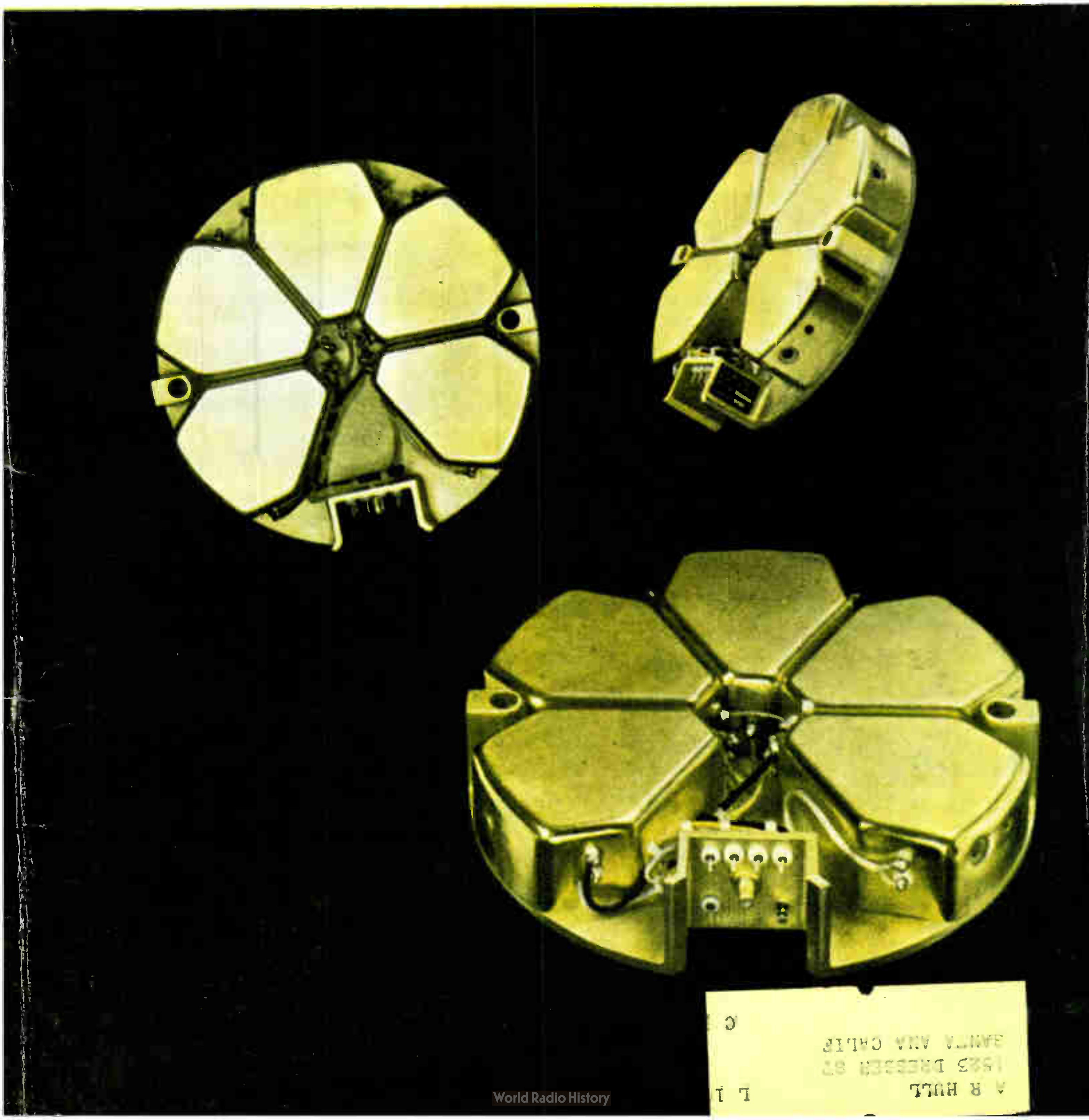
May 6, 1960

electronics

Gold-plated pie-plate below is a telemetry transmitter for an artificial earth satellite. The transmitter uses a new phase modulator circuit described on p 68

A McGraw-Hill Publication 75 Cents



Creative Microwave Technology

Published by MICROWAVE AND POWER TUBE DIVISION, RAYTHEON COMPANY, WALTHAM 54, MASS., Vol. 1, No. 9

NEW RAYTHEON MAGNETRONS FOR A WIDE RANGE OF APPLICATIONS

Designed for C-band systems requiring tunability, the RK-7156 magnetron has a minimum peak power output rating of 250 kilowatts over a frequency range of 5,450 to 5,825 megacycles. Applications include a flight-tested, revolutionary airborne weather radar system. The RK-7156 is in quantity production.

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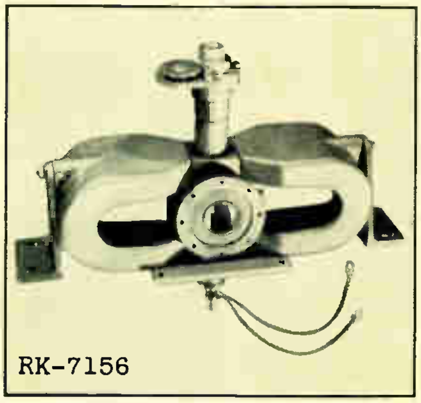
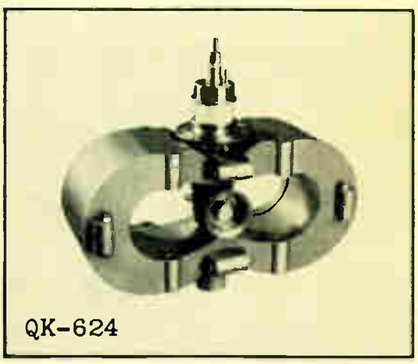


RK-7156

* * *

X-band magnetron for airborne search radar provides one megawatt minimum peak power and 875 watts average power within a frequency range of 9,340 to 9,440 Mc. Designated QK-624, this pulsed-type tube is liquid cooled and should give at least 1,000 hours of reliable service.



QK-624

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* * *

For ground-based and airborne radar systems, the RK-7529 magnetron provides a 2.0 microsecond pulse of 3.5 megawatts minimum peak power over 2,700 to 2,850 Mc. This liquid-cooled tube is interchangeable with other fixed-frequency S-band tubes operating at similar power levels.

CIRCLE 279
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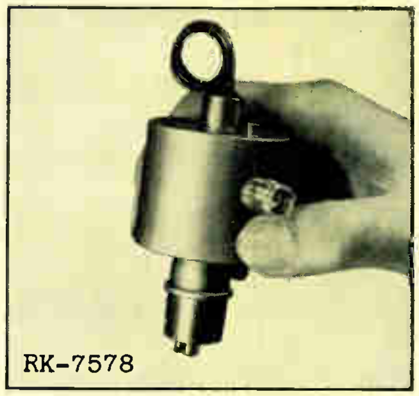
RK-7529

* * *

A one kilowatt beacon magnetron, the RK-7578 weighs only 14 ozs., yet will withstand vibrations of 15 G's at 20 to 2,000 cycles and shock up to 100 G's. It is mechanically tunable and covers the 5,400 to 5,900 Mc range.



RK-7578

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* * *

Developed to withstand extreme environmental conditions, the RK-7449 magnetron is a lightweight, compact tube with a minimum peak power output of 45 kilowatts at the operating frequency of 24 kmc. The RK-7449 is required to withstand repeated shocks of 50G. Stable operation is guaranteed at vibration frequencies up to 2,000 c.p.s. with 30G applied.

RK-7449

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A Leader in Creative Microwave Technology

RAYTHEON

May 6, 1960

electronics

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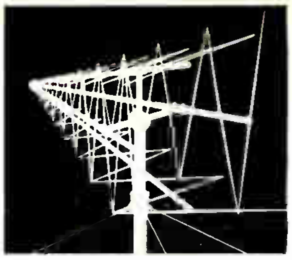
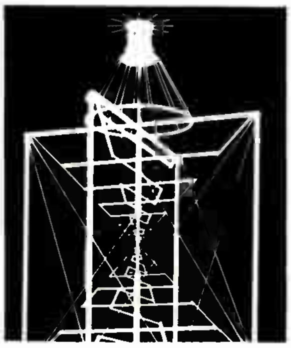
BUSINESS

ENGINEERING

DEPARTMENTS

BROAD-BAND LOG-PERIODIC ANTENNAS FROM GRANGER ASSOCIATES





Specifications for typical Granger Associates log-periodic antennas (Models 720 and 721 shown)

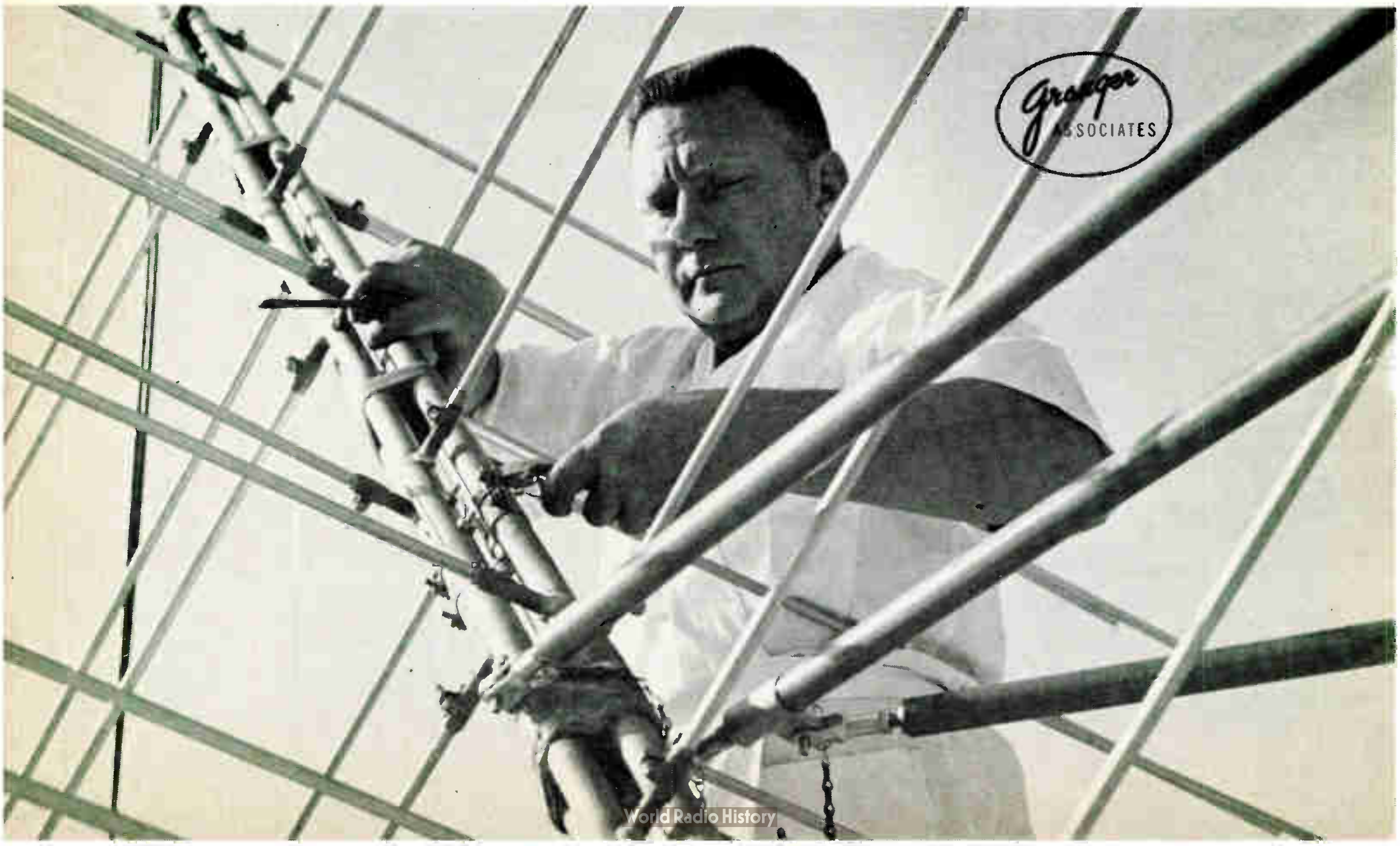
	Model 720 (uni-directional)	Model 721 (omni-azimuthal)
Frequency range	50 to 1000 megacycles	
Polarization	Linear, remotely selected vert. or horiz.	
Pattern Beamwidth		
Horizontal Polarization	Azimuth 60 deg. Elevation 60 deg.	Azimuth 360 deg. Elevation 55 deg.
Vertical Polarization	Azimuth 60 deg. Elevation 60 deg.	Typical discone patterns
VSWR	3.6:1 relative to 50 ohms over the band	
Environment	withstands 100 mph wind; ½" ice coating	
Dimensions	75" high & wide 76" long; mounted on 36" guyed mast	176" high; 92" wide & deep

Note: Model 720 is provided with 360 deg. azimuth drive at 2 rpm with left-stop-right controls and remote position indicator.

Bandwidth of ten to one or greater independent of frequency—that's why system planners in communications, back scatter, range instrumentation, signal intercept and ECM are excited about log-periodic antennas. Translating this new theory into practical hardware is a specialty of Granger Associates; one of the few organizations that not only understands the concept, but actually builds log-periodics and delivers them to highly satisfied customers. Our accomplishments in this category include omnidirectional designs, high gain pencil beam designs, designs that permit remote selection of polarizations, feeds for reflectors, direction finders, scanning and switched beam arrays. System planners will also find G/A an excellent source for low noise preamplifiers, receiving multicouplers, wide-band baluns, special purpose transmitters. They will find more: an adroit team of specialists with a unique approach to problem solving that results in dependable equipment—the right kind at the right time.

Granger Associates / 974 Commercial Street / Palo Alto, California / DAvenport 1-4175

Circle 2 on reader service card



electronics

May 6, 1960 Vol. 33, No. 19

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CROSSTALK

TUNNEL DIODES AND RADIATION. Today radiation is becoming increasingly important as a factor to be reckoned with in the design of electronic instruments for space research probes and satellites. This is certain to become even more apparent as work begins on the SNAP-8 nuclear electric power regenerating system for spacecraft.

With future needs in mind, ELECTRONICS editors have been studying available knowledge of what effect neutron bombardment has on electronic devices. Since the tunnel diode has been so much in the news, Assistant Editor Wolff questioned several research labs about it. What he learned, which may surprise some, is on p 32.

SELF-HELP PAYS OFF. Banding together to let industry know the potential of an area . . . and to go after business . . . can pay off in results. A case in point is Long Island, where morale and business volume had shown signs of lagging behind other parts of the country. Executives of many small L. I. firms have joined forces to paddle their collective canoe. Already the results are promising. One survey taken among 35 companies shows that combined net sales for the group went from $387,725,000 in 1954 to more than $600 million by 1959. They expect to pass the $633-million mark by the end of this year. Associate Editor Emma made a series of plant tours and conducted interviews. For details of what he found, see p 38.

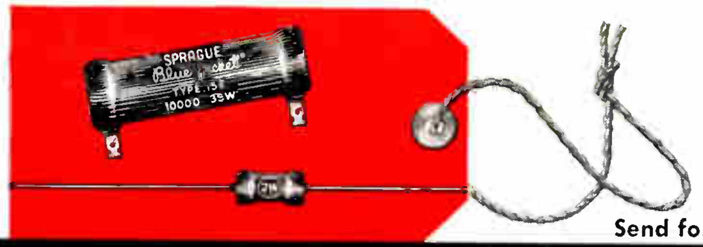
Coming In Our May 13 Issue

MICROSOLIDS. Work with semiconductors, thin films, passive and other materials in combination is presently at a stage where a diversity of opinion exists as to what the prime objective should be. Some researchers believe a major improvement in reliability is of greatest importance. Others think that a significant reduction in size and weight should be the prime objective. Still others feel that cost reduction should be paramount.

Next week ELECTRONICS adds to the growing list of feature articles which have kept our readers out front concerning various approaches to future circuitry. Three members of the Semiconductor-Components Division of Texas Instruments Incorporated team up to state their concepts. J. W. Lathrop, R. E. Lee and C. H. Phipps discuss reliability, size and weight, and cost.

Their article also describes in detail a fabrication technique which combines oxide masking diffusion, metal deposition, alloying and surface shaping. You'll learn how a complex circuit is developed, from schematic diagram to network, on and within a single-crystal semiconductor wafer.

Lathrop is a senior project engineer working on semiconductor networks and is well known for his work at Diamond Ordnance Fuze Laboratories on ceramic-base printed circuits. He holds a Ph.D in Physics from MIT. Lee is manager of the Semiconductor Networks department, heading a project team responsible for design, development, engineering, production and marketing of such networks. He is also head of the Circuit Development branch of the Semiconductor-Components Division, has worked on radar anti-jamming, aircraft fire control systems and guided missile range instrumentation. He holds a Ph.D in Electrical Engineering from Stanford University. Phipps is marketing manager of the Semiconductor Networks department. He holds a B.S. in electrical engineering from Case Institute of Technology and an M.B.A. from Harvard.



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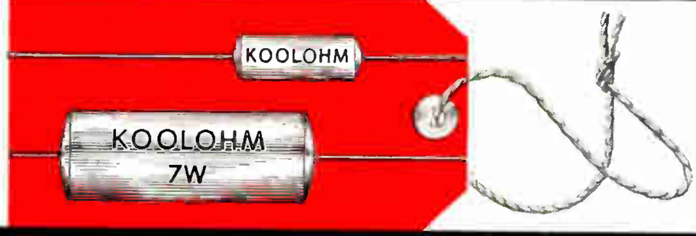

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COMMENT

Tracking Telemetry Antenna

With reference to the article "Tracking Radar for Tiros Weather Satellite" (p 57, Apr. 15), I wish to correct the title. The title as published was not that one which was submitted on the original manuscript. Indeed, the system described in the article is not a radar but is rightfully classified as a telemetry and space communications receiving system.

Since the time that the original manuscript was submitted, Radiation Incorporated engineers have added to the design so that automatic tracking on the 108 mc band is included. The conical scan error signal at 10 cps is generated by prism rotation. The 108 mc signal is preamplified, converted to the 216-260 mc band, and carried to the telemetry receivers through the existing RF plumbing.

H. E. O'KELLEY
MELBOURNE, FLA.

Thank you for your letter of Apr. 15. Of course you are quite right—the title we used for your article was a case of over-exercised editorial license.

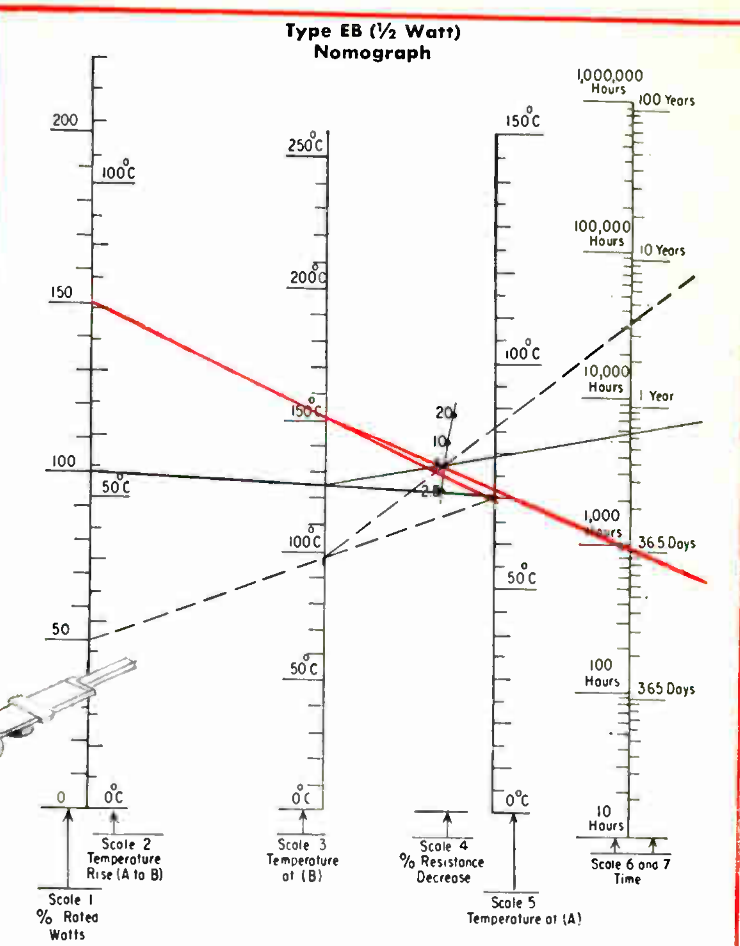
Wire Mesh Cushions

In your article, "Resilient Mesh Cushions System" (p 94, Mar. 18), the reference of knitted wire to pot cleaners could well be misinterpreted by those engineers who are not familiar with the engineering which has gone into the development of MET-L-FLEX cushions.

The MET-L-FLEX resilient cushions used by Robinson Technical Products in systems consist of a high grade of stainless steel round wire held to close diameter tolerances and fabricated by a knitted process and carefully rolled, and crimped and compressed to exacting requirements.

Pot cleaners are heterogeneous mixtures of loose fibers without regard to any continuity and with no attempt for homogeneous density. Furthermore, wires used in pot cleaners are flattened with sharp edges which are necessary for the scrubbing action required. The use

A guide for predicting resistor performance



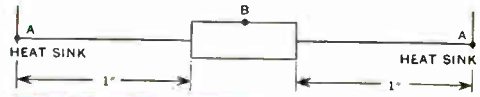
NOMOGRAPHS PREDICT LIFE PERFORMANCE OVER LONG PERIODS OF TIME FOR ALLEN-BRADLEY HOT MOLDED COMPOSITION UNITS

An Example of Predicting Resistor Performance

Illustration shows use of nomograph to predict the rate of resistance change with life for standard Allen-Bradley resistors. This example is based on a maximum of 5% resistance change with 70°C temperature at points "A" (see drawing below) when operated at

- – – – – – – 50% LOAD
- ———— 100% LOAD
- ———— 150% LOAD

RESISTOR TEST CONDITIONS

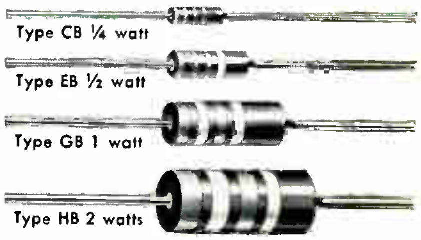


Allen-Bradley's exclusive hot molding process produces resistors with such uniform characteristics that their performance can be predicted with a high degree of certainty. Test data produced in the last 20 years not only in the Allen-Bradley environmental laboratories but also in independent laboratories have been carefully compared and analyzed and have served as a basis for developing the above power nomographs.

And Allen-Bradley has been conservative in projecting test data. Inasmuch as catastrophic failure has yet to occur, the design engineer can develop circuitry with predictable performance.

WRITE TODAY—Power nomographs for standard Allen-Bradley composition resistors are published in Technical Bulletin 5000E. You'll find this information of genuine help and value to you.

A-B HOT MOLDED COMPOSITION RESISTORS



ACTUAL SIZE

Allen-Bradley Co., 110 W. Greenfield Ave. Milwaukee 4 Wis. • In Canada: Allen-Bradley Canada Ltd., Galt, Ont.

ALLEN-BRADLEY | *QUALITY ELECTRONIC COMPONENTS*

CIRCLE 7 ON READER SERVICE CARD

of such low quality sharp edged wire in MET-L-FLEX cushions would be contrary to our objective wherein great effort is made to maintain consistent qualities throughout the cushion with spring rate, damping and life characteristics prime objectives. MET-L-FLEX is made from a single piece of wire and is not capable of unraveling or becoming disassembled.

As an example, MET-L-FLEX cushions, which we have tabulated at our plant and which are currently in use in a number of our mounting systems, are identified by a number of engineering parameters. The knitted mesh alone is quality controlled by a minimum of eight specifications. The cushions themselves are controlled by at least eight more engineering specification requirements, and we have well over 2,000 different cushions of specific dynamic characteristics currently utilized in mounting systems designed and produced by Robinson Technical Products, Inc.

The rest of the article is very fine and certainly points out the virtues of a low-frequency mounting system for such shipboard applications as the Collins URC-32.

H. E. NIETSCH
ROBINSON TECHNICAL PRODUCTS, INC.
TETERBORO, N. J.

Things are not always what they seem, and as Mr. Nietsch points out, all wire mesh does not masquerade as MET-L-FLEX. The demonstrated effectiveness with which these all-metal mounting systems have met the exacting vibration and shock control requirements for guided missiles, fire-control systems and electronic devices speaks for the engineering which has gone into the development and construction of these cushions.

Interpretation Needed

I like the interpretative approach taken in "Recent Progress in Solid State Technology," p 39, Mar. 4. This is more meaningful than mere factual reporting.

E. J. FERRIS
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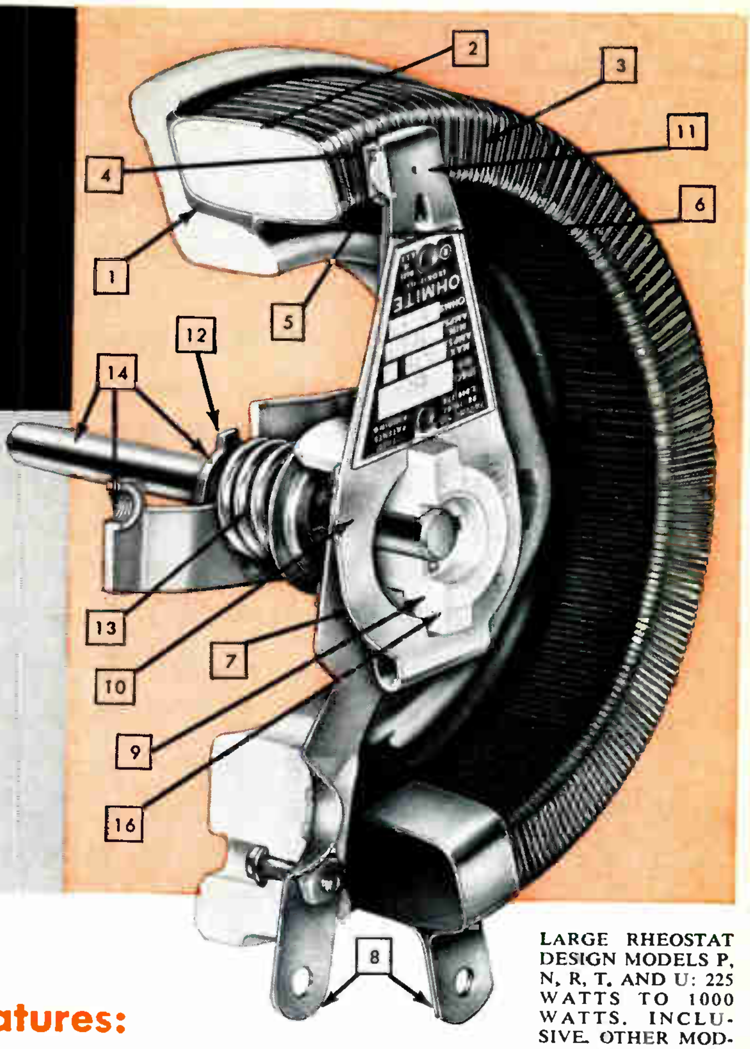

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4. Large, flat surface upon which the contact brush rides.
5. Metal-graphite contact brush (varied to fit current and resistance) insures good contact, with negligible wear on the resistance wire.
6. Shunt pigtail of ample size carries the current directly to the slip-ring.
7. Large slip-ring of high-current carrying ability minimizes mechanical wear and provides connection from the moving contact to the terminal.
8. Potentiometer use. The rheostats are provided with three terminals so they can be used as potentiometers or voltage dividers.
9. High strength ceramic hub insulates the shaft and bushings from all live parts. All sizes will stand a 3000 volt a-c breakdown test to ground.
10. The contact arm is a long tempered steel spring which assures uniform contact pressure at all times. Cadmium-plated for corrosion resistance.
11. Rounded pivot holds contact brush in flush-floating contact with wire.
12. Stops which are keyed to the shaft and base limit the rotation—thus no torsional strain is imposed on the contact arm on stopping.
13. Compression spring maintains uniform pressure and electrical contact between slip-ring and center lead at all times.
14. Models E, H, J, G, K, and L: End-thrust is taken by a retaining ring. Models P, N, R, T, and U: End-thrust is taken by a stop washer. Steel shaft in brass bushing provides a wear-resistant, wobble-free bearing.
15. Ohmite rheostats meet requirements of NEMA and EIA (formerly RETMA).
16. There are only ceramic and metal in the construction of Ohmite rheostats—there is nothing to char, burn, shrink, or deteriorate.

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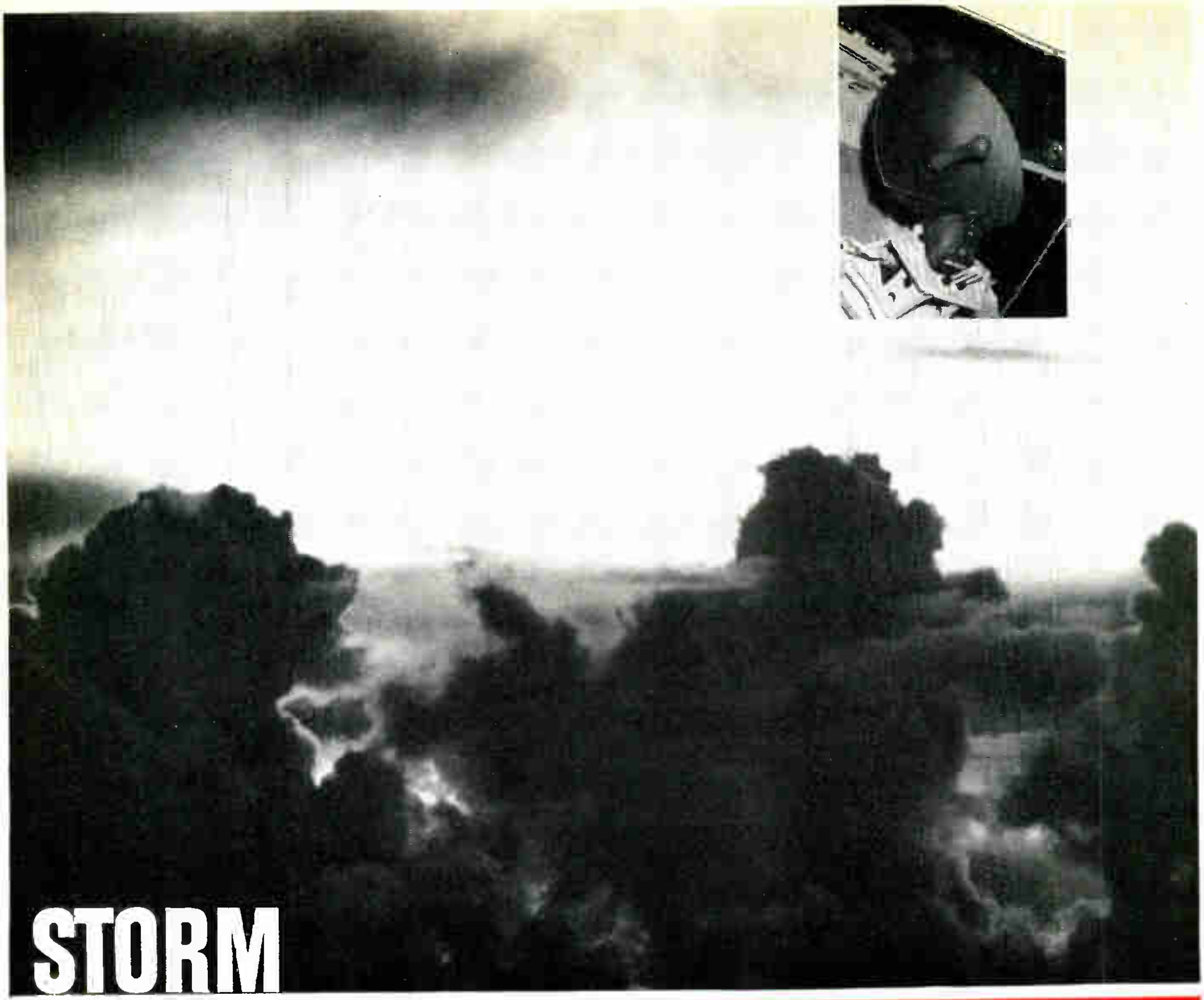

STORM WARNING... BY RADAR

Atmospheric turbulence has the characteristic of reflecting microwave signals, with the degree of reflection depending on the severity of the turbulence. Returned to the aircraft, this reflected radar warning is displayed in a manner that warns the pilot of the exact location and extent of the turbulence, enabling him to change his course and fly around dangerous storms. Since the radar display also shows him "holes" in storms where there is little or no turbulence, the pilot can choose a course that will result in maximum safety and minimum delay.

Commercial airlines use Varian klystron equipped weather radar to assure the comfort and safety of passengers and the reduction to a minimum of storm hazards and delays. Photo above shows radar antenna inside the Radome nose of a United Air Lines plane.

In addition to the technical advantages of Varian klystrons to the equipment designer, their rugged mechanical construction and long life are vital benefits to the user. These characteristics are reasons why Varian has become the world's largest manufacturer of klystrons.

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ELECTRONICS NEWSLETTER

STRETCH Computer Handles 100 Billion Computations A Day

Announcement of the solid-state, $10-million-and-up STRETCH class of computers highlighted last week's annual meeting of shareholders of International Business Machines Corp. in New York.

The new class of computers, the same size as the IBM 704 but 75 times faster, can complete 100 billion computations in a day. They will be similar to the STRETCH computer being completed for the Atomic Energy Commission at Los Alamos, N. M.

Typical system has internal capacity of more than 1½ million decimal digits, with retrieval rate of 2.18 millionths of a second from the main units. Company says that since several storage units can be operated at once, the system will accommodate 2 million instructions and 2 million pieces of data a second.

An "exchange" computer within the system routes information over 32 channels, each of which can handle many input-output devices that are compatible with existing IBM computers. Some STRETCH computers will have a new random access magnetic disk storage. A "Look-Ahead" device enables the computer to anticipate what is to come and automatically assign tasks to its various parts.

IBM president Thomas J. Watson, Jr. said the small unit costs of work performed at STRETCH speeds make the machine ideal for IBM Tele-processing data systems. Announced last month, these systems can gather information from many points, process and store it in a central computer, and make the data available to all points on demand.

At the other end of the speed and cost range from STRETCH, IBM announced the new solid-state, general-purpose 609 punched card calculator which will rent for $1,175 a month or sell for $55,500. Company says it performs additions and subtractions at microsecond speeds (12-digit numbers in 392 microseconds), and multiplications and divisions in milliseconds. Also disclosed: New TRACTOR magnetic tape system that can store 60 billion characters and will read and write at a speed of 1½ million letters or numbers per second.

B-58's Countermeasures System Cost $124 Million Over 6 Years

Delivery of the first operational Convair-made B-58 Hustler to the Strategic Air Command prompted release of information last week about work on the plane's "invisible electronic shield." Sylvania said it has been awarded more than $124 million in contracts over the last six years for development and production of the system, which baffles radar and radar-guided missiles.

