counting as one. A small ferrite E-transformer was selected for use as the second tuned circuit with the coils wound on the center leg. The transformer can be tuned by placement of the bar which closes the gap. The magnetic path is closed by the bar and there is minimum detuning once the bar has been cemented in place. The coil Q exceeds 100. The two tuned circuits are loaded to give a 10 kc at 6 db overall bandwidth.

Transistors Q_1 and Q_2 are resistance coupled to reduce complexity and give a degree of isolation between the two tuned circuits. The diode detector has a forward bias applied through R_1 to improve both detector sensitivity and linearity. The detected output is applied through volume control R_2 to audio stages Q_3 and Q_4.

The output load (earphone) has a 1,000 cps impedance of 150 ohms and requires 50 mv for a medium loud output.

Single-resistor constant-base biasing has been used. This type of biasing does not provide the best interchangeability and stability but is used because it requires the minimum number of parts. Base bias resistors are individually selected to produce 0.5 ma collector current in each stage.

The overall sensitivity of the receiver is 1,000 μv/meter for 50 mv across the earphone and the current drain is 2 ma giving a battery life of approximately 100 hours.

Antenna

The antenna primary is 79 turns of 10-44 Litz wire wound on a $\frac{1}{4} \times \frac{1}{8} \times 2\frac{1}{2}$ in. ferrite form. Adjust last ten turns for correct inductance. The secondary is 10 turns of the same wire wound at start of primary. Transformer L_2 primary is 65 turns 5-44 Litz wire and the secondary is 22 turns No. 40 enamel wire both wound on $\frac{1}{2} \times \frac{1}{8} \times \frac{9}{32}$ in. ferrite E-transformer core.

The eyeglass radio was constructed for use at a disk-jockey convention which was held at Miami, Florida.

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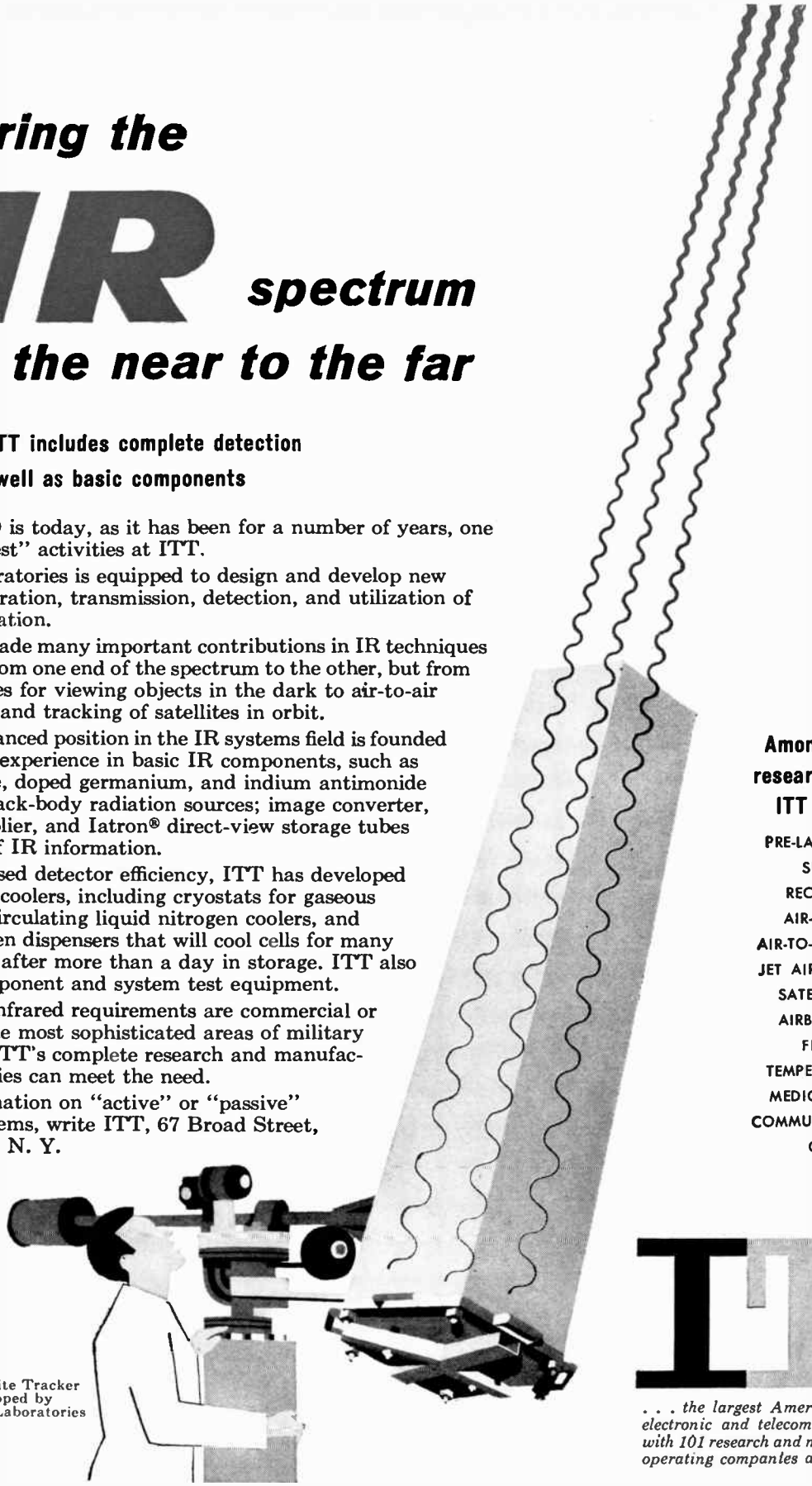

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Locked Oscillator for Color Tv

By I. N. METH, Brookhaven National Lab, Upton, N. Y.

COLOR TV receivers require that a c-w signal of reference (subcarrier) phase be reconstructed from the 8 to 12-cycle burst (color synchronizing signal) transmitted within the horizontal blanking interval. The circuit for phase locking the locally generated subcarrier to the transmitted burst is called the color hold (color synchronizing) circuit. The generated subcarrier establishes reference phase for the color demodulators.

Variations of propagation conditions, front-end tuning and drift affect the level of the chroma signal, requiring automatic gain adjustments for the chroma amplifiers. The chroma control signal is generally obtained by measuring the level of the transmitted burst and is commonly referred to as automatic chroma control (acc). If the received signal is monochromatic or if the chroma level of the received signal is below a usable minimum, the receiver is required to automatically operate as a monochromatic receiver, biasing the color demodulators beyond cutoff. Failure to disable the demodulators for the indicated conditions can result in the introduction of color noise to the picture. Color-killer sensing voltage can be obtained from the acc signal.

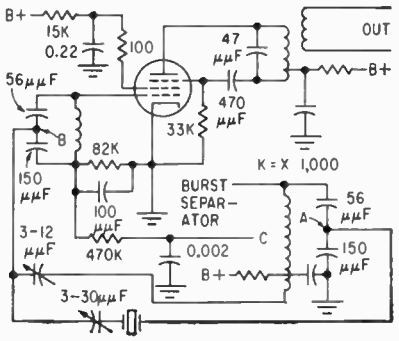


FIG. 1—Color hold circuit provides automatic chroma control and color-killer voltage

Circuit Description

A novel color hold circuit and control voltage source for acc and color-killer operation has been developed. The circuit shown in Fig. 1 is inherently stable, insensitive to variations of burst amplitude and supply voltages, and it performs well under weak signal conditions. The circuit uses a passive filter to separate the subcarrier frequency from the sync burst and an injection-locked oscillator that combines the functions of amplitude limiting and power amplification, which are required for direct drive of the color demodulators.

The separated color synchronizing burst is obtained from the composite video signal in a gated amplifier controlled by a 3.5-μsec pulse derived from the horizontal flyback transformer. The gate is opened only during the burst interval and closed for the rest of each horizontal line, preventing extraneous video information and noise from upsetting the color hold circuit.

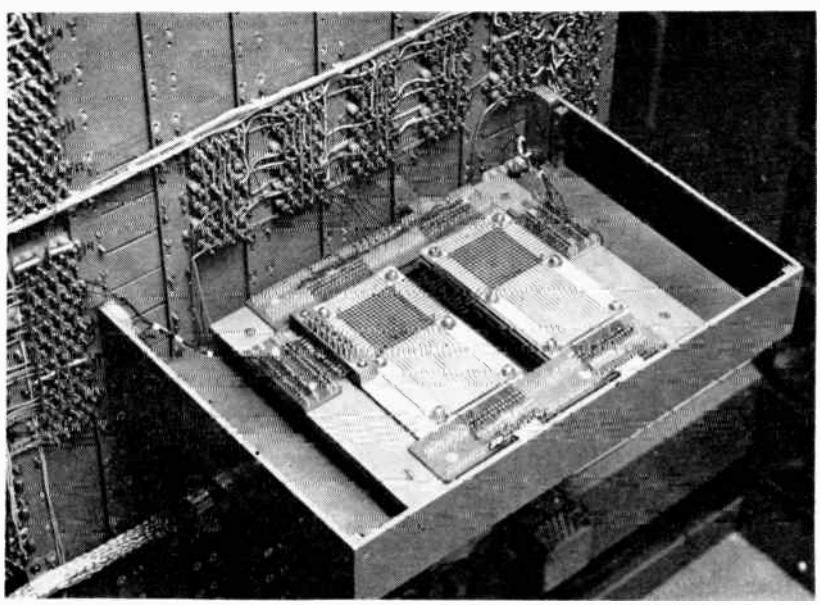
All burst sidebands are removed from the gated synchronizing burst with a narrow-band crystal filter, producing the required c-w signal of reference phase. The crystal, operating in its series-resonant mode, couples a suitable tapping point of the burst-separator output tank circuit (point A) with a suitable tapping point of the oscillator control grid tank circuit (point B) forming an extremely narrow bandpass filter.

Crystal-holder capacitance is neutralized by driving a small (3-12 μμf) adjustable capacitor with a signal opposite in phase to that at point A. The required neutralizing voltage is readily obtained by extending the output winding a number of turns beyond its r-f grounding point. Crystal neutralization prevents direct feed of unfiltered burst to the locked oscillator.