The electronic system has been fully integrated to meet the specific space and weight needs of the B-58, as well as its electrical, electronic and thermal characteristics, it was disclosed. The lightweight countermeasure system consists of three major subsystems: radar warning, chaff dispenser control and radar track breaker.

Studying Use of SAGE In Air Traffic Control System

Two study programs relating to the possible use of the SAGE continental air defense system for air traffic control are now underway.

One involves a two-year $5,974,500 contract awarded by the Federal Aviation Agency to the MITRE Corp., Lexington, Mass. Contract covers design of and experiments with a semiautomatic air traffic enroute control system using current air defense SAGE facilities. Cost will be shared by FAA and USAF.

FAA says the project will use a SAGE computer at Lexington and long-range radars in New England, New York and New Jersey. The agency says the test facility will tie in with experimental gear at the National Aviation Facilities Experimental Center near Atlantic City, N. J. (ELECTRONICS, p 28, Apr. 8).

Second program is FAST (for Flight Advisory Service Test), part of a larger joint Air Force-FAA project (TRAILSMOKE) which will run through the summer. FAST marks the first operational evaluation of the SAGE Direction Centers by FAA traffic controllers, uses selected controllers at 38 sites in a test of the system's capability to provide civil and military planes with radar advisory information on potential air traffic conflicts.

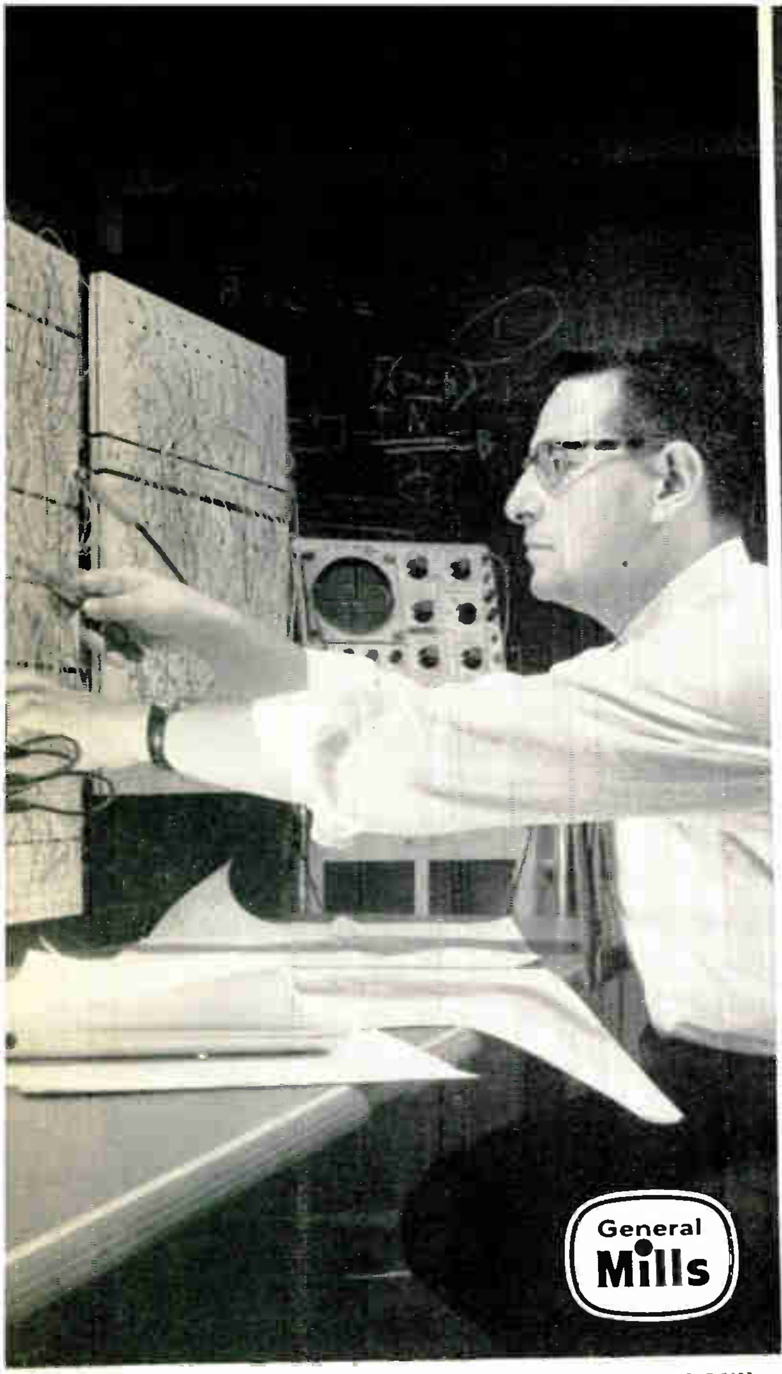
NEWS BRIEFS . . .

G. Barron Mallory has been elected president of P. R. Mallory & Co., Indianapolis, Ind., succeeding Joseph E. Cain. Philip R. Mallory was re-elected chairman of the board of directors. Cain was elected co-chairman of the board and chairman of the executive committee. Charles Barnes was elected vice president for finance and Leon Linn was elected vice president.

Ballistic missile computer for the Sky Bolt GAM-87-A guidance system will be supplied by GE's Light Military Electronics department. Northrop's Nortronics division has guidance subsystem responsibility for the air-launched missile. Douglas Aircraft Co. has USAF prime weapons systems contract.

Electron tube sealing process using optically-ground and mated glass stems and envelopes is expected to extend life of military tubes. Method, called polyoptic sealing, enables evacuation of tubes before sealing, preventing degradation of internal elements. Chatham Electronics division of Tung-Sol Electric Inc., developed production methods under a contract with U. S. Army Signal Supply Agency. In a sample lot of miniature hydrogen thyratrons produced by the method, 75 percent were still operating after 1,500 hours. Flame-sealed tubes of the same type showed a 90-percent failure rate after 1,500 hours.

NASA has selected Aeronutronic division of Ford Motor Co. for negotiation leading to construction of a 300-lb instrumented package to be landed on the moon in 2 years.



Here is Francis Alterman, Manager of General Mills Digital Computer Laboratory, checking one of our newest computers which he helped design. General Mills computers, both analog and digital, are being used in missile guidance, bombing and navigation systems, automatic surveying and in industrial control. In future space travel, computers will help control navigational systems of space vehicles and will process data gathered in outer space.

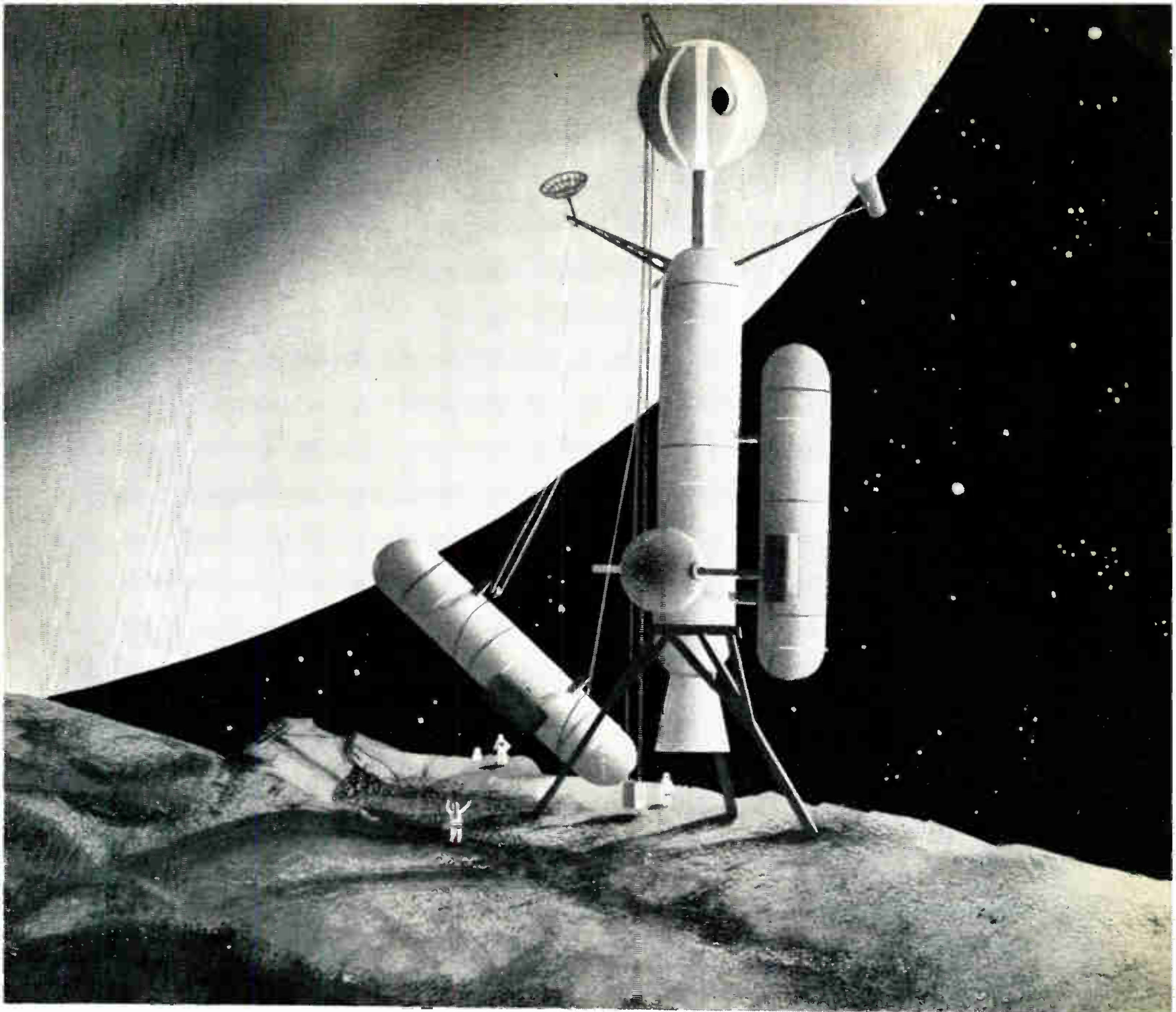
General Mills engineers work today .

General Mills has been producing computers for nearly 20 years. Exciting new concepts in high speed magnetic tape units, ultra-high precision analog to digital converters and optical keyboards are examples of continuous developments in our over-all computer program. We work to improve reliability, increase speed, cut cost.

Our research activities cover broad areas in physics, chemistry, mechanics, electronics and mathematics. Some of the studies representative of these activities are: ions in vacuum, deuterium sputtering, dust erosion, magnetic materials, stress measurements, surface friction and phenomena, trajectory data and infrared surveillance.

In our engineering department, current projects include: specialized inflatable vehicles and structures, airborne early warning systems, micro wave radar test equipment,

CIRCLE 12 ON READER SERVICE CARD



Mars seen from one of its moons . . . illustration from book written for General Mills by Willy Ley.

. to help you explore space tomorrow

antennas and pedestals, infrared and optics, inertial guidance and navigation, digital computers—and many other activities.

Our entire manufacturing department is geared to produce systems, sub-systems and assemblies to the most stringent military requirements. Our people have a wealth of experience in complex military projects.

Write for free booklets: (1) Complete research, engineering and manufacturing capabilities of the Mechanical Division (2) New booklet on General Mills computers.

MECHANICAL DIVISION

1620 Central Avenue, Minneapolis 13, Minnesota

To wider worlds—through Intensive Research • Creative Engineering • Precision Manufacturing

General Mills

CIRCLE 13 ON READER SERVICE CARD

WASHINGTON OUTLOOK

THE DEFENSE DEPT. has stirred up a new rumpus with a proposal to control "controversial" or "inappropriate" advertising and public relations activity by military contractors.

The new rules would go far beyond current security restrictions. They are in line with the Hebert Committee's recommendations that the Pentagon clamp down on advertising and PR which "provokes controversy and promotes dissension, and introduces biased, narrow, and prejudicial considerations into purely military decisions".

This is what the new Pentagon regulation would bar: "inappropriate claims" of operational availability or capability of new weapons; discussion of the economic impact of contract awards or cutbacks; discussion of relative merits of conflicting military strategy which might affect contracting.

Rep. John Moss (D., Calif.), who heads the House Government Information subcommittee, denounces the new rule. He claims Asst. Defense Secy. Murray Snyder would get the powers of an "advertising czar" under its provisions.

THE PENTAGON'S new $700-million budget overhaul includes the special allocation of $16.7 million to offset "price adjustments" and production delays in procurement of Air Force surveillance radar.

Of this sum, $1.3 million is earmarked for use in the next three months, the remainder for fiscal 1961 starting July 1. The Air Force won't identify the contractors involved. The equipment includes height-finder radars and low-powered gap filler radar. The $16.7 million sum is being added to a $225.9-million radar procurement budget for fiscal years 1960 and 1961.

ELECTRONIC INDUSTRIES ASSOCIATION has objected to the Labor Dept.'s proposed definition of the "electronic equipment" industry for purposes of a survey of prevailing wages. This would be the first step in the prolonged determination of a Walsh-Healey minimum wage for producers of end-items.

Walsh-Healey determinations are now also under way for producers of electron tubes and semiconductors and of component parts. The end-item case is in the earliest phase of the three electronic Walsh-Healey cases.

The Labor Dept.'s proposed industry definition covers "the manufacture of electrical apparatus and sub-assemblies . . . involving the use of electronic tubes and/or solid state semiconductor devices."

EIA claims this definition would conflict with Walsh-Healey definitions of other electronics industry segments. Instead, the association proposes a definition in terms of classes of products the industry makes—and limited to those that are specifically electronic.

Examples: radio and tv transmitters and receivers; electronic navigational devices; electronic sound distribution devices; electronic search, detection, surveillance, and tracking devices; etc.

THE PENTAGON has made a special analysis of prime contract awards to the 25 leading contractors in fiscal 1959. It shows that 40.9 percent of the contracts (in terms of dollar value) were awarded on a fixed-price basis and 58.6 percent on a cost-reimbursement type basis.

The 25 leading contractors accounted for $12.3 billion worth of military business—or 54.6 percent of the total value of defense contracts placed in fiscal 1959.

Over half the fixed-price contracts included incentive provisions—that is, the contractor's profit allowance increased or dropped as production costs fell below or exceeded contract target prices. The next most common type of fixed-price contract provided for a firm fixed price.

All but $800 million worth of the cost-reimbursement type contracts included fixed fees—that is, the contractor was awarded a specific percentage of the costs as his profit. Only one percent of the contract awards to the 25 top companies were made on a formally advertised basis.

Doing pulsed or "fast" circuit work?

Square Wave Generator

1 cps to 1 MC; 0.02 μsec rise time

hp 211A Square Wave Generator. Versatile, wide range instrument for testing oscilloscopes, networks, video and audio amplifier performance, modulating signal generators, measuring time constants. Offers simple control of electronic switchers; is also convenient for indicating phase shift, frequency response and transient effects.

Special features include two separate outputs — a 7 volt, 75 ohm circuit for television work and a 55 volt, 600 ohm output for high level work. Both outputs offer full amplitude variation. May be operated free-running or externally synchronized with positive going pulse or sine wave signal of 5 volts minimum amplitude. Compact, weighs only 25 lbs. Cabinet model, $300.00; rack mount model, $305.00.

Pulse Generator

0.07 to 10 μsec pulses, 0.02 μsec rise time

hp 212A Pulse Generator. Time saving basic instrument for radar, television and other "fast" circuit work, including testing rf amplifiers, filters, band pass circuits; oscilloscopes and peak measuring equipment, pulse modulating uhf signal generators. Offers positive or negative pulses of 50 watts amplitude, delay and advance sync out circuits for synchronizing to other circuits, direct-reading pulse length control, high quality pulses with 0.02 rise and decay, flat top and minimum overshoot. Jitter less than 0.01 μsec. Permits delivery of accurate pulses to end of long transmission lines; if line is correctly terminated, pulse shape is independent of line length, sync conditions, input voltage or output attenuator setting. Internal impedance 50 ohms or less, either polarity. Repetition rate, internal sync 50 to 5,000 pps, external sync approximately 2 to 5,000 pps. Cabinet model $585.00; rack mount model, $570.00.

Call your hp representative for details or write direct.

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

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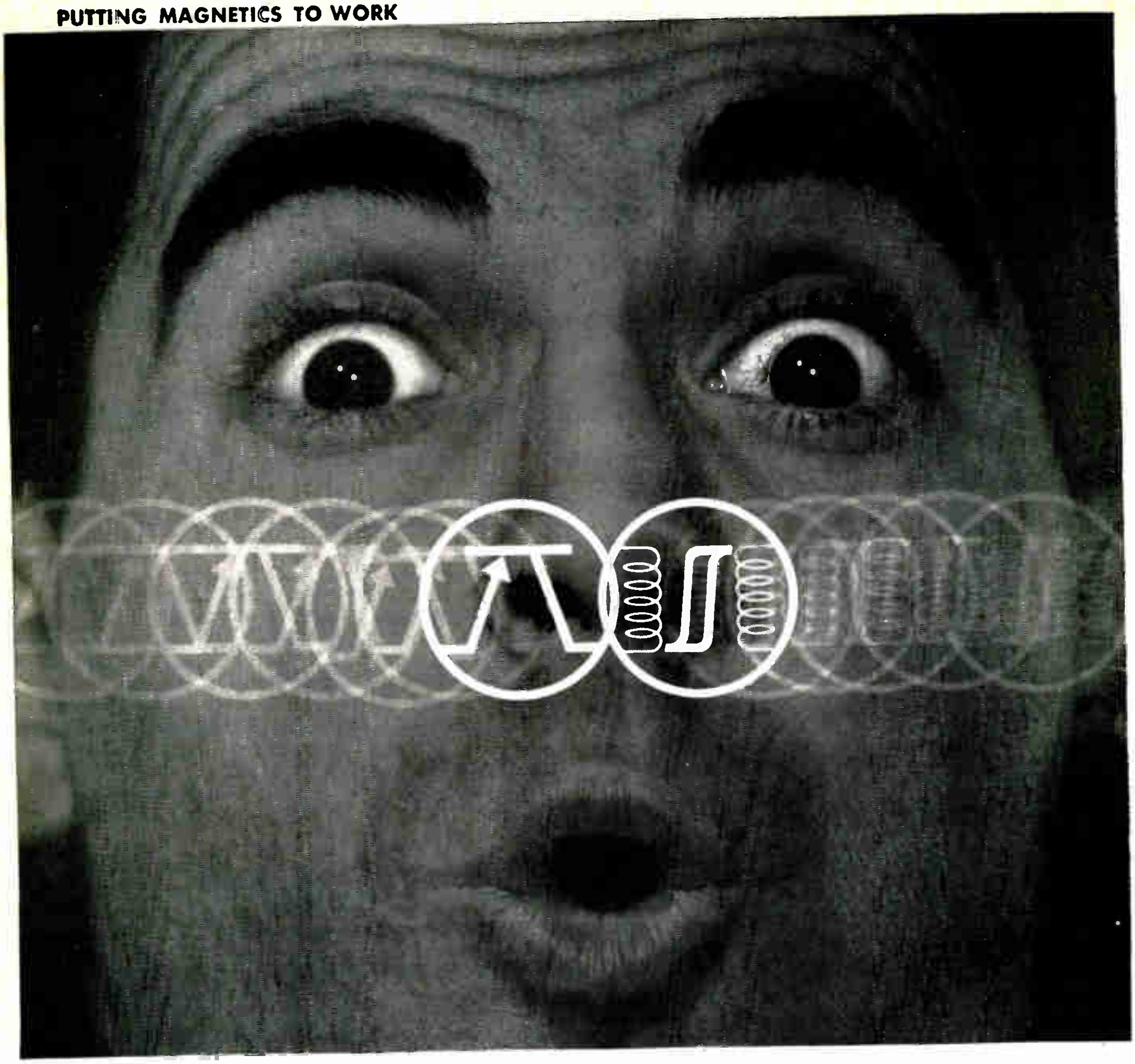
6370

hp offers 122A Oscilloscope; dual trace, 200KC, $625



Open your eyes to new amplifier designs!

See how to combine tape wound cores and transistors for more versatile, lower-cost, smaller amplifiers

Tie tape wound cores and transistors into a magnetic-transistor amplifier, and open your eyes to new design opportunities.

To start with, these are static control elements—no moving parts, nothing to wear or burn out. Next thing you find is that you reduce components' size—your amplifier is smaller and costs less. That's because between them the core and the transistor perform just about every circuit function . . . and then some.

For instance? The core has multiple isolated windings. Thus you can feed many inputs to control the amplifier. The core also has a square hysteresis loop, and thus acts as a low loss transformer. That means you save power. In addition, the core can store and remember signals—so time delay becomes simple.

There's no need for temperature stabilization, either. The transistor acts only as a low loss, fast, static switch—and in this function it has no peer.

How do you want to use this superb combination? As a switching amplifier—or a linear one? In an oscillator? A power converter (d-c to d-c or d-c to a-c)? You'll have ideas of your own—and if they involve tape wound cores, why not write us? Ours are Performance-Guaranteed. *Magnetics Inc., Dept. E-81, Butler, Pennsylvania.*

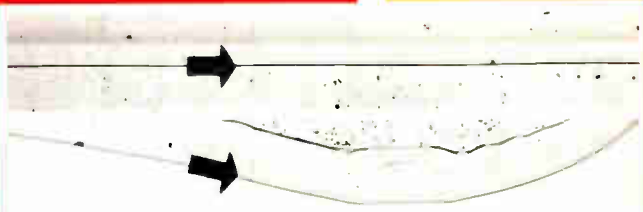
MAGNETICS inc. ®

 CIRCLE 16 ON READER SERVICE CARD

CIRCLE 17 ON READER SERVICE CARD →

LOW POWER. Consider the high-efficiency Raytheon 1N536 series.

MEDIUM POWER. Look into the Raytheon 1N253 and the new 1N2512 series.



Raytheon diffused junction (upper photo) gives utmost uniformity, highest performance, greatest reliability. Compare with irregular fusion junction (below).

HIGH POWER. Note the all-new Raytheon 1N248A, 1N1191A and 1N1195 series.

For reliable power . . .

Depend on diffused junction rectifiers!

Here are reliable Raytheon diffused junction silicon rectifiers spanning the complete semiconductor power spectrum!

Raytheon manufacturing success in diffused junction rectifiers has long provided fast recovery, low forward voltage drop and extreme uniformity of device characteristics. Outstanding mechanical design and production under stringent quality control result in rectifiers with excellent ratings and characteristics. Utmost reliability is assured by constant life and environmental testing beyond the most stringent requirements of Mil 19500B, over the guaranteed temperature range of −65°C. to +165°C.

Of special interest in low current applications of the 1N536 series are the excellent reverse recovery, fast start and fast rise of Raytheon diffused junction rectifiers.

In the four amp range, the Raytheon 1N2512 series features low reverse current and is available in three package styles: with insulated stud, stud connected to anode, or stud connected to cathode.

In the higher current range, the new Raytheon diffused junction silicon rectifiers offer ratings up to 22 amps (at 150°C.)—plus the important advantages of low forward voltage drop and high efficiency, for exceptional regulation in power applications.

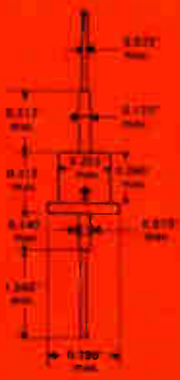
Further information on all these reliable Raytheon rectifiers is given on the following page. Semiconductor Division, Raytheon Company, 215 First Avenue, Needham Heights 94, Massachusetts.

RAYTHEON

RAYTHEON SEMICONDUCTORS

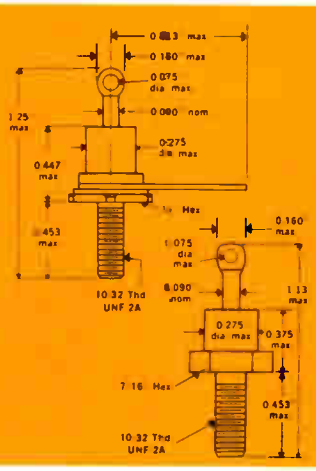
Raytheon diffused junction silicon rectifiers

LOW CURRENT SERIES. The fast reverse recovery, low current Raytheon rectifiers. Feature both fast start and fast rise. Temperature range —65°C. to +165°C.



Type	P.I.V.	Ave. Rectified Current 25°C	Ave. Rectified Current 150°C	Reverse Current (Max.) in µA at rated P.I.V. 25°C	Reverse Current (Max.) in µA at rated P.I.V. 150°C
		mA	mA		
1N536	50	750	250	2	400
1N537	100	750	250	2	400
1N538	200	750	250	2	300
1N539	300	750	250	2	300
1N540	400	750	250	2	300
1N1095	500	750	250	2	300
1N547	600	750	250	2	300

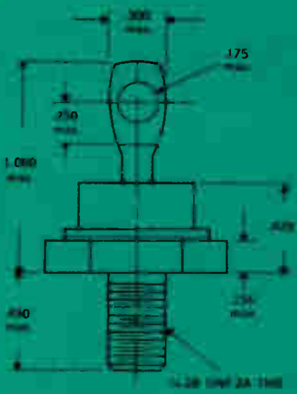
MEDIUM CURRENT SERIES. Workhorse of the Raytheon rectifier line. High efficiency and stability. Insulated or non-insulated stud, standard or reverse polarity. Temperature range —65°C. to +165°C.



Cathode to Stud	Anode to Stud	INSULATED Stud	P.I.V. Volts	Ave. Rectified Current 30°C amps.	Ave. Rectified Current 150°C amps.	Reverse Current (max.) µA at rated P.I.V. 25°C	Reverse Current (max.) µA at rated P.I.V. 150°C
1N2512	1N2512R	1N2518	100	4.0	1.0	2.0	250
1N2513	1N2513R	1N2519	200	4.0	1.0	2.0	250
1N2514	1N2514R	1N2520	300	4.0	1.0	2.0	300
1N2515	1N2515R	1N2521	400	4.0	1.0	2.0	300
1N2516	1N2516R	1N2522	500	4.0	1.0	2.0	350
1N2517	1N2517R	1N2523	600	4.0	1.0	2.0	400
1N253			95		1.0*		100*
1N254			190		0.4*		100*
1N255			380		0.4*		150*
1N256			570		0.2*		150*

*At 135°C.

HIGH CURRENT SERIES. The heavy current family of reliable Raytheon rectifiers. Features low forward voltage drop, high efficiency, exceptional regulation. Temperature range—65°C. to +175°C.



Type	P.I.V.	Ave. Rectified Current, Amps @ 150°C	Reverse Current (Max.) at Rated P.I.V., mA @ 150°C
1N248A	50	20	5
1N249A	100	20	5
1N250A	200	20	5
1N1191A	50	22	5
1N1192A	100	22	5
1N1193A	150	22	5
1N1194A	200	22	5
1N1195	300	18	10
1N1196	400	18	10
1N1197	500	18	10
1N1198	600	18	10

J-6949

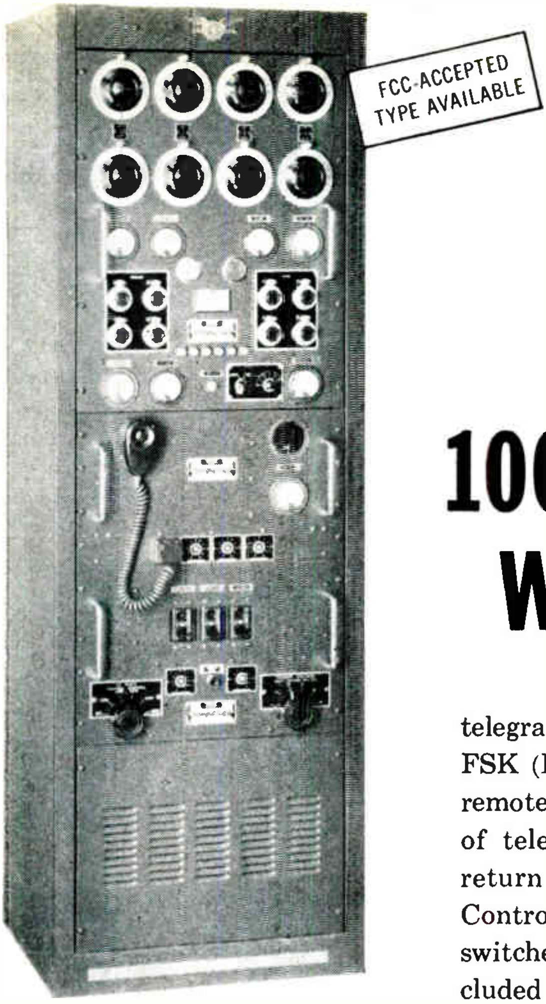
Your local authorized Raytheon Distributors carry in-stock inventories for immediate delivery.

RAYTHEON

SEMICONDUCTOR DIVISION RAYTHEON COMPANY

SILICON AND GERMANIUM DIODES AND TRANSISTORS • SILICON RECTIFIERS • CIRCUIT-PAKS

ENGLEWOOD CLIFFS, N. J., LOwell 7-4911 (Manhattan Phone, WIsconsin 7-6400) • BOSTON, MASS., HIllcrest 4-6700 • CHICAGO, ILL., NAtional 5-4000 • LOS ANGELES, CAL., NOrmandy 5-4221 • ORLANDO, FLA., GArden 3-0518 • SYRACUSE, N. Y., GRanite 2-7751 • BALTIMORE, MD., SOuthfield 1-0450 • CLEVELAND, O., WInton 1-7716 SAN FRANCISCO, CAL., FIreside 1-7711 • CANADA: Waterloo, Ont., SHerwood 5-6831 • GOVERNMENT RELATIONS: Washington, D.C., MEtropolitan 8-5205



The world-famous

AEROCOM 1046 TRANSMITTER

1000 W CARRIER POWER WITH HIGH STABILITY

The Aerocom 1046 Transmitter is designed to give superior performance for all point-to-point and ground-to-air communications. It is now in use throughout the world in climates ranging from frigid to tropical (operates efficiently at −35° to +55° Centigrade).

As a general purpose High Frequency transmitter, the 1046 supplies 1000 watts of carrier power with high stability (above −10° Centigrade: ±.003% for telegraph and telephone. Temperature controlled oven for FSK). Multichannel operation is provided on telegraph A1, telephone A3 and FSK (Radio Teletype). It can be remotely controlled using one pair of telephone lines plus ground return with Aerocom Remote Control Equipment. Front panel switches and microphone are included for local control.

Four crystal-controlled frequencies (plus 2 closely-spaced frequencies) in the 2.0 - 24.0 megacycle range can be used one at a time, with channeling time only two seconds. Operates into either balanced or unbalanced loads. The power supply required is nominal 230 volts, 50 - 60 cycles, single phase.

The housing is a fully enclosed rack cabinet of welded steel, force-ventilated through electrostatic filter on rear door.

Telegraph keying (A1): Up to 100 words per minute. Model 1000 M Modulator (mounts in transmitter cabinet) is used for telephone transmission; a compression circuit permits the use of high average modulation without overmodulation. Model 400 4 Channel exciter is used for FSK.

Output connections consist of 4 insulated terminals (for Marconi antenna) and 4 coaxial fittings Type SO-239, which can be used separately or in parallel in any combination. For 600 ohm balanced load, Model TLM matching network is used, one for each transmitter channel.

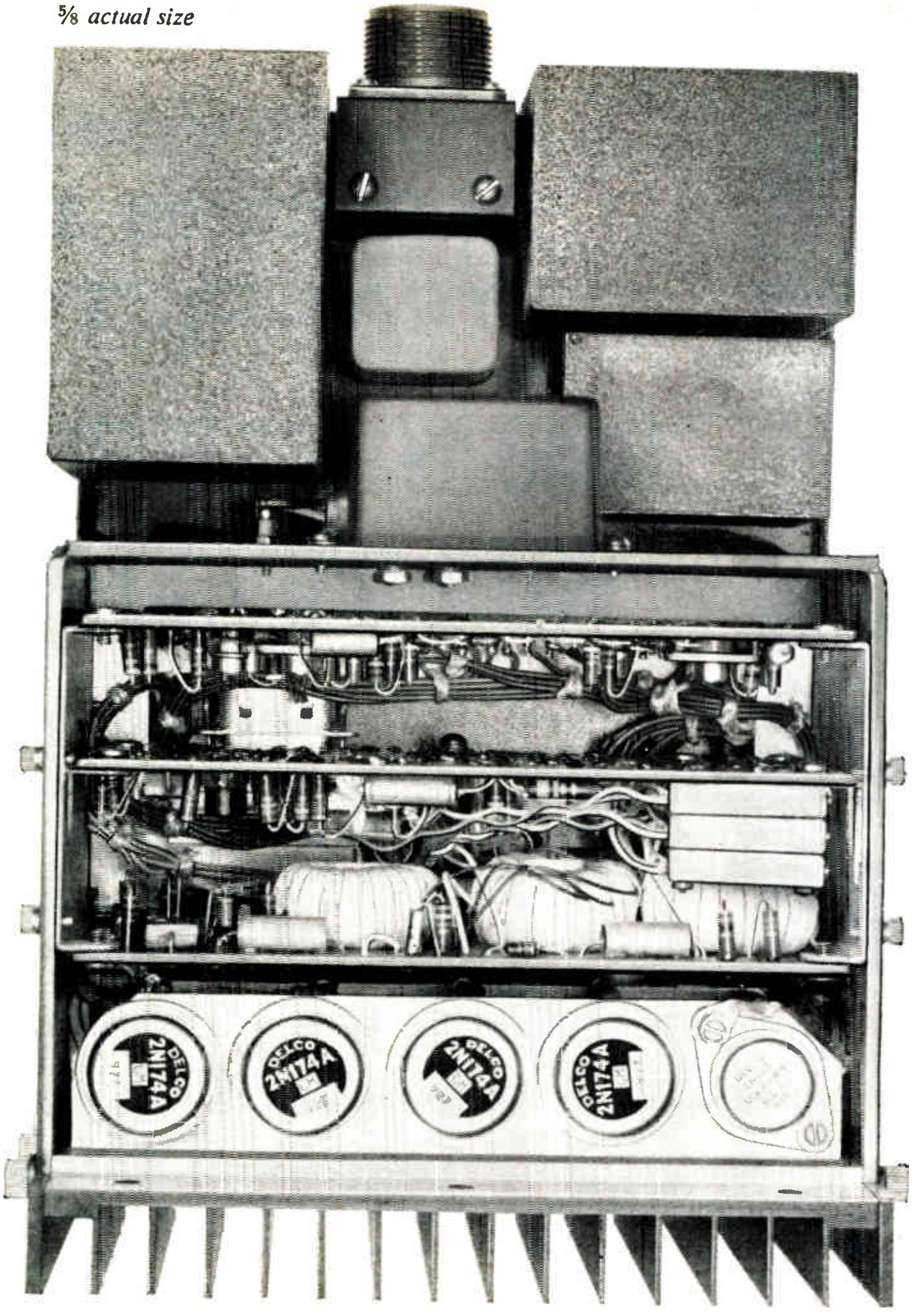
As in all Aerocom products, the quality and workmanship of Model 1046 are of the highest. All components are conservatively rated. Replacement parts are always available for all Aerocom equipment.