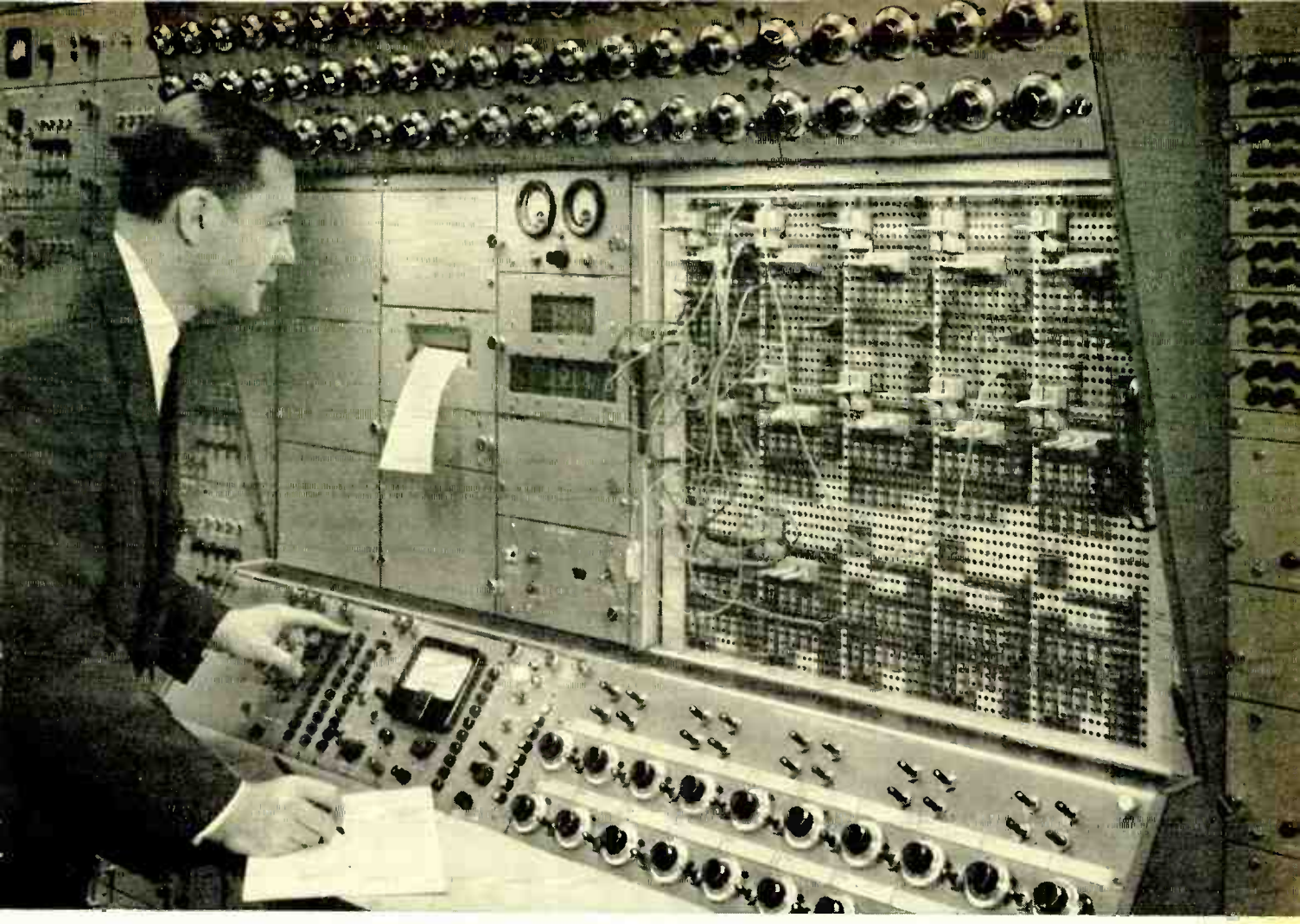
Oscillation

Oscillations at reference frequency are maintained by external feedback from plate to suppressor of the oscillator tube, with the cathode as the common electrode. The control grid, being free of oscillator voltage, is used to electron couple the filtered burst into the oscillator circuit, injection-locking the oscillator in phase synchronism with the transmitted color burst. Neutralization of the grid to plate

Memories Speed Computer Cycle



Experimental magnetic-film memory has been operating in digital computer at M. I. T. Lincoln Laboratory since July. Read-write cycle time of 0.8 μsec with memory elements of Permalloy film is achieved in computer, with cycle time as short as 0.4 μsec achieved in bench tests



Engineer sets up a problem on patch panel control center of a PACE 231-R Analog Computer System made by Electronic Associates, Inc., Long Branch, New Jersey.

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Accurate and efficient computer operation permits no compromise on component quality. That's why Electronic Associates, Inc.—pioneer and leader in analog computer development and manufacture—specifies only materials of proved reliability for its Precision Analog Computing Equipment. In line with this policy, Tung-Sol tubes hold important posts in the 231-R and other EAI PACE systems.

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capacitance is accomplished with a small unbypassed screen resistor without which quadrature feedback of oscillator to the control grid would upset the reference phase established by the color synchronizing signal. Oscillator output is derived from the output winding, inductively coupled to the oscillator tank circuit.

The filtered burst is clamped by the grid-cathode diode in the oscillator tube, developing a burst responsive bias voltage at the control grid. Detected bias voltage is filtered and delivered to terminal C for use with acc and color-killer circuits.

The oscillator tube may be used to provide additional d-c amplification for the detected burst-responsive bias voltage by a simple bootstrap arrangement. The cathode is returned to ground via a parallel *RC* network; *R* is effective d-c load and *C* holds the cathode at r-f ground potential. The control-grid tank circuit is returned to the cathode, rather than to ground, causing the clamping action to develop between grid and cathode. An amplified bias voltage appears between cathode and ground, which is filtered and delivered to terminal C for use with acc and color-killer circuits. This bootstrap arrangement preserves the proper phase relationship for the control-voltage source.

Simple Heart Pacer Is Highly Reliable

By L. D. TRUMP and R. L. SKINNER

EXPERIMENTAL heart-stimulating circuit may aid those suffering from heart block. In this condition, the heart may not beat or may beat very slowly unless stimulated.

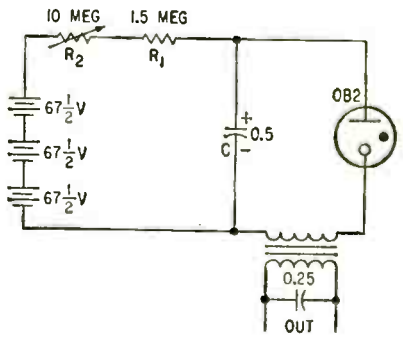

FIG. 1—Frequency of simple relaxation oscillator is controlled between 50 and 200 ppm by R_2

Battery-operated heart pacer in small package can be mounted on harness of test animals

The portable pacer supplies electrical pulses that drive the heart at the desired rate. Output of the pacer is connected directly to the heart by small wires.

Simplicity of the circuit in Fig. 1 makes it very reliable. The entire assembly mounted in a small box can be carried about by a human or fastened to a dog harness as shown in the photograph. The circuit is simply a gas tube relaxation oscillator. Capacitor C_1 is charged through R_1 and R_2 until ionization voltage of the gas tube is reached. After the tube fires, C_1 is discharged through the primary of the transformer.

The transformer is a stepdown unit because impedance of the heart is only a few hundred ohms. Transformer output is a pulse of 3 to 4 millisec duration and has an amplitude of about 10 volts. Charging rate of C_1, and thus frequency of output pulses, is controlled by R_2 to give an output from 50 to 200 ppm. Total battery drain is only about 18 μamp. One unit has been continuously running for about 8 months on the original battery.

An NE 51 neon bulb may be substituted for the OB 2 tube. This substitution results in lower output voltage.

This heart pacer has proved satisfactory on many research animals. In one case, it was used on an animal with an intentionally introduced heart block. The animal can be exercised on a treadmill while its heart is controlled at a fixed rate. This enables the researcher to obtain information on the mechanism that controls heart beat rate.

Ceramic Wafer Tubes for Modular Units

By C. P. MARSDEN, Chief, Electron Devices Section, National Bureau of Standards, Washington, D. C.

Mechanized assembly and processing means have been designed and constructed to show that ceramic wafer tubes can be produced with a yield of better than 75 percent and with a high degree of reliability and ruggedness in military environments. This article discloses the design, methods of fabrication and the processing of these tubes.

CERAMIC WAFER tubes, conceived and developed at the National Bureau of Standards, demonstrate that tubes with a minimum 1,000-hr life at 300 C can be produced with simple automatic equipment.

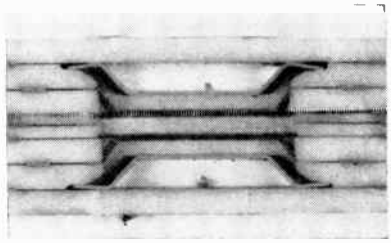

FIG. 2—Cross-section view of twin triode ceramic wafer tube. The three top shapes are repeated in the bottom half of the tube in reverse order. Simple wafer design makes stacking and assembly easy

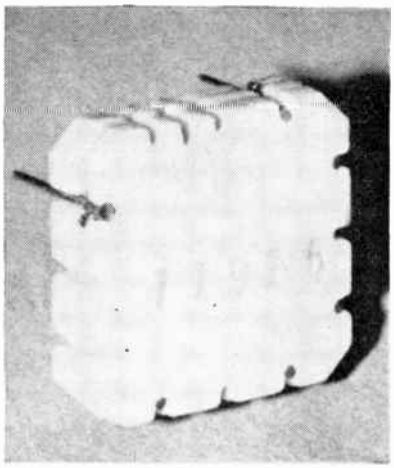

FIG. 3—Assembled ceramic wafer tube

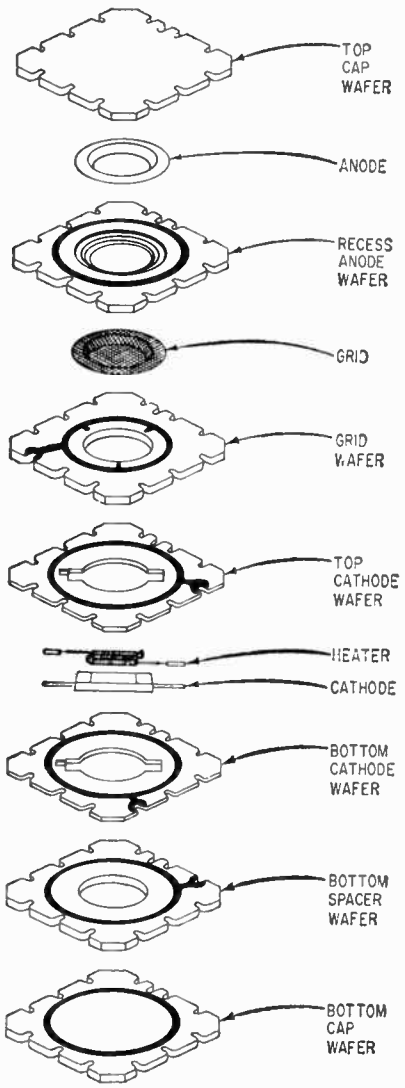

FIG. 1—Printed wafer tube developed at the National Bureau of Standards. This view is of an unassembled single-sided triode that uses printed conductors

These tubes are designed to be compatible with the Tinkertoy[1] module, which contains only passive circuit elements. The main objective of the tube development program, supplemented by a contract with Sanders Associates, Inc., Nashua, N. H., has been to produce a rugged, reliable tube easily adaptable to high-speed, low-cost automatic assembling and processing.

Five tube types have been developed: a twin diode, a high-mu triode, a low-mu triode, a sharp cut-off pentode, and a remote cut-off pentode. Electrical characteristics of these tubes are similar to a number of military tubes now in widespread use.

Physical Description

The exploded view of a single-sided triode, Figure 1, shows the simplicity of the design. The tube consists of seven notched wafers, $\frac{7}{8}$-in. square and 0.040-in. thick. The hole that forms the vacuum chamber is 0.340-in. in diameter. A silk-screen-printed metallic ring on each side of a wafer provides a vacuum-tight seal when brazed.

Anode and grid structures are pie-plate shaped. These elements drop into recesses around the edges of the holes in the wafers and make contact with printed conductors that extend out to the wafer notches. The anode material is 0.005-in. nickel, and the grid is formed from a fine tungsten mesh, gold-plated and fused. The flat oxide-coated cathode structure contains a coiled heater.