Complete technical data on Aerocom Model 1046 available on request.

AER-O-COM

3090 S. W. 37th AVENUE MIAMI 33, FLORIDA

⅝ actual size



AVAILABLE NOW FROM TI

100:1 miniaturization with SOLID CIRCUIT* semiconductor networks

Now — 3 years ahead of industry's expectations — *Solid Circuit* semiconductor networks from Texas Instruments for many of your high-reliability miniaturized systems!

Solid Circuit networks are a major departure from conventional components because they integrate resistor, capacitor, diode, and transistor functions into a single high-purity semiconductor wafer. Protection and packaging of discrete elements is eliminated, and contacts between dissimilar materials are minimized, reducing element interconnections as much as 80%. Fabrication steps have been reduced to one-tenth those required for the same circuit function using conventional components.

Only a few process steps and time-proved TI mesa production techniques permit a high degree of process control in *Solid Circuit* network fabrication. The result of these facts: *reliability is built into* each *Solid Circuit* network.

If you need to reduce equipment size and weight — or to design a more complex system in the same size — investigate *Solid Circuit* networks for your missile, satellite, space vehicle, and other microelectronic programs. TI engineers are ready to custom design this concept to your requirements. Contact your nearest TI Sales Engineer today. The TI Type 502 *Solid Circuit* network is immediately available for your evaluation.

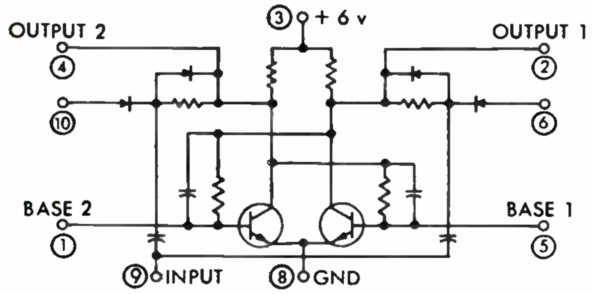
SEMICONDUCTOR NETWORK CONCEPT

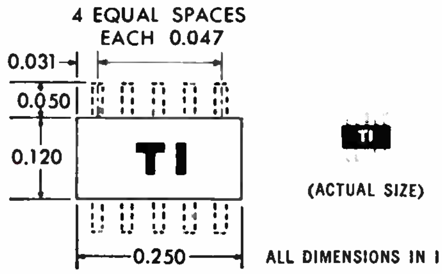
The concept of a semiconductor network is the relation of conductance paths in a semiconductor to the classical circuit elements, establishing an orderly design approach based on circuit knowledge. In this manner, semiconductor networks may be designed to perform the functions of a wide variety of existing circuits. Through the proper selection and shaping of semiconductor conductance paths, it is possible to realize such electronic functions as amplification, pulse formation, switching, attenuation, and rectification.

An assembly of 13 **Solid Circuit** networks, actual size, performs a full serial adder function, replacing 85 conventional components with a 100:1 size reduction. Weight: 1.5 gm. Volume: 0.02 cubic inch.

*Trademark of TEXAS INSTRUMENTS INCORPORATED

TI Type 502 silicon **Solid Circuit** network is intended for binary counter, flip-flop, or shift register applications. The dimensions of the glass-to-metal hermetic-sealed package are 0.250 x 0.120 x 0.030 inch.





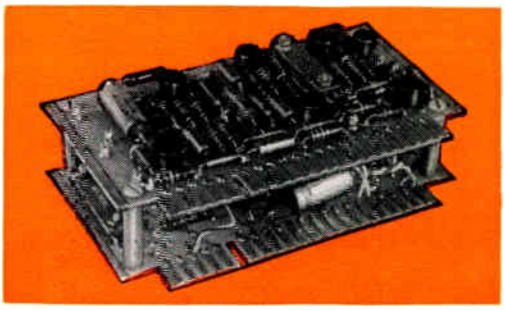
TEXAS INSTRUMENTS INCORPORATED
SEMICONDUCTOR-COMPONENTS DIVISION
POST OFFICE BOX 312 • DALLAS, TEXAS

TAPCO ANALOG COMPONENTS

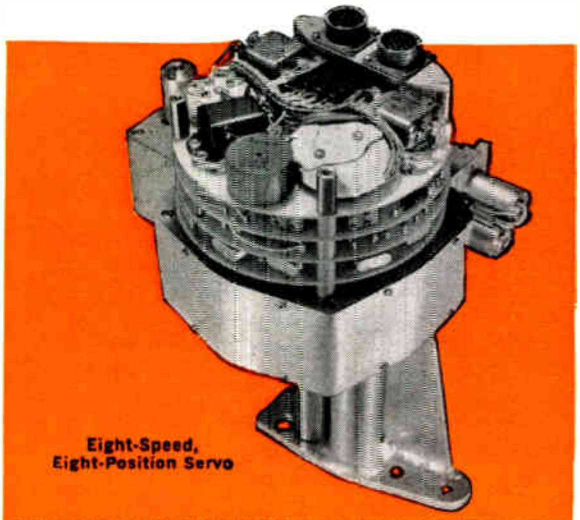
For airborne equipment

TAPCO analog components have been proved in various classified aircraft and missile applications. The TAPCO line includes:

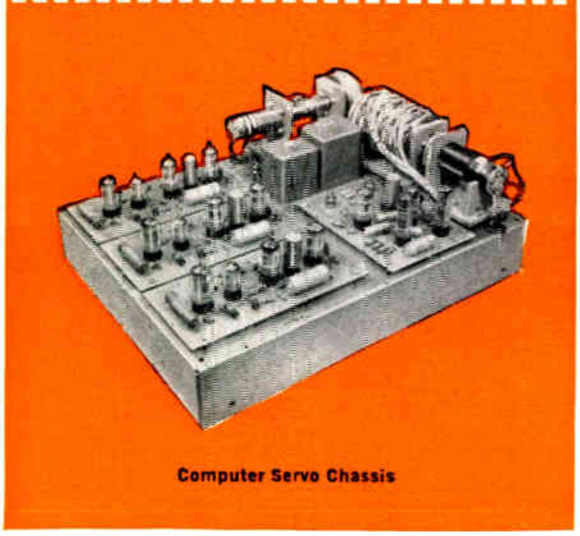
- Position Servos
- Velocity Servos
- Miniaturized Servo Amplifiers
- Tracking Computers
- Data Conversion Units
- Arithmetic Computers



Transistorized Servo Amplifier



Eight-Speed, Eight-Position Servo



Computer Servo Chassis

PERFORMANCE DATA: TRANSISTORIZED EIGHT-SPEED SERVO (Illustrated at left)—**Speed Range:** From 1 to 2.5 rpm. **Speed Tolerance:** ±0.2% over temperature range of 50°F to 85°F. **Angular Vibration Tolerance:** 5 x 10^{-5} radians double amplitude. **Acceleration:** Zero to maximum speed within 0.2 seconds. **Transition time:** Speed change time within 0.1 seconds. **Torque Output:** 100 oz. in. with 15 watts input. Higher torque available with increased power consumption. **Power Requirements:** 10.0 watts steady rate. 18 watts peak during acceleration or speed change. **PHYSICAL DATA—Size:** 10¾" x 7¾" x 8½". **Weight:** 5¼ lbs.

For ground support equipment

All TAPCO GSE analog computer components use MIL-approved parts for highest reliability. Modular construction of these components allows compact assembly on chassis. The TAPCO line includes: DC Operational Amplifiers, Servo Amplifiers, Buffer Amplifiers, Electronic Modulators, Position and Rate Servos, Vector Servos, Aircraft Dynamic Simulator, Coordinate Converters, Special Multipliers and Dividers, Ballistic Computer.

PERFORMANCE DATA: DC OPERATIONAL AMPLIFIER—Gain: 10^6 open loop at 0.01 cps. **Drift:** Less than 100 micro-volts. **Linearity:** ±.1% of input voltage. **Input Power:** 25 watts. **Output Voltage:** ±85 V DC—50K Load, ±40 V DC—8K Load. **Noise:** Less than 100 micro-volts. **PHYSICAL DATA—Size:** 4" x 8⅜" x 2½". **Weight:** 9 oz.

PERFORMANCE DATA: AC SERVO AMPLIFIER—Gain: Open loop 60,000. **Gain:** With external feedback 10,000. **Input Impedance:** Greater than 1 megohm. **Frequency Response:** To 40 cycles. **Input Power:** Approx. 40 watts. **Output Power:** Approx. 6 watts. **High Impedance Servo Motor Output. PHYSICAL DATA: Size:** 5" x 7" x 3⅜". **Weight:** 11 oz.

For further information, write on your company letterhead indicating your specific product interest.

TAPCO GROUP

TRW

Thompson Ramo Wooldridge Inc.

DEPT. EL-560 • CLEVELAND 17, OHIO

DESIGNERS AND MANUFACTURERS FOR THE AIRCRAFT, MISSILE AND SPACE, ORDNANCE, ELECTRONIC AND NUCLEAR INDUSTRIES

GE Orders Rise 9 Percent

FIRST-QUARTER SALES for General Electric Co. this year totalled $957,433,000, off two percent from the equivalent period of 1959 when the figure was $976,568,000. Net earnings for both periods were "practically identical," according to GE, with this year's amount standing at $52,614,000 or 60 cents a share. R. J. Cordiner, company chairman, calls the outlook for the remainder of the year "favorable" and says total orders received for all GE products are up 9 percent over last year's first quarter. The net earnings of $52.6 million were equivalent to 5.5 cents per dollar of sales, a slight rise over the 5.4 cents for a year before.

The Martin Company reports increases in sales and earnings for the first quarter of this year. Sales and other income came to $140,839,907, compared with $122,332,650 in 1959, an increase of 14.9 percent. Net income after federal taxes rose 14.8 percent in 1960 to $3,488,112, up from $3,038,470. Net earnings per share in the 1960 first quarter were $1.13, compared with 99 cents in 1959.

Westinghouse Air Brake Co., Pittsburgh, Pa., announces consolidated sales for itself and its subsidiaries of $46,757,163 for the first quarter of 1960. This compares with $41,988,902 for the same period in 1959, an increase of 11 percent. Earnings before income taxes were $3,902,273, compared with $3,615,216 the year before. Net income after taxes in the 1960 first quarter was $2,008,417, and in the 1959 first quarter, $1,985,814. Per-share earnings in this year's first quarter were 48 cents, up one cent over a year ago.

Texas Instruments reports record first-quarter sales this year of $56,198,000 and earnings (after taxes and preferred dividends) of $3,897,000, or 99 cents a share on 3,916,921 shares outstanding. These figures compare with 1959 first-quarter sales of $29,993,000 and earnings after taxes of $2,400,000, or 74 cents a share on 3,256,988 shares then outstanding. The 1960 first-quarter sales and earnings were both up 32 percent over the 1959 mark.

Standard Coil Products, Melrose Park, Ill., announces first-quarter 1960 sales up 32 percent over last year, with earnings up 47 percent. The consolidated sales figures this year were $21,871,820, compared with $16,591,852 in the same period of 1959. Net income in 1960 was $572,125, equal to 29 cents a share. In 1959 it was $390,397, equal to 20 cents a share. These figures are both first-quarter totals only.

Westinghouse Electric Corp. reports net income for this year's first quarter increased 35 percent over the corresponding period a year ago, $19,496,000,000 on billings of $458,817,000. Net income equal to 55 cents a share was the second highest ever reported by the company, having been exceeded only in 1954. Last year, this figure was 41 cents a common share. Net bookings are up 20 percent this year over the 1959 first quarter.

25 MOST ACTIVE STOCKS

WEEK ENDING APRIL 22

	SHARES (IN 100's)	HIGH	LOW	CLOSE
Ampex	2,109	35 3/8	31 1/8	32 3/8
RCA	1,505	78 3/8	72 1/2	74 1/4
Int'l Tel & Tel	1,367	42	39 7/8	41 1/4
Gen Inst	1,180	30 1/4	25 1/2	29
Gen Tel & Elec	1,138	87	81 1/4	84 3/8
Varian Assoc	864	51 3/4	48 5/8	50 1/4
Barnes Engn'r	795	36 3/4	27 3/4	35 3/4
Beckman Inst	752	78 7/8	71 3/8	77
Sperry Rand	748	21 7/8	21	21 1/8
Siegler Corp	704	40 1/4	37 5/8	39 1/2
Westinghouse	634	55	53 3/8	54 3/4
Philco Corp	589	33 3/4	31 3/8	31 5/8
DuMont Labs	576	10	9 1/8	9 1/4
Western Union	574	46 5/8	43 3/4	46 1/4
Raytheon Mfg	454	42	39 3/4	39 3/4
Avco Corp	454	13 1/8	12 3/4	13
Heli Coil	411	47 3/8	43 1/8	44 5/8
Lockheed	397	45 3/8	41 1/8	44 1/8
Litton Ind	381	78 7/8	73	74 5/8
Dynamics Corp Amer	362	11 1/2	10 1/4	11 1/8
Herold Radio	348	6 5/8	5	6
Texas Inst	344	218 1/4	202 1/4	207 5/8
Electronics Corp	340	16 1/8	13 5/8	16
Collins Radio	313	60 1/4	56 1/4	56 1/4
Standard Coil	312	14 7/8	13 3/8	14 3/8

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., investment bankers.

NOW AVAILABLE
Rugged New Eimac X778 Traveling Wave Tube . . . One Watt Output, 55-60 db Gain

Purchase orders are now being accepted on Eimac's pioneering new high gain traveling wave tube, the X778.

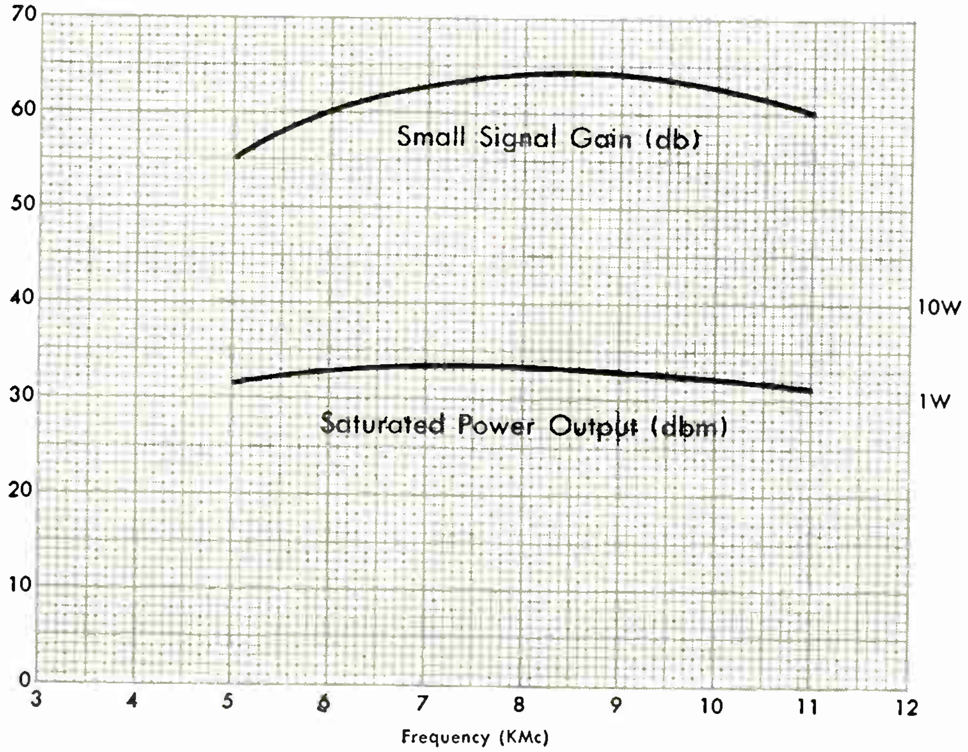
Unique features of this advanced one watt CW traveling wave tube include its exceptionally wide frequency range—5.0 to 11.0 KMc., small signal power gain of 55-60 db, and light weight permanent magnet focusing.

Like all other Eimac ceramic-metal tubes, this TWT "can take it." The X778 was especially designed to operate under severe environmental conditions of shock, vibration, temperature variation and high altitude. Breakage is a thing of the past, resulting in greatly reduced tube replacement costs.

The Eimac X778 finds wide usage in electronic counter-measures, radar augmentors, data links—in any application where more than one tube would normally be required to cover the C and X bands. This means significant cost reduction and increased system reliability.

Contact R & D Marketing Department for additional details and information on how this tube type may be modified for your requirements.

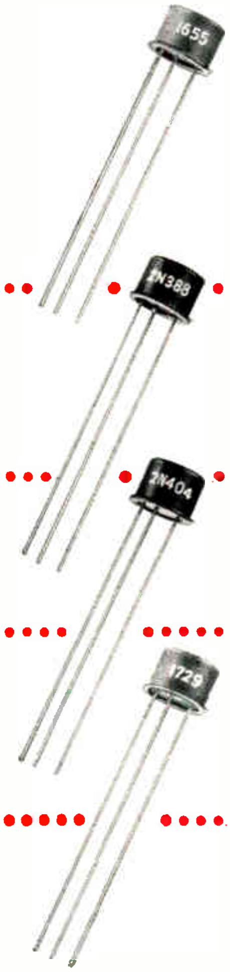
General Performance Characteristics
Eimac X778 Traveling Wave Tube



EITEL-McCULLOUGH, INC. • San Carlos, California

NON-SECRET

USN·USAF·SAC standards are met by SYLVANIA TRANSISTORS



SYLVANIA-1655 . . . for example, is used extensively in POLARIS. Imagine the complexity of the electronic system that must obtain target data, translate it into launching information and transmit intelligence to the guidance system of the "bird." Here, there can be no compromise with reliability. That's exactly why SYLVANIA has become a principal source of supply for NAVY-type R-212 (SYLVANIA-type SYL-1655) PNP-transistors used in the Polaris "bird" and its underwater "nest."

SYLVANIA-2N388 meets all requirements of MIL-T-19500/65 (NAVY). Originated by SYLVANIA, this NPN unit is designed and controlled specifically for computer applications where reliability, high gain and rapid switching capabilities are needed.

SYLVANIA-2N404 meets all requirements of MIL-T-19500/20 (USAF). This Sylvania PNP-type incorporates many of the features of the ultra-reliable SYL-1655 used in Polaris.

SYLVANIA-1729 is an NPN switching-transistor developed especially for SAC PROJECT 465L, the world-wide digital communications system. SYL-1729 is further proof of SYLVANIA capability in the design, production — and delivery — of reliable semiconductors.

Sylvania is prepared to custom-design semiconductor devices to your specific requirements, too. Contact your Sylvania Representative. For technical data on current types, write Semiconductor Division, Sylvania Electric Products, Inc., Dept. 224A, Woburn, Mass.

SYLVANIA

Subsidiary of **GENERAL TELEPHONE & ELECTRONICS** GENERAL SYSTEM

Exports $415 Million, Down 3%

ELECTRONICS INDUSTRY exports in 1959 totaled nearly $415 million, less than 3 percent below record year 1958 exports of $427.7 million, according to a tabulation of month-by-month figures issued by the Foreign Trade Division of the Bureau of the Census.

The following table shows comparable dollar export figures in 1958 and 1959 for 21 product groups:

	1958	1959
	(Thousands of Dollars)	
Radio sets	$ 9,215	$ 7,720
Television sets ...	25,036	20,600
Phonographs, all types, incl. parts and accessories.	24,001	23,136
Recorders, disk, tape and wire..	12,187	10,986
Amplifiers and amplifier systems, all types.	4,669	4,488
Tubes, cathode-ray	17,183	16,338
Tubes, receiving..	17,859	14,671
Other tubes and parts	16,985	18,328
Semiconductors ..	7,778	9,159
Capacitors	5,400	6,129
Resistors	3,840	4,175
Inductors	4,946	3,972
Loud speakers ...	2,171	2,137
Unclassified parts	31,792	38,637
Broadcast transmitters and studio equipment	12,823	18,456
Test and measurement equipment	27,063	36,679
Nuclear radiation detection&measuring equipment	3,081	4,631
Computers and related processing machines & parts	17,627	22,875
Land mobile, aeronautical and shipborne radio eqpt.	123,404	90,679
Detection & navigational eqpt...	44,175	44,351
Other equipment and apparatus..	16,453	16,772
	$427,688	$414,919

Big gains show up in test and measuring equipment (up 35.5 percent) in computers and associated equipment (up 29.8 percent) and in transmitters and equipment for radio and tv broadcasting (up 44 percent). Value of nuclear devices exported in 1959 is 50 percent higher than in 1958.

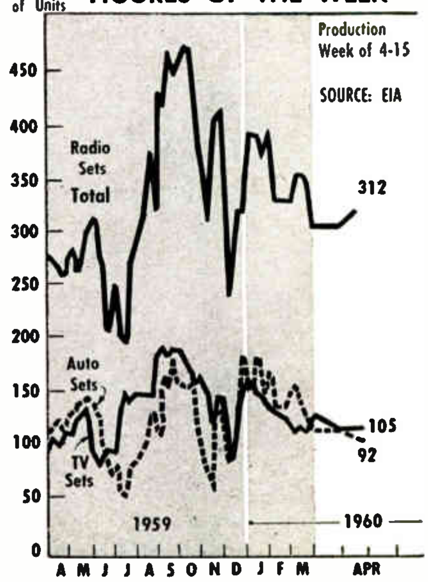
While consumer electronics has lost ground in 1959—radio and tv sets are down; so are phonographs, but not so sharply—most components are up. Semiconductors, capacitors and resistors all show healthy gains, although inductors, loud speakers and some tubes are down.

Biggest drop was in exports of land, sea and air mobile radio equipment, down 26.5 percent from $123 million in 1958 to $90.7 million in 1959.

The Sixties will see marketing research and planning activities merging, Dr. Wendell R. Smith, RCA's director of marketing research and development, told the Electronic Industries Association's semiconductor marketing forum.

Pointing to use of techniques developed by market researchers in solving nonmarketing business problems, he sees the possibility that in some firms marketing research may become known as management research.

FIGURES OF THE WEEK



Extending existing modulation systems to make more space available in the spectrum, and possibly even broadening the useful spectrum . . . this is a fundamental problem in modern communications. It is the problem to which ITT Laboratories is devoting intensive effort.

At the low end we're designing a new type antenna for very low frequencies. With a conventional antenna this would require a tower more than three miles tall. On the top side — at the high end — we're making radiation pattern surveys for the super high frequency bands. Here the entire antenna consists of a few millimeters of number eighteen copper wire. We're matching these efforts with advances in componentry . . . for instance, the parametric amplifier and now the ingenious ferroelectric converter which converts solar heat to high voltage electricity to power new satellite communications.

If you are a communications engineer who would like to be associated with some of the most significant programs in modern communications development . . . if you would like to work with men who are stretching the spectrum toward direct current at the bottom and the cosmic rays at the top . . . write Manager Professional Staff Relations . . . tell him your interests, your background and the kind of work you would like.

ITT LABORATORIES
A Division of International Telephone and Telegraph Corporation

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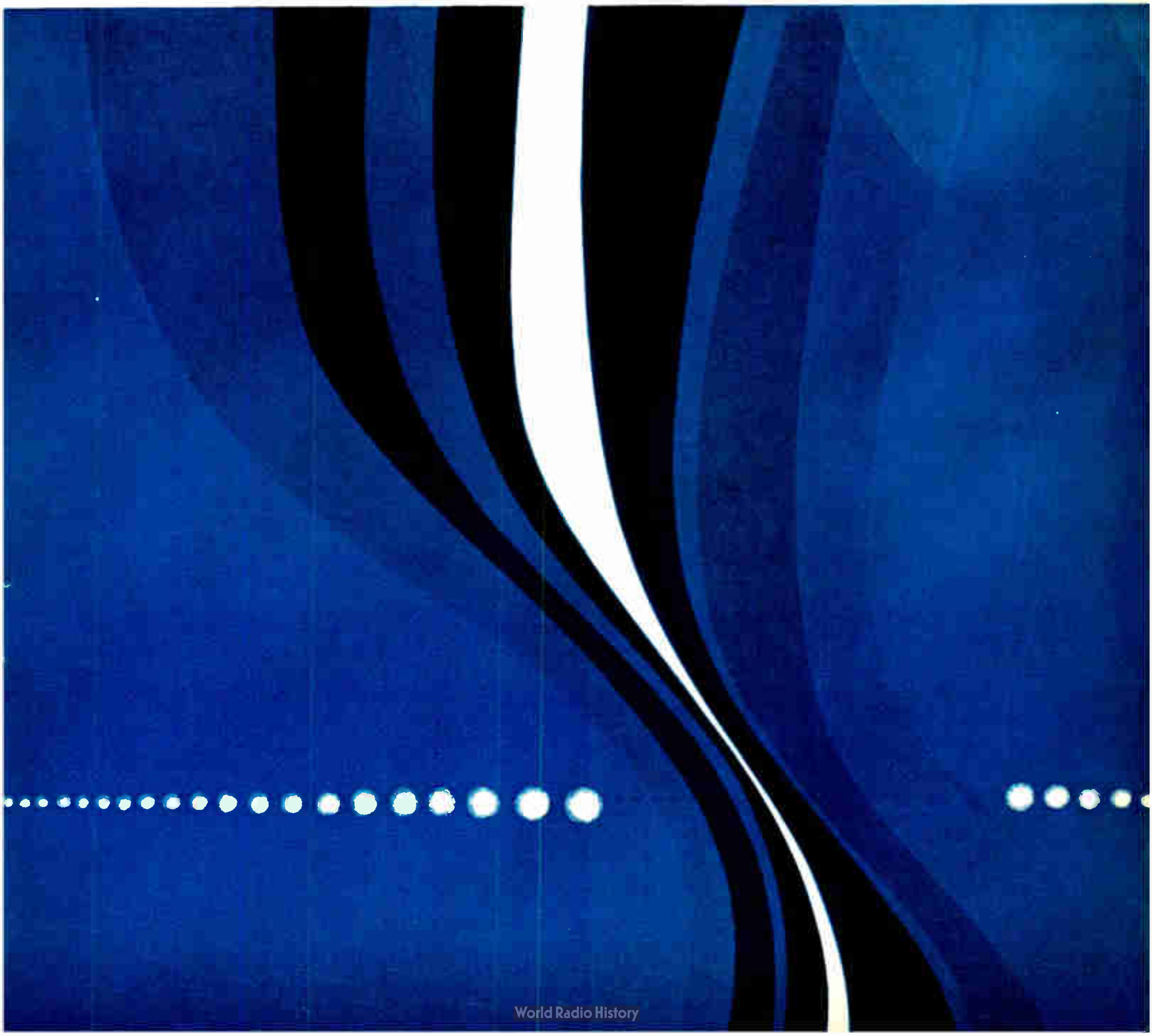
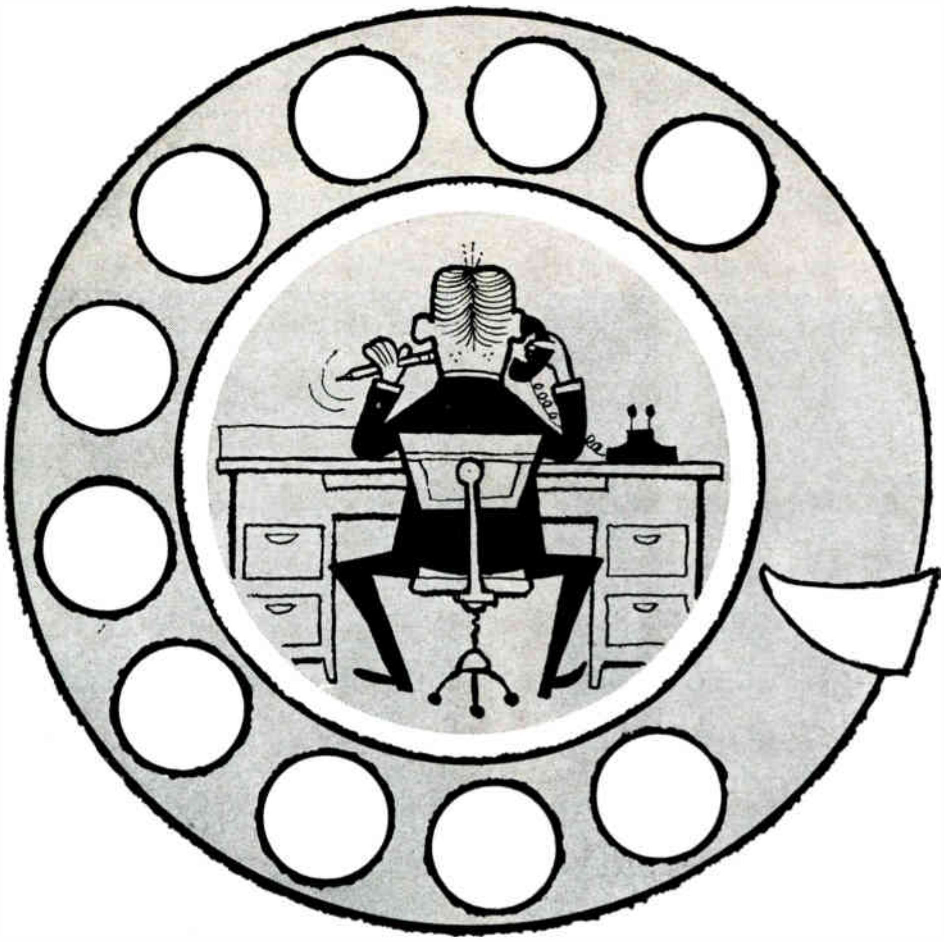
Fort Wayne, Indiana • Palo Alto and San Fernando, California



Who's the local rep?
What's his number?



LOOK IN THE NEW

electronics BUYERS' GUIDE

You'll find the local representative . . . his name, telephone number . . . his address. You'll find such detailed information about more than 25,000 local sales offices of more than 4,000 major manufacturers.

There's also a wealth of reference data about markets, materials, components and applications that make buying easier. Catalog informa-

tion on nearly 700 different advertised products (that's about 42% more than you'll find anywhere else). Also complete lists of manufacturers . . . registered trade names . . . and also, of course, the most complete listing of electronic and related products. Tells what you want to know . . . *when you're ready to buy.*

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Unhampered by traditional thinking, TELECHROME engineers have developed an entirely new concept in telemetering equipment — unequalled in compactness, ruggedness and dependability.

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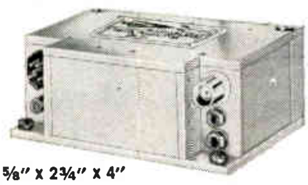
TELEMETERING TRANSMITTERS

FM/FM or PDM/FM Crystal Controlled
215 to 260 Megacycles

NEW! 1483A1 — 4 Watt FM Transmitter.



1⅝" x 2¾" x 4"
Features AFC for .005% stability

Model 1463 Transmitter.

5 19/32" x 3 13/16" x 4"
15 to 30 Watts

Model 1460-M RF Amplifier

3.37" x 3.25" x 2"
2 Watt input; 10-30 Watt output

Model 1466A-AF Amplifier

6.5" x 4" x 3.25" RF Amplifier
2 watts in — 100 watts out

Model 1462 Transmitter.

6" x 4¼" x 3¾"
50 to 80 Watts

800C — Sub-Carrier Oscillator

1.5" x 1.9" x 2.45"
Dev. Stab: ± 1% band width
Dev. Linearity: Less than 1% band width

Full Specifications & Details Available on Request

CIRCLE 29 ON READER SERVICE CARD

Only the New AIL Type 74

offers a continuously Tunable (40 to 180 mc) IF Amplifier

for continuous automatic noise figure measurement

Adding new versatility to your Automatic Noise Figure Measurement equipment, AIL now offers the outstanding Type 74 Automatic Noise Figure Indicator with a tunable Frequency IF Amplifier...or you can purchase the Tunable IF Amplifier for modification of your present Type 74 equipment.

Single frequency units are also available with greater sensitivity and broader bandwidth.

The AIL Type 74 is designed to permit the adjustment of receiver parameters to minimize noise figure. No special training is required for use on the production line, in the laboratory, or in the field.

check these high performance features

Noise Figure Range, RF or IF.. High range —23 to 36 db with extension to infinity
Low range —0 to 25 db

Accuracy .... Automatic: Low range ±1/2 db; High range ±1 db
Manual: ±0.1 db with AIL Type 30 Attenuator

Automatic Operation .... AGC range: 65 db minimum

Manual Operation .... Front panel IF gain control

Input Frequency .... 30 and 40 to 180 mc (tunable); other frequencies available

Sensitivity .... 100 microvolts

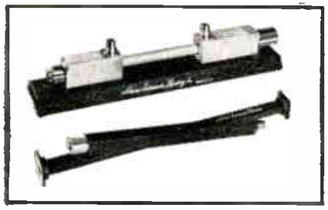
Bandwidth .... 2.0 mc minimum

Recorder Outputs .... Noise figure and AGC

Standard Models Available

Part Number	IF (mc)	Band-Width	Sensi-tivity	Price
07413	30 (fixed)	6	50	$765
07416	60 (fixed)	6	100	$765
07414	30 & 40 to 180	2	100	$830
07404*	30 & 40 to 180	2	100	$330

*IF Amp. Only



Twelve AIL Type 70 Noise Generators provide continuous coverage from 12 mc to 40,000 mc...most complete line of noise generators available for automatic noise figure measurements.

Write for full information to:

AIRBORNE INSTRUMENTS LABORATORY

DEER PARK, LONG ISLAND, NEW YORK

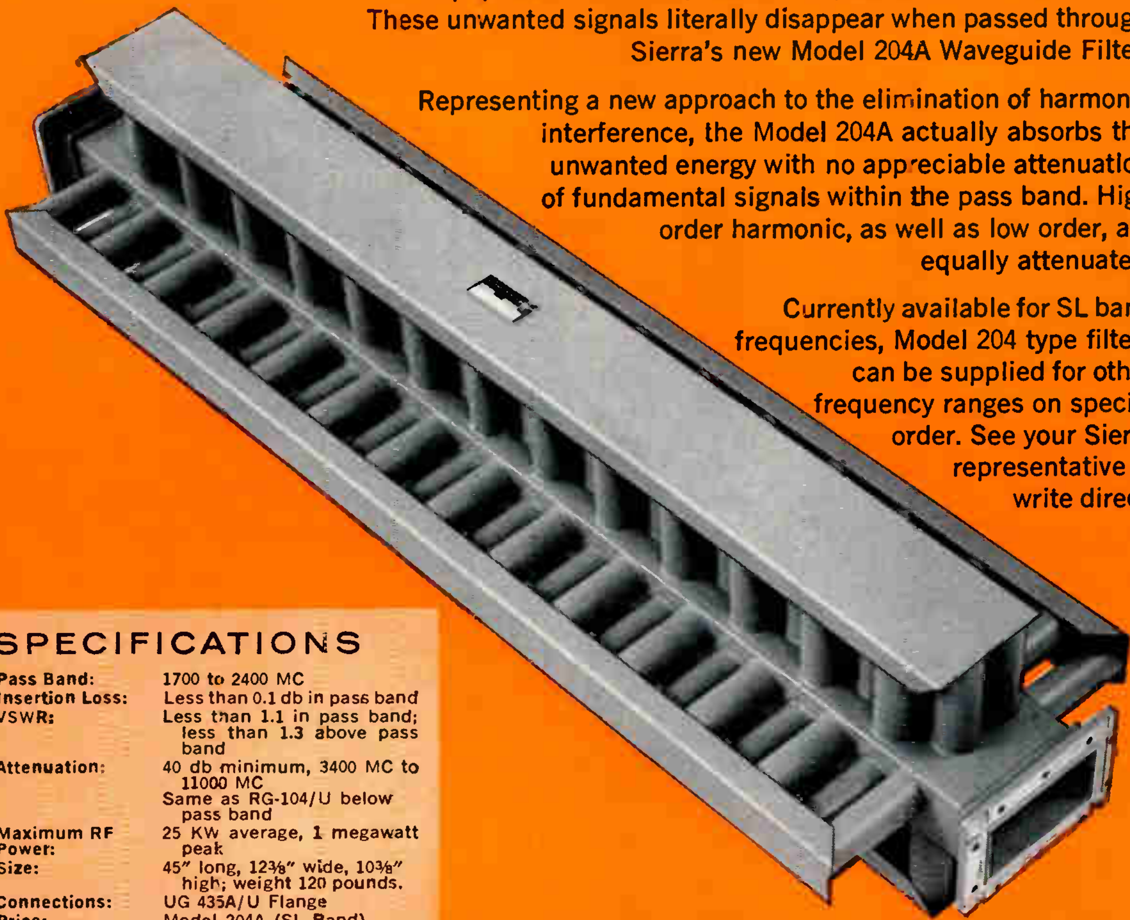
A DIVISION OF CUTLER-HAMMER INC.

new high-power harmonic ABSORPTION filter for SL band—1700 to 2400 mc

Harmful harmonic interference from high-power microwave equipment should be, **and can be,** eliminated at the source. These unwanted signals literally disappear when passed through Sierra's new Model 204A Waveguide Filter.

Representing a new approach to the elimination of harmonic interference, the Model 204A actually absorbs the unwanted energy with no appreciable attenuation of fundamental signals within the pass band. High order harmonic, as well as low order, are equally attenuated.

Currently available for SL band frequencies, Model 204 type filters can be supplied for other frequency ranges on special order. See your Sierra representative or write direct.



Sierra 204A SL Band Pass Filter

SPECIFICATIONS

Pass Band:	1700 to 2400 MC
Insertion Loss:	Less than 0.1 db in pass band
VSWR:	Less than 1.1 in pass band; less than 1.3 above pass band
Attenuation:	40 db minimum, 3400 MC to 11000 MC; Same as RG-104/U below pass band
Maximum RF Power:	25 KW average, 1 megawatt peak
Size:	45" long, 12⅜" wide, 10⅜" high; weight 120 pounds.
Connections:	UG 435A/U Flange
Price:	Model 204A (SL Band) $2,195.00

Data subject to change without notice

NEW 10 KW AND 1 KW KLYSTRON POWER AMPLIFIERS

Two klystron power amplifiers, Model 216A (10 KW output) and Model 217A (1 KW) are now available from Sierra. Both units employ 4-cavity klystron tubes, and are designed for scatter communications systems, space programs and high power point-to-point data transmission systems.

Both units are continuously tunable from 1700 to 2400 MC and as broadband amplifiers provide a minimum gain exceeding 40 db.

Except for its heat exchanger, Model 216A (10 KW, pictured) is housed in three connected cabinets. Its frequency bandwidth is 18 MC at ½ power points. Model 217A (1 KW), is housed in one cabinet. Its ½-power bandwidth is 15 MC. Write for details.

sierra

SIERRA ELECTRONIC CORPORATION

A Division of Philco Corporation

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6333

CIRCLE 31 ON READER SERVICE CARD

How Radiation Affects Tunnel

Researchers at three companies now report severe degradation of tunnel diode's characteristics by exposure to certain magnitudes of nuclear radiation

EVIDENCE is mounting this week that Esaki tunnel diode characteristics are severely degraded by exposures to nuclear radiation of the order of 10^{17} fast neutrons/cm^2.

General Electric and Bell Telephone Laboratories' researchers now support results of work performed by Thomas A. Longo of the Sylvania Semiconductor division. Longo, who experimented with Sylvania tunnel diodes, reported his findings at a recent meeting of the American Physical Society.

Valley Current Increases

Longo's irradiation experiments with pile neutrons and 7-Mev electrons indicate that germanium tunnel diode characteristics are severely degraded with exposures of the order of 10^{17} neutrons/cm^2 and 10^{17} electrons/cm^2.

Principal effect is an increase of the valley current which washes out the negative resistance region.

In Air Force-sponsored work, J. W. Easley and R. R. Blair of BTL noted similar results in germanium and silicon tunnel diodes which they tentatively interpret in terms of a bombardment-induced increase in the so-called diode excess current with little change of the band-to-band tunnel component of the total current.

For germanium tunnel diodes, an increase in valley current occurred at the rate of 10 percent per 10^{16} neutrons/cm^2 and the negative resistance, which was initially 9 ohms, increased on the order of 5 percent per 10^{16} neutrons/cm^2. From Fig. 1 it can be seen that at an exposure of 9.5 x 10^{16} fast neutrons/cm^2 the valley current had increased to approximately 160 percent of its initial value and the peak current decreased by approximately 4 percent.

Power Output Drops

A 1-Gc cavity oscillator showed, for a given operating point, a power output decrease of 1.5 db per 10^{16} neutrons/cm^2, becoming inoperative at 10^{17} (see Fig. 2).

A much more rapid rate of change was found for silicon units. At room temperature, the valley

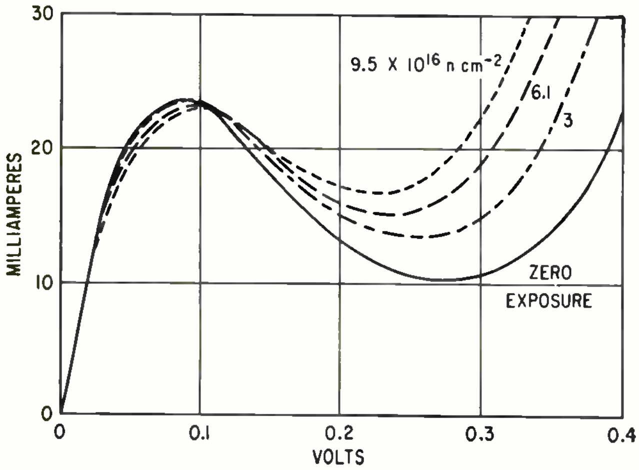


FIG. 1—Characteristic curves of germanium Esaki diode measured at several levels of fast neutron exposure at Bell Telephone Laboratories

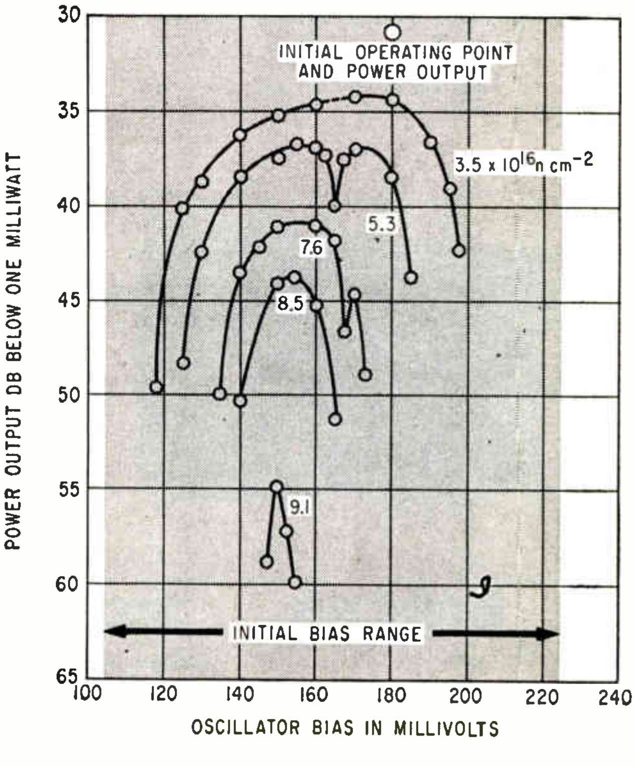


FIG. 2—Power output versus voltage bias for an approximately 1-Gc germanium Esaki diode cavity oscillator

Diodes

current increased by a factor of approximately two for an exposure of 9×10^{15} neutrons/cm^2.

R. A. Logan and A. G. Chynoweth of BTL irradiated several Esaki diodes with 800-Kev electrons and found the valley current rose quite rapidly until the negative resistance region of the device was entirely destroyed at integrated electron fluxes of the order of 10^{17} electrons/cm^2.

How They Compare

According to Bell researchers, this means tunnel diodes are somewhat, but not substantially, less sensitive to radiation than the least sensitive of other semiconductor devices. They point to the germanium diffused-base transistor which was reported[1] to permit circuit operation up to 10^{16} neutrons/cm^2.

GE researchers feel, however, that tunnel diodes are still generally much more radiation resistant, as ordinary transistors are affected by 10^{13} neutrons/cm^2. On the other hand, they claim their 7077, 7462 and 7266 ceramic tubes have withstood 10^{19} fast neutrons/cm^2 without any observed permanent changes in their characteristics.

By way of reference, the Enrico Fermi Fast Breeder Reactor being built at Lagoona Beach on Lake Erie is designed to have an average effective core flux of 0.5×10^{16} neutrons/cm^2/sec.

REFERENCE

(1) R. R. Blair, W. P. Knox and J. W. Easley, Transistor Circuit Behavior at Exposures Greater than 10^{15} Fast Neutrons/cm^2, paper presented at 1959 Second Conference on Nuclear Radiation Effects on Semiconductor Devices, Materials and Circuits.

Electronic Survey Gear Measures Lake

New magnetometer by Varian Associates computes and measures magnetic field components. Firm says unit cuts point reading time considerably

European Combine To Produce Hawk

HAWK AIR DEFENSE guided missile system will be produced in Europe by a company jointly set up by five electronics firms in as many countries.

Under an agreement signed this month with U. S. Hawk prime contractor Raytheon, Setel (for Societe Europeanne de Teleguidage) will get patent licensing rights and knowhow.

The European companies are Thomson-Houston, France; Finneccanica, Italy; Telefunken, West Germany; Ateliers de Construction Electrique de Charleroi, Belgium; and Philips, Netherlands.

Hawk production plans, which will give NATO its most advanced weapon system to counter air attack, will go ahead after additional agreements are signed by Setel with NATO's production organization and the five member national prime companies. Raytheon will assist in setting up the European production lines.

Recently, the Hawk scored the first interception and destruction of a ballistic missile when it demolished the larger Honest John.

Both missiles were traveling at supersonic speeds.

The arrangements for European production of Hawk are expected to set a pattern for production of new weapons for NATO.

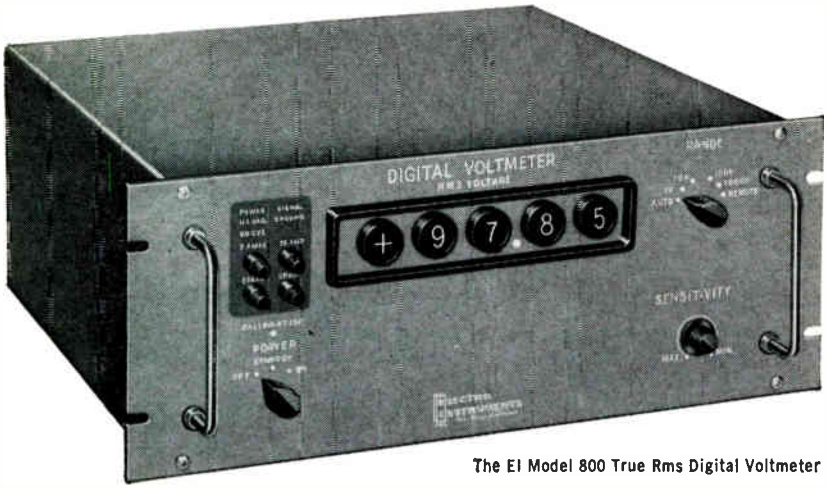
Telescope Cost Soars Over $100 Million

SUGAR GROVE, W. VA.—Cost estimate on the world's largest radio-telescope now under construction has soared to $100,600,000, Capt. Frank C. Tyrrell, Navy officer in charge, said. The installation, known as the Sugar Grove Radio Research Station, is located about 75 miles northwest of Waynesboro, Va.

Tyrrell recalled that the first estimate of the cost was $79 million. He said the development of scientific and mechanical facilities never before attempted in a comparatively new field of research had caused the original estimates to be upped.

The Navy officer said that steel erection on the big dish will start by the end of this month. American Bridge Division of U. S. Steel has the $19-million contract for the steel now being fabricated.

AT LAST!



The EI Model 800 True Rms Digital Voltmeter

A TRUE RMS DIGITAL VOLTMETER

This revolutionary instrument incorporates a unique temperature stabilized diode network, operating on the square law principle, to yield a true rms voltage reading, regardless of the AC wave form or DC. No hot wire elements of any kind are used.

- **All-electronic, totally-transistorized**
- **0.1% accuracy for crest factors up to two**
- **0.1% response from 50 cps through 5KC and at DC**
- **Higher frequency response (at least 10KC) at reduced accuracy and for certain waveforms**
- **3 second balance time, typical**
- **Calibration accuracy held for minimum of 30 days—typically much longer**
- **Automatic ranging**

Ask your nearest EI sales office or representative for complete information today!

SPECIFICATIONS

Accuracy: Within the range and frequency capability of the instrument, RMS value of crest factor not exceeding two will be indicated to ±0.1% of reading or two digits, whichever is greater.

The instrument accurately accounts for:

Harmonic components	50 cps to 5KC	0.1% or 2 digits
Sinusoidal response	50 cps to 5KC	0.1% or 2 digits
Square wave	50 cps to 1KC	0.1% or 2 digits
Triangular wave	50 cps to 1KC	0.1% or 2 digits
DC (no polarity sense)		

Accuracy maintained 30 days without calibration adjustment. Above accuracies after 45 min. warm-up time.

Range: Automatic ranging, 1 volt to 999.9 volts with manually selected 0.1 volt to 1 volt range.

Balance time: Typically less than 3 seconds. Maximum 5 seconds per range.

Temperature: 0° to 50°C.

Power: 60 cps, single phase, 125 watts

Dimensions: 19" wide x 8¾" high x 20" deep.

Engineers: Many challenging positions are now open. For details contact Mr. Carl Sebelius.

Electro Instruments, Inc. 3540 AERO COURT SAN DIEGO 11, CALIF.

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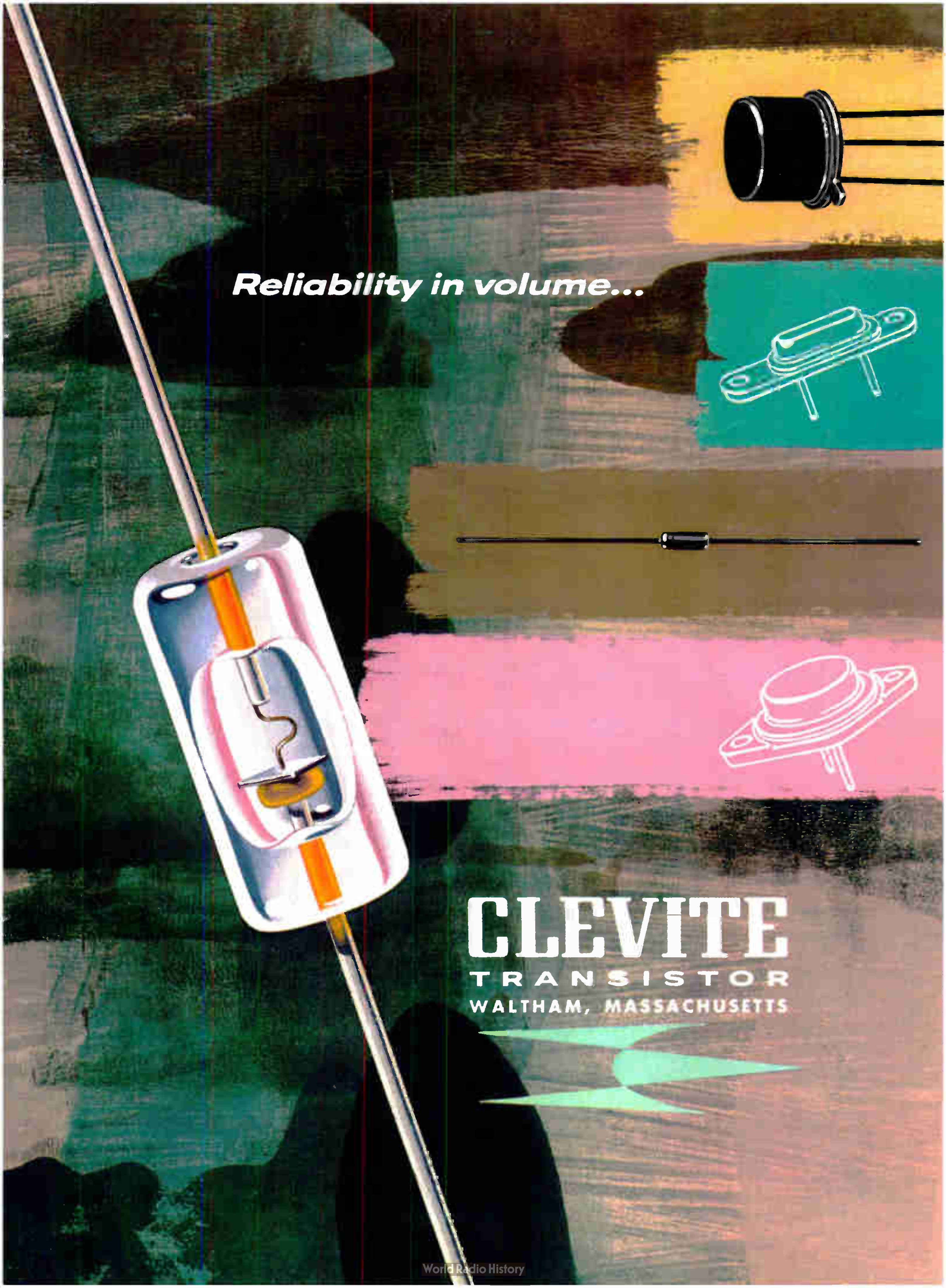
Reliability in volume...
CLEVITE
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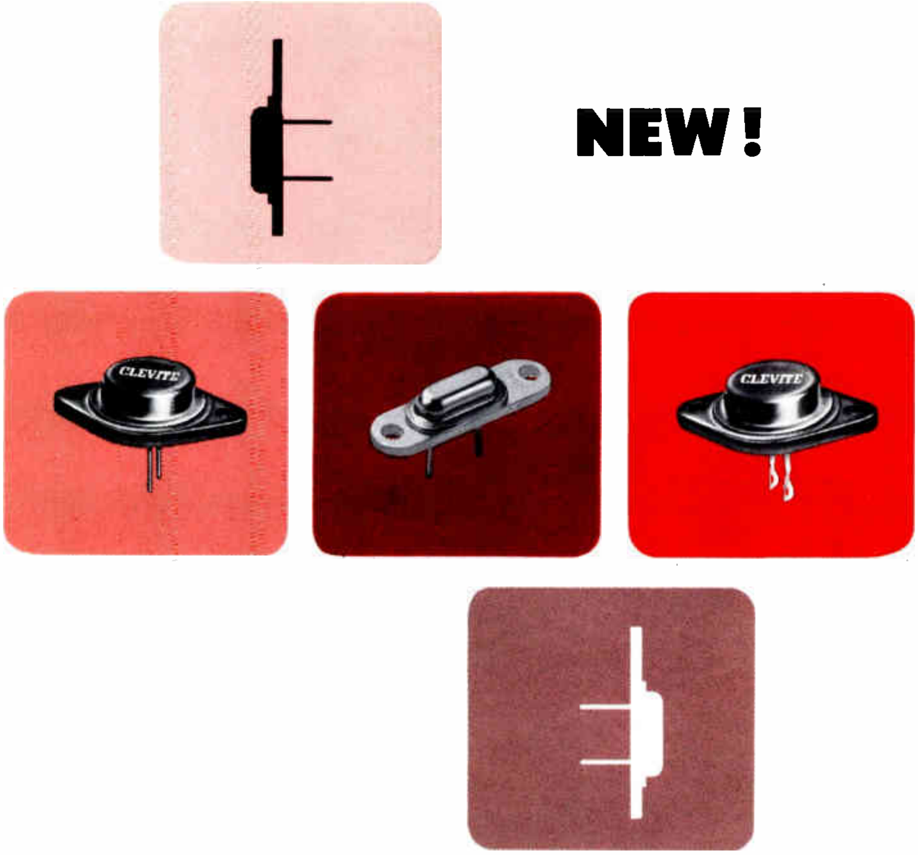


NEW!

ADVANCED DESIGN POWER TRANSISTORS FROM CLEVITE

Three new lines of germanium power transistors by Clevite feature new advances in controlled gain spread, fully specified collector-to-emitter voltage characteristics and low current leakage — even at maximum voltages and high temperatures.

The new 8 ampere switching series can be used to replace the older, more costly ring-emitter types in 3 to 8 ampere service.

The new 25 ampere switching type offers exceptionally low saturation voltage and is available with either pin terminals or solder lugs.

The new Spacesaver design not only affords important savings in space and weight, but its significantly improved frequency response means higher audio fidelity, faster switching and better performance in regulated power supply applications. Its low base resistance gives lower input impedance for equal power gain and lower saturation resistance, resulting in lower "switched-on" voltage drop. Lower cut off current results in better temperature stability in direct coupled circuits and a higher "switched-off" impedance.

CLEVITE NOW OFFERS THESE COMPLETE LINES

Switching Types	Amplifier Types
5 ampere	2 watt
8 ampere	4 watt
15 ampere	2 watt Spacesaver
25 ampere	
3 ampere Spacesaver	

All Clevite germanium power transistors are designed for low thermal resistance, low base input voltage, low saturation voltage and superior current gain.

For latest data and prices or application assistance, write for Bulletin 60 . . .

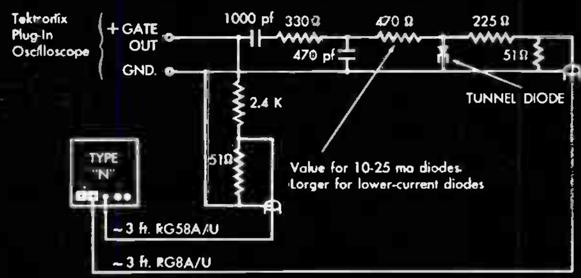
A DIVISION OF CLEVITE CORPORATION

Reliability in volume . . .

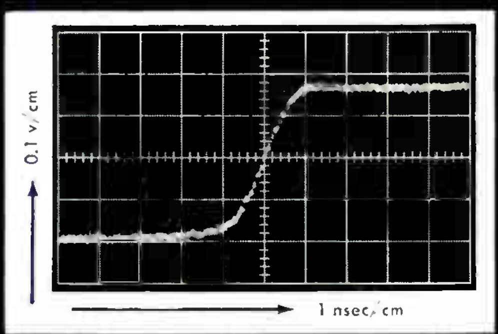
CLEVITE TRANSISTOR

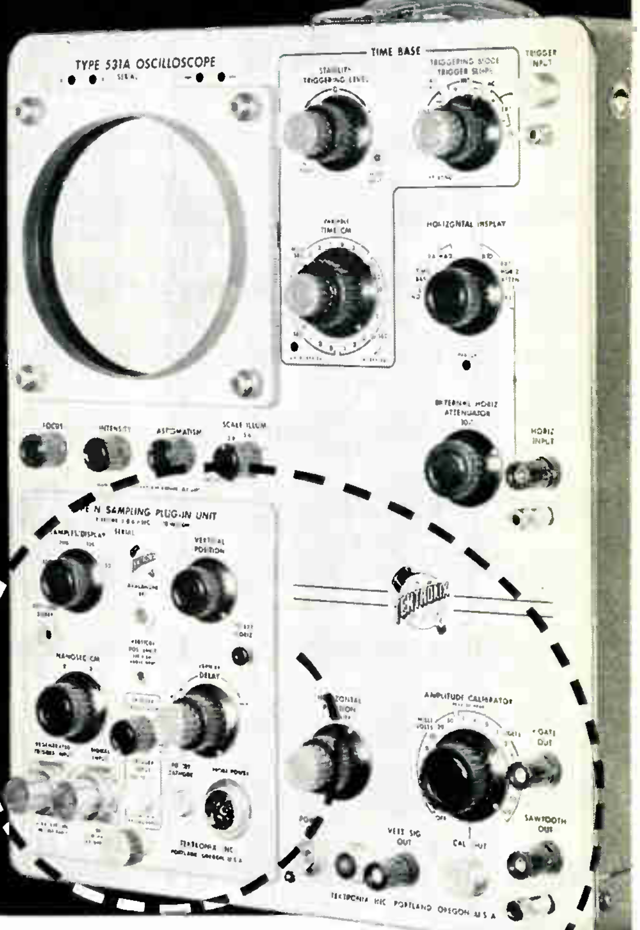
254 Crescent Street Waltham 54, Mass. Tel: TWinbrook 4-9330

Tunnel Diode Switching Time Measurement
with Tektronix Type N Sampling Plug-In Unit



A convenient low-cost method of testing tunnel (Esaki) diodes with nanosecond switching speeds is shown above. A Tektronix Plug-In Oscilloscope provides both the current ramp source for the tunnel diode and the pretrigger for the Type N Unit. The N Unit is set up in the usual way — however, the oscilloscope main sweep generator is allowed to free run at 1 μsec/cm. The + GATE OUT not only triggers the N Unit but also provides a delayed current ramp with a low rate of change—which allows the tunnel diode to switch at essentially its own rate.





NEW PULSE-SAMPLING UNIT
for all Tektronix Plug-In Oscilloscopes

The new Type N Unit converts your Tektronix Plug-In Oscilloscope to a Pulse-Sampling Oscilloscope with a risetime of 0.6 nanoseconds. Applications in which the signal source can furnish a "pretrigger", such as that shown above, require no additional equipment.

For a completely versatile Pulse-Sampling System, Tektronix also manufactures a Pulse Generator and Trigger Takeoff, a 60-nsec Delay Line, a Pretrigger Pulse Generator, and several useful accessories. Please call your Tektronix Field Engineer for complete details and, if desired, a demonstration of the Type N Unit or the complete System.

Characteristics

0.6 nsec risetime (approximately 600 mc).

10 mv/cm sensitivity. (2 mv or less amplitude noise.)

1, 2, 5, and 10 nsec/cm equivalent sweep times (20 to 50 psec time noise).

50-ohm input impedance.

50, 100, 200, and 500 samples per display.

Sampling rate — 50 c to 100 kc.

±120 mv minimum linear range (safe overload 4 v).

Trigger input requirement: +0.5 v, 1 nsec duration, 40 nsec in advance of signal. Recovery time is 10 μsec. Counts down from 50 mc.

PRICE **$600**
f.o.b. factory

Tektronix, Inc.

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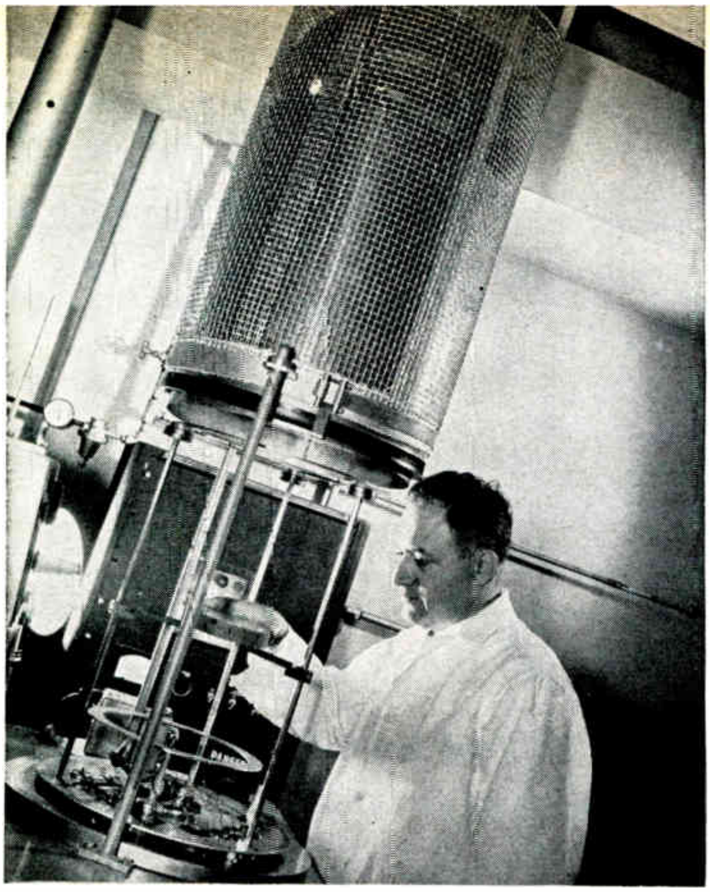

Vacuum evaporator is readied for operation in bolometer lab at Servo Corporation, one of more than 56 firms working to aid Long Island growth

LONG ISLANDERS LAUNCH
SELF-HELP PLAN

INTERVIEWS THIS WEEK with electronics companies on Long Island reveal the growth of a regional awareness that is bringing new vitality to this once "depressed" island appendage to New York state.

Industry expansion in the area began during World War II in support of the then booming aircraft production there. After the war, business activity declined sharply —dragging down with it the finances and morale of many small electronics companies.

A survey this week by ELECTRONICS reveals this: a greatly increased morale and much constructive activity and thinking are lifting the region by its bootstraps. Increased plant facilities, larger payrolls, more sales volume and other growth signs are readily evident (see survey table covering 35 firms).

Credit for this upturn is given basically to two instrumentalities: one is the formation of bidding teams in which a number of small firms go out after contracts too large for any of them to handle individually (ELECTRONICS, p 40, Feb. 20, 1959). The other is the formation of a strong trade association aimed at promoting regional loyalty and industry potential.

Presently the fastest-growing trade organization on the island, the Long Island Electronics Manufacturers Council numbers 56 companies, with more now on the way. Membership includes such corporations as Republic Aviation, Sperry Gyroscope, Sylvania, as well as medium companies and small firms having as few as 18 employees in 4,000 sq ft of plant space.

Many Handicaps

Spokesmen from member companies of LIEMC point out there are many handicaps to their aims. The president of a major component company says a good bit of the trouble is political. "In such heavy electronics states as California and Massachusetts, voices can be raised at the federal level in matters affecting the industry, but there is no senator from Long Island."

A test equipment manufacturer adds this comment: "Here on the island, there is no institute of higher learning to act as a rallying point. No MIT or UCLA."

A number of LIEMC members are working to remedy this particular shortcoming via an assistance program with Garden City's Adelphi Research Center. Funds and technical assistance being channeled into the center will someday make it a focal research site, according to its supporters.

Another obstacle Long Island electronics men have to overcome is the competition and political attention of the rest of New York state. Such major electronics centers as Rochester, Schenectady, Syracuse and others are vital factors in the way Long Island's industry can grow.

HOW FAST 35 L. I. FIRMS ARE GROWING*

	1951	1959	1960 (Projected)
NET SALES	$389,725,000	$605,000,000	$633,100,000
EMPLOYEES	25,533	34,517	36,396
PAYROLL	$135,211,000	$222,500,000	$230,675,000
MATERIALS & COMPONENTS PURCHASED	$128,115,000	$215,951,000	$222,580,000
PURCHASES OFF L. I.	—	$182,000,000	—
PURCHASES ON L. I.	—	$34,000,000	—
PLANT SPACE (Ft^2)	4,403,800	5,965,000	6,178,000
MILITARY SALES	—	$570,000,000 ($126 Million—Prime contracts) ($144 Million—Sub contracts)	—
COMMERCIAL SALES	—	$35,000,000	—
LOCAL TAXES PAID	—	$2,100,000	—

*Source: Survey by Long Island Electronics Manufacturers Council

Despite these handicaps, electronics has become Long Island's number one industry. There has been a step-up in inter-company liaison, a closer look at local suppliers before purchase orders are written, and an increase in regional subcontracting.

Some credit for this is given to what the president of a systems producer calls "the second generation of electronics men."

The new executives aren't content to sit back and wait for orders. They are going out after contracts, visiting each other's plants and bringing vitality into the whole area.

Bid Combinations

One group recently formed to stimulate trade is the National Electronics Facilities Organization, Inc. Of the seven member companies, all but two are headquartered on Long Island. The five L. I. firms are: Dade Associates, Garden City; General Transistor, Jamaica; Servo Corp. of America, Hicksville; Specialty Electronics Development Corp., Syosset, and Technical Research Group, Syosset.

The purpose of this joint venture is to bid for government work at prime contractor levels. NEFO has combined assets of nearly $30 million and had 1959 sales of $61 million. In the aggregate it has more than 4,000 employees (including 30 Ph. D's). President this year is Henry Blackstone of Servo Corp.

Within the next 30 days the group expects to submit bids on contracts. A NEFO spokesman tells ELECTRONICS seven bids will be made on military, commercial and government agency work.

Members of LIEMC include:

Acoustica Assoc., Aerotest Labs., Airborne Inst. Lab., Amperex Electronic, Analogue Controls, Amer. Bosch Arma, Audio Equip. Co., Avien Inc., Avnet Electronics, Bam Electronics Lab, Belock Instr., Cable Designs Inc., Computer Instruments, Consolidated Avionics, Continental Connector, Crosby Teletronics, Dorne & Margolin, Fairchild Camera & Inst., Ferranti Electric, Filtors Inc., Filtron Co. Inc., General Transistor, Glass-Quar Co., Hitemp Wires.

And, Grumman Aircraft, IMC Magnetics Corp., Instruments for Industry, Intercontinental Electronics, Leemath Inc., Madigan Corp., Magnetico Inc., Mechatrol div. of Servomechanisms Inc., Paromal Products, Inc., Photocircuits Corp., Polarad Electronics, Republic Aviation, Republic Electronic Ind., Rosedale Electronics Inc., Servo Corp of America, Silicon Transistor Corp., Skills Unlimited, Sperry Gyroscope, Sylvania Electric, Telechrome Mfg., Tempo Instrument, Transistor Specialties, Trio Laboratories, Trygon Electronics, Victory Electronics, Waldorf Electronics, Wheeler Laboratories.

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MG Electrical Supply Co.

BOSTON, MASS.
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BROOKLYN, N. Y.
Electrical Equipment Corp.

CLEVELAND, OHIO
Pioneer Electronic Supply Co.

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DAYTON, OHIO
Srepco, Inc.

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INDIANAPOLIS, IND.
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Sun Radio & Electronics Co., Inc.

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C & G Electronics Co.

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Interstate Supply Co.

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Morris Electronics of Syracuse, Inc.

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C & G Radio Supply Co.

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Electronic Industrial Sales, Inc.