The only close dimensional tolerances are the thickness of the wafers and the depth of the grid and anode "pie plates." No parts other than the wafers require orientation.

Design Characteristics

The tubes were designed to satisfy military requirements of ruggedness, reliability, low noise, and fast warm-up. Parts that are known to reduce tube reliability, such as micas, getters, tubulations, welds, and glass, have been eliminated.

Particular emphasis was placed on designing tubes with low interelectrode capacitance, low vibration noise, high interelectrode resistance, good shock resistance, and long life at high ambient temperatures. Measurements of some characteristics of production-line tubes show 20-sec average warm-up time, interelectrode resistance over 100 megohms throughout tube life, interelectrode capacitances ranging from $3\frac{1}{2}$ to 6 $\mu\mu$f, and white-noise vibration output less than 100 mv.

Production

Tubes are assembled by stacking wafers and components in the

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the significance of envelope delay in communication networks . . .

The design of electronic wave filters is an exact science requiring painstaking attention to even the most minute detail. Of no less importance is the preparation of filter performance specifications. The transmission of pulsed sinusoids, steep-front modulation envelopes and other complex wave forms in modern telemetry, speech and facsimile systems has made the preparation of adequate component specifications an absolute necessity. The omission of a single required performance detail can lead to serious malfunctioning of the component in the completed system.

Envelope delay is one of the important characteristics in filter applications requiring minimum distortion of the transmitted signal. The systems engineer must give proper attention to this requirement. Mathematically, envelope delay may be defined as:

$$T_d = -\frac{d\beta}{d\omega}$$

Where: T_d = envelope delay in seconds
β = phase shift in radians
ω = angular frequency in radians per second

To hold distortion to a minimum, the envelope delay must be nearly constant over the entire frequency spectrum of the transmitted signal. It is the constancy of envelope delay rather than the actual magnitude of the delay which governs a network's ability to transmit a complex wave form without introducing objectionable distortion. The distortion arising from non-constant envelope delay is termed envelope delay distortion. From the above equation it is apparent that T_d is constant as long as phase shift varies linearly with frequency. Unfortunately, the realization of a filter network with perfectly linear phase shift over its entire pass band is not always practical or even possible. For this reason, the systems engineer should carefully evaluate the degree of constancy of T_d which his system requires as well as the range of frequencies over which T_d must be maintained nearly constant.

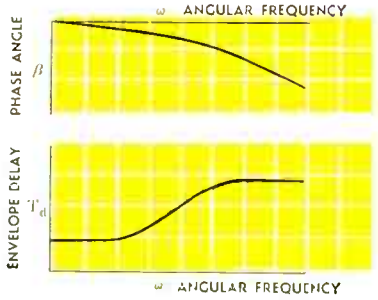


FIG. I *Illustrates the relationship between phase shift and envelope delay.*

The effect of envelope delay distortion on a transmitted signal is illustrated in figure 2. Figure 2 (a) shows the input signal. It is composed of a fundamental frequency plus the third and fifth harmonics. Figure 2 (b) shows the output signal. The network has shifted the fundamental frequency by 45°, the third harmonic by 90° and the fifth harmonic by 180°. The net result of such non-linear phase shift is a highly distorted output signal. If components of the wave had been shifted 45°, 135° and 225° respectively, the signal would have been transmitted without distortion.

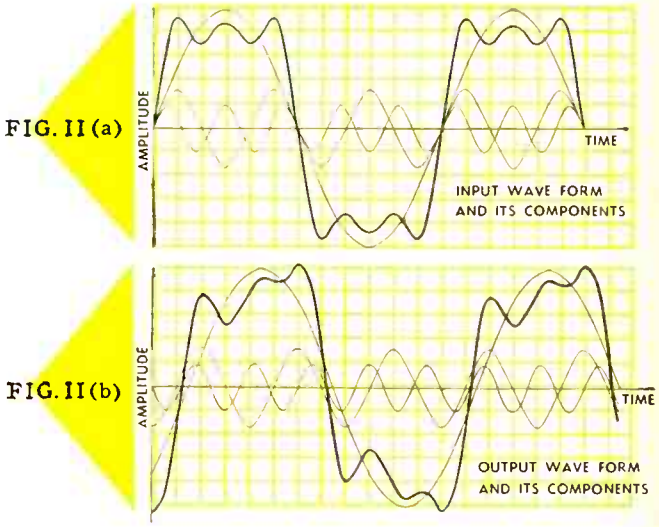


FIG. II(a)

FIG. II(b)

Since envelope delay is defined as the derivitive of phase with respect to frequency, exact measurement of envelope delay is difficult. In practice, however, envelope delay may be approximated by the following definition:

$$T_{\Delta d} = -\left(\frac{\Theta_2 - \Theta_1}{f_2 - f_1}\right)\frac{1}{360}$$

Where: Θ_2 = phase angle in degrees at f_2

Θ_1 = phase angle in degrees at f_1

f_2 = frequency in cycles per second at which phase shift equals Θ_2

f_1 = frequency in cycles per second at which phase shift equals Θ_1

$T_{\Delta d}$ is the average envelope delay between f_2 and f_1. By convention, $T_{\Delta d}$ is assumed to be the envelope delay at a frequency equal to $\frac{1}{2}(f_1 + f_2)$. When the approximate formula is used to calculate envelope delay from empirical phase shift versus frequency data, it should be remembered that the approximation holds only for small differences between f_1 and f_2.

The IBM "650" computer services maintained at Sangamo materially aid our design engineers in solving complicated networks for envelope delay, phase shift and attenuation characteristics.

proper order in a simple jig. This assembly is introduced into a vacuum and heated to a high temperature. The combination of heat and vacuum serves to degas the tube, activate the cathode, and braze together the metallized surfaces of the ceramic wafers to make a hermetically sealed unit in a single operation.

This processing is carried out in a continuous vacuum furnace. It is essentially a long vertical pipe of heat-resistant alloy steel, surrounded by a heating unit, and open to the atmosphere at both ends. Through the pipe passes a series of hollow carriers containing tube assemblies. Adjacent carriers are separated by short pistons fitting closely inside the pipe. These parts are introduced into the top of the pipe at atmospheric pressure; once inside, the air is evacuated through ports along the side of the pipe and through holes in the carriers. After processing, the parts are removed from the lower end of the pipe, at atmospheric pressure and at reduced temperature. The ceramic tubes are then ready for testing.

Evaluation

Tubes produced by this method were tested at normal electrical operating conditions for more than 1,000 hrs at room temperature and at 300 C. with less than 15 percent change in transconductance. They were also subjected to shock without loss of characteristics and vibrated at 15 g with noise output of less than 100 mv over the complete audio range.

Development Program

The wafer tube was conceived as part of an electronics development program formerly code-named Project Tinkertoy: The Modular Design and Mechanized Production of Electronics. The basic objective in establishing this project, sponsored at NBS by the Navy Bureau of Aeronautics, was the development of facilities or systems suitable for rapid mobilization in emergency periods. Circuitry and component activity was brought to a pre-scheduled conclusion in 1956, and private industry has carried it on since then. However, the tube development part of the program has been

continued by the National Bureau of Standards.

REFERENCE

(1) Project Tinkertoy, *NBS Tech News Bul.* 37, 11 Nov. 1953.

Advanced Image Tube Now Being Developed

IMAGE TUBES can make present optical telescopes equal, in observing power, to instruments 2½ times their actual size. Such tubes contain a sensitive surface of cesium with an antimony base. They do the work of coarse-grained photographic plates in telescopes, but much better.

Gerald E. Kron, astronomer at the University of California's Lick Laboratory, has been working full time for over half a year to develop an improved image tube, and now reports excellent progress.

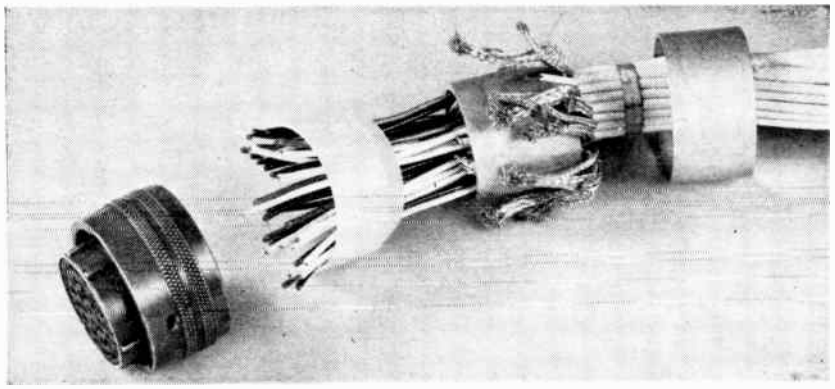
The best image tube made so far has been designed by Andre Lallemand, a French astronomer. However, the key component of this instrument—the sensitive cesium surface—must be sacrificed after each experiment, and tedious procedures repeated to put the tube back into operation.

In an image tube, the cesium-antimony cell is the cathode in an electronic circuit. When photons, or packets of light energy from a star under observation, strike this cathode, electrons come off the other side of the surface. These electrons are accelerated towards the anode, a fine grain photographic film.

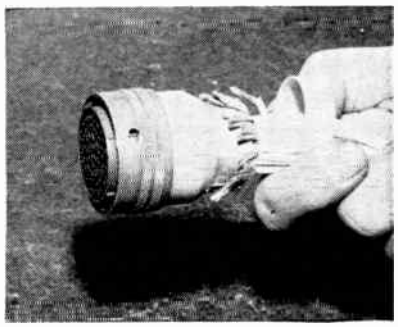
The electrons are focused sharply by a series of charged, annular rings through which they pass. The film makes a permanent record of the image. However, the cesium surface is easily contaminated. Kron is designing a very high vacuum unit, free of contamination, into which he can insert and remove films routinely without cell damage. He reports significant progress using the latest vacuum techniques and substituting fluorine plastics for rubber. A two-inch field, now used, would cover the whole field of the prime focus for the 120-inch telescope nearing completion at Lick Laboratory, and would make it equal to a 300-inch telescope.

Ferrules Shield Multiconductor Cable

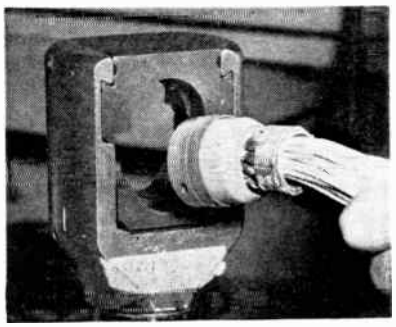
By FREDERICK C. MARCH, Omaton Div., Burndy Corp., Norwalk, Conn.



Exploded view of cable ends prepared for terminating. Left to right are miniature connector, potting shell, inner and outer ferrules. Individual conductors are pulled through braid shielding. All shields are folded back under inner ferrule and then brought back over the ferrule



Assembled and potted connector ready for termination of shields. All conductor ends are stripped and attached to connector contacts. Potting shell and inner ferrule are in position



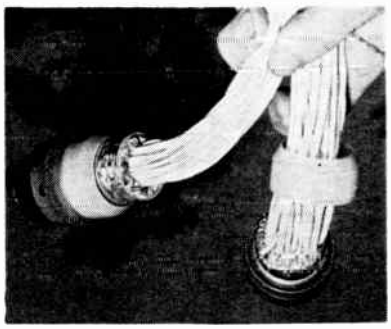
Completed cable assembly. Outer ferrule is slipped forward and positioned over conductor shields and ground wire. Assembly is crimped in Hypress compression tool with proper die set

TERMINATING SHIELDS on multiconductor cable used with round connectors can be troublesome. Space limitations prevent bridling the individual shields with standard compression type connectors for shielded cable.