WATERBURY, CONN.
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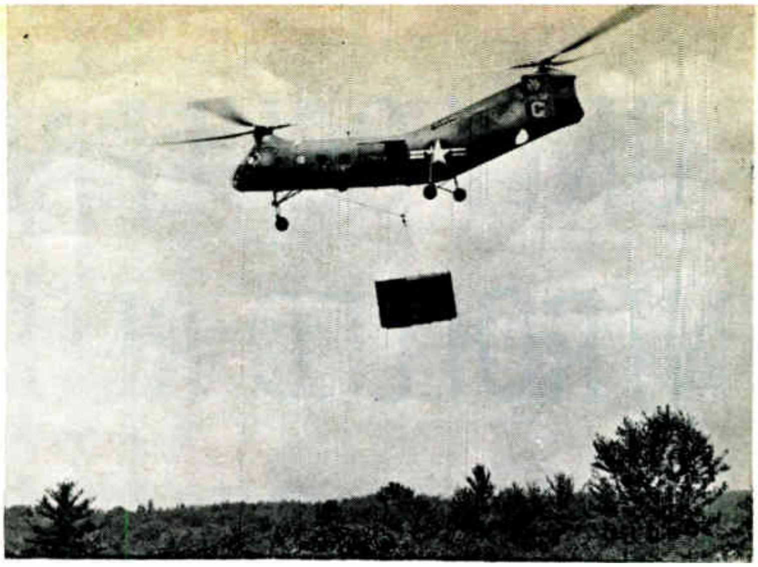
STACKPOLE

Automatic Weather Station



Craig Systems' Helicop-Hut holds gear for collecting weather data

TRAVELS BY HELICOPTER

By FRANK JACOBS

Project Engineer,
Specialty Electronics Development Corp.,
Syosset, N. Y.

A NEED FOR MEANS of gathering meteorological information in mountainous and other impassable areas has led to development of a completely automatic and easily transportable weather station.

The station was made by Specialty Electronics Development Corp. for the Army Electronic Proving Grounds at Fort Huachuca, Ariz. Its essential characteristics are automatic operation and mobility—plus its ability to operate for months without attention.

Records, Transmits Data

The station records data and then, when called upon by a central point, transmits the readings by radio or wire line.

Each station, weighing less than a ton, is housed in a standard shelter designed for lifting by helicopter.

The weather report consists of a station identification number, free air temperature, dew point temperature, wind direction, wind speed, air pressure, precipitation.

The accuracy of the apparatus is confined to the following limits:

Air Temperature ±1.5 degrees F; dew point temperature ±3 degrees F; wind direction ±5 degrees; wind speed ±5 knots (5.77 mph); air pressure from 650 to 1050 millibars ±0.33mb; precipitation ±0.02 in.

The system is not limited to the data listed, but can be adapted or expanded for the recording of cloud ceiling heights (ceilometer), atomic radiation detection, ground temperatures, or seismographic tremors.

The recording is done through a standard teleprinter code. The meteorological parameters are measured and coded at the remote locations and are received on a Teletypewriter TT-8/FG at the central station. Provision is made for service checking at the various stations, by means of an identical teletypewriter.

The remote stations are selected by means of an automatic triggering system, consisting of a Hupps Electronics Co. (ERX) sender selector connected through a converter to a radio transmitter or to a wire line.

Each remote station is provided with a receiver selector.

The operator of the central station presses a numbered button corresponding to the remote station identification, and the selection is made automatically by means of a selective code. Control is had of "group" or "individual" stations. Alerting all stations and turning on wind speed reading is done by group.

Readout is accomplished by individual station.

The central station is relatively simple, consisting only of the radio link, converter, teletypewriter transmitter and control.

Weather-gathering equipment is connected by electrical cables and capillary tubing to the termination panel and then to the coder panel. The latter panel accepts converted analog to digital data from printed boards for wind direction, air temperature, dew point temperature and air pressure. A clamping circuit fixes the data momentarily, and a master stepping selector switch picks up the information.

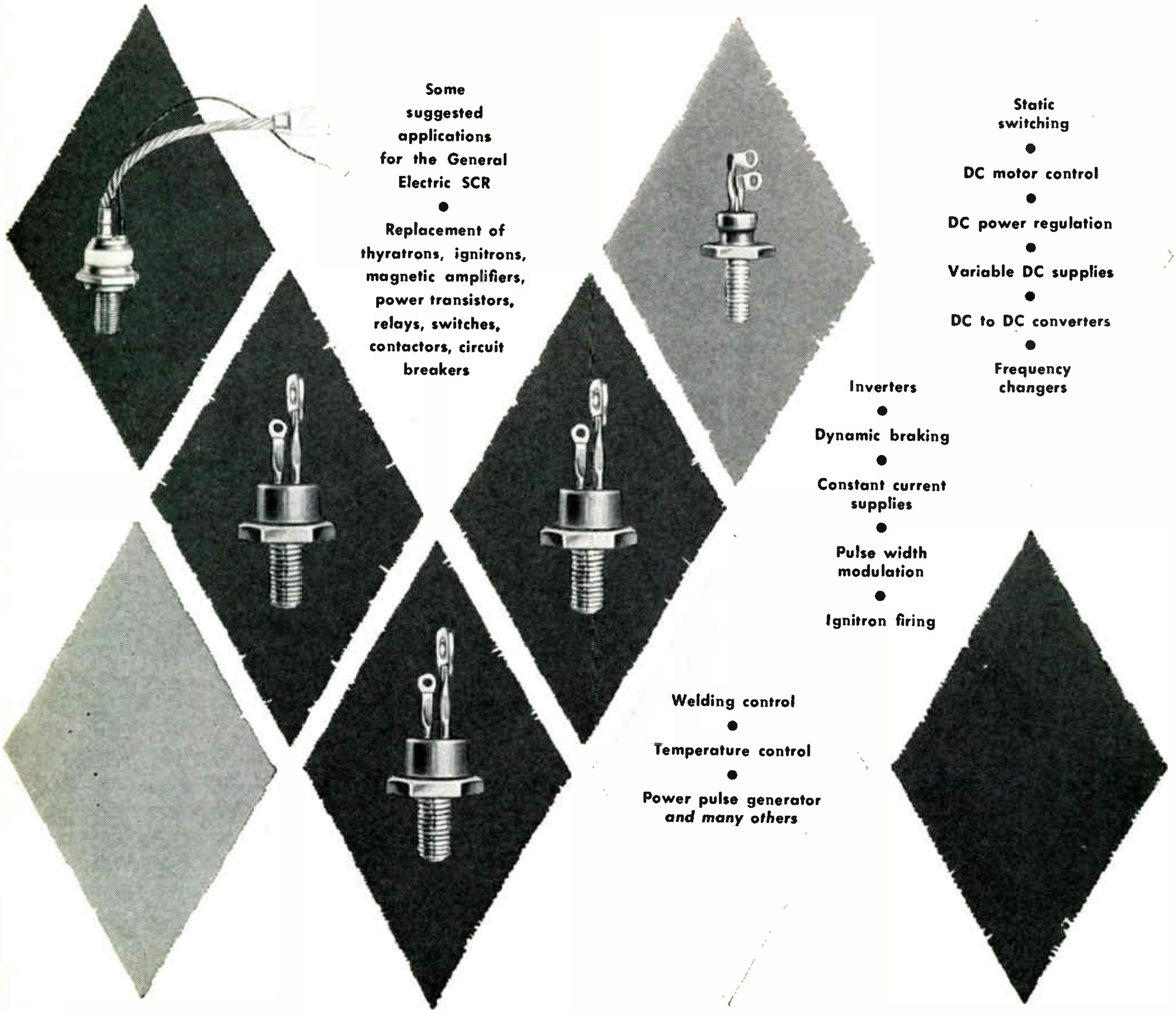
Series of Steppers

In the case of wind speed, the data is the average over a period of one minute, recorded on a separate series of steppers. Rainfall is also accumulated by means of digital steppers, but for the entire period between readouts.

As the master stepper scans the variously collected data, the digital information is transformed into a code acceptable to the teletypewriter, by means of a diode matrix. The diode matrix connects to the transmitter-distributor panel and then to the converter panel and transceiver for transmission to the teletypewriter of the central station.

The maximum power requirement of a remote station is 3 kw, 95 to 130 v, 57 to 63 cycles. This includes a 75 watt rf output transceiver and a space heater requiring 1,650 watts, as well as lights and work bench service equipment. Continuous operation over a wire line in a mild climate requires less than 1 kw.

ONLY GENERAL ELECTRIC CONTROLLED RECTIFIER FOR PURPOSE - A COMPLETE 1 TO 50 AMPS, 25 TO 400



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VOLTS

Since its introduction in 1957 by General Electric, hundreds of firms have successfully incorporated G-E Silicon Controlled Rectifiers into their products. The impact of this revolutionary device that not only rectifies but controls current is growing every day. Volume production of a wide range of SCR types is now a reality at General Electric.

G.E.'s medium-current C35 Series provides blocking voltages to 400 volts and load currents to 16 amperes. The high-current C60 Series goes to 300 volts and 50 amperes; low-current C10 Series 400 volts and 4 amperes. The C40 Series has ratings identical to C35, but is specially selected to furnish guaranteed fast turn-off time for inverter circuits. The C36 Series has ratings lower than C35, with currents up to 10 amperes. The C60 features an all hard-solder design for a high degree of freedom from thermal fatigue.

New SCR Application Manual presents all significant design information developed to date and many new circuits. Your G-E Semiconductor Sales Representative also has complete application data. Many authorized G-E Distributors now stock Silicon Controlled Rectifiers for fast delivery at factory prices in quantities up to 100.

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General Electric Company, Semiconductor Products Dept., Electronics Park, Syracuse, N. Y. In Canada: Canadian General Electric Co., 189 Dufferin St., Toronto, Ont., Export: International General Electric Co., 150 East 42nd St., N. Y. 17, N. Y.

Maximum Allowable Ratings*	C10 Series (8 types)	C35 Series (8 types)	C40 Series (5 types)	C36 Series (8 types)	C60 Series (7 types)	
Continuous Peak Inverse Voltage (PIV) and Minimum Forward Breakover Voltage (V_{BO})	25-400	25-400	100-300	25-400	25-300	Volts
Transient Peak Inverse Voltage (non-recurrent <5 millisecond)	35-500	35-500	35-500	35-500	35-400	Volts
Average Forward Current, Single Phase (up to)	4.7 @ 60°C Stud	16 @ 65°C Stud	16 @ 65°C Stud	10 @ 43°C Stud	50 @ 87°C Stud	Amperes
Peak One Cycle Surge Current	60	150	150	125	1000	Amperes
Operating Temperature	−65°C to +150°C	−65°C to +125°C	−65°C to +125°C	−40°C to +100°C	−65°C to +150°C	
Characteristics At Maximum Ratings						
Maximum Forward Voltage (full cycle Avg.) at Maximum Forward Current	0.75	0.86	0.86	1.25	0.75	Volts
Maximum Gate Current to Fire (I_{GF})	6	25	25	50	50	ma
Maximum Gate Voltage to Fire (V_{GF})	2	3	3	3.5	3.5	Volts
Maximum Thermal Resistance (R_T)	3.1°	2°	2°	2.5°	0.7°	°C/watt Junction to Stud

*Ratings shown are from the lowest to the highest rated types within the series.

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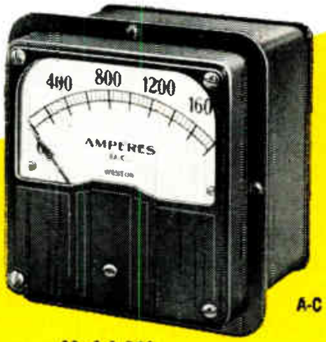

Model 921

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	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

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CIRCLE 47 ON READER SERVICE CARD

Japan Ponders Export Policy

Nippon manufacturers fear government will set a quota for transistor radios to U. S.

TOKYO—Japanese transistor radio manufacturers fear the government will impose a quota system on their exports, it was learned last week.

The manufacturers had asked MITI (Ministry of International Trade and Industry) to approve a reduction in the export floor price from $14 to $11. They expected to put lower price schedules into effect April 1, but MITI held up approval until April 11.

As a result of the government's delay, many U. S. orders placed in anticipation of lower prices were canceled and prospective buyers held off.

Makers In 'Squeeze'

Although MITI explains the delay officially as a "matter of procedural routine," industry sources note that some government officials have been advocating a quota system along with the price changes. Observers feel the government has now given a conditional go-ahead and may impose the quota system if the floor price is violated.

Now some Japanese manufacturers find themselves in a "squeeze" because they have been exporting to the U. S. standard model transistor radios (six or more transistors) for as low as $9 a set.

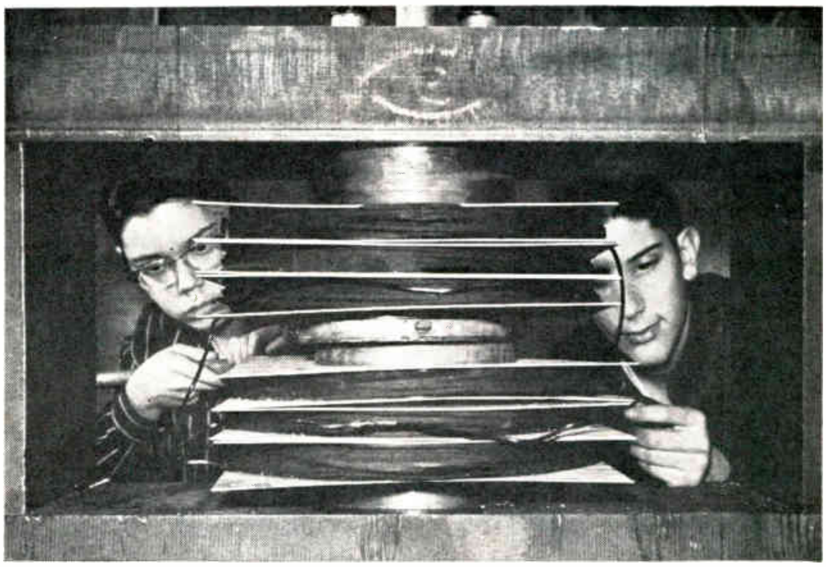
From April 1 to April 16 the rush by manufacturers to apply for export licenses covered 400,000 units. The number of sets covered by applications this month was expected to reach 600,000.

Both MITI and the Japanese Foreign Office now fear that if permission is granted to export more than 500,000 sets monthly to the U. S. the result may be an intensification of American moves to restrict Japanese transistor radio imports, as well as throw the highly competitive domestic industry into confusion.

The opinion seems to be gaining ground in government circles that some check on the transistor radio exports is necessary, either control of the quantity or a temporary suspension of export permits.

Industry spokesmen have said they oppose any quantitative control, regard it as running counter to general foreign trade liberalization trends. They contend that the

Magnetic Unit Attracts Students



Two-ton magnetic unit is studied by Levittown High, N. Y., student members of JETS (Junior Engineering Tech Society), who will use it in a cyclotron they are building. JETS is a nationwide group sponsored by industry and education.

1-million-sets-plus a month that they exported last year to the U. S. did not bring restrictive measures because the exports merely met orders. These sources assert that this year's big rush for export applications by Japanese companies was stirred by foreign buyers who placed large orders in expectation of lower prices.

Expect Stabilization

The industry spokesmen add that they believe Japanese export of transistor radios would be stabilized at 500,000 units a month anyway in "due course."

Meanwhile, Sony president Masaru Iouka, who returned last week to Tokyo from a U. S. visit, said one of the most promising export items for the U. S. market this year is transistor tv. He noted that inventories of transistor radio sets in the U. S. were "rather high."

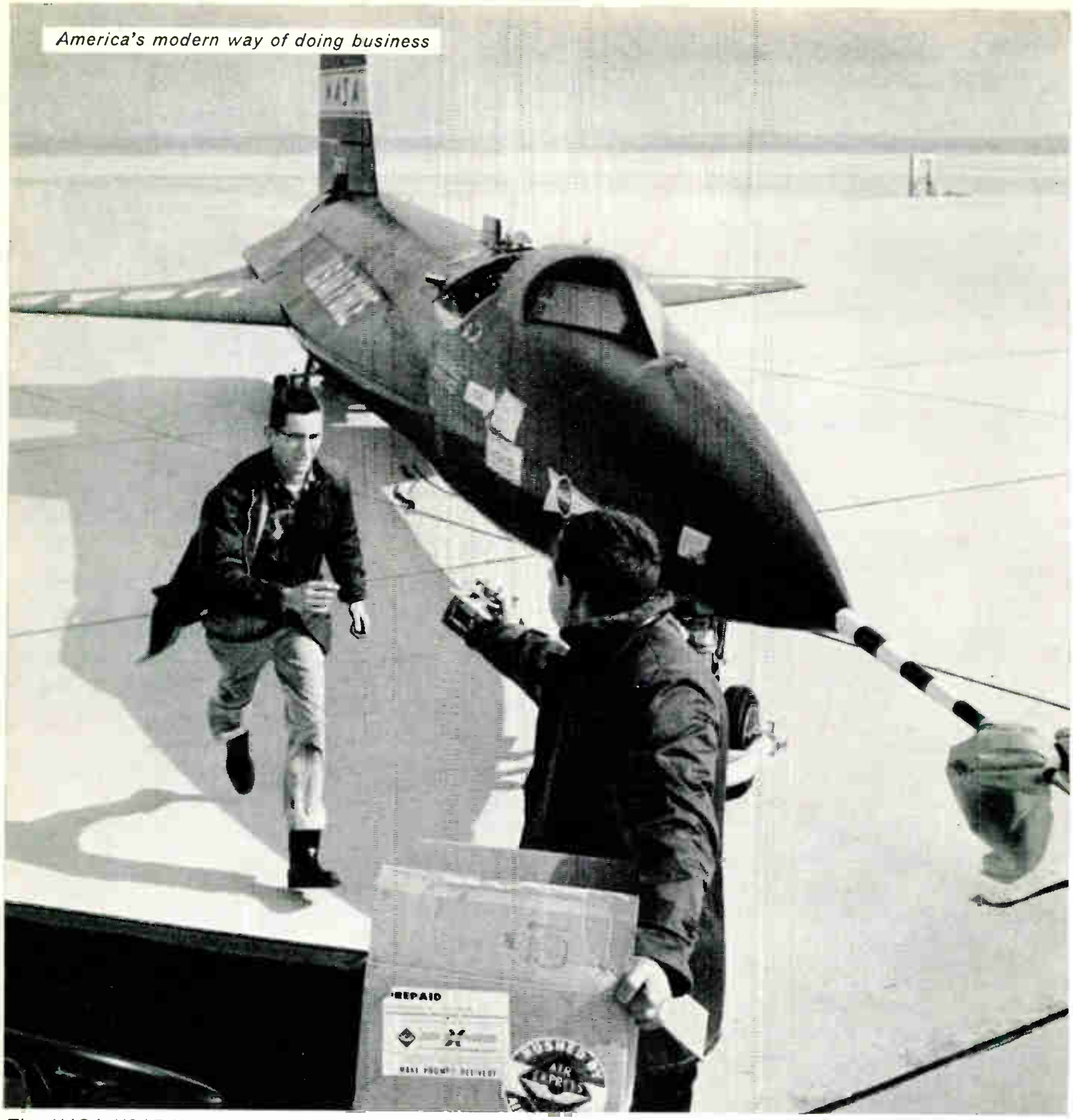
Industry sources also predict a pickup in exports of tape recorders this year, note that Japan exported about two-thirds of the 70,000 units shipped to the U. S. from abroad last year.

New High-Speed Fax For Weather Maps

U. S. WEATHER BUREAU is completing installation of advanced, high-speed facsimile recording equipment for its high-altitude weather map network.

Equipment produced by the Alden Electronic & Impulse Recording Equipment Co., Westboro, Mass. is expected to be in operation soon at all network stations located throughout the U. S., including Alaska, Hawaii, and Puerto Rico. Last June the first units went to weather stations at Suitland, Md., and New York's Idlewild Airport.

The system, which provides comprehensive jetstream data to transoceanic aircraft, can now transmit 120 lines a minute, the Weather Bureau says. However, Alden reports its equipment is capable of up to 900 lines a minute with higher capacity lines but without reengineering. The company says its flatcopy scanners permit continuous scanning of any size map without cutting because map doesn't have to fit the size of a scanner drum.



The NASA-USAF-Navy X-15 manned rocket gets a vital part . . . delivered with jet-age speed by AIR EXPRESS

X-15 part flies first 3000 miles by Air Express

The scene: Edwards Air Force Base, Calif. Crack engineers work 'round the clock to ready the X-15 for its flight to the brink of outer space. Its engine, built by Thiokol in Denville, New Jersey, packs a 400,000 HP punch—more than the power of two giant ocean liners! Because of an accelerated assembly schedule, some parts—like this turbine pump control—are installed right on the flight line. They must be shipped fast, with kid-glove handling. In short, a job for low-cost AIR EXPRESS. Give your business these advantages, too. Call AIR EXPRESS to speed your products FIRST TO MARKET . . . . FIRST TO SELL.

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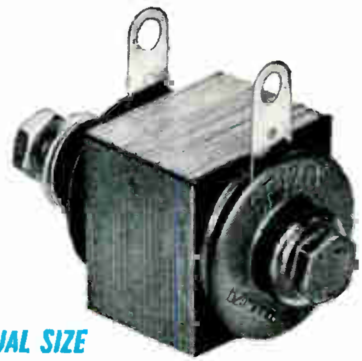
SURGE PROTECTORS for Silicon Rectifiers



ACTUAL SIZE

GUARD SILICON RECTIFIERS AGAINST BREAKDOWN FROM TRANSIENT HIGH VOLTAGES

REDUCE INITIAL RECTIFIER COST

To protect silicon rectifiers against destructive voltage surges, design engineers are using rectifiers rated considerably higher than the normal operating level. This is a costly practice, and doesn't always guarantee reliable rectifier performance and freedom from breakdown.

The new Vickers CaptiVolt Surge Protector, with its non-linear resistance characteristics, eliminates the need for extreme derating of cells . . . assures greater reliability and longer rectifier life. Connected across the secondary of the transformer supplying AC to the rectifier circuit, the CaptiVolt absorbs excessive intermittent energy up to 3000 watts. Extreme decrease in CaptiVolt resistance with small increase in voltage shunts destructive voltages . . . protects the rectifier. Under normal operating voltages the high resistance of the surge protector consumes less than 5 watts.

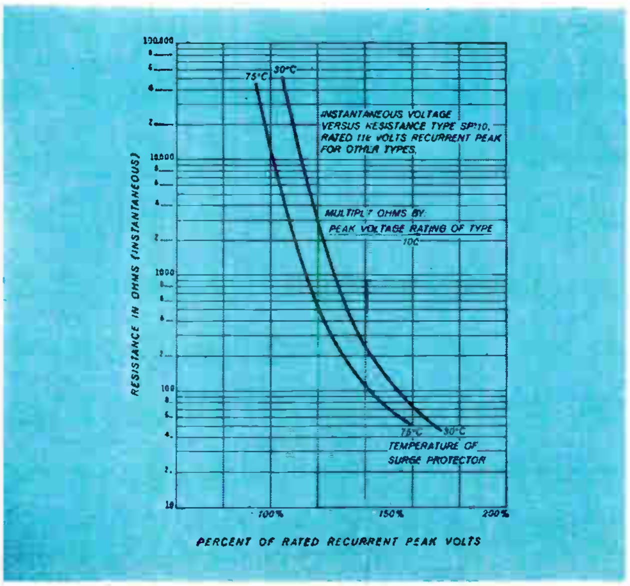


Chart below shows the remarkable savings with just one of these low-cost devices.

AN EXAMPLE OF THE COST SAVINGS WITH THE NEW VICKERS SURGE PROTECTOR

Normal operating conditions 200 p.i.v. with 600 p.i.v. transient voltage	Rated rectifier required (p.i.v.)	Cost
WITHOUT CAPTIVOLT Surge Protector	600	$100.00
WITH CAPTIVOLT Surge Protector	400	53.00
Savings on rectifier.		$47.00
Cost of surge protector. . . .		1.80
NET SAVINGS.		$45.20

The CaptiVolt has been field tested for more than a year, laboratory surge tested for more than 20,000,000 cycles.

STANDARD TYPES AND RATINGS

Type No.	Rated Peak Volts, Recurrent Continuous Duty Across AC Line	Rated RMS Volts, Continuous Duty Across Sinusoidal AC Line	[1]Maximum Dissipation, Average Watts	Maximum Recommended Surge Amperes, Instantaneous (Convection Cooling)	PRICE EACH (NET)
SP105	50	35	12	5	$1.95
SP110	100	70	14	5	2.20
SP115	150	105	17	5	2.50
SP120	200	140	20	5	2.70
SP125	250	175	23	5	2.95
SP130	300	210	26	5	3.15
SP140	400	280	32	5	3.70
SP150	500	350	38	5	4.20
SP160	600	420	44	5	4.65

[1]If fan cooling at velocity of 600 LFM is employed, multiply watts by two (2).

EPA 3130-1

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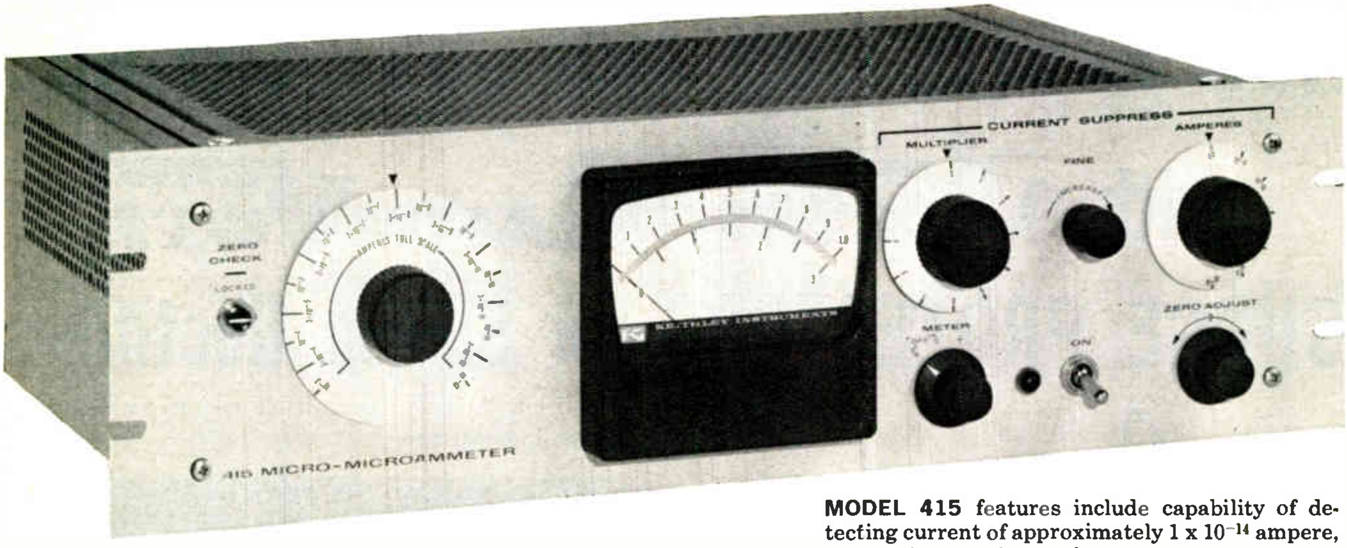
CIRCLE 51 ON READER SERVICE CARD



MODEL 415 features include capability of detecting current of approximately 1 x 10^{-14} ampere, a 1% mirror scale panel meter.

new high-speed research micro-microammeter

Model 415 offers high speed of response, accuracy, and zero suppression.

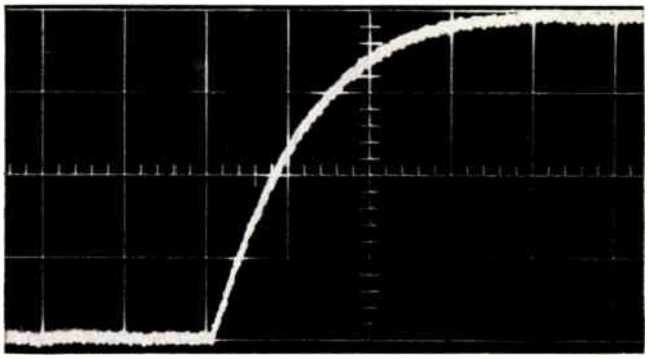
The new Model 415 incorporates advanced high-speed circuitry developed by Keithley Instruments for rocket and satellite experimentation — where measurements of Lyman-Alpha night glow and upper air density require fast response.

A speed response of less than 600 milliseconds to 90% of final value at 10^{-12} ampere is possible where external circuit capacity is 50 picofarads ($\mu\mu f$). Critical damping of the circuit, with any input capacity, is maintained on all ranges through one infrequent adjustment. There is no possibility of oscillation or poor response, on any range.

Accuracy is ±2% of full scale on 10^{-3} through 10^{-8} ampere ranges, and ±3% of full scale on 3 x 10^{-9} through 10^{-12} ampere ranges.

The 415 also provides zero suppression up to 100 full scales, permitting full scale display of one per cent variations of a signal. Once suppressed to zero, such variations may be observed on any of the next four more sensitive ranges without re-setting the suppression.

Excelling other Keithley 400 Series Micro-micro-ammeters in speed of response, the 415 is ideal for current measurements in ion chambers, photomultipliers, gas chromatography, mass spectrometry.



AN OSCILLOGRAM demonstrating response to a current step of 10^{-12} ampere. Input capacity is 35 picofarads ($\mu\mu f$). One major horizontal division equals 200 milliseconds.

BRIEF SPECIFICATIONS

RANGES: 10^{-12}, 3 x 10^{-12}, 10^{-11}, 3 x 10^{-11}, etc. to 10^{-3} ampere f.s.

ACCURACY: ±2% f.s. 10^{-3} thru 10^{-8} ampere ranges; ±3% f.s. 3 x 10^{-9} thru 10^{-12} ampere ranges.

ZERO DRIFT: Less than 2% of f.s. per day after warmup.

INPUT: Grid current less than 5 x 10^{-14} ampere.

OUTPUT: 1 v f.s. at up to 5 ma. Noise less than 20 mv.

RISE TIME: Typical values given in sec. to 90% of final values.

Range amps f.s.	C_{in} = 50 $\mu\mu f$ seconds	C_{in} = 150 $\mu\mu f$ seconds	C_{in} = 1500 $\mu\mu f$ seconds
10^{-12}	.600	.800	2.5
3 x 10^{-12}	.200	.300	1.0
10^{-11}	.060	.080	.250
3 x 10^{-11}	.020	.030	.100
10^{-10}	.006	.010	.030
3 x 10^{-10}	.002	.003	.010
10^{-9}	.001	.001	.003
3 x 10^{-9} and above	.001	.001	.001

PRICE: Model 415, $750.00

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KEITHLEY INSTRUMENTS, INC.
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Israel Forms Electronics Group

Seeks to attract foreign investors and expand production activities. Government giving full support to new move

TEL-AVIV—Government, local scientific institutions and all manufacturers of electronic devices have decided to join forces in an effort to facilitate the industry's expansion and enable it to gradually cover all requirements of the Israel market.

An Electronic Manufacturers Association, incorporating 21 manufacturers, has been established. The Hebrew University, the Israel Institute of Technology and the Weizman Institute of Science and the Standards Institution are advisory members.

What's Planned

Defense Ministry and Trade and Industry Ministry will back the Association, whose plans call for:

1. Contacts with the U. S. Operations Mission aimed at securing the assistance of foreign experts in research problems and having Israel engineers participate in research and industrial projects in the U. S.

2. The introduction of a quality control system evolved in cooperation with the Standards Institution where a laboratory will go into operation in the near future.

Some 80 electronic engineers are turned out each year by the Israel Institute of Technology. Besides, technicians are trained at six vocational schools offering four-year courses. Many of the school graduates are inducted into the Armed Forces as electronic technicians and undergo additional training.

Output: $6 Million

The industry is still in its embryonic stage and its global output does not appear to exceed $6 million a year.

Items produced include: radio receivers, transistors, amplifiers, switches, capacitors, tape recorders, pickups, tube testers, signal generators, inter-communication systems, high-frequency dielectric heaters, fire and burglar alarm systems, X-ray apparatus.

Lately some agreements have been concluded with foreign firms with a view to extending the range of products, partly in order to meet some of the demand of electronic equipment for defense and the postal services.

To Make TV Parts

The industry is also getting ready to manufacture parts for tv sets in anticipation of a government decision to erect a tv transmitter.

In view of the available skilled know-how and labor force, the electronics industry here will try to attract foreign investors and engage in production of more devices.

Expanding Market

X-RAY ANALYSIS equipment will find an expanding market in the field of product control.

That's the prediction of Philip I. Wolf, manager of product specialists for Philips Electronic Instruments, Mt. Vernon, N. Y. Wolf says his firm has noted a marked increase in industry's interest in applications of X-ray analytical instrumentation.

Fuel Cell Power

Portable power pack using 30 ion-membrane fuel cells and weighing about 30 lb is reported by GE to be under development for Marines and Army. Cutaway shows cell setup

MEETINGS AHEAD

May 9-11: Microwave Theory & Techniques, National Symposium, PGMTT of IRE, Coronado Hotel, Coronado (San Diego), Calif.

May 9-12: Instrument-Automation Conf. and Exhibit of 1960, Civic Auditorium and Brooks Hall, San Francisco.

May 10-12: Rural Electrification Conf., AIEE, Sheraton-Fontenelle Hotel, Omaha, Neb.

May 10-12: Electronic Components Conference, PGCP of IRE, AIEE, EIA, WEMA, Hotel Washington, D. C.

May 16-18: Electronic Parts Distributors Show, Electronic Industry Show Corp., Conrad-Hilton Hotel, Chicago.

May 17-18: Superconductive Techniques for Computing Systems, Office of Naval Research, Dept. of Interior Auditorium, Washington, D. C.

May 23-25: National Telemetering Conf., Annual, West Coast, ISA with ARS, AIEE, Miramar Hotel, Santa Barbara, Calif.

May 23-26: Design Engineering Conf., ASME, Coliseum, N. Y. C.

May 24-26: I. E. A. Exhibition, Instruments, Equipments & Components, Olympia, London.

May 24-26: Technical Conf. and Trade Show, Seventh Regional, IRE, ISA, Olympia Hotel, Seattle, Wash.

May 31-June 2: Frequency Control Symposium, USA, Signal Research & Devel. Lab., Shelbourne Hotel, Atlantic City, N. J.

June 1-3: Analysis Instrumentation, Latest Advances, ISA, Queen Elizabeth Hotel, Montreal, Can.

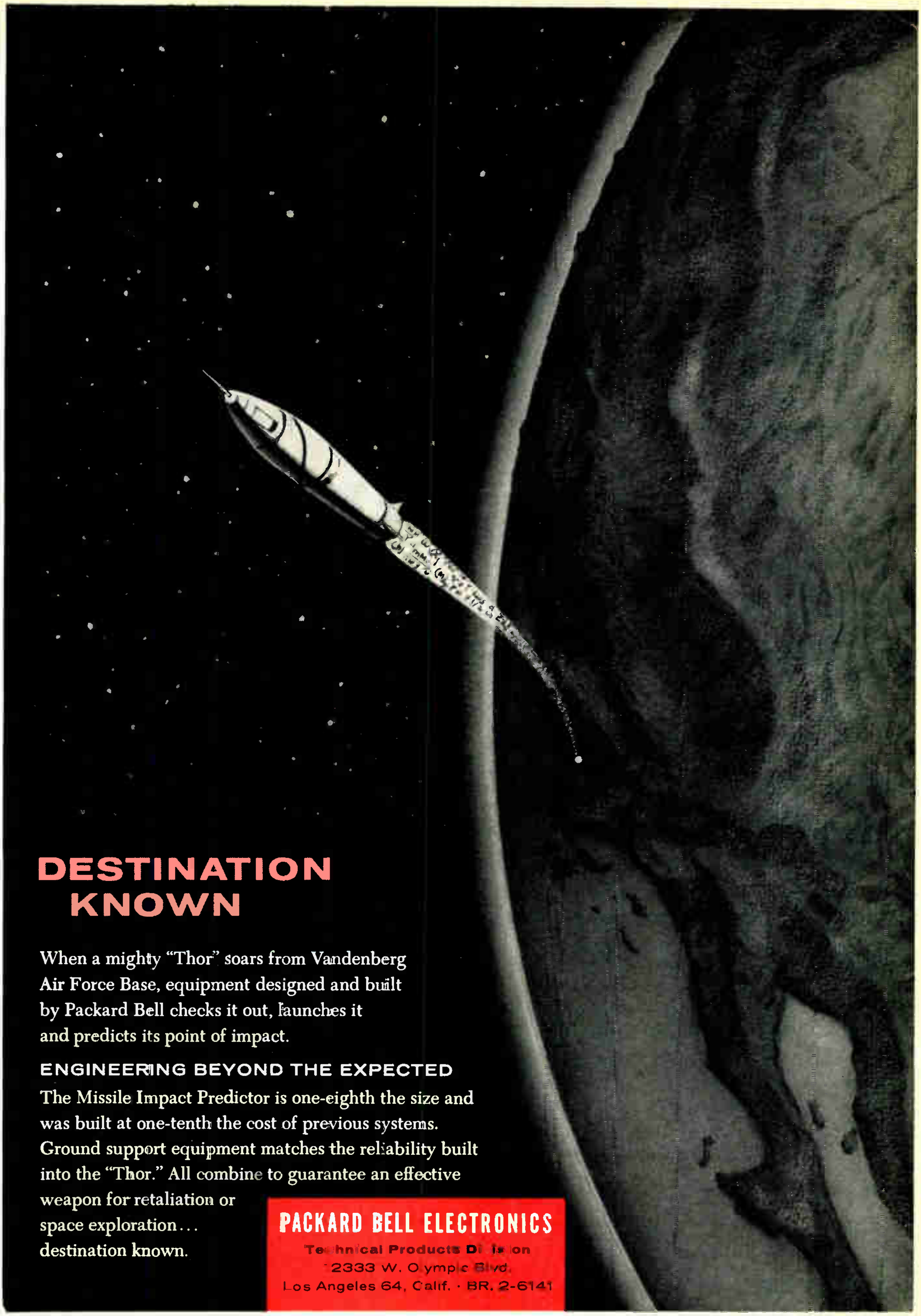
June 1-3: Radar Symposium, Willow Run Laboratories, Univ. of Michigan, Ann Arbor, Mich.

June 14-16: Railroad Communications, Assoc. of Amer. Railroads, Communications Section, Sheraton-Cadillac Hotel, Detroit.

Aug. 23-26: Western Electronic Show and Convention, WESCON, Memorial Sports Arena, Los Angeles.

Oct. 10-12: National Electronics Conf., Hotel Sherman, Chicago.

There's more news in NEW ON the MARKET, PEOPLE and PLANTS and other departments beginning on p 92.



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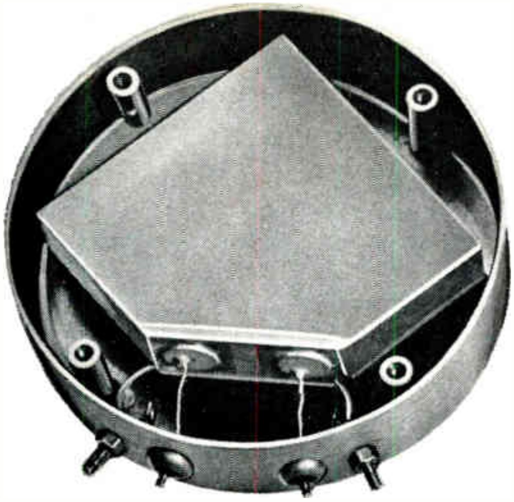
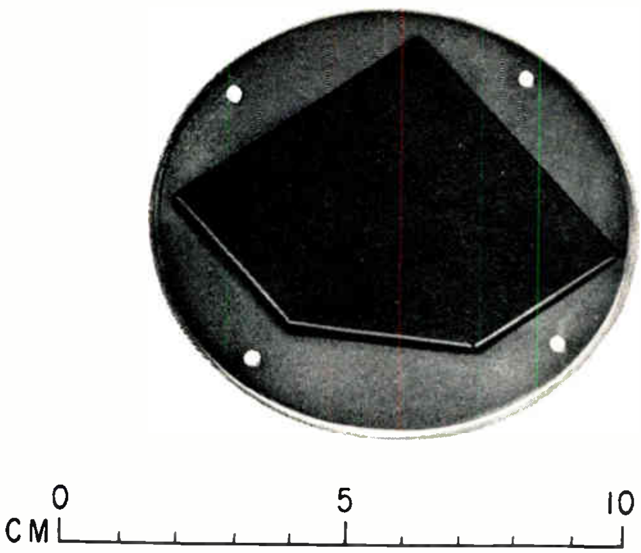


electronics

May 6, 1960

SEQUENTIAL RECEIVERS FOR

French Color Tv System



Henri de France method for compatible tv features simple chrominance circuit. System uses sequential transmission of chrominance and employs one-line memory in receiver

Only special element used is ultrasonic type delay line

By ROGER CHASTE,
Compagnie Générale de TSF, Paris, France;
PIERRE CASSAGNE
and MARCEL COLAS,
Compagnie Francaise de Télévision, Paris, France

BANDWIDTH occupied by a black and white television signal depends on the number of lines used. This number corresponds to a given vertical definition, and it is natural to demand the same definition in the horizontal direction.

Thus, a given number of horizontal spots are made to correspond to a given number of lines and so the duration of a point is finally related to some bandwidth. Since the eye requires less definition for the color information than for the luminance information, it is proper to distribute the decrease in definition between the horizontal and vertical directions. In the Henri de France (HDF) system this is done through time multiplexing of the two chrominance signals.

At the transmitter, only the Y signal and one of the chrominance signals are transmitted at every instant. At each line, the transmitted chrominance signal is permuted. In short, the color is analyzed with the number of lines cut down by half, while the total number of lines is retained for the black and white.

At the receiver, which is examined in detail later, there are only two signals available at any instant, while three are necessary for reconstructing a color picture. To get three signals, use is made of the two signals available at that instant and the chrominance signal that was transmitted in the preceding line. Thus, the three signals are made available by taking advantage of the fact that the eye is incapable of discerning color variations from one line to the next. From one frame to the next, the type of analysis changes for each line. A line analyzed in blue for one frame is analyzed in red for the next.

By time multiplexing of the chrominance signals, a single signal is added to the luminance signal to secure the transmission of a color picture. This single additional signal is then used to modulate a subcarrier whose frequency is situated at the end of the spectrum of the luminance signal Y. Using a process which is now classical, the visibility of this subcarrier is lowered to a frequency that is equal to an odd multiple of half the line frequency. In the first version of the HDF system the subcarrier is amplitude-modulated. Thus, the quality of color reproduction is entirely independent of accidental phase variations. This ensures great ease of transmission, particularly over long radio links.

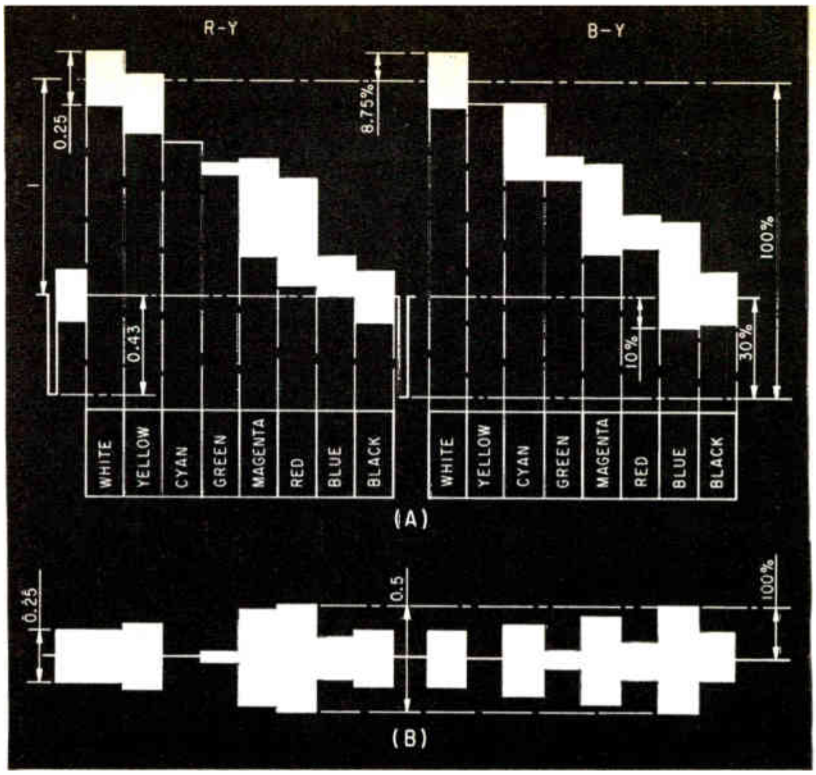


FIG. 1—Composite signal cro pattern (A) and sub carrier signal pattern (B) show differences in transmitted signals

The transmitted signal is different from one line to the next as shown in Fig. 1. Figure 1 corresponds to the case in which the chosen chrominance signals are R-Y and B-Y. The picture transmitted is the test pattern of color bands consisting of a white band, a black band, 3 bands corresponding to the primary colors red, green and blue, and 3 bands corresponding to their complementary colors of yellow, cyan and magenta.

The figure shows the superposition of the amplitude-modulated subcarrier on the stepped signal corresponding to luminance. A given color is defined by the combination of the two subcarrier amplitudes corresponding to two successive lines.

Figure 1 also shows the presence of a nonmodulated subcarrier on the back porch of the R-Y line. This burst is used at the receiver to identify the chrominance signal transmitted.

The experimental receiver shown in Fig. 2 has been designed for band III (174-216 Mc) while in Europe generally and more particularly in France, proposed bands for color television are IV and V (470-960 Mc). The number of lines used is 625. Frequency of the chrominance subcarrier is 4.43 Mc and that of the sound subcarrier is 5.5 Mc. Sound is frequency modulated.

In the receiver (Fig. 2), the r-f amplifier, the mixer, the i-f amplifiers for sound and picture are similar to those used in a black and white receiver. Just a few precautions are taken in the picture channel so that the elimination of sound does not cause a disturbance on the color subcarrier whose frequency is close to that of the sound carrier.

It is mainly after picture detection that the receiver takes up a special aspect due to the color television system used. After first being amplified, the chrominance signal is extracted by filtering from the complete picture signal (luminance + chrominance). This signal is fed to three parallel channels.

The first channel provides both a given amplification and a delay equal to the duration of one line. The second channel amplifies without introducing any delay. These two channels are then switched at line frequency towards two specialized detectors, one detecting the

---

COMPATIBLE COLOR TELEVISION

To make a color television system compatible, one of the electrical signals corresponding to the color picture has to be the same as that given by a simple black-and-white analyzer. This signal, generally denoted Y, is the so-called luminance signal. It is the signal which gives the color picture its definition. It occupies the normal bandwidth corresponding to the tv standard used.

Color can be reproduced at the receiver by two complementary signals, one corresponding to red, R, for instance, and the other to blue, B. For convenience, other complementary signals may be chosen.

Because of the physiological properties of the eye, color signals can be transmitted over a much narrower band than the Y signal. This spectral property corresponds to the fact that the eye is unable to distinguish the color of details, and that these details are provided with all the information in black and white which the eye can make use of.

In any color television system the three signals have to be multiplexed. One of them, the luminance signal Y, has to be transmitted wideband and without transposition, to ensure compatibility. A wider range of methods can be used for the other two colors.

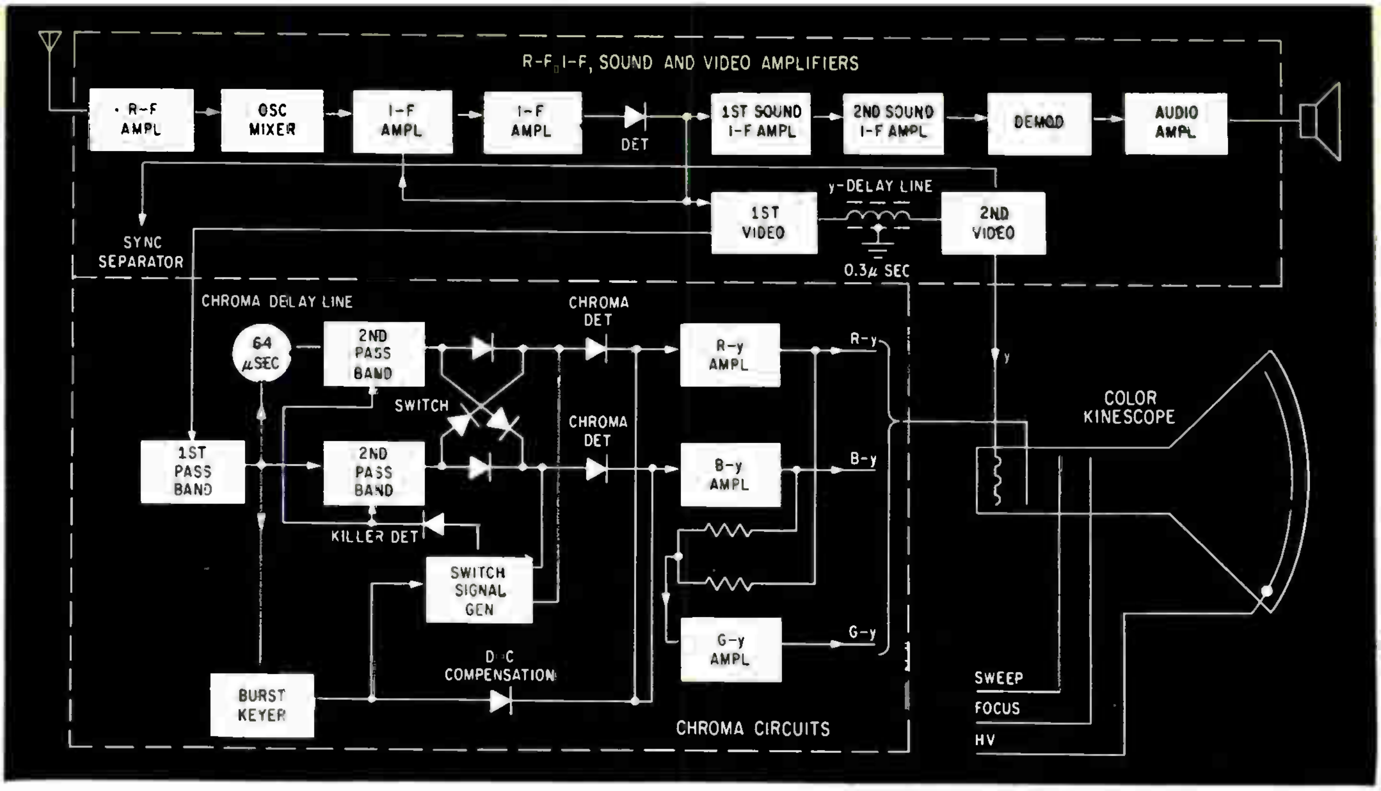


FIG. 2—System is also called Secam for "sequentiel a memoire", pointing up its main features of sequential transmission of chrominance and the use of a memory in the receiver

R-Y signal and the other detecting the B-Y signal. This operation is shown diagrammatically in Fig. 3.

Figure 3A corresponds to the case of line n being analyzed at the transmitter in R-Y. In this case the signal B-Y is that of the preceding line $(n - 1)$ delayed by the duration of one line. Figure 3B corresponds to the next line $(n + 1)$ analyzed in B-Y. By means of the switch, at every instant the two signals can be passed to the appropriate detectors.

The third channel (Fig. 2) identifies at every instant the nature of the chrominance information transmitted, providing means for operating the switch. This identification relies on the use of the few subcarrier cycles present on the back porch of the R-Y lines.

The subcarrier pulsed signal also allows compensation of the d-c component of the chrominance signals and blocking of the chromatic channel when the chrominance signal level is too low (color-killer).

The chrominance circuits are shown in Fig. 4. The untuned primary of transformer T_1 is inserted in the anode circuit of the first video amplifier tube. The low-Q tuned secondary drives the grid of the pentode section of V_1. Potentiometer R_1 in the screen circuit provides for the manual adjustment of the gain of the chrominance chain.

This saturation adjustment is the only chrominance adjustment available to the viewer.

Anode circuits of V_1 match the tube to the low input impedance of the delay line. The latter (see photo) is of the ultrasonic type and consists of a fused silica block of suitable dimensions to cause a delay equal to the duration of one line (64 μsec).

The transducers are small piezoelectric wafers of barium titanate. They convert the voltages to mechanical vibrations in tension. Transformer T_3 matches the low output impedance of the delay line to the input impedance. V_{2A}.

Undelayed signals are collected on potentiometer R_2 which is set up at the delay line input. This potentiometer also equalizes the voltages on the two channels. After amplification by V_{2B} and V_{3B} the direct and delayed signals are transmitted to the switching system by transformers T_4.

The switch consists of silicon diodes D_1, D_2, D_3 and D_4 which, depending on their bias conditions, conduct or cut off the signals to transformers T_5. Through the effect of this switching, the subcarrier modulated by signals B-Y appear only at the secondary of the upper T_5 transformer and the subcarrier modulated by signals R-Y appears

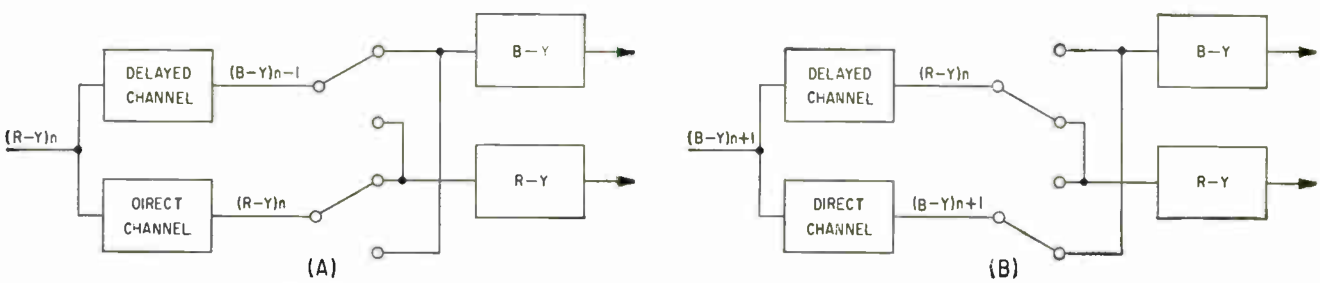


FIG. 3—Operation of switching system is simplified by using one-line memory

only at the secondary of lower T_5 transformer.

After detection by silicon diodes, the R-Y and B-Y signals are filtered and amplified by the two sections of V_1. Each resistance amplifier is provided with inductive compensation and a cathode negative feedback. The output voltages are applied to the R and B guns of a three-color tube through the arrangement for compensating the d-c voltages.

Also, the matrix of R_3, R_5 and the 270K between them restitutes the green signal which is then dealt with in the same manner as the R and B.

Switching voltages are supplied by monostable multivibrator V_{2B} and V_{3B}. They are transmitted to the switch through high-value capacitances. The multivibrator is controlled by a pulse which identifies the chrominance signal in every other line transmitted. This pulse is obtained as follows.

A few cycles of the subcarrier are transmitted only on the back porch of the lines corresponding to red. The complete signal is passed to tube V_{3A} which acts as an open gate for the duration of the back porch. The gate is opened by positive pulses from the line sweep transformer and passed to the screen of V_{3A}. Thus, a pulse of a few subcarrier cycles is collected at TB_2 during every other line. This pulse is detected and used to control the switching diodes through the monostable multivibrator.

After detection, the chromatic signals possess a d-c component which is not zero in the absence of chrominance. This component is proportional to the amplitude of the unmodulated subcarrier. It is compensated by a d-c voltage of equal value and of opposite sign obtained by integrating the chrominance synchronizing pulses. Integration is obtained by diode D_5 and capacitor C_1.

For extreme reception conditions it may be useful to suppress the chrominance subcarrier automatically to get only a black-and-white picture. Automatic suppression is secured by cutting off tubes V_{2A} and V_{3A}. When the amplitude of the subcarrier becomes too low, the chrominance synchronizing pulse is no longer capable of triggering the multivibrator. Under this condition V_{2A} and V_{2B} are cut off.

The only special element in the circuits is the delay line. Its price, based on monthly production of 500 units, is $16. Mass production is $16. Mass production would substantially reduce this.

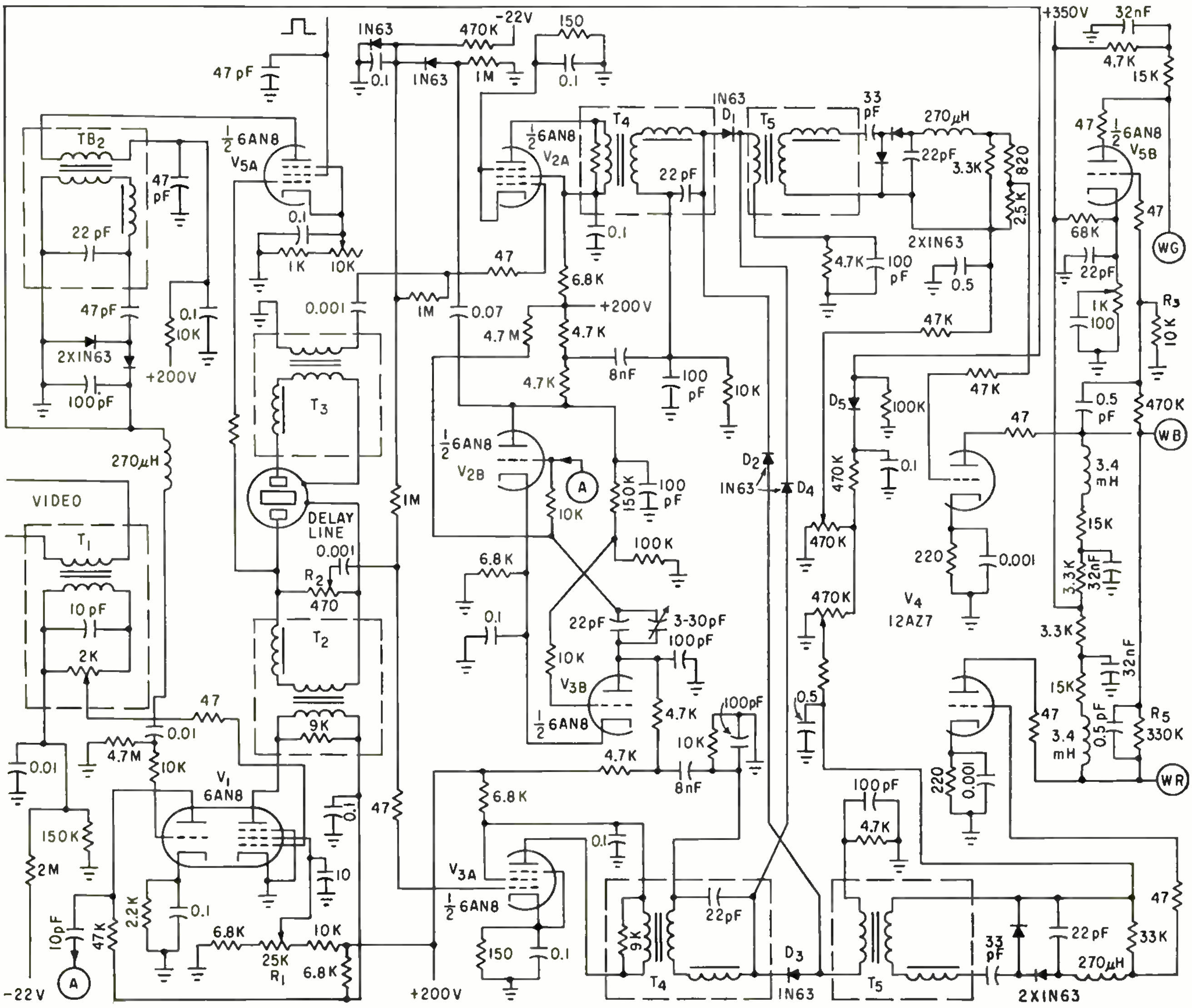
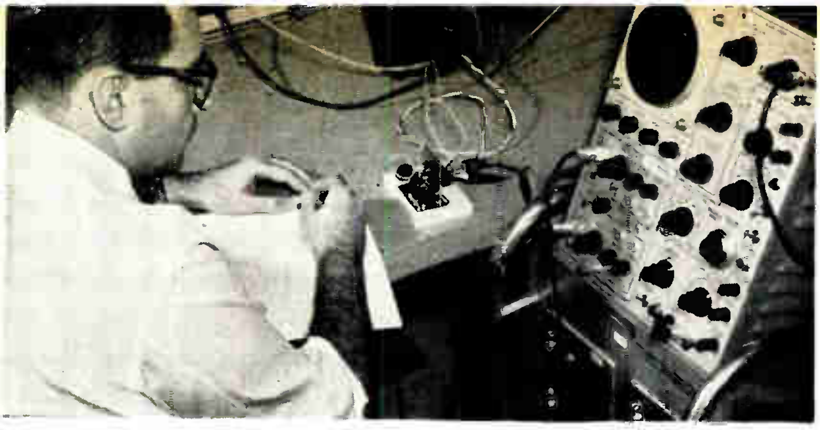


FIG. 4—Relatively simple chrominance circuits should result in stability and high reliability



Maximum delay of circuit is one pulse out of every ten cycles of supply

Counting and Timing Circuits

USE SATURABLE REACTOR

Operating primarily as frequency dividers, adjustable timing circuits use a controlled rectifier and a saturable reactor. Division by 10 is possible when the supply frequency is 400 cps

By J. S. SICKO
Light Military Electronics Department,
General Electric Co.,
Johnson City, New York

WHEN A D-C VOLTAGE is applied to the control winding of a saturable reactor, a finite time will elapse before the magnetic flux reaches its final value. This time delay characteristic is used with a controlled rectifier in the circuit to be described to form what is essentially a frequency divider. At a supply frequency of 400 cps, for example, division by 10 or less is possible. Thus, the output is one pulse for every ten cycles—or other preset number of cycles—of the supply.[1, 2]

The timing circuit is shown in Fig. 1. Winding N_1 of the saturable reactor is excited with direct voltage E_B and is in series with the gate of the controlled rectifier. When the saturable reactor is driven into positive saturation, the gate of the controlled rectifier has a large enough signal to turn on the controlled rectifier, provided the anode voltage is going positive with respect to the cathode.

For the output pulse to be repetitive, the flux in the saturable reactor has to be changed in the negative direction. This is accomplished by winding N_2 of the saturable reactor, which is in series with the anode, and thus the load of the controlled rectifier. After the controlled rectifier has been turned on, the voltage across N_2 is used to change the flux in the saturable reactor in the negative direction.

With the flux changed in the negative direction, the operation of the circuit to turn on the controlled rectifier can be repeated. Repetition rate in the controlled rectifier output circuit will be $1/n$ of the supply frequency, with n (an integer) easily adjusted by varying E_B.

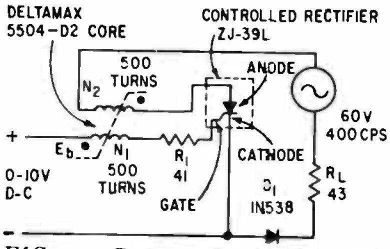


FIG. 1—Controlled rectifier and saturable reactor circuit is adjusted by varying bias voltage E_B

The circuit will be explained by considering its four separate modes of operation, modes that correspond to the four sides of the loop that the magnetic core traverses. Fig. 2A shows an ideal BH loop on which the various modes are indicated.

In mode *A* operation, flux in the saturable reactor is being changed in the positive direction; in mode *B*, the reactor is saturated but the controlled rectifier has not been turned on. Mode *C* occurs when the controlled rectifier is turned on and the saturable core is driven from positive saturation to a point where the flux can be changed in the negative direction. Mode *D* occurs when the flux is changing in the negative direction.

The time delay of the circuit is obtained during mode *A* operation and is the time required to move from point 1 to point 2 of Fig. 2A. With the controlled rectifier not conducting, the impedance in series with N_2 is high and this circuit is essentially open. When the bias voltage is applied to N_1, the voltage induced in the coil is $e = N_1 \times$

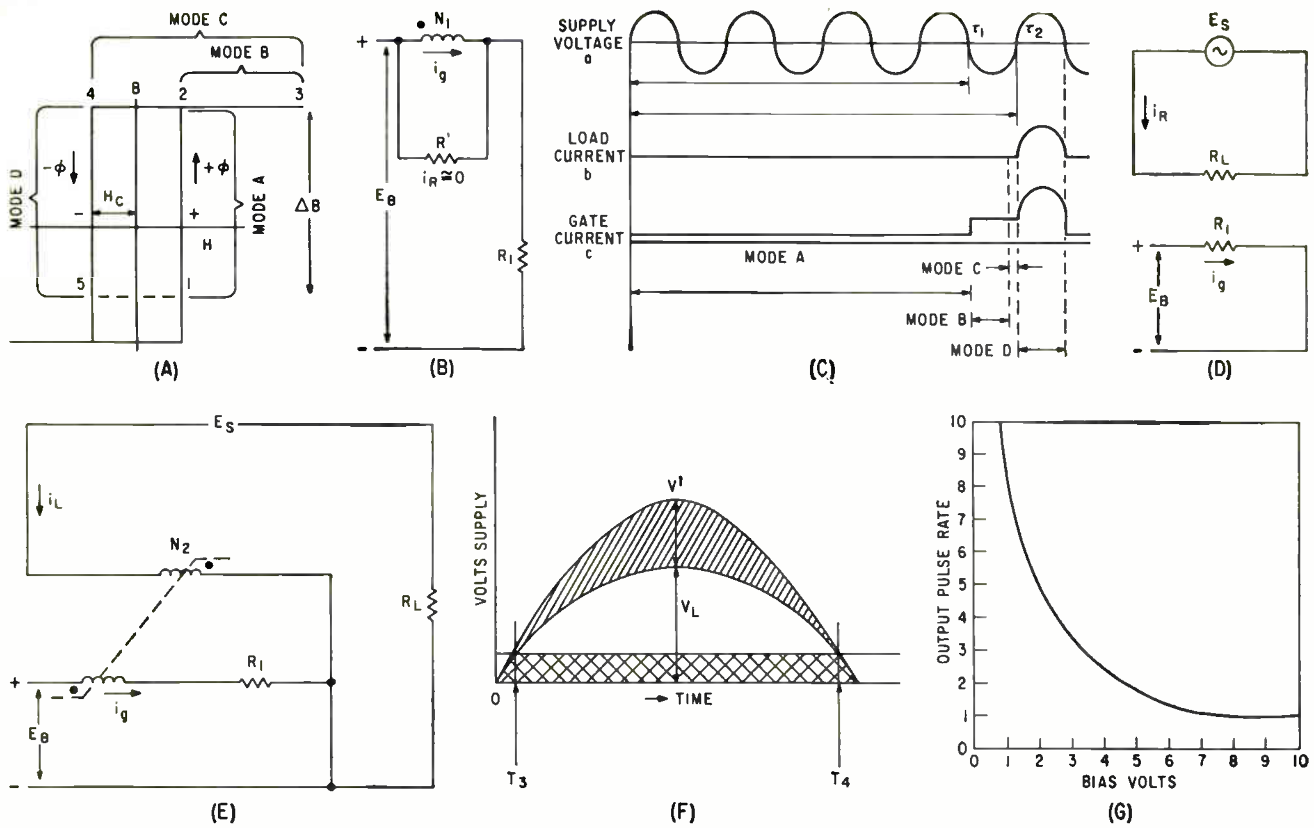


FIG. 2—Stages of reactor cycle are defined in (A) Equivalent circuit for mode A in (B); wave-forms in various parts of the circuit (C); equivalent circuit for mode C (D); equivalent circuit for mode D (E). During the conducting pulse, the voltage available for reset is shown as V' in (F). Output pulse rate as a function of bias voltage (G)

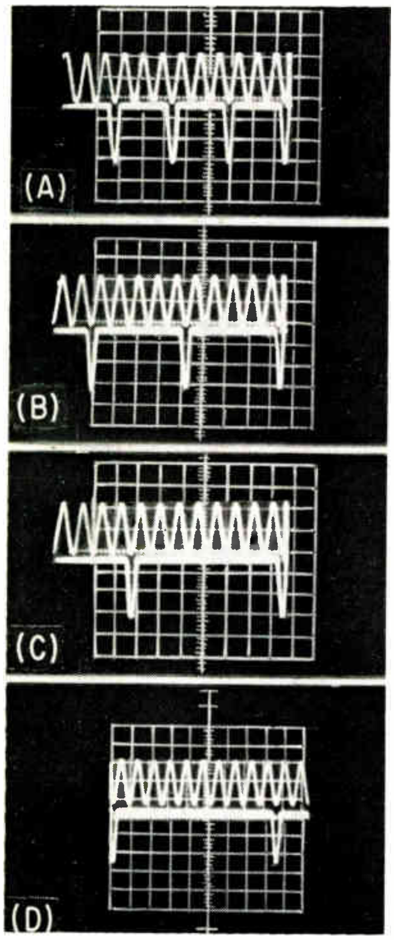


FIG. 3—Load circuit waveforms for various pulse rates

$10^{-8} d\phi/dt$. Using differentials, $\Delta t = N_1 \times 10^{-8} \Delta\phi/e$. Because e must equal the applied bias voltage E_B, which is constant and not a function of time, the preceding equation defines the time delay available as the flux is changed in the core.

The equivalent circuit for mode *A* operation is given in Fig. 2B. For this period, the current in the controlled rectifier anode circuit is practically zero. Thus R'—the reflected load resistance—is much greater than R_1 and i_R is approximately zero. The gate current for mode *A* is given by Eq. 2 of the design box. The value of H_c in Eq. 2 depends on the frequency at which the saturable reactor is being driven into saturation.

After the flux level in the saturable reactor has reached position 2, Fig. 2A, the gate current i_g is limited primarily by the resistance of the gate circuit. This value of gate current places the operation of the saturable reactor at position 3. The gate current now is large enough to turn on the controlled rectifier. However, the controlled rectifier will not be turned on during this time because the anode voltage is negative with respect to the cathode.