For the Thor and Jupiter missile programs, a series of large Hyring compression sheath connectors were developed. These permitted grounding all shields by a single ground wire, terminated in a pin or socket of the AN type connector.

The problem was intensified in cable assemblies for the new solid-fueled Pershing missile, where there is even less space behind the connector for terminating the shields.

The solution was to shorten both the inner and outer ferrule of the connector and to develop a new termination technique (with Army Ballistic Missile Agency laboratory, Redstone Arsenal and the prime contractor, The Martin Company, Orlando, Fla.) Both ferrules have been designed dimensionally for each standard shell size from No. 8 through No. 24. The photographs show assembly steps and compare the new technique with the old method of soldering shields and ground wires to common points.



Old method (left) and new. Formerly all shields and the ground wire were soldered to common points. New technique grounds shield compactly, economically

Martin has found that the new procedure speeds production and cuts costs appreciably. Sample installations by Burndy indicate that the time required to terminate the shields of a 50-conductor cable, for example, can be cut from about 5 hours to as many minutes.

Copper Braze Allows Steel Heat Treating

SILVER BRAZING is commonly used in electronic production. But copper brazing is an alternative method which permits high temperature processing after brazing.

The following method of copper brazing was devised by John Gombos Co., Clifton, N. J. to fix 52100 tool steel pivots on RH Monel gyro gimbals. The steel is hardened to a minimum of Rockwell 60 after brazing. A customer had specified silver braze, which was consistently damaged by the temperatures required for heat treating. Copper, 99.9 per cent pure, allowed a successful braze, without flux.

Gimbal brazing surfaces are finished to 32 microfinish or better and ultrasonically cleaned. Braze areas are liquid honed with a glass particle compound (Brite Blast 1,000) to clean any oxidation and slightly roughen the surface to facilitate brazing.

The castings are rinsed and stored in water. The honing is done just before brazing and underwater storage prevents oxidation in the interim. This method will also protect other high nickel alloys, Gombos reports.

Pivot braze areas are plated with 0.0005 inch of pure copper. The plating is the braze material. A copper braze ring is also used to provide a fillet. Gloved hands are used to assemble the gimbals, pivots

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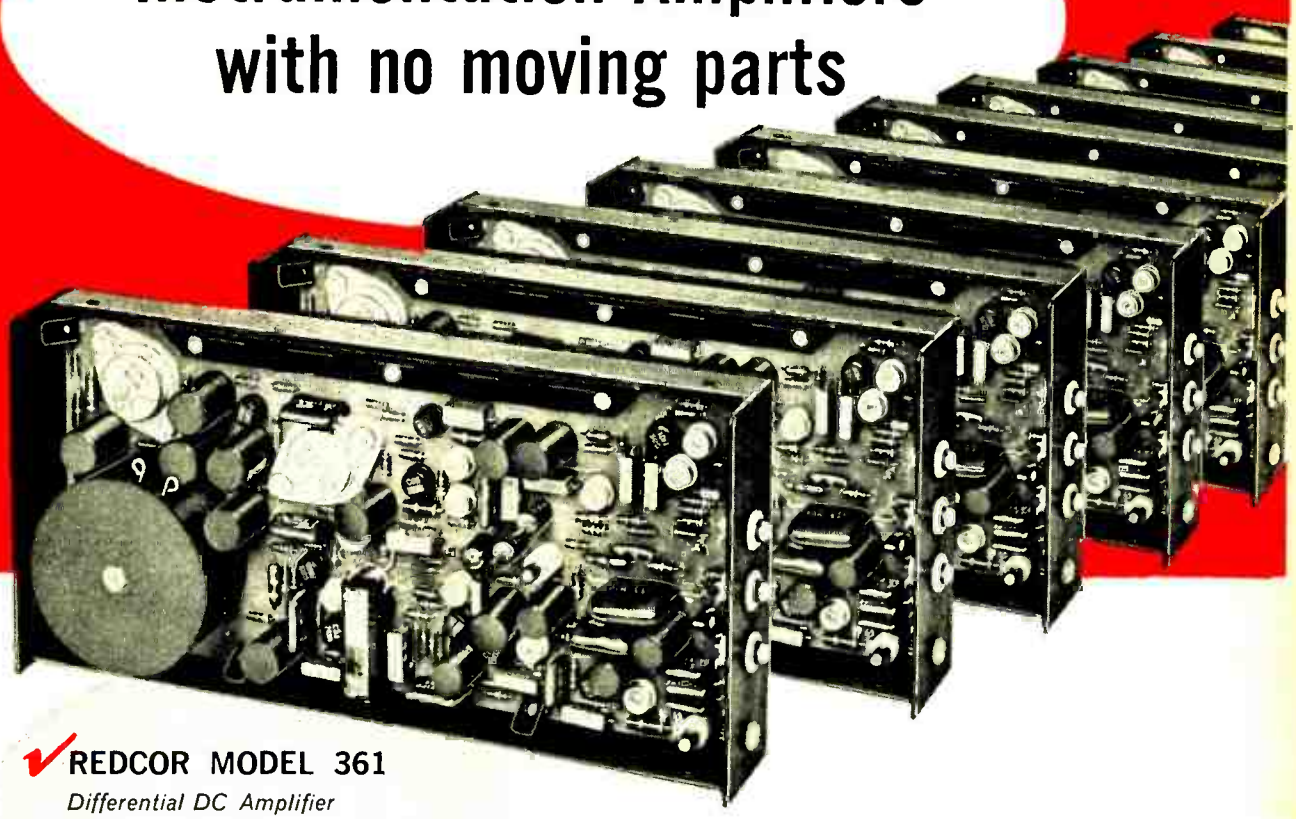

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and rings in the brazing fixtures.

Brazing is done in a pusher type furnace in dissociated ammonia, or in a bell type furnace in dry hydrogen.

Completed assembly. Pivots are brazed to Monel body

Liquid honing prepares braze areas by cleaning and roughening

Water protects cleaned nickel alloy during temporary storage

Temperature is held at 2,050 F for 25 to 35 minutes. The assembly is cooled in an atmosphere chamber for 35 to 45 minutes.

The steel is annealed in an atmosphere furnace for 2 hours at 1,250 F and then is cooled at 50 degrees an hour. After machining, it is hardened in a neutral atmosphere or neutral salt bath at 1,525 to 1,550 F and quenched in oil at 110 to 140 F. It is tempered in an air furnace at 250 F for 2 hours. Finish machining follows.

Only the pivot is hardened since the temperatures used are not high enough to disturb the Monel. The Monel is stress-relieved, however. Low sulfur oil is used for machining and quenching. Castings and pivots are periodically checked by Die

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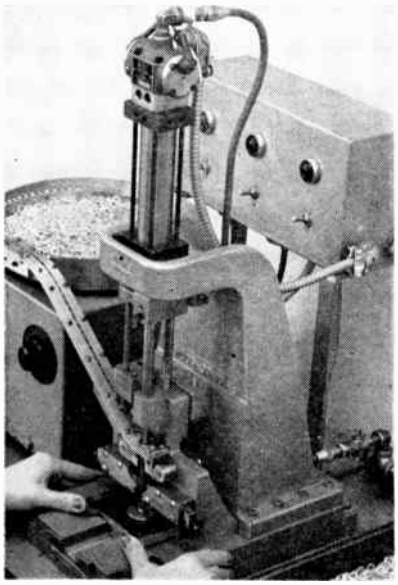
Tapered Mandrel Puts Retainers onto Shaft



Hopper-fed station rapidly places retaining rings on control knob shaft

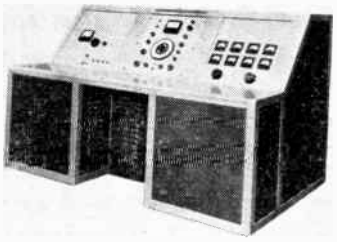
RETAINING RINGS may be automatically placed on assemblies by pushing them down over a free-floating tapered mandrel. The assembly station shown was developed by Waldes Kohinoor, Inc., Long Island City, N. Y., to place its external-type Series 5100 rings on a control knob stud and disc assembly.

Rings fed from a vibratory hopper are fed one at a time by an escapement. They drop onto the narrow upper portion of the mandrel and are pushed down by a sleeve. The rings are expanded by the bottom of the mandrel, slightly larger in diameter than the control knob shaft, and snap into a groove in the shaft.

Initially 2 mechanical fingers hold the mandrel upright. As the sleeve descends, the fingers are pushed aside and the mandrel is supported by the workpiece. As the sleeve retracts, the fingers return to support position and a bracket on the sleeve actuates the escapement.

Machines vary according to application. In most cases, Waldes Kohinoor supplies the ring user with basic components or construction plans.

On The Market



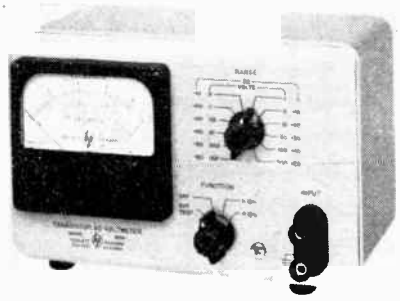
Power Amplifier
3-kw unit

MB ELECTRONICS, 20 Fitch St., New Haven 11, Conn. Model T-151 is a 3-kw power amplifier for vibration testing. The console unit's distortion is less than 5 percent at full output. Noise and hum level is at least 40 db below signal level at full output. Unit features a new automatic power-factor corrector, and a new 5-5,000 cps wide band cycling oscillator with automatic acceleration and displacement control.

CIRCLE 200 ON READER SERVICE CARD

A-C Voltmeter
transistorized

HEWLETT-PACKARD Co., 275 Page Mill Road, Palo Alto, Calif. Model 403A portable, battery-operated a-c voltmeter has a useful frequency range of 1 cps to 1 mc. It measures a-c voltages from 1 mv full scale to 300 v full scale with



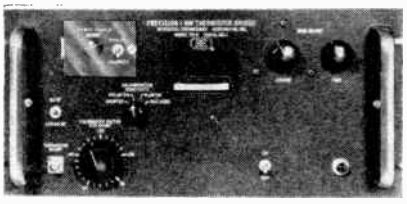
an accuracy of ±5 percent from 5 cps to 500 kc, and ±5 percent above and below this range. Unit has 12 voltage ranges and also reads db from −72 to +52 db. Battery life is 400 hr. Noise is less than 50 μv, and the instrument is completely isolated from power line or ground interference. Price is $250.

CIRCLE 201 ON READER SERVICE CARD

Thermistor Bridge
precision unit

WEINSCHEL ENGINEERING, 10503 Metropolitan Ave., Kensington, Md. Model TB-2 d-c thermistor bridge is completely self-contained except for the external thermistor mount and has an accuracy of ⅓ of 1 percent of substituted power. This equipment is designed for use in the calibration of the output of signal generators at 1.000 mw.