Circuit operation will be considered only when the saturable reactor saturates during the time when the anode to cathode voltage of the controlled rectifier is going negative. The operation of the circuit during Mode *B* illustrates a significant advantage of the timing circuit. The saturable reactor can be driven into positive saturation anytime between T_1 and T_2, Fig. 2C and the circuit will still operate properly. Therefore, small variations in E_B and core parameters do not affect the time that the controlled rectifier is turned on.

During mode *C*, the saturable reactor is being driven from point 3 to point 4, Fig. 2A, and remains in saturation. This mode of operation is completed during a small period compared to one-half cycle of the supply voltage.

Equivalent circuits for the load current and gate current are given in Fig. 2D. There is no coupling be-

Design of Timing Circuits With Saturable Reactors and Controlled Rectifiers

N_1 = number of turns in series with gate of controlled rectifier
N_2 = number of turns in series with anode of controlled rectifier
$\eta = N_2/N_1$
E_B = d-c volts to gate circuit
R_1 = lumped resistance in ohms of the gate circuit
R_L = lumped resistance in ohms of the load circuit
B = flux density of core in gausses per square centimeter
A = cross section area of core in square centimeters
i_L = instantaneous current in amperes in the load circuit
i_g = instantaneous current in amperes in the gate circuit
H_c = coercive force in oersteds
l_{fe} = mean length of magnetic path in centimeters
e_s = instantaneous value of supply voltage
E_{sM} = maximum value for the supply voltage
E_s = rms supply voltage
R' = reflected impedance from the load circuit when flux in the saturable reactor is changing in the positive direction
ϕ = magnetic flux in gauss
K = net ampere-turns required in the saturable core to place the operating characteristics of the saturable reactor at position 4 of Fig. 2A.

Mode *A*—Controlled rectifier OFF, flux is being set in the positive direction in saturable reactor

$$i_L = 0 \qquad (1)$$

$$i_g = \frac{Hl_{fe}}{0.4\pi N_1} \qquad (2)$$

Mode *B*—Controlled rectifier OFF, saturable reactor in positive saturation

$$i_L = 0 \qquad (3)$$

$$i_g = E_B/R_1 \qquad (4)$$

Mode *C*—Controlled rectifier $\overline{\text{ON}}$, saturable reactor in positive saturation

$$i_L = e_S/R_L \qquad (5)$$

$$i_g = E_B/R_1 \qquad (6)$$

Mode *D*—Controlled rectifier ON, flux is being set in the negative direction in the saturable reactor. It is assumed that the mutual impedance between the gate circuit and the load circuit in the controlled rectifier is negligible.

Kirchhoff's voltage equations for the load and gate circuits are written

For load:

$$e_S = N_2 \frac{d\phi}{dt} + R_L i_L \qquad (7)$$

For gate:

$$E_B - N_1 \frac{d\phi}{dt} = R_1 i_g \qquad (8)$$

The required net ampere turns in the saturable reactor in order to be in mode *D* operation

$$N_2 i_L - N_1 i_g = K \qquad (9)$$

$$i_g = N_2 i_L/N_1 - K/N_1 \qquad (10)$$

$$-N_1 \frac{d\phi}{dt} = [R_1 i_g - E_B] \qquad (11)$$

From (7) and (11),

$$e_s = \frac{N_2}{N_1} [R_1 i_g - E_B] + R_L i_L \qquad (12)$$

From (10) and (12),

$$e_s = \frac{N_2}{N_1}\left[R_1\left(\frac{N_2 i_L}{N_1} - \frac{K}{N_1}\right) - E_B\right] + R_L i_L \qquad (13)$$

Setting $N_2/N_1 = \eta$ and solving for i_L,

$$i_L = \frac{E_{sM} \sin \omega t + \eta E_B + \eta R_1 K/N_1}{(\eta^2 R_1 + R_L)} \qquad (14)$$

Gate current during mode *D* operation is obtained by solving Eq. 7 and 8 and takes the form

$$i_g = \frac{E_B + e_S/\eta - R_L K/\eta N_2}{R_1 + R_L/\eta N_2} \qquad (15)$$

Time delay

$$\Delta T = N_1(\Delta\phi) \times 10^{-8}/E_B \qquad (16)$$

where

$$\phi = BA$$

tween the load circuit and the gate circuit during this period of time. This assumption can be made if the mutual impedance in the controlled rectifier is neglected and if the magnetic material has an ideal BH loop. Curves of the load current and gate current are illustrated in Fig. 2C. The time duration of mode *C* operation in Fig. 2C has been exaggerated for illustration purposes. In a practical timing circuit, mode *C* terminates at approximately 1/90 of a positive half cycle of the supply voltage.

Mode *C* operation will be completed when the net ampere turns of the saturable reactor is equal to $-H_c l_{fe}/0.4\pi$. The value of H_c depends on the frequency of the load current.

Mode *D* begins when the saturable reactor is at point 4 on the BH loop. Equivalent circuits for the gate circuit and the load circuit are given in Fig. 2E. For this discussion the resistance of the anode to cathode and gate to cathode of the controlled rectifier are considered to be negligible compared to the other resistances in the circuits. Also, the mutual impedance between gate circuit and the load circuit in the control rectifier is neglected.

Assuming that the saturable reactor behaves like an ideal transformer, the volt-time area available to set flux in the negative direction —to go from point 4 to 5—is represented by V' in Fig. 2F. Equations for the load circuit and gate current are given in the design box.

The timing circuit of Fig. 1 was designed to operate at 400 cps. The output current pulse is available every *n*th cycle of the supply frequency, where *n* can be made to vary from 1 to 10, and control is obtained by d-c excitation in the gate circuit. Gate circuit voltage versus output current repetition rate is illustrated in Fig. 2G. Figure 3 shows the output curves.

The diode in the output circuit is used to prevent thermal runaway in the controlled rectifier when the anode is going negative in respect to the cathode and there is a positive voltage from gate to cathode of the controlled rectifier.

Typical curves[3] of instantaneous gate voltages versus instantaneous gate current for a controlled rectifier for various ambient temperatures are shown in Fig. 4.

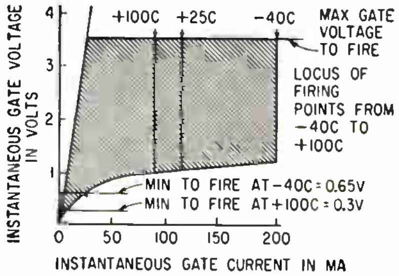


FIG. 4—Characteristic curves of the controlled rectifier

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Novel Approach to Pulse Amplifier Design

Current to charge load and stray capacitances is supplied by auxiliary amplifier. Standby current is reduced, gain is improved

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LINEAR amplification of a pulse waveform is, ideally, the reproduction in the load of all frequency components of the waveform correct in amplitude and phase. Conventional pulse amplifiers, therefore, normally keep the effective series resistance low compared with the shunt capacitive reactance for all wanted frequency components. This is usually achieved by reducing plate load resistance, by negative feedback, or by a limited use of inductive correction which effectively reduces the shunt capacitance at certain frequencies.

The amplifier described[1] is suitable for the application of 50-volt pulses with rise time of the order of 0.1 μsec to capacitive loads of upwards of 100 pf. Its design is based upon the fact that the necessity for wide frequency bandwidth occurs only during the transient portions of the pulse—the leading and trailing edges.

The action of the pulse amplifier is more easily explained, however, by energy transfer rather than frequency response. For, in any pulse amplifier, limit to the steepness of output-pulse edges is imposed by shunt capacitance charging time. This charging time varies inversely with available current and, subject to limitations, current, in turn, is inversely proportional to source resistance.

Common methods of reducing source-impedance result in high plate current during the quiescent parts of the pulse waveform. If the conventional type of amplifier is to be used with positive and negative pulses, it must be operated in class A with the result that a high level of no-signal current is also drawn.

A numerical example will best illustrate this disadvantage of conventional pulse amplifiers. Regarding a pentode as a constant current generator, the rise-time of R-C coupled amplifiers is given by $t = 2.3026\ CR$, where C is load capacitance and R is load resistance, and t is time for the voltage to reach 90 percent of the pulse height. Thus if $C = 100$ picofarad, $t = 0.1$ microsecond, $v = 50$ volts, then $R = 10^{-7}/(2.3026 \times 100 \times 10^{-12})$ ohms $= 430$ ohms. Plate resistance is therefore 430 ohms and plate current $50/430 = 0.116$ ampere. To handle positive and negative going pulses, the tube must be operated in class A, implying a standby current of over 100 ma.

Furthermore, with plate load of 430 ohms and transconductance of, say, 10 mmhos, the gain would be only 4.6, as compared with 25 for the system to be described. A novel procedure is adopted in the following design, whereby an auxiliary amplifier is used to provide the short-duration charging current drawn by the shunt capacitance during the transient parts of the pulse. Thus, with the auxiliary amplifier supplying high-value charging currents, the main amplifier need provide only a comparatively small standby current in the plate load.

The basic arrangement of the system is shown in Fig. 1. Tube V_1 is the main pulse amplifier. Total capacitance shunting its output is represented by capacitor C_s, shown dotted. Current in the shunt capacitance is sampled by inserting a low value resistor in series with part of it. This is done by means of the network C_1 and R_1 where capacitance C_1 actually forms part of the total shunt capacitance. Providing the time constant of this network is small compared with the rise time of the output pulse, the instantaneous voltage across R_1 is

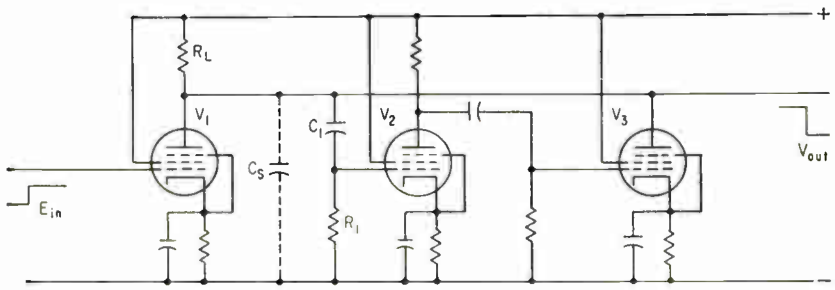

FIG. 1—Tube V_1 is main amplifier; input to V_2 is proportional to the required charging current; V_3 charges stray and load capacitance

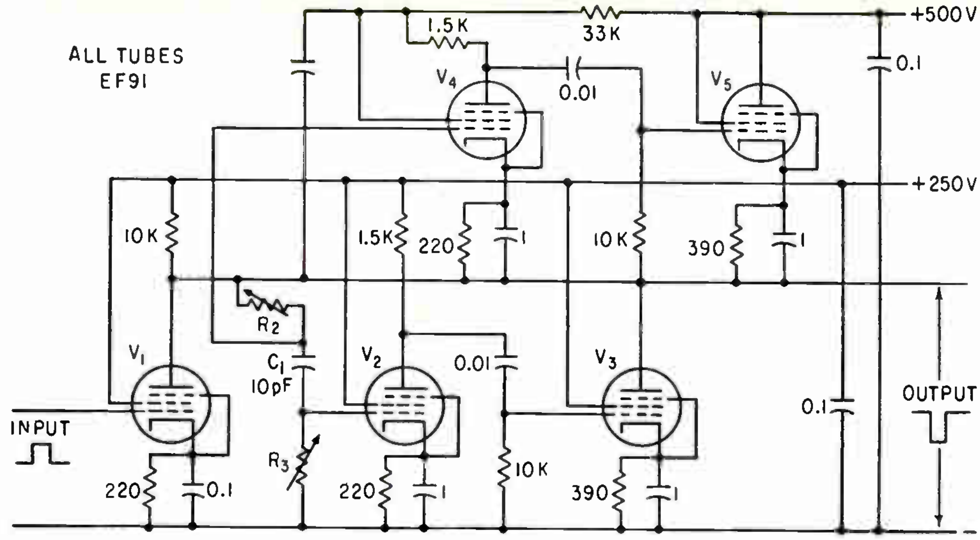

FIG. 2—Final circuit uses two auxiliary amplifiers for positive and negative inputs

directly proportional to the instantaneous current in the total shunt capacitance.

The differentiated voltage pulse developed across R_1 is amplified and inverted by tube V_2, and the output from the plate of this tube is fed to the grid of tube V_3. Tube V_3 is a class *B* amplifier connected in shunt with tube V_1.

A sharp positive-going step voltage applied to the grid of tube V_1 causes it to draw an increased current so that C_s and C_1 begin to discharge. Pulse output voltage, however, does not increase to its peak until these capacitances have discharged fully. But, because of the amplified differentiated pulse appearing at its grid, tube V_3 conducts heavily during the discharge period giving a steep transient edge to the output pulse.

It is important that the gain of the auxiliary amplifier comprising tubes V_2 and V_3 must be just sufficient to supply the charging current for the shunt capacitance. If the gain is too small the rise of the pulse will be too slow and, if it is too large, the circuit will tend to oscillate.

In the completed amplifier the effective gain is finally set up empirically by a preset control; so a practical calculation of the required gain can be based upon the assumption that the time constant $C_1 R_1$ is negligible compared with the rise time of the output pulse.

It can be argued that the instantaneous current (i_p) supplied by V_3 must be equal to the instantaneous current (i_{cs}) in the shunt capacitance. If i_p is less than i_{cs}, part of the charging current will be drawn from tube V_1; it will be flowing in C_s rather than R_L and the correct instantaneous voltage will not be developed. Conversely, if i_p is greater than i_{cs}, part of the current from V_3 will flow in R_L causing the instantaneous voltage to rise above peak pulse height and producing instability.

The output from V_3 is equal to the voltage developed across R_1 multiplied by the combined transconductance of V_2 and V_3. Calling this transconductance *A*, the relevant design formula becomes:

$$A = (C_1 + C_s)/C_1R_1 \qquad (1)$$

The rate of rise of the output pulse is limited by two primary factors, the ability of the auxiliary amplifier to deliver sufficient charging current, and its ability to respond to the brief differentiated pulse developed across R_1.

The first of these depends upon the maximum available instantaneous plate current from tube V_3. The necessary current is readily calculable from the capacitance of the load plus the stray capacitance of the amplifier and the required pulse rise time. If it is assumed that the pulse has an exponential rise, the instantaneous current to charge the shunt capacitance is given by the expression:

$$i_c = \frac{C_s V}{T} e^{-t/T}$$

where i_c is the instantaneous charging current, V is the pulse height, T is the effective time constant.

The charging current is at its maximum at time $t = 0$ and is then equal to C_sV/T. If the rise-time is reckoned as that required for the voltage to reach 90 percent of pulse height, T is given by the formula:

$$T = \text{time of rise}/2.3026$$

And the peak current required then becomes:

$$i_c = 2.3026 C_s V/\text{Time of rise} \qquad (2)$$

The rise time of the auxiliary amplifier is determined by the response of tube V_2 as a voltage amplifier. For a mathematically perfect exponential rise to the output pulse the maximum current should be available at time $t = 0$. This implies an instantaneous response on the part of V_2. However, rise time is normally reckoned as being the time elapsing between 10% and 90% of the voltage step; practical pulses are seldom truly exponential, having some rounding at the start of the rise.

Therefore, there is negligible deterioration if the rise time of the auxiliary amplifier is about a tenth of that of the desired output pulse.

The amplifier system described in this article is not intended for fast-rise pulses, although no tests or calculations have been made by the author to discover its ultimate limitations in this respect. As the rise time is reduced, however, it becomes difficult to obtain sufficient gain from V_2 without using a large tube.

Obtaining sufficient output from V_3 then depends upon the voltage developed across R_1. This, in turn, is determined by the ratio of C_1 to C_2, and the value of R_1. The capacitance ratio is largely decided by the total amount of shunt capacitance that can be tolerated; the resistor value has a direct bearing on the stability of the system. For, if the time constant of the sampling network is too large, the potential developed across R_1 will correspond to the voltage across C_2 rather than the charging current.

From the mathematical analysis of the amplifier[1] the following expression has been derived for the fastest rise obtainable without instability.

$$\frac{v}{V} = 1 - \left[1 + \left(\sqrt{\frac{C_2R_L}{C_1R_1}} - 1\right)\frac{t}{C_2R_L}\right] \times \exp\left[-t/(C_1R_1C_2R_L)^{1/2}\right] \quad (3)$$

where v is the instantaneous output voltage, V is the pulse height t is the time. This expression assumes an ideal auxiliary amplifier.

The circuit in Fig. 1 provides for negligible deterioration of the negative-going edge of the output pulse, but it does not operate when the input voltage to the grid of V_1 is a negative-going step. The circuit of a complete amplifier suitable for positive-going and negative-going pulses is shown in Fig. 2.

Two additional tubes V_4 and V_5, form a second auxiliary amplifier which provides the charging current for the shunt capacitance during the positive-going output step. The operation of tubes V_4 and V_5 is similar to that of V_2 and V_3. However, as this second pair of tubes operates in the reverse direction from the first pair, it is necessary to connect it between the output line and a separate 500 volt line.

The circuit shown in Fig. 2 is an experimental amplifier, designed to provide a 50 volt output pulse with rise time 0.1 μsec across a capacitive load of about 100 pf. A 6AM6 tube (similar to 6AK5) is used in all stages.

The required maximum cathode current, obtained by substitution in expression (2), is $2.3026 \times 10^{-10} \times 50 \times 10^{7}$ amps = 115 ma. The 6AM6 is capable of delivering about 300 ma instantaneous current so it is adequate for use as V_3 and V_5.

With a 10,000 ohm plate-load resistor and a B+ voltage of 250 volts, tube V_1 has a dynamic gm of 2.5 $m$mhos, giving a voltage gain of 25. The load capacitance having been arbitrarily set at 100 pf, 10 pf is chosen for capacitor C_1. The stray shunt capacitance is small compared with the load capacitance and, in this experimental circuit, may be neglected. To keep the time constant of the sampling network small compared with the rise time, the total for R_1 is made 500 ohms. This is shared between the two auxiliary amplifiers so that each responds to the voltage developed across about

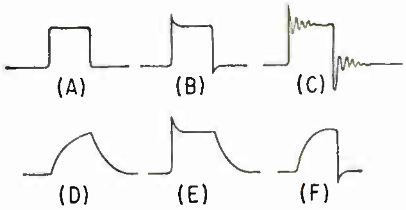

FIG. 3—Positive output pulses for various setting of the linearity controls (R_2 and R_3). Correctly adjusted (A), both too high (B), much too high (C), both too low (D), R_2 too low, R_3 too high (E), R_2 too high, R_3 too low (F)

250 ohms. In practice a pair of 500-ohm variable resistors (R_2 and R_3) are used, each set to approximately 250 ohms. Thus $C_2R_L = 10^{-6}$, $C_1R_1 = 10^{-8} \times 0.5$, and $t = 10^{-7}$. These figures may be substituted in expression (3) as follows:

$$\frac{v}{V} \ngtr 1 - \left[1 + \left(\sqrt{\frac{10^{-6}}{0.5 \times 10^{-8}}} - 1\right)\frac{10^{-7}}{10^{-6}}\right] \times \exp\left[-10^{-7}/0.25 \times 10^{-7}\right]$$

Substituting values, the expression becomes:

$$\frac{v}{V} \ngtr 1 - \frac{4.9}{e^4} \approx 0.95$$

Assuming the rise time is reckoned in terms of 90 percent of pulse heights $v/V = 0.9$ so that the circuit conforms to the condition for stability.

The required gain of the auxiliary amplifiers is obtained by substituting in Eq. 1

$$A = [(100 + 10) \times 10^{-12}] / (10 \times 5 \times 10^2 \times 10^{-12})$$
$$= 2 \times 10^{-2} \text{ amps per volt} = 20\ m\text{mhos}$$

But the voltage applied to each auxiliary amplifier is that developed across half the value of R_1, so the effective transconductance of each auxiliary amplifier must be twice that shown above, or 40 $m$mhos. This figure is only about six times the g_m of the tube used, so the voltage gain of V_2 and V_4 need only be of the order of seven to allow for small circuit tolerances. This gain is easily achieved with the use of 1,500 ohm plate-load resistor. The stray capacitance shunting this resistor should not exceed 7.5 pf even allowing for wiring strays. This gives a time constant for the plate circuits of tubes V_2 and V_4 of the order of 0.01 μsec, so there will be negligible deterioration of the differentiated pulse if the rise time of 0.1 μsec is adequate.

Because of component tolerances and other variations, it is not possible to set the gain of the auxiliary amplifier precisely; adjustment is made with variable resistors R_2 and R_3. These resistors control the voltages applied to the respective auxiliary amplifiers; thus they control the effective gain of these circuits.

The amplifier is set up empirically. A pulse signal having a rise and fall time of less than 0.1 μsec is fed to the grid of tube V_1. Output pulse is monitored by a cathode-ray oscilloscope. With the desired capacitive load connected, variable resistors R_2 and R_3 are adjusted for the sharpest obtainable output pulse with no overshoot on the leading and trailing edges.

Figure 3 indicates the form of oscillograms of the output pulse for various settings of the variable controls. In the circuit arrangement of Fig. 2, the settings of the controls are interdependent so that it is necessary to adjust them simultaneously. Simultaneous adjustment can be avoided by wiring them as potentiometers rather than variable resistors, although this has the theoretical disadvantage that the time constant of the sampling network would be slightly higher.

The total mean plate current consumed by the amplifier is of the order of 15 ma.

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Plastics For Potted Cables

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CABLE SYSTEMS using cold-molding techniques have received considerable attention in the past few years. Cold-molding—with castable elastomers—uses a polymer in liquid form which cures to a solid elastomer from heat, a curing agent or both. The trend to the technique is extending to industrial areas.

EPOXY RESINS—Epoxy casting resins do not have rubber-like flexibility and are therefore not tabulated.

SILICONES—The so-called RTV silicones cure, by catalyst, to a rubber having excellent electrical performance, resistance to temperatures in excess of 500 F and good flexibility at low temperatures. Because of their high cost and mediocre physical characteristics, they are used only in cable systems designed for high temperatures and only then in conjunction with extruded silicone sleeving. Lack of suitable primers also presents obstacles to extensive application.

POLYSULFIDES—This class of liquid polymers represents almost the ultimate in ease of use and reproductiveness. However, they are characterized by extreme cold flow under moderate load deflections and only fair mechanical and electrical properties.

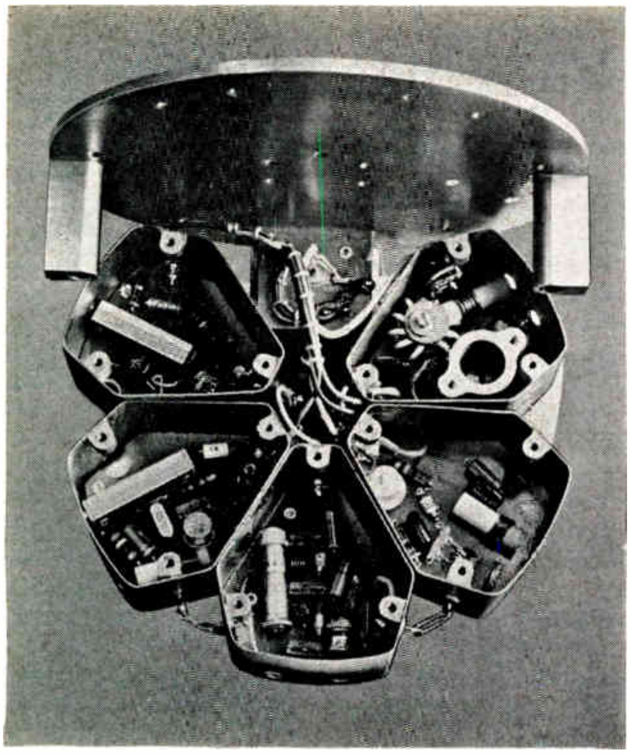
VINYL PLASTISOLS — This type of plastic holds a special position among cast-in-place polymers: it is cured by heat alone. When ground to a small particle size it is easily dissolved in a wide variety of plasticizers at temperatures of 300-400 F. Upon cooling, a plastic is formed with rubber-like proptries. While the low cost of the plastisols is attractive and their performance is frequently satisfactory, they present many difficulties.

POLYURETHANES — Adaption of polyurethane liquid polymers for cable molding has become widespread in the past few years. While they are already replacing polysulfides and the plastisols it is not anticipated that the use of silicones will be affected.

PRIMERS — Because of the variety of substrates to which the molding compound must adhere, it has been typical to use primers. The problems of adhesion are compounded by sleeving and insulation materials. Manufacturers of extruded rubber products must meet specifications but do so with different compounding ingredients. For these reasons the suppliers of molding compounds have developed primers for chloroprene, vinyl, nylon, dacron, polyethylene, and conductor metals.

TABLE I — PROPERTIES OF REPRESENTATIVE LIQUID POLYMERS

	Property	Silicones	Polysulfides	Vinyl Plastisols	Polyurethanes
ELECTRICAL	Insulation Resistance (Ohms)	10^{13}–10^{14}	10^{8}–10^{10}	10^{8}–10^{10}	10^{9}–10^{13}
	Volume Resistivity (Ohm–CM)	10^{12-13}	10^{9}–10^{11}	2–3 x 10^{10}	10^{9}–10^{13}
	Surface Resistivity (Ohm–CM)	——	10^{9}–10^{10}	5 x 10^{10}	10^{9}–10^{13}
	Dielectric Constant (60 Cps)	3.6–4.2	7–10	7–8	3–8
	Electric Strength (V/Mil)	300–500	200–250	300–500	250–600
	Power Factor (60 Cps)	0.015–0.019	0.025–0.05	0.25–0.15	0.01–0.05
MECHANICAL	Durometer Hardness (Shore "A")	45–60	35–50	75–80	30–90
	Tensile Strength (Psi)	250–400	200–300	1500–2000	250–5000
	Ultimate Elongation (Percent)	80–200	200–350	300–350	150–500
	Tear Strength (Pli)	25–50	25–60	75–150	25–100
	Abrasion Resistance	Poor	Fair	Good to Excellent	Excellent
	Resilience	Good	Fair	Fair	Fair to Excellent
	Specific Gravity	1.1–1.5	1.7–1.8	1.2–1.4	1.0–1.3
ENVIRONMENTAL	Flame Resistance	Fair (Non-Conducting Ash)	Fair	Good	Fair
	Ozone Resistance	Excellent	Excellent	Excellent	Excellent–Outstanding
	Fluid Resistance:				
	Water	Good–Excellent	Good	Good–Excellent	Fair–Excellent
	Jet Fluid (JP-4)	Poor	Excellent	Fair	Good–Excellent
	Diester Oil	Fair	Fair	Poor–Fair	Fair–Good
	Hydrocarbon Oil	Poor	Outstanding	Excellent	Good–Outstanding
	Skydrol	Good	Poor–Fair	Poor	Poor–Good
	Lox	Poor	Poor–Fair	Excellent	Good–Excellent
	Kerosene	Poor	Outstanding	Poor	Poor–Good
	Ketones	Poor	Fair	Poor	Poor–Fair
	Heat Resistance (Deg. F)	450–500	180–200	Thermoplastic (250–275)	300–350
	Low Temperature (Deg. F)	−100	−65	−10 to −35	−65 to −100
	Radiation Resistance	Good	Poor	Poor	Fair–Good
	Ease of Use	Good	Excellent	Poor	Good



Satellite transmitter before potting. Shock, vibration, acceleration and high altitude tests had no electrically measurable effects on these units

Telemetry

Transmitter incorporates a

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A TELEMETRY transmitter for a late-model satellite incorporates the novel phase modulator circuit to be described. This circuit developed from an NASA requirement to investigate further the Van Allen radiation belt from a satellite in a high-apogee orbit with a life expectancy of 12 to 18 months. The transmitter, which has an output of 300 mw, operates on a frequency of 108.03 Mc.

A primary requirement for this satellite transmitter was that it be disk-shaped. Further, for easy servicing, the sections of the transmitter were constructed in pie-slice modules around the disk (see photo); modules are individually potted in foam. Direct-current power to the modules is supplied near the center of the disk; r-f signal terminations are near the outside of the disk for isolation.

Complete circuit for the transmitter is shown in Fig. 1. The crystal-controlled oscillator circuit uses a feedback network which excludes the crystal to prevent the oscillator drop-out effect with tuning. Its output is approximately 2 mw at 100 ohms.

The driver takes 2 mw input and furnishes an output of 39 mw matched to 50 ohms by the pi-network. By tying the collector to ground for a heat sink the transistor output must be taken from a point common to the emitter and base. The power amplifier is similar to the driver except that a balun transformer is used to convert the unbalanced input to the balanced condition required by the emitter and base of the transistor. Transistor output power is excluded from the previous circuit by the high impedance of the balun.

The telemetry amplifier is required for gain and preemphasizing the subcarrier signals.

The phase modulator circuit (see Fig. 1) is a modified conventional bridged T network evolved from a lattice network. Its advantages, besides simplicity, are: a modulating capability of + 1.5 radions with a minimum audio signal in the frequency range of 400-1,300 cps; more favorable operating parameters; greater suitability to low impedance characteristics of the crystal oscillator output circuit.

Figure 2A shows the basic lattice network that can be evolved into a bridged T. If the legs are reactive and reciprocal with respect to the characteristic impedance, then the network has zero attenuation to all frequencies and a phase shift that changes with frequency. For a phase modulator it is desired rather that the phase shift at the constant input frequency be variable. This can be done by varying the two reactive legs together so that the reciprocal relationship is maintained. One pair of reactive legs may be capacitive diodes; then, to be reciprocal, the other pair of legs must be inductances which can be varied electronically. This problem may be solved by quarter-wave networks which have the same characteristic impedance as the lattice, because when a quarter-wave network is terminated with a reactance, the reciprocal to this reactance is always seen at the other end of the quarter-wave network. Therefore, the evolution to Fig. 2B allows the exclusive use of identical capacitance diodes as the jX reactances. To reduce the diodes required to two, the hybrid version shown in Fig. 2C or the bridged transformer T of Fig. 2D may be used. Either is classically equivalent to Fig. 2B. The T gives a common input and output terminal with the simplest transformer. The variable reactance, $j2X$, of Fig. 2D may be a capacitance diode alone or it may be the diode combined with other reactances. The tangent

Transmitter FOR RADIATION SATELLITE

novel phase modulator circuit based on a modification of conventional bridged-T network

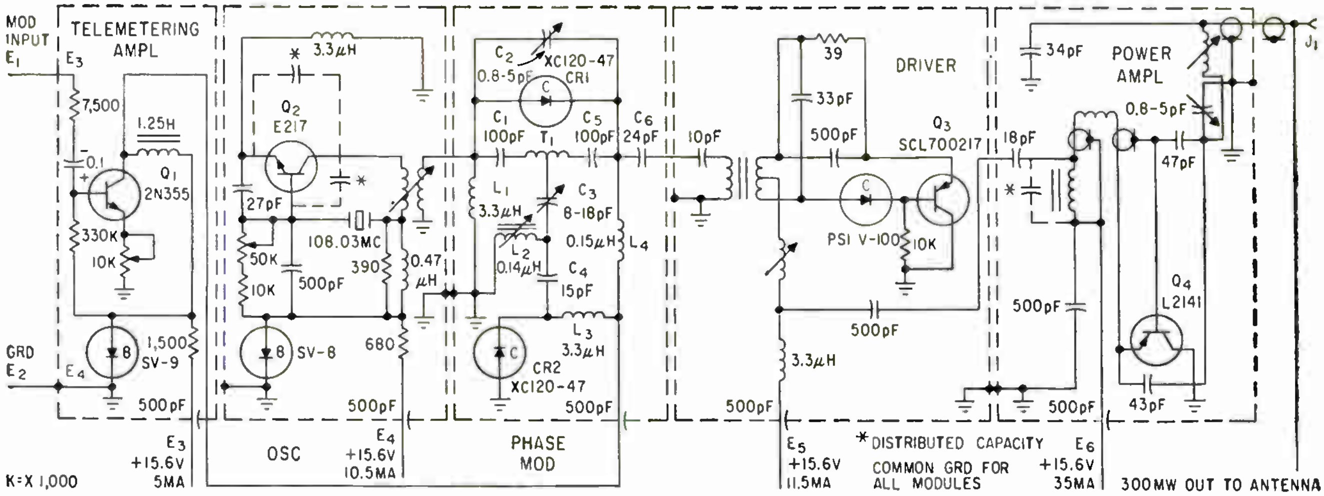

FIG. 1—Satellite transmitter. Dotted sections indicate individual modules. E_1—E_6 and J_1 are on connection panels

function of the basic phase formula (Fig. 2A) and the capacitance-voltage characteristic of the capacitance diode are two nonlinearities to be considered when trying to obtain a linear relation between diode control voltage and phase shift in the modulator. By forming the basic reactance, jX, from a capacitance diode and linear inductance in series or shunt it is possible to find combinations where the two nonlinearities compensate. The shunt combination results in less signal voltage on the diode. For most capacitance diodes: $C = C_n/\sqrt{E_n}$, where C is capacity, C_n, normalized capacitance at fixed bias, and E_n is the instantaneous voltage normalized with respect to the fixed bias. With diode and inductance in shunt

$$1/jX = \omega C - 1/\omega L = (\omega C_n/\sqrt{E_n}) - 1/\omega L$$

Let

$$\omega^2 = 1/LC_n$$

$$1/jX = \omega C_n\,[(1/\sqrt{E_n}) - 1]$$
$$= (1/XC_n)\,[(1/\sqrt{E_n}) - 1]$$

and

$$\beta = 2\tan^{-1}\left\{X_c/Z_o\,[(1/\sqrt{E_n}) - 1]\right\}$$

By plotting this last equation it was determined that, by making $X_c/Z_o = \frac{1}{2}$, a linear phase versus diode control voltage characteristic could be obtained over a 1.5 radian shift in phase. A characteristic impedance of 100 ohms was chosen since at 50 ohms the diode capacitance required was large and stray inductances were troublesome. The phase modulator circuit in Fig. 1 may be seen to be similar to Fig. 2D. The upper $j2X$ basic reactance is composed of CR_1 and T_1. The quarter-wave network is composed of C_3, L_2 and C_4. The second diode CR_2 has no inductance shunting it because a series capacitance at the input of a quarter wave network is equivalent to a shunt inductance at the network output, and therefore C_3 may be slightly reduced in capacitance to offset the equivalent inductance shunting CR_2. The mutual inductance of T_1 also provides the transformer action required in Fig. 2D and C_2 allows for slight differences in diodes and coils. C_1 and C_5 are blocking capacitors so that bias may be applied to CR_1 without upsetting the transformer T_1 symmetry. L_1, L_3 and L_4 are for application of bias and modulating signal to the diodes. C_6 and L_4 form a network to match the 100 ohm characteristic impedance to the 50 ohm module output terminals.