CIRCLE 202 ON READER SERVICE CARD



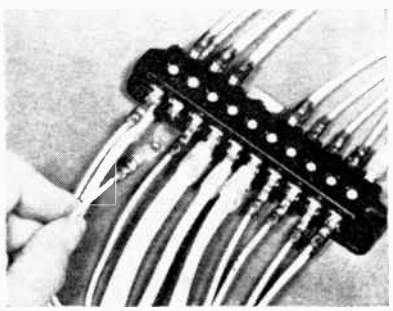
Disk Indicator
medium-sized

BALDWIN-LIMA-HAMILTON CORP., 42 Fourth Ave., Waltham 54, Mass. The SR-4 type 12 disk indicator was developed specifically for use in measuring and control systems which employ resistance strain gage transducers. It provides the accuracy and ease-of-reading of larger units, but requires less than a sq ft of panel area for mounting. It features a horizontal read-out window and up to 500 engraved dial graduations for fast, accurate reading. Unit is an automatic, null-balance type using a servo-driven slide wire to balance an internal bridge circuit. Specified accuracy is ±0.15 percent of full scale.

CIRCLE 203 ON READER SERVICE CARD

Terminal Block
side entry type

TWIN LOCK INC., 1024 W. Hillcrest Blvd., Inglewood, Calif. The T-1010 side entry terminal block is largely designed for use with ground support equipment such as missile launchers, trailers and test stand equipment. It is constructed of a



molded phenolic base with reinforced barriers between the numbered, easily-read terminal cavities; one cavity will accommodate four terminals. Up to 40 connections can be made with one block. Adjacent terminals can be bussed together with TwinLock jumpers. Block measures 5 in. long by 1¼ in. wide by ¼ in. high. Terminal lugs

DC AC NEW

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VOLTMETER

MODEL 803
$845.00

NOW . . . make precise measurements of either DC or AC voltages with this **all** new jf instrument. Use the 803 as an AC Differential Voltmeter, DC Potentiometer or DC/AC VTVM. Actually 3 INSTRUMENTS IN ONE.

FEATURES

1. Standard Cell Reference
2. Direct in-line readout
3. Mirror Scale Meter
4. Eight Search and four Null ranges

DC

Accuracy: .05% from .1 volt to 500 volts

Input voltage ranges: 500-50-5-.5v

Null ranges: 10-1-.1-.01v

Input Resistance: Infinite at Null

Resolution: .005v at 500v to .00005v at .1v

AC

Accuracy: .2% from .5 volt to 500 volts from 30 CPS to 5 KC

Input voltage ranges: 500-50-5v

Null ranges: 10-1-.1-.01v

Input Impedance: 1 Meg. shunted by approx. 25 mmf

Resolution: .005v at 500v to .00005v at .1v

For complete details
of the new jf Model 803 write direct or
contact our engineering representative in your area
Cabinet Size: 9¾ x 13 x 17—Price: $845.00 F.O.B. Seattle factory

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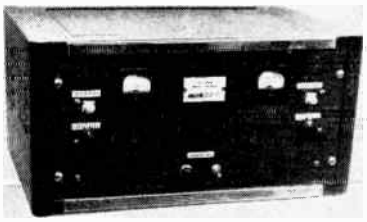
and block sockets are gold plated to meet environmental conditions of salt spray and humidity.

CIRCLE 204 ON READER SERVICE CARD



F-M Receiver
less than 200 w drain

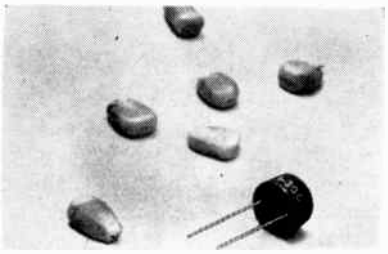
ALTO SCIENTIFIC CO., INC., 855 Commercial St., Palo Alto, Calif. Model XN-305-A f-m receiver can be tuned ±15 mc from its center frequency of 288 mc. With an input sensitivity (for limiting) of 10 mv, a video output of 2 v peak is obtained with a 20 mc swing. The instrument's output discriminator has a linearity of 5 percent over a 20 mc band, while the total i-f bandwidth is 24 mc. Video response ranges from 100 cps to 4½ mc.

CIRCLE 205 ON READER SERVICE CARD

Power Transistors
series of nine

BENDIX AVIATION CORP., Long Branch, N. J. Series of nine power transistors with high d-c current gain and flat beta curve for power switching and power control. Industrial applications include d-c/d-c converters, d-c/a-c inverters, static converters and regulators, relay replacements and drivers for relays, magnetic clutches, and solenoids.

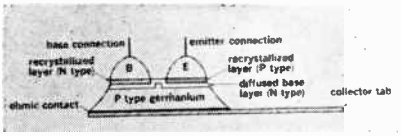
CIRCLE 206 ON READER SERVICE CARD



Toroidal Inductors
to 500 mh

BURNELL & Co., 10 Pelham Parkway, Pelham, N. Y. MT 34 Kernel microminiature toroidal inductors for printed circuit use are supplied with inductances up to 500 mh; recommended frequency is 30 kc max; Q is greater than 55 at 25 kc; size is 0.437 o-d by ⅜ in.; spacing between leads 0.3 in., and weight, 0.06 oz. MT 35 inductance is up to 200 mh; frequency, 200 kc max; and Q, over 60 at 100 kc.

CIRCLE 207 ON READER SERVICE CARD

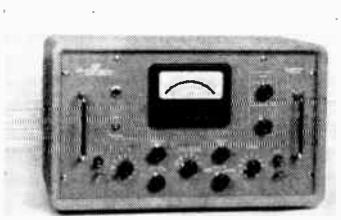


PNP Transistor
70 mc cut-off

AMPEREX ELECTRONIC CORP., 230 Duffy Ave., Hicksville, L. I., N. Y. Type OC170 germanium transistor, with its high cut-off frequency of 70 mc and high gain (average beta is 80), is designed for use in the vhf band as a mixer oscillator for mobile radio equipment, car radios and short wave receivers, and as an

r-f and i-f amplifier for f-m receivers. Units feature uniform characteristics and are priced at less than $2. They are manufactured by the new alloy-diffusion process, a method said to combine the best features of the alloy and diffusion processes, without their drawbacks.

CIRCLE 208 ON READER SERVICE CARD

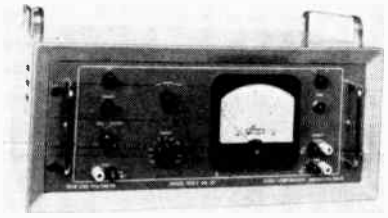


Phase Angle Meter
highly accurate

AD-YU ELECTRONICS LAB., INC., 249 Terhune Ave., Passaic, N. J. Vectorlyzer can be used to measure very small phase angles (such as a fraction of 1 deg) with maximum error of 0.02 deg or 2 percent and a sensitivity of 1 deg full scale. Phase angle range is 0-1, 0-2, 0-4,

0-10, 0-20 and 0-180 deg full scale; frequency range, 20 cps to 150 kc with binding posts, 100 kc to 500 mc with probe; voltage range with binding post, 0.04, 0.1, 0.2, 0.4, 1, 2, 4, 10, 20, 40 and 100 v rms full scale; with probe, 0.4, 2 and 4 v rms full scale.

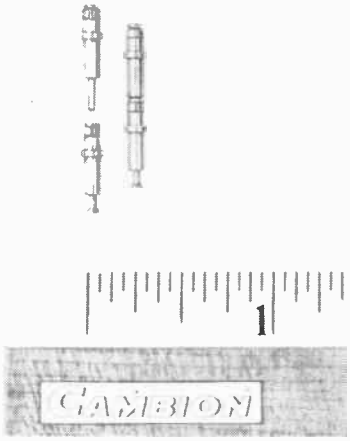
CIRCLE 209 ON READER SERVICE CARD



Random Signal Meter high peak factor

FLOW CORP., 85 Mystic St., Arlington 74, Mass. Model TBM-2 is a true rms voltmeter designed specifically for high-accuracy random signal power measurement, either frequency-filtered or broadband. Features include: high peak factor of 10 or more, even for full scale readings; two selectable time constants of 0.5 sec and 16 sec; wide frequency range between 1 cycle and 500 kc; 18 voltage ranges between 0.5 mv and 250 v, extra amplifier and meter outputs, and built-in line regulation.

CIRCLE 210 ON READER SERVICE CARD



Plug and Jack five shaft lengths

CAMBRIDGE THERMIONIC CORP., 445 Concord Ave., Cambridge 38, Mass. The 2650 combination plug and jack is specifically designed to permit

DON'T INVEST IN TEST EQUIPMENT 'TIL YOU COMPARE FEATURES WITH THE

NEW Simpson LABORATORY LINE

PULSE GENERATOR . . . model 2620

No Unit Offers Such Accuracy, Versatility, and Set-Up Speed Within This Price Range

Twin meters read pulse repetition frequency and pulse duration simultaneously. Rise time is 0.02 microseconds; decay time, 0.03 microseconds. Pulse duration, continuously variable from 0.1 to 1000 microseconds. Jitter, less than 0.005 microseconds. Pulse repetition rate, continuously variable from 10 to 100,000 pps in four ranges. Price **$625**

WRITE FOR COMPLETE SPECIFICATIONS

WIDE-BAND OSCILLOSCOPE . . . model 2610

For the 1001 Jobs Where You Don't Need an Expensive Specialized Scope

Here's a high-gain scope that makes your test equipment appropriation go farther. Vertical sensitivity, 6 mv RMS. Vertical calibration accuracy, ± 3%. Response (linear position): DC to 5.0 mc/sec, ± 0.5 db; DC to 8.0 mc/sec, ± 1.5 db. Response (transient position): DC to 3.5 mc/sec, −3 db, and −6 db at 5.0 mc/sec. Triggered and recurrent sweeps. Precalibrated sweep positions of 5, 50, 500, 5000 microseconds. Price **$575**

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LABORATORY STANDARD VOLT-OHM-MILLIAMMETER . . . model 2600

A Self-Powered Calibrator for Electrical Instrument Maintenance and High Accuracy Testing

Two terminal connections cover all 49 ranges for unusually fast operation. DC accuracy is ± 0.5% F.S.; AC, ± 0.75% F.S. (at 77°F, 25°C). Separate meters (*self shielded* movements) for DC and AC readings. Price **$1620**

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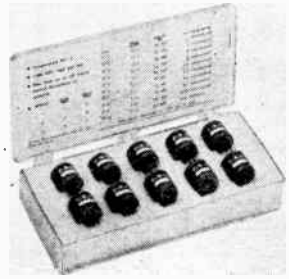
piggy-backing of patch panels with additional plugs. It can be plugged into a Cambion 2378 jack on a board and another plug can be plugged into it. Equipped with a D slot or key and compression spring for permanent gripping power, the 2650 ensures solid electrical connections at all times. It is available in five shank lengths (0.062, 0.093, 0.125, 0.156 and 0.219 in.), has a 0.045 in. pin, and is processed from quality brass with a bright alloy plate.

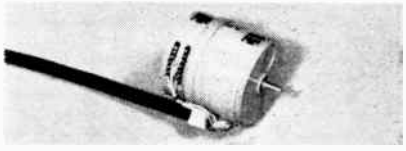
CIRCLE 211 ON READER SERVICE CARD



Pulse Transformers kit of ten

CBC ELECTRONICS CO., INC., 2601 N. Howard St., Philadelphia 33, Pa. KA-1 kit consists of ten MIL-T-27 type transformers of the plug-in blocking oscillator and impedance matching types. Hermetically sealed units operate up to 95 C. Included in the standard line are seven different types for various mechanical and electrical applications.

CIRCLE 212 ON READER SERVICE CARD



Encoder Assembly small, accurate

DATEX CORP., 1307 So. Myrtle Ave., Monrovia, Calif. Resolving shaft positions to 1 part in 36,000 can be done with the CG-702 geared encoder assembly of minimum size and weight. Assembly uses two shaft position encoders and a gear box. Encoder on input shaft provides 1,000 positions of the least significant digit per 360 deg rotation. Because disk of this encoder

Our most potent weapon in the battle of time:

QRC*

In advanced military electronics research, the ability to do the job *isn't good enough*. The job must be done *reliably* and *on time*.

Hallicrafters' QRC program was originated to provide not only the finest of engineering facilities and people, but the flexibility required for immediate, crash effort on critical electronics problems.

Hallicrafters has provided our military forces for the past six years with a Quick Reaction Capability that has played a major role in helping to win the battle against time.

* Quick Reaction Capability: Refer to Air Force Reg. No. 80-32

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Qualified Engineers: new contracts have created openings. Contact William F. Frankart, Director of Engineering.

CIRCLE 141 ON READER SERVICE CARD

DID YOU KNOW THAT

PRODUCTS ADVERTISED in electronics BUYERS' GUIDE *are UP-DATED WEEKLY?*

Advertisers in the *electronics* BUYERS' GUIDE use the 52 regular issues of *electronics* magazine to promote new products and keep the industry informed about their latest technical developments. *electronics* advertisers are offered the opportunity to up-date their product advertising by keying it to the catalog-type advertising in the BUYERS' GUIDE.

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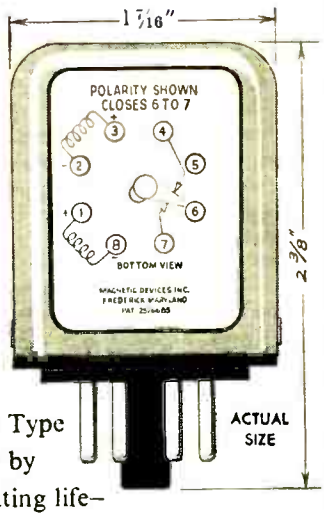
MDI POLARIZED RELAYS

COMPACT
RUGGED
HIGH SPEED
LONG LIFE
TESTED and PROVEN



High speed, sensitive Type 300 Polarized Relays by MDI give long operating life—tested and proven by years of military use.

Coil Resistance
25 to 4,000 ohms

Operating Current
2 to 60 MA

Overall Dimensions
1-7/16" x 1-7/16" x 2-3/8"

For full details, write, wire or phone today

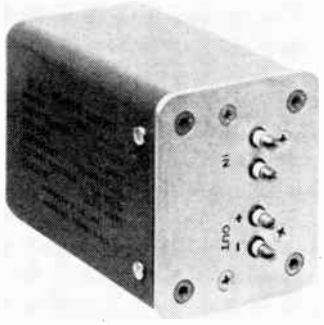
MAGNETIC DEVICES, MDI INC.

Dept. E, 712 East Street • Frederick, Md.

CIRCLE 111 ON READER SERVICE CARD

is coupled directly to the input shaft, accuracy is that of the encoder used (±1 count). This input unit is then geared 36:1 to a 36-position encoder. The low speed encoder utilizes double-brush, lead-lag logic to eliminate ambiguities due to gear inaccuracy and backlash.

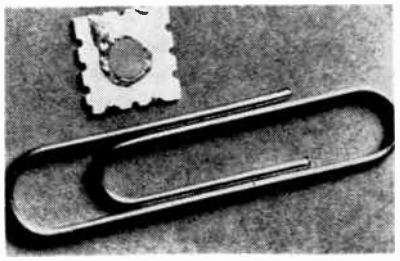
CIRCLE 213 ON READER SERVICE CARD



D-C Supplies regulated

SORENSEN & Co., South Norwalk, Conn. QM series miniature, transistorized supplies operate from 115 v a-c, 50-60 or 400 cps. For 50-60 cps input, 36 models cover 9 output voltages, from 3 to 36 v d-c in 14 percent increments, with output power capacities of 2, 4, 8 and 15 w; for 450 cps input, a like number of models is available. Voltage regulation is ±0.05 percent against line and load variations and ripple is less than 0.01 percent.

CIRCLE 214 ON READER SERVICE CARD

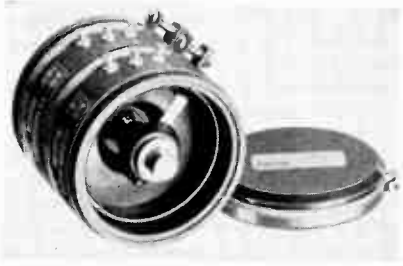


Germanium Diodes micromodule type

GENERAL INSTRUMENT CORP., 65 Gouverneur St., Newark, N. J. Contained in ceramic wafer only 0.01 in. sq and 0.016 in. thick, type F-1 gold-bonded germanium diode converts a-c to d-c, detects radio frequencies and acts as a switching device in computer circuits. Piv is 125; d-c output current, 75 ma; for-

ward current, 100 ma at 1 v max.; max. reverse current at room temperature, 10 μa at 10 v and 50 μa at 50 v; at 75 C, 75 μa at 10 v and 250 μa at 50 v.

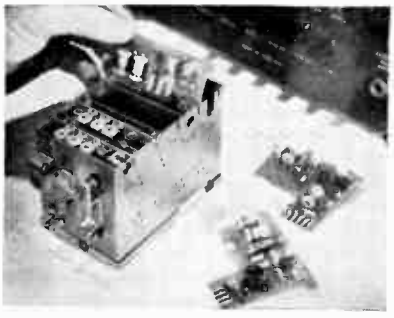
CIRCLE 215 ON READER SERVICE CARD



Single-Turn Pot
high accuracy

GIANNINI CONTROLS CORP., 918 E. Green St., Pasadena 1, Calif. Model 1750 single-turn precision pot is 1¾ in. in diameter and is built to NAS-710 standard, style RR-18. It is highly accurate with linearity to ±0.1 percent, resolution of 0.030 percent, and total resistances ranging from 10 to 300,000 ohms. Mounting surface is anodized aluminum with cups and rear cover of shock and humidity resistant molded plastic. Unit features versatility since it can be supplied singly, or in externally phaseable ganged units.

CIRCLE 216 ON READER SERVICE CARD



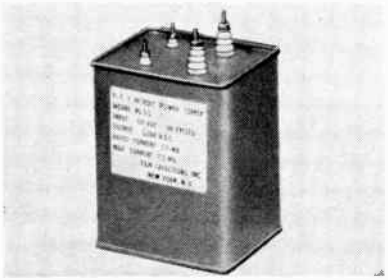
VHF Converter
transistorized

P. R. MALLORY & CO., INC., 3029 E. Washington St., Indianapolis 6, Ind. A new transistorized vhf converter provides continuous tuning from 30-76 mc in two bands (30-53, 53-76) with 4.2 turns per band. Model HLH-103-1 utilizes printed circuitry for compactness and size reduction. The converter utilizes a new linearized Inductuner which

CIRCLE 113 ON READER SERVICE CARD→

provides essentially a straight line frequency - versus - rotation curve. Maximum deviation over the 30 to 76 mc range is 150 kc. Local oscillator stability of ±130 kc maximum over the temperature range of −40 C to +85 C has been accomplished in the converter.

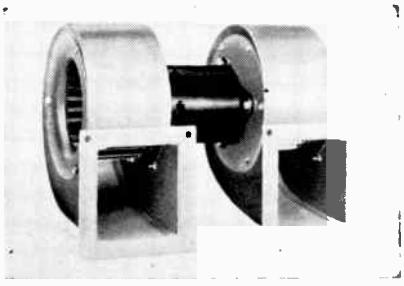
CIRCLE 217 ON READER SERVICE CARD



H-V Power Supply miniaturized

FILM CAPACITORS, INC., 3400 Park Ave., New York, N. Y. Hermetically sealed and oil filled power supply, variable from 0 to 5 kv at 5 ma, is housed in a CP70 container 3¾ by 3⅛ by 5 in. Selenium rectifiers and safety rated capacitors ensure working dependability and long trouble-free life, at operating temperatures up to 65 C. Ripple is held to 1 percent and maximum output current is 7.5 ma.

CIRCLE 218 ON READER SERVICE CARD



Dual Blowers two new models

MCLEAN ENGINEERING LABORATORIES, P. O. Box 228, Princeton, N. J. Dual blower units for electronic cooling: model 2NB300 will produce 160 cfm and model 2NB408 will produce 320 cfm. Both are equipped with a long life, quiet, isolated motor. Motors are shaded pole, semienclosed, fan cooled with Class A insulation (105C). Permanently sealed ball bearings are lubricated with a MIL-C-3278 lubri-

cant having a temperature range of − 68 C to + 93 C. Blowers have stainless steel shaft, are fungus protected, moisture and corrosion resistant.

CIRCLE 219 ON READER SERVICE CARD

Magnetic Circuit with Halltron

OHIO SEMICONDUCTORS, INC., 1035 W. Third Ave., Columbus 8, Ohio. Model MC-1 combines Halltron device and magnetic circuit. Special magnetic materials and indium arsenide Halltron result in extreme linearity, low hysteresis and accuracies of 0.1 percent. Circuit applications include choppers, analog multipliers, power meters, modulation, phase detectors and many other electronic functions.

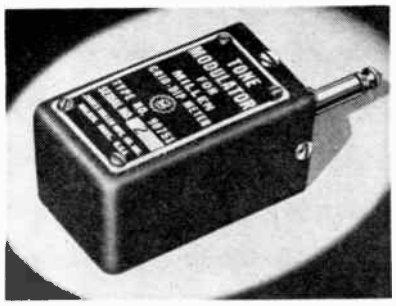
CIRCLE 220 ON READER SERVICE CARD

Electronic Counter uniform readout

HEWLETT-PACKARD CO., 275 Page Mill Road, Palo Alto, Calif. Model 524D, featuring a uniform 8-decade numerical readout, has a crystal oscillator stability of 3 parts in 10^7 short-term; 5 parts in 10^7 per week. It provides for full frequency measurements from 10 cps to 10 mc and period measurements from 0 cps to 10 kc. These ranges may be extended by use of plug-in units. Another plug-in provides for time measurements from 1 μsec to 100

days. Counter is priced at $2,150 (cabinet) and $2,125 (rack mount).

CIRCLE 221 ON READER SERVICE CARD



Tone Modulator
for grid dip meters

JAMES MILLEN MFG. CO., INC., 150 Exchange St., Malden, Mass. Model 90751 transistor tone modulator is designed to modulate grid dip meters. A small package containing a transistor oscillator and its mercury battery plugs into the phone jack of a grid dip meter to modulate the signal at approximately 800 cycles. Modulator turns on when plugged into the meter.

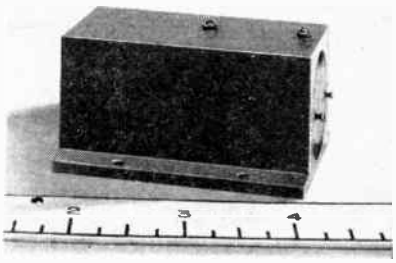
CIRCLE 222 ON READER SERVICE CARD

Magnetic Amplifiers
molded type

AIRPAX ELECTRONICS INC., Seminole Division, Ft. Lauderdale, Fla. A new line of 400-cps molded magnetic amplifiers feature: life at least 10 years, near indestructibility in shock and vibration, ability to operate efficiently with overloads of 1,000 percent and into dead shorts. The M-5501 is a general purpose unit with a wide variety of circuit applications. The M-5502 has one very sensitive 100 kilohm winding and a 5 kilohm feedback winding. The M-5503 is especially designed for use as a thermocouple amplifier. Type

M-5504 is a general purpose unit with smaller bandwidth and higher gain.

CIRCLE 223 ON READER SERVICE CARD



Inertia Switch
for airborne use

INERTIA SWITCH, INC., 311 W. 43rd St., New York 36, N. Y. Model 60U-01 switch is sensitive to accelerations of 0.05 g to 1.0 g, for missile and airborne unidirectional control applications. Response time is less than 35 millisec; accuracy, within 10 percent; service life, over 100,000 cycles; meets MIL-E-5272A or better. Unit is factory preset as specified by the user.

CIRCLE 224 ON READER SERVICE CARD

Coil Winder
and comparator

UNIVERSAL MFG. CO., INC., 1168 Grove St., Irvington, N. J. S-series coil winding machines feature: shuttle speed of 1,200 rpm, minimum shuttle cross-section for winding coils with small inside diameters, and fast set-up. Inductance comparator for powdered molybdenum permalloy and ferrite cores is also available. Preset value of inductance shows operator when coil has reached required inductance, making core grading unnecessary.

CIRCLE 225 ON READER SERVICE CARD

Literature of the Week

MATERIALS

Copper-Cored Wire. Metals & Controls Division of Texas Instruments Inc., 34 Forest St., Attleboro, Mass. Copper-cored No. 446 alloy glass sealing wires are described in the second and third of a series of bulletins on cored and clad wires.

CIRCLE 250 ON READER SERVICE CARD

COMPONENTS

Delay Line Data. Deltime, Inc., 608 Fayette Ave., Mamaroneck, N. Y. Latest advances and refinements in delay-line techniques are dealt with in bulletins 201, 202 and 203.

CIRCLE 251 ON READER SERVICE CARD

Fixed Coaxial Attenuators. Weinschel Engineering, 10503 Metropolitan Ave., Kensington, Md., has released a 4-page, 2-color brochure containing detailed specifications on 1 to 12.4 kmc fixed coaxial attenuators.

CIRCLE 252 ON READER SERVICE CARD

Selenium Rectifier Selection. General Electric Co., Syracuse, N. Y. A 24-page brochure gives a step-by-step method for selecting specific selenium rectifiers for circuit applications.

CIRCLE 253 ON READER SERVICE CARD

EQUIPMENT

Shaft Position Encoders. Datex Corp., 1307 S. Myrtle Ave., Monrovia, Calif. Description, chief features and specifications on the C-100 and C-200 series shaft position encoders are contained in bulletin 319.

CIRCLE 254 ON READER SERVICE CARD

Computer. Ebex Sales Inc., Orem, Utah. A catalog lists the four models of the Microlog series 2 computer which is expressly designed to meet the requirements

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CIRCLE 255 ON READER SERVICE CARD

Microwave Meters and Filters. Frequency Standards, P. O. Box 504, Asbury Park, N. J., has available a 12-page catalog containing complete technical data on a line of microwave meters and filters.
CIRCLE 256 ON READER SERVICE CARD

Brazing Machines. Eisler Engineering Co., Inc., 750 So. 13th St., Newark 3, N. J., has released catalog No. 100–59 on automatic brazing and soldering machines.
CIRCLE 257 ON READER SERVICE CARD

D-C to A-C Inverters. Sorensen & Co. Inc., Richards Ave., South Norwalk, Conn., has available a bulletin containing a description, general information, specifications and prices for model QI series miniature transistorized inverters.
CIRCLE 258 ON READER SERVICE CARD

Plating Rectifiers. Djeco Division of Djordjevic Engineering Co., 1933 N. Damen, Chicago 47, Ill. Bulletin 100 is a 16-page description of rectifiers for electroplating and anodizing.
CIRCLE 259 ON READER SERVICE CARD

Recorder - Reproducer. The SoundScriber Corp., 6 Middletown Ave., North Haven, Conn., has available a brochure describing its 24-hr continuous tape recorder-reproducer.
CIRCLE 260 ON READER SERVICE CARD

Differential Amplifier. Epsco, Inc., 275 Massachusetts Ave., Cambridge, Mass. A recent folder illustrates and describes the DA-102 wide-band, low-level, differential d-c amplifier.
CIRCLE 261 ON READER SERVICE CARD

FACILITIES

Precision Metal Fabrication. Donnelly Mfg. Co., 580 Winter St., Waltham 54, Mass. A recent booklet illustrates samples and discusses the company's facilities for close-tolerance metal fabrication.
CIRCLE 262 ON READER SERVICE CARD

BDSA Honors Spriggs

THE Business and Defense Services Administration of the U. S. Department of Commerce recently honored Commodore A. J. Spriggs (USN Ret.) with flag presentation ceremonies. The flag, which had flown over the Capitol, was presented to Spriggs, vice president of Packard-Bell Electronics Corp., on completion of his 10-month tour of duty as advisor to the director of the Electronics Division, BDSA. During this period he served the government without compensation, on loan from his company.

He also received a Certificate of Service and a personal letter of appreciation from the Secretary of Commerce.

Pictured in the foreground (l to r) are: Commodore Spriggs; H. Hubert Hughes, acting administrator, BDSA; Mrs. Spriggs; Capt. D. R. Hull (USN Ret.), president, Electronic Industries Association; and Donald S. Parris, director, Electronics Division, BDSA. In the background are other members of the Electronics Division.

Orbom Heads Epsco Division

ORVILLE E. ORBOM has been appointed to head Epsco-Worcester, new division of Epsco, Inc., of Cambridge, Mass. Prior to joining Epsco in 1958, he was a research engineer with the Aluminum Co. of America and engineer in charge of automation at Allegheny Ludlum Steel Corp.

The Worcester division manufactures equipment for medical electronics and industrial instrumentation.

Daystrom Fills Four Positions

FOUR appointments were recently announced by Daystrom Systems, the San Diego division of Daystrom, Inc.

They are David Driscoll, former manufacturing division controller at Collins Radio, as controller; H. Lee Denning, former Marquardt Aircraft controller, as contracts administrator; Cheng Ling, formerly with North American Aviation's Autonetics Division, as a systems analyst and project leader; and Gerald D. Hevron, formerly with Stromberg-Carlson, Rochester, N. Y., as production manager.

GE Establishes New Operation

MISSILES, Arming and Fuzing Program office, a new operation, has been established in General Electric's Missile and Space Vehicle Department, Philadelphia, Pa.

Named as manager of the new operation is Charles C. Botkin, formerly manager of the GE department's nuclear ordnance projects operation. He has been associated with GE's missile activities since 1947.

In his new position, Botkin will be responsible for the integration of the department's missile and arming and fuzing activities.

Elect Ginzton Board Chairman

EDWARD L. GINZTON is the newly elected chairman of the board of Varian Associates, Palo Alto, Calif., filling the vacancy left by the death of Russell H. Varian.

Like his predecessor, Ginzton was one of the original founders of Varian Associates and has served as a member of the board of directors and of key committees since

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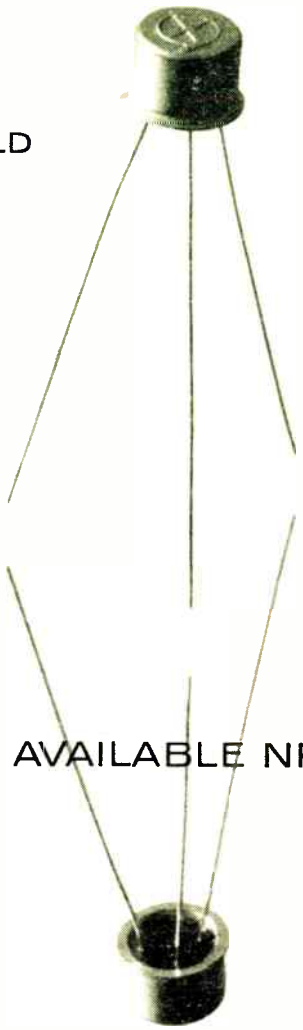
PNP SILICON MESA TRANSISTORS



A "MIRROR IMAGE" OF AVAILABLE NPN CHARACTERISTICS

Same high-speed switching capabilities with which Fairchild startled the industry are now available in PNP — 80 milli-micro-second rise time, 2 watts dissipation, 300° C. survival. Fairchild Silicon Transistors are multiple solid-state diffused. Their mesa construction affords excellent heat dissipation and extraordinary ruggedness.

Complementary symmetry within computer circuit designs now affords another technique for reducing number of components and increasing reliability. The advantages of complementary symmetry have been well known, but the high performance silicon transistors that could take advantage of the technique have not been available.

Direct replacement of germanium by silicon is feasible now that high performance silicon PNP mesa transistors are readily available. In silicon transistor circuits, you need no longer hesitate to make use of the particular advantages of PNP polarity. Availability is firmly assured.

COMPETITIVE ADVANTAGES FOR YOUR DESIGNS either in terms of price or functional efficiency are a likelihood that you should investigate. PNP silicon transistors with these speed-power characteristics have not been generally available, hence until now it has not been possible to design circuits using the complementary symmetry concept.

Special attention will be given to inquiries received on company letterhead.

PNP — 2N1131, 2N1132

Symbol	Specification	Rating	Characteristics	Test Conditions
V_{CE}	Collector to Emitter voltage, 25° C.	30v		
P_C	Total dissipation at 25° C. Case temp	2 watts		
h_{FE}	D.C. current gain		2N1131 15 to 45 2N1132 30 to 90	I_C 150ma V_C 10v
R_{CS}	Collector saturation resistance		6 Ω typical 10 Ω max	I_C 150ma I_B 15ma
h_{fe}	Small signal current gain at f 20Mc		2.5 typical	I_C 50ma V_C 10v

NPN — 2N696, 2N697

Symbol	Specification	Rating	Characteristics	Test Conditions
V_{CE}	Collector to Emitter voltage 25° C	40v		
P_C	Total dissipation at 25° C. Case temp	2 watts		
h_{FE}	D.C. current gain		2N696 20 to 60 2N697 40 to 120	I_C 150ma V_C 10v
R_{CS}	Collector saturation resistance		3.5 Ω typical 10 Ω max.	I_C 150ma I_B 15ma
h_{fe}	Small signal current gain at f 20Mc		5 typical	I_C 50ma V_C 10v

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FAIRCHILD SEMICONDUCTOR CORPORATION

the company's inception in 1948. For the past several years he also was assistant to the late chairman of the board.

Ginzton is director of the microwave laboratory at Stanford University as well as professor of applied physics and electrical engineering.

LEL Appoints Walter Hollis

As PART of a planned program of expansion, LEL, Inc., Copiague, L. I., N. Y., has hired Walter Hollis, formerly director of engineering of Resdel Engineering Corp., Pasadena, Calif.

As engineering assistant to Charles Neubling, general manager, Hollis brings to LEL eighteen years of experience in the electronic field in radar, countermeasures, and communications equipment. Formerly he was associated with the Sperry-Rand Corp. and the W. L. Maxson Corp.

Krafve Moves Up In Raytheon Shift

SIX months after leaving Ford Motor Co. to join Raytheon, Richard E. Krafve takes over as executive vice president, a post vacated by Harold Geneen in June, when he became ITT president.

Krafve joins president Charles F. Adams and senior vice president Percy L. Spencer to make up the three-man Office of the President.

Homer R. Oldfield, vice president and manager of Raytheon's Government Equipment Division, takes over Oct. 1 the newly created post of group vice president—electronic components and devices. David D. Coffin is group vice president—government equipment and systems.

Reporting directly to the Office of the President will be the Equipment and Systems, Distributor Products, Industrial Apparatus, Research, and International divisions.

Underscoring the latest Raytheon organization chart are the firm's efforts to broaden its commercial base—now 15 percent of volume—and to decentralize operations, giv-

ing more authority to division managers.

While with Ford, Krafve helped decentralize manufacturing operations. He had been associated with the management consulting firm, of Cresap, McCormick and Paget before joining Ford in 1947.

Oldfield resigned as general manager of GE's computer department, Phoenix, in December '58 to join Raytheon. He was elected a vice president in July '59.

News of Reps

Associated Industries, Seattle, Wash., has been appointed to represent Rogers Corp., Rogers, Conn., in the states of Oregon and Washington and at the Boeing Co., Wichita, Kan. Rep firm will handle the Rogers line of electronic insulation, sealing and high temperature materials.

Manufacturer's reps for RCA mobile communications equipment have been named in five areas. They are: **J. F. Ottmar Co.** of Spokane, Wash., operating in northeast Oregon, northern Idaho and western Washington; **Mobile Radio Service & Communications Corp.** of Shreveport, La. (northwest Louisiana); **Miami Mobile, Inc.** of Miami, Fla. (southern Florida); **Rocky Mountain Communication Co., Inc.**, Denver (Colorado, Utah, Wyoming, western Kansas and western Nebraska); and **Modern Electronics Laboratory Corp.**, Syracuse, N. Y. (central New York State).

Chicago Telephone Supply Corp., Elkhart, Ind., appoints **Koehler-Pasmore Co.** of Detroit, Mich., and **Hollingsworth & Still** of Atlanta, Ga., to handle CTS variable resistors, switches, bobbinless precision fixed resistors and other products in those areas. This brings to 25 the firm's total number of U.S. sales offices and reps.

Freed Transformer Co., Inc., Brooklyn, N. Y., has appointed **Nelson Co.** of Denver, Col., as its rep covering eastern Montana, Wyoming, Utah, South Dakota and Colorado.

COMMENT

A Difference of Circuits

Re D. E. Thomas and J. M. Klein, "How to Construct a Miniature F-M Transmitter," p 80, July 31 . . .

The article by Louis E. Garner, Jr., "Transistorized FM Wireless Microphone", in *Radio & TV News* for July, 1957, gives complete construction details and specifies standard components. While an experimental transistor was specified, it was available as a stock item with RETMA number by the time the article appeared.

Could it be that engineers and gadgeteers writing for more popular magazines frequently anticipate the work of ivory-tower professionals, but that their work is conveniently ignored unless it appears in a "professional journal?"

LUIS VICENS
OMNICO
WHEATON, MD.

Our article describes an f-m transmitter using a modern pnp alloyed-junction transistor; the *Radio & TV News* story described a transmitter using an experimental junction tetrode transistor. The single circuit described in ELECTRONICS performs the functions of audio amplification, r-f oscillation and frequency modulation; the signal from the microphone is effectively amplified by a common-emitter audio amplifier. In the *Radio & TV News* article, the signal from the microphone is used almost directly to frequency-modulate the r-f oscillator.

In July 1957, the ZJ7-2 (3N30) tetrode transistor was experimental and beyond the reach of most experimenters; it is now available at $28.80. The 2N499 transistor in the ELECTRONICS article retails at $8.25.

For many reasons we felt that authors Thomas and Klein described a substantial advance, not only over the circuit described by Garner, but also over a circuit described by Thomas in ELECTRONICS for Feb., 1954.

Transformerless Supplies

It would appear that the magnitude of the surge current at switch-on is not appreciated by your

contributor F. G. Kelly when he recommends the use of transformerless supplies in his article ("Transformerless A-C Filament Supplies," p 56, June 26).

If switch-on happens to occur at peak voltage, 165 v, and a tube heater (e.g. 12AU7) is cold, having, say, $\frac{1}{10}$ normal resistance, this is the only thing limiting surge current apart from supply impedance. Thus the surge current could be 20 amps; to use a series capacitor is to invite a high tube failure rate.

A. B. Morrow
Bushey Heath, Herts.
England

Author Kelly replies:

I would like to point out that while it is theoretically possible to experience a surge approaching 20 amps, this situation does not invite a high tube failure rate. Consider the case of a series-string heater connection. Here surge currents of the order of 10 times normal are experienced for a significant fraction of a minute. Several decades of experience with so-called a-c/d-c radios point to an uncommonly high degree of reliability in such devices.

The surge current attendant with my proposed reactive voltage-divider lasts no more than a few milliseconds and induces no observable degradation of tube properties. It does cause physical stresses on the capacitor due to electrostatic attraction between electrodes, but I have been using this scheme with ordinary components for several years with abundant success.

F. G. Kelly
Space Technology Laboratories
Los Angeles

Credit Where Due

Re: our article "Data Storage and Display With Polarized Phosphors," p 39, Aug. 28.

In the section dealing with p.i.p. (persistent internal polarization) photography, Dr. Kallman and I wanted a footnote included giving credit to Miriam Sidran for this phase of the work. We would appreciate it if this were brought to the attention of your readers.

J. Rennert
New York University
New York City

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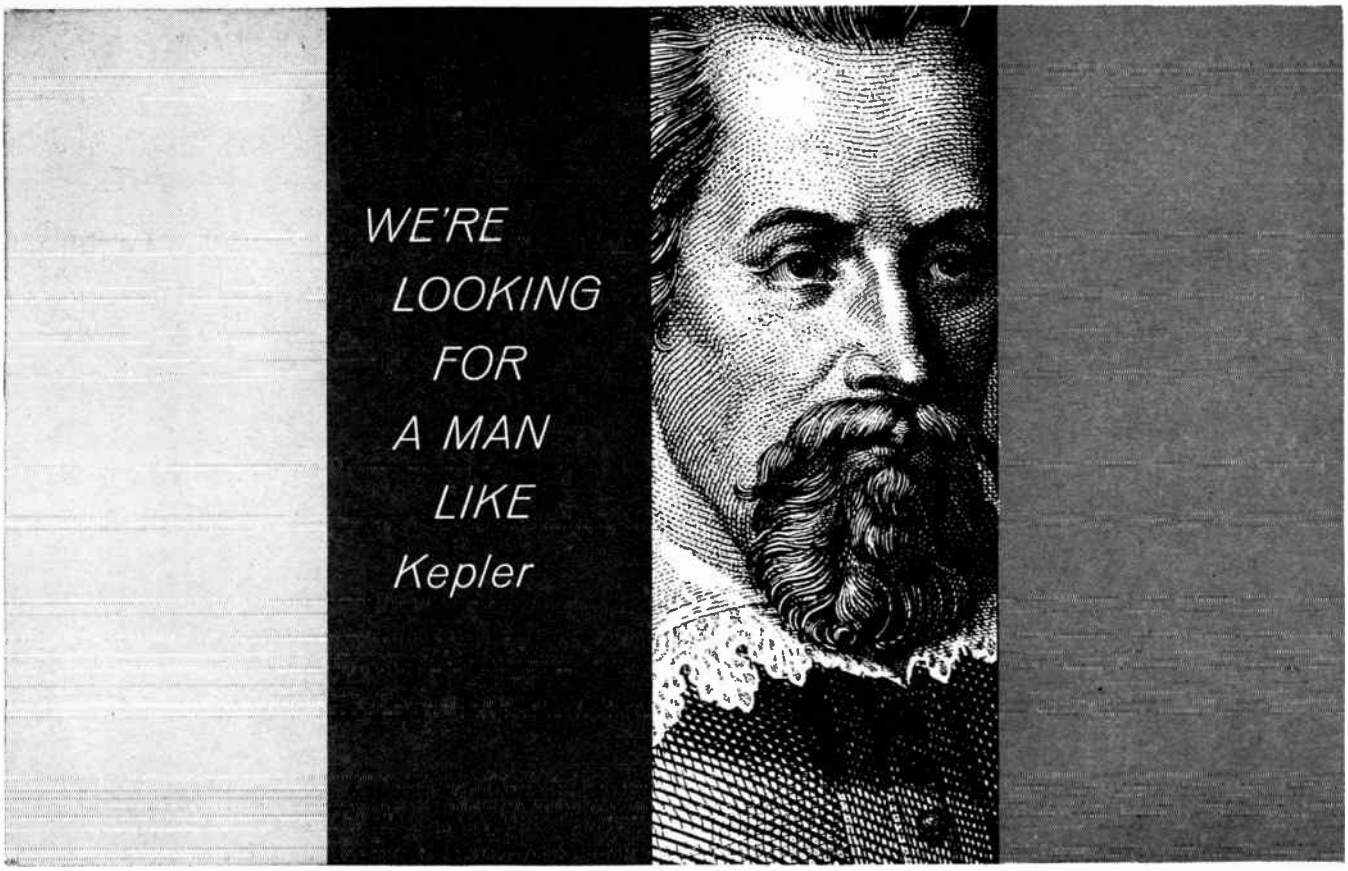

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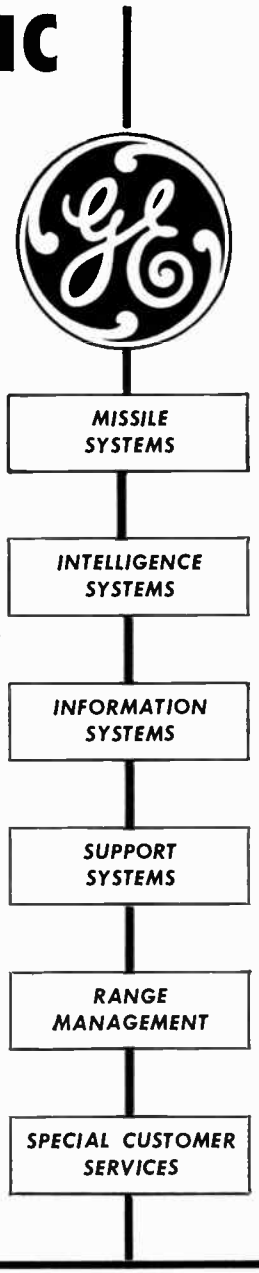

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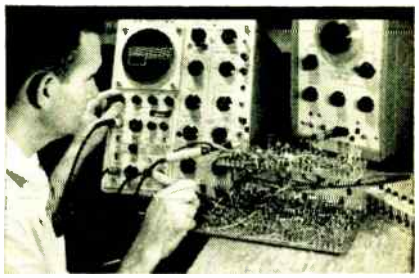

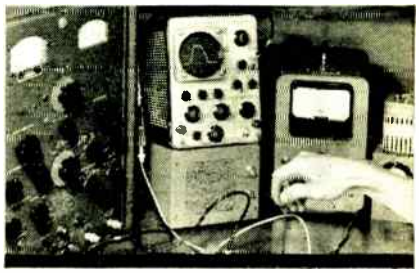

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