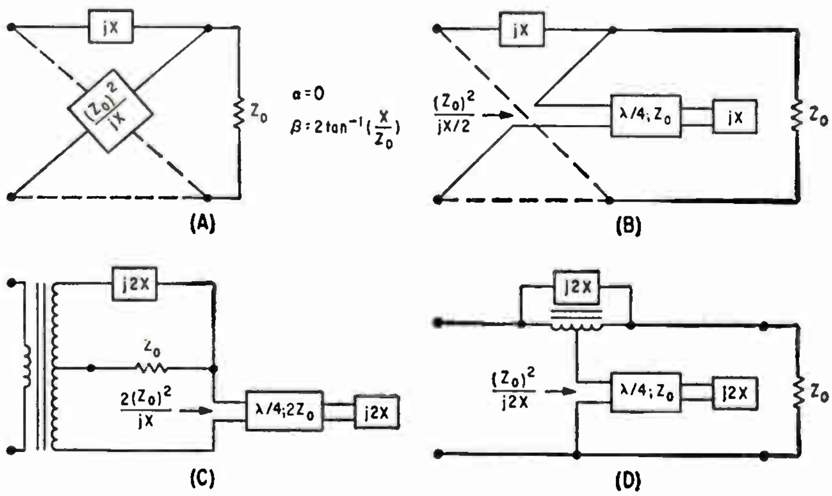

FIG. 2—Stages of evolution of phase modulator circuit

Ground-Mapping Antennas

WITH FREQUENCY SCANNING

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FREQUENCY scanning is one technique of steering antenna beams electronically which has not found much use in airborne installations despite the obvious advantages of small volume and no moving parts. While frequency-scanned two-dimensional arrays will not necessarily replace more conventional reflector-type antennas, they do show considerable promise for high-speed vehicle applications.

Electronic beam scanning or sweeping can be accomplished by amplitude or phase control of an antenna-array aperture distribution. Amplitude scanning is obtained by keeping the phase distribution constant while varying the amplitude distribution of the individual radiators. Phase scanning is accomplished by varying the phase while holding the amplitude distribution constant. Of the two, phase scanning is the most common; frequency scanning is one method of phase scanning.

Frequency scanning can be understood by considering an array with a series feed involving several feed-line wavelengths between uniformly-spaced feed points. (An example is a snake or helical-waveguide feed.) For one frequency, f_o, there is an integral number of delay wavelengths between feed points, and the radiating elements will be in phase and the beam will be broadside, Fig. 1A. When the frequency is less than f_o, there will be a uniformly progressive phase lead all along the aperture and the beam will be directed away from broadside toward the feed. Conversely, when the frequency is greater than f_o, there will be a uniformly progressive phase lag and the beam will be directed toward the load end of the array. Thus, as the frequency is swept from f_1 to f_2, the beam will scan from $-\theta_1$ to θ_2.

As a working guide in the development of the ground-mapping antenna, a number of tentative specifications and design objectives were established. The more relevant of these are listed in Table I under Objectives.

Although the objectives might apply to any ground-mapping antenna, there is one characteristic of a frequency-scanned ground-mapping antenna which differentiates it from mechanically-scanned antennas. As is true of all electronically-scanned arrays, the frequency-scanned antenna beam lies on a conical surface, resulting in a

TABLE I — Desired Antenna Characteristics and Results Obtained with a Slot Array and a Grid Radiator Array

	Objectives	Slot array	Grid Radiator Array
Azimuth pattern and scan angle	Single lobed pattern with 45 degree scan angle from normal to array	Within 3 db	Within 3 db
Azimuth pattern side lobes	At least 22 db below pattern max	28 db down	30 db down
Elevation pattern shape and coverage	θ from -8 to -45 degrees, where θ is elevation angle	$\theta = -8$ to -45	$\theta = -16$ to -45
Elevation pattern side lobes	At least 22 db below pattern max	21 db below	20 db below
Input vswr	Less than 1.2 to 1, except where beam is normal to array	Less than 1.1 to 1	Less than 1.2 to 1 except 1.22 at 17 Gc

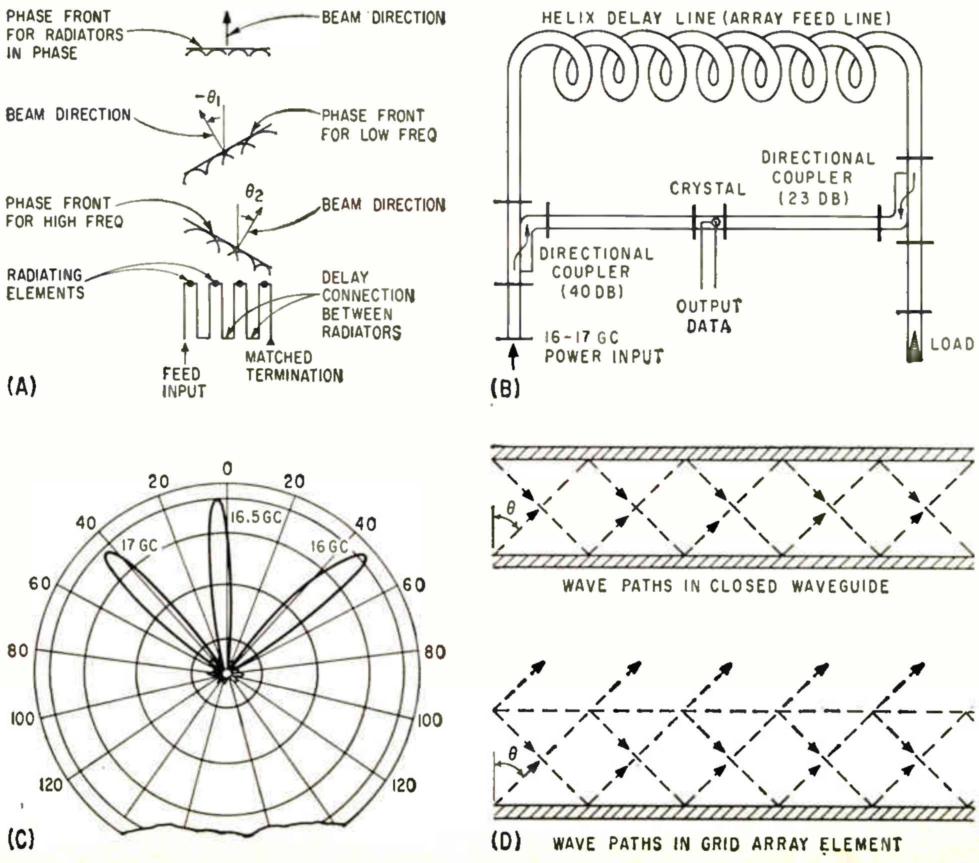


FIG. 1—As the frequency of the signal to the array is changed, the direction of the radiated beam is varied (A). Method for determining the angle of the radiated beam (B); scan pattern of 20-turn helical waveguide feed (C); wave paths in closed and grid-covered waveguides (D)

By controlling the driving frequency of an array, the transmitted beam can be controlled accurately. A slotted aperture array and a leaky grid array prove the feasibility of this method

hyperbolic ground intercept as the beam scans off the normal to the array. This characteristic is best shown in Fig. 2, where three beam positions are indicated with their corresponding frequencies.

The prototype antenna is a two-dimensional array of waveguide radiators which are fed from a waveguide helical delay line. The aperture distribution required for the narrow azimuth beam is formed from 20 two-slot directional couplers which couple energy from each turn of the helical feed to the radiators. Two approaches were made in the development of the shaped-beam radiators and these resulted in two slightly different versions of the antenna. One version uses vertically polarized narrow-wall slot radiators with cross-polarization suppressing baffles; the other version exploits horizontally-polarized, leaky-grid radiators[1]. The helical feed and both types of radiators are excited by a traveling wave.

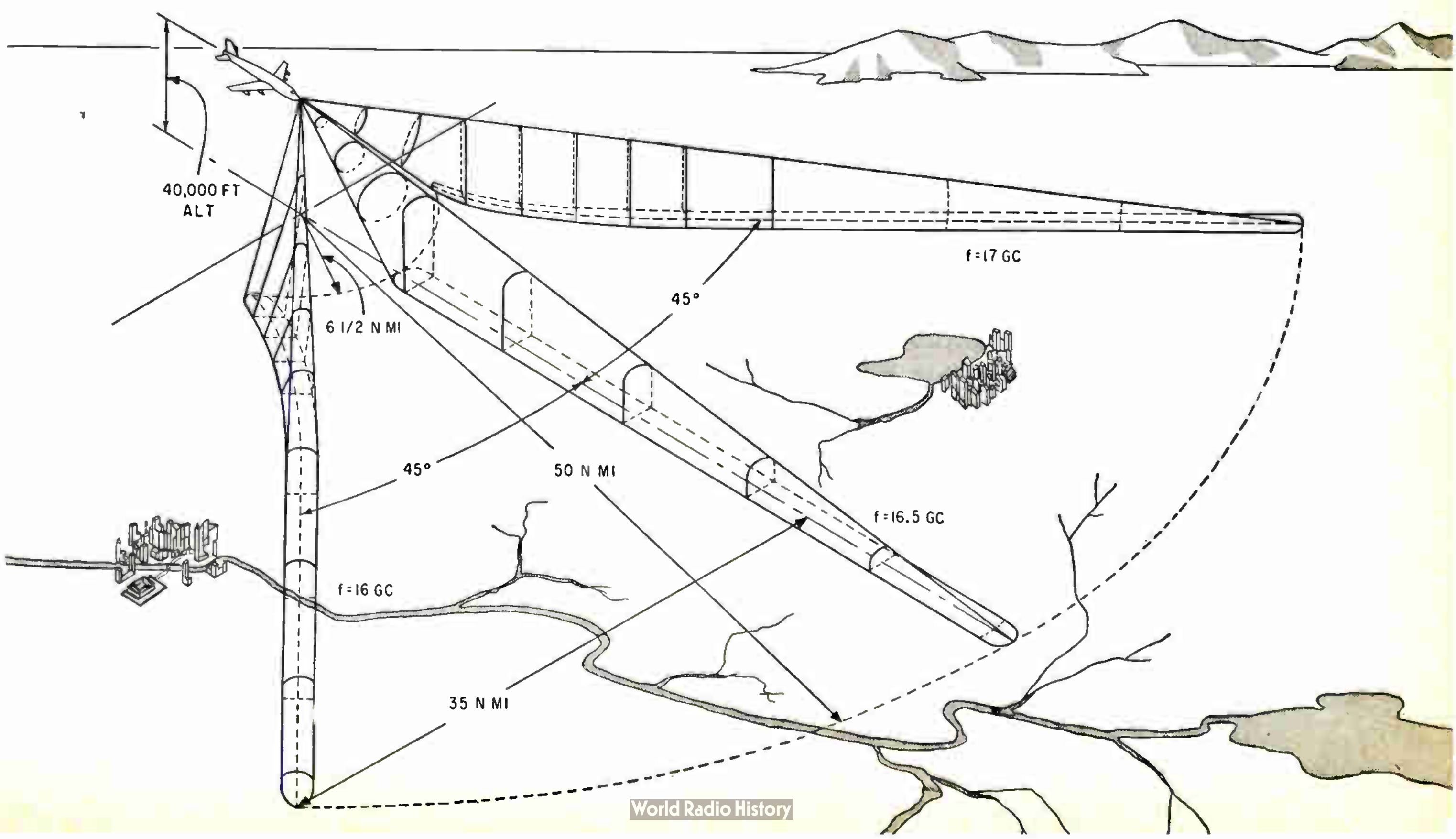
The WR-51 size waveguide delay-line feed was made in the form of an H-plane bend helix to obtain the high degree of accuracy possible on a thread-cutting machine and for coupling convenience. A mean circumference of six guide wavelengths was used to obtain radiation normal to the array at 16.5 Gc. Scan across the ground was ±45 degrees, with end frequencies of 16 and 17 Gc. To excite the branch-line radiators, two-slot narrow-wall directional couplers[2] were precisely aligned on each turn of the helix. Directional couplers easily provide the desired broadband coupling with good interelement isolation and impedance match. Like the helical feed, the coupler manifold was machine cut for accuracy.

Data for the two-slot directional couplers were measured on a test coupler with replaceable coupling-slot inserts. The range of coupling values was determined by the choice of a 30-db Taylor distribution[3], the number of helix turns, and the percentage of power to the load. For the 20-turn helix, coupling values ranged from 8.5 to 23 db down. Patterns measured on the helical feed to demonstrate scan are shown in Fig. 1C; scan angle is very nearly a linear function of frequency shift.

Both the shaped-beam radiator designs in Fig. 3 are based on the synthesis procedures outlined by A. S. Dunbar in his work on progressive-phased antennas for shaped beams[4]. Using the principle of stationary phase, the procedures take a given amplitude distribution and determine a corresponding phase distribution to obtain a stated far-field pattern. Because of different practical design considerations in the two types of radiators, the manner in which the synthesis is applied varies. These differences are roughly analogous to the convergent-ray diagram and divergent-ray diagram shaped-beam reflectors.

Waveguide narrow-wall inclined

FIG. 2—Ground intercept of frequency scanned antenna with slot array radiators



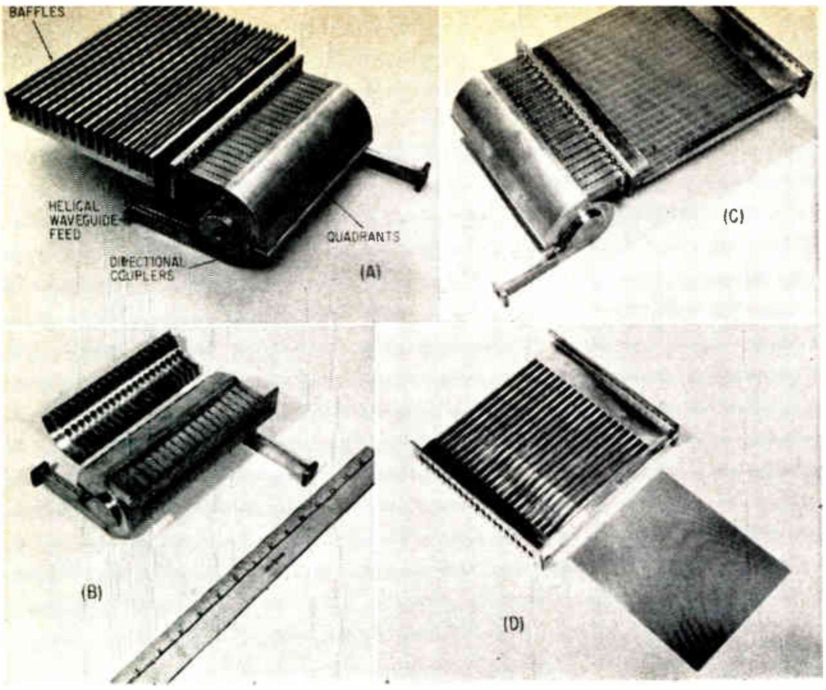


FIG. 3—Twenty-element frequency scanned antenna with slot radiators (A); helical waveguide feed showing exposed coupling manifold (B); antenna with leaky grid radiators (C); grid array with waveguide and grid separated (D)

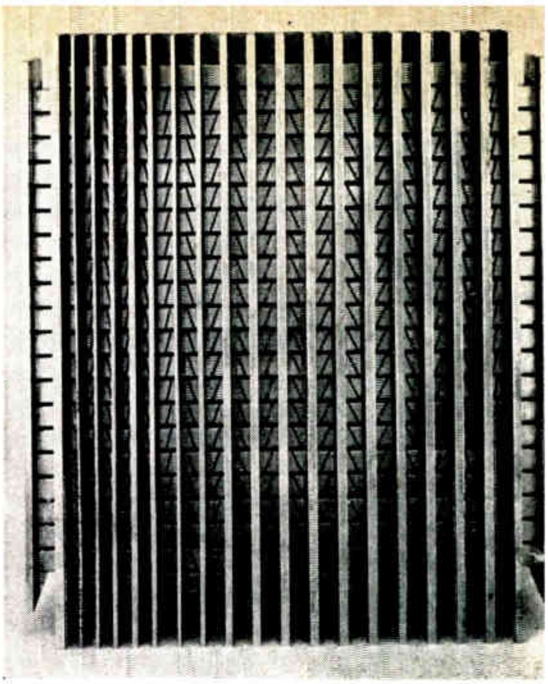


FIG. 4—Twenty-element array of slot radiators with baffles

shunt slot arrays are widely used in large aperture antenna designs. In such antennas, slot spacings near one-half guide wavelength, λ_g, are usually used to obtain approximately broadside radiation. If, however, slot spacings between $0.25\lambda_g$ and $0.45\lambda_g$ are used, the full range of squint angles required for the geometrical optics approximations obtained from the shaped beam synthesis can be obtained. It should be pointed out that backward-wave radiation (toward the generator) obtained with less than one-half guide wavelength spacings is used because of the practical considerations of slot density and freedom from multilobed responses.

Progressive slot positions in an element, such as shown in the array of Fig. 4, are established in a shaped-beam design by referring to the squint-angle data from the synthesis and a curve of squint angle versus slot spacing, considering each succeeding in-phase slot as a slot pair with the preceding slot. Corresponding slot conductance values are found by using the slot amplitude values derived for the synthesis and the computation procedure required for a matched traveling-wave slot array[5].

Since published slot-conductance to slot-inclination-angle data were unusable at other than approximately half-wavelength slot spacings—because of mutual coupling effects—new measurements were necessary. A family of WR-51 waveguide test sections, each containing ten equally-spaced slots, were fabricated to provide this data. Baffles required to suppress cross-polarized lobes were also built and used on the test sections to include their effect on slot conductance. Two different baffle openings were used to cover the range of slot spacings. Also, quarter-wavelength deep chokes were formed by the baffle construction, and dummy waveguides were clamped on either side of the test section during measurements.

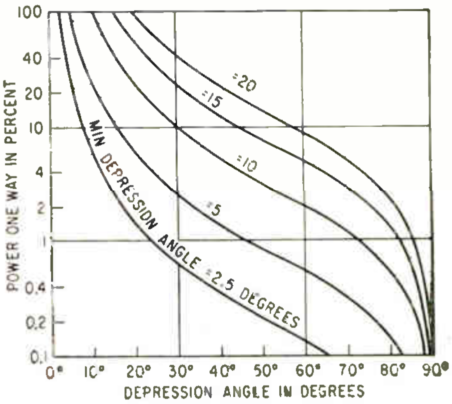
Incremental slot-conductance values were determined by the insertion-loss method, assuming each of the ten slots to have the same conductance value. Families of slot-conductance to slot-angle curves were plotted which showed that

---

Beam Shaping

For a ground-mapping or ground-scanning radar system, it is desired that the output, such as a ppi presentation, be at approximately the same brightness and contrast over the whole area being scanned. The ground directly beneath the airplane should not appear so much brighter than the distant area that details or definition of some of the area is lost. The most practical way to obtain equal definition over the total area being surveyed is to make sure that the signal received back at the antenna, after reflection from equal targets, is the same strength regardless of the distance traversed.

Investigations into the geometry of the problem and the radar range equation reveal that the power output of the scanning antenna, for a ground-mapping airplane, should be $P = \csc^2\theta \cos^{1/2}\theta$, where θ is the angle between the horizon and the depression of the scanning beam. The curves below are taken from "Microwave Antenna Theory and Design" edited by Samuel Silver, Volume 12 of MIT Radiation Lab Series, McGraw-Hill Book Co., Inc., 1949.



conductance increases with slot spacing and baffle opening as well as slot angle.

A typical pattern measured on the eight-wavelength-long shaped-beam slot array (Fig. 4) is given in Fig. 5A. Data from this and other measurements over the 16- to 17-Gc band are included in Table I.

Excellent impedance characteristics resulted from the traveling-wave feed and the non-uniform slot spacing. The variation in radiation efficiency at the ends of the band caused a gain decrease of about 0.65 db at the extremities of scan.

The grid radiator arrays consist of rectangular waveguides with one narrow wall replaced by a flat wire grid and the other wall shaped so that the width dimension varies with distance along the guide. The grid is photoetched from copper-clad dielectric which serves as grid support and pressure seal. The shaped wall is machined into a metal slab which is grooved to hold the top and bottom wave-guide walls.

Operation of the grid radiators may best be explained in terms of ordinary waveguide operation. The TE_{10} mode in a rectangular waveguide may be considered to consist of uniform plane waves bouncing between the side walls at such an angle that interference between them causes a zero electric field at the walls (see Fig. 1D). The angle, θ, of the bounce depends on the width of the waveguide and the frequency; when the width of the guide is just one-half wavelength, θ is zero; when the wavelength becomes very small with respect to the width, θ approaches 90 deg, and the waves do not tend to bounce at all.

Suppose one narrow wall is replaced by a grid of flat wires which are in line with the electric field. The resulting mode may still be considered to consist of plane waves bouncing between the grid and the opposite wall, excepting that some of the energy directed toward the grid passes on through into space outside the grid. The remainder bounces back, as before, to continue a net movement of energy down the guide. Size and spacing of the wires determines how much is bounced; the angle at which the plane waves bounce is still dependent on the width of the guide, the wavelength, and the amount of interference which is necessary for the field to be zero on the solid wall. Since the energy that passes through the grid continues in the bounce direction, it may be seen that the angle of radiation from the grid-array element as well as the amplitude may be controlled by controlling the wire size and spacing simultaneously with the waveguide width.

The elevation pattern of such an array element 6.25 inches long at 16.5 Gc, with 10-percent power into the load, is shown in Fig. 5B. The patterns show a beam shape which is preserved with changes in frequency, but exhibits a tendency to scan. The undesirable beam scanning may be compensated by tilting the array. Assuming an antenna tilt is used, the performance data shown in Table I applies.

One of the problems with frequency-scanned antennas is providing beam-angle data takeoff. The problem was solved with the circuit shown in Fig. 1B. Directional couplers at each end of the helical delay line provide inputs to a phase detector. By virtue of the long electrical length of the helical delay line, the phase detector output will be amplitude modulated at an audio rate as the transmitter frequency is varied to achieve antenna beam scanning. After boxcarring and amplification, the audio frequency component can be used to drive a servo follower if a constant scan rate is used. In cases where intermittent and variable scans are required, a two-phase phase detector will provide continuous servo tracking under all scan conditions.

Use of directional couplers and traveling-wave elements necessitates the use of a large number of termination loads in the frequency-scanned antenna. To minimize the space required, 0.255-inch long resonant loads of epoxy-iron and carborundum-ceramic materials were used, giving vswr of less than 1.2 to 1 over the band.

The authors wish to thank J. K. Smith for his contributions to the angle takeoff circuit and resonant loads.

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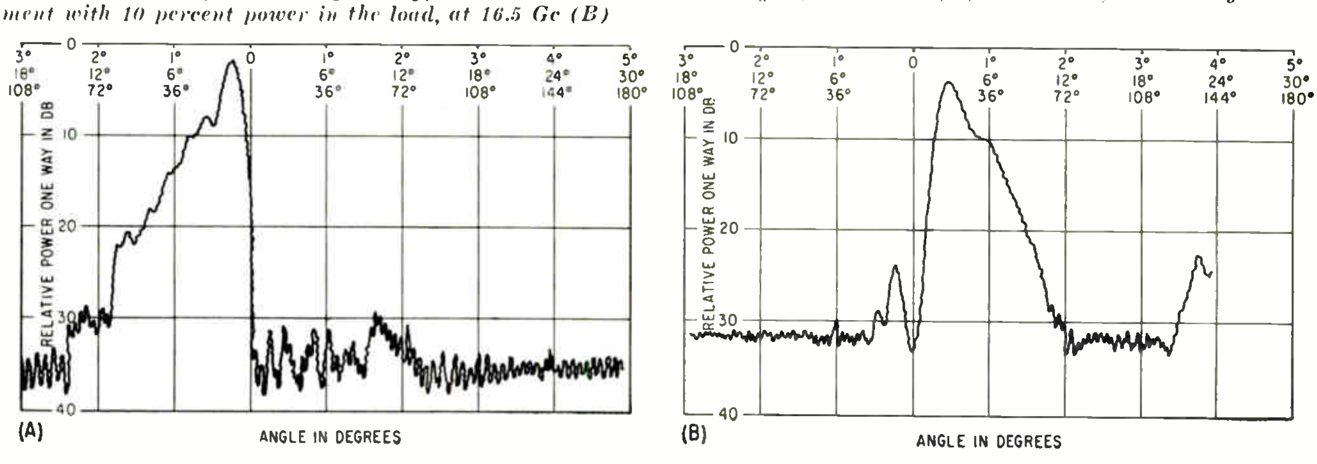
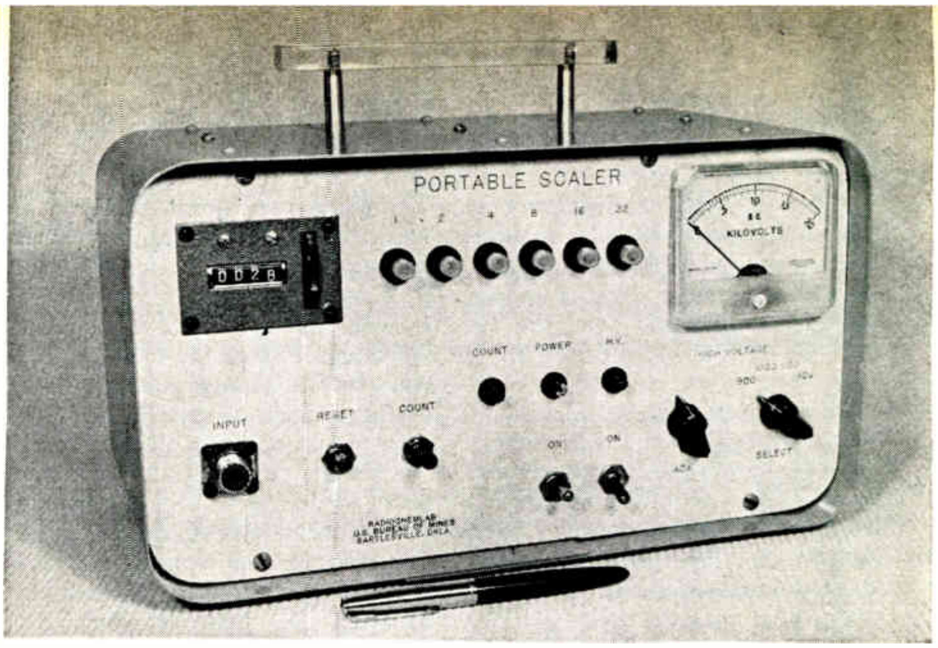
(3) T. T. Taylor, Design of Line Source Antennas for Narrow Beamwidth and Low Side Lobes, *IRE Trans* V01. AP-3, p 16, Jan. 1955.

(4) A S. Dunbar, A Method for the Calculation of Progressive-Phase Antennas for Shaped Beams, *SRI Report No.* 10, June 1950.

(5) N. T. Norwood, Notes on Method for Calculating Coupling Coefficients of Elements in Antenna Array, *IRE Trans* AP-3, p 215, Oct. 1955.

FIG. 5—Pattern of 8-wavelength long, inclined slot element with baffles, at 16.5 Gc (A). Pattern of 6.25 inch grid element with 10 percent power in the load, at 16.5 Gc (B)





Transistorized scale-of-64 counter has neon-lamp readout, and is backed-up by a four-digit register

Battery

Lightweight design dispenses

By F. E. ARMSTRONG,
Bartlesville Petroleum Research Center
Bureau of Mines,
U. S. Department of the Interior,
Bartlesville, Okla.

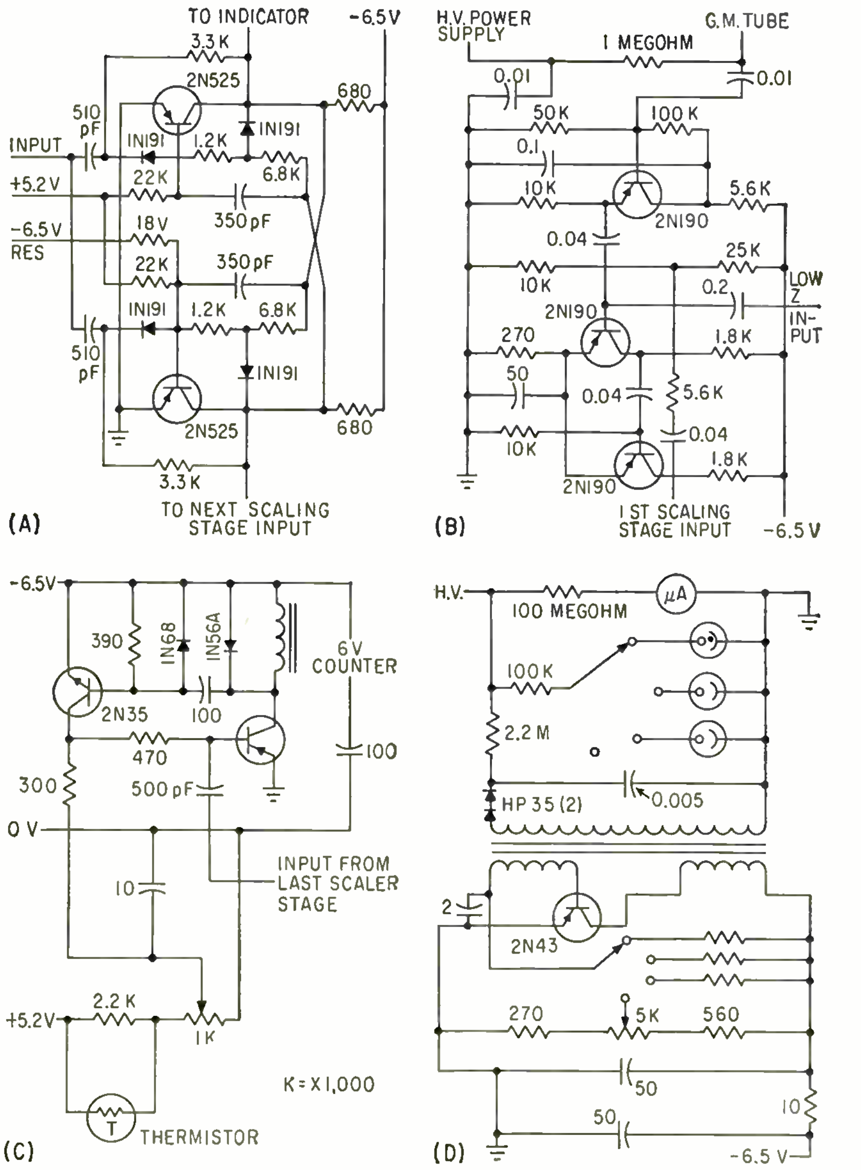
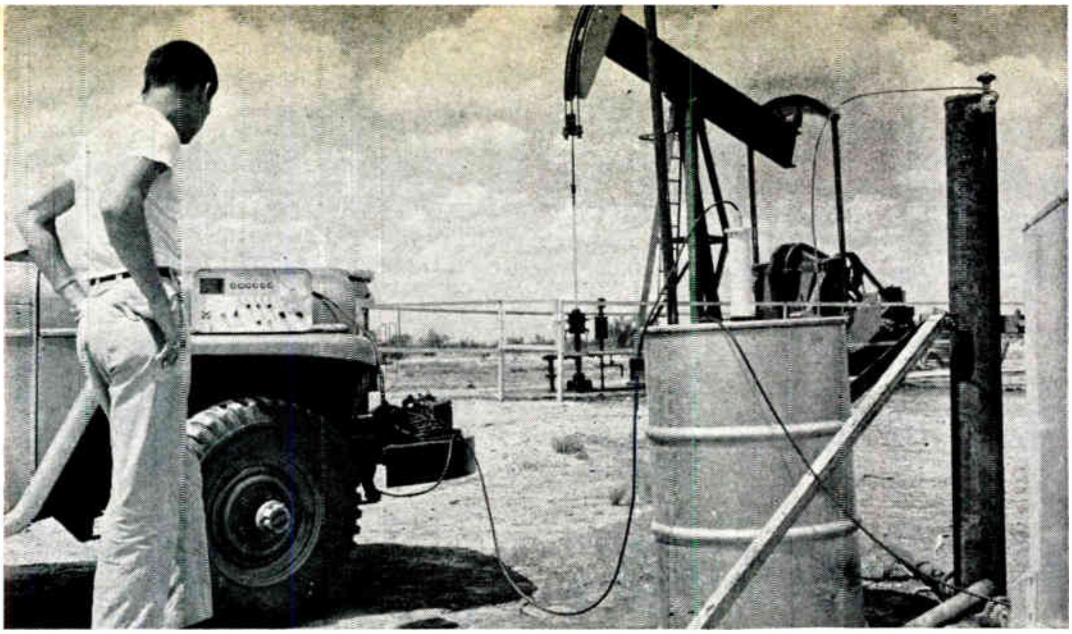


FIG. 1—Typical counting stage—readout is provided by neon indicator (A); input-circuit shapes G-M pulses for triggering counter chain (B); output from scale-of-64 circuit triggers drive circuit of the mechanical counter once for every 64 inputs from the G-M tube (C); blocking oscillator converter provides three stabilized levels of high-voltage for the G-M tube (D)

A SIMPLE BATTERY-POWERED SCALER has been designed for quantitative measurements in field radioactive-tracer studies. The instrument incorporates a binary scaling circuit driving a mechanical register, a pulse-amplifying circuit and a regulated high-voltage supply for Geiger-Muller tube operation. The transistor scaling stages are non-saturating and temperature compensated. Neon indicator lamps are used.

The instrument consists of a scale-of-64 scaling circuit driving a 4-digit mechanical register, a regulated high-voltage supply and a pulse amplifier. Timing is done with an ordinary stop watch. Power for the unit is furnished by 9 single cells, either flashlight cells or mercury cells, and a single 90-volt battery which supplies power for the neon indicator lamps. One set of batteries will permit operation for several months with an average use



Portable scaler in field use. Count rate is determined by stop-watch timing of count period.

Powered Portable Scaler

with frills to improve reliability and to reduce cost and weight

of 3 to 4 hours daily. Total weight of the instrument is 14½ pounds.

The six transistor binary scaling stages are diode clamped for non-saturated operation. Nonsaturated operation of the scaling stages was chosen for several reasons. The decrease in required triggering voltage allows operation from slightly lower supply voltages. Stability under extremes of temperature is improved, and the variation in current demand with attendant poor voltage regulation is reduced.

The circuit for a single scaling stage is shown in Fig. 1A. Readout for the stage is a commercial transistorized neon indicator. The power consumption of 0.5 ma from the 90-volt battery, and about the same from the bias supply (2.6 volts), is not excessive. A one-shot multivibrator is used to drive the first scaling stage. Provision is made for both high and low impedance inputs. The low impedance input drives the multivibrator directly. The high impedance input is through an impedance-matching stage and the high-voltage coupling network for the Geiger tube. The circuit of the input stages is shown in Fig. 1B.

The mechanical register used with the instrument is a 4-digit, reset-type electric counter with a 6-volt coil. Its maximum driving rate of 600 counts per minute determines the maximum scaling speed of the instrument. This, however, corresponds to a maximum scaling rate with a scale-of-64, circuit of nearly 40,000 counts per minute—well beyond the useful scaling frequency of most Geiger tubes.

The coil of the register acts as the collector load of a complementary multivibrator circuit, whose time constants are chosen to provide a 40-millisecond square-wave pulse across the register coil. The circuit is shown in Fig. 1C. Use of a power transistor as the second transistor in the circuit reduces the ON period resistance to a fraction of an ohm and provides reliable operation. A thermistor in series with the bias supply for the *pnp* transistor stabilizes operation of the circuit over a wide temperature range.

High-voltage power supply is a conventional blocking-oscillator circuit which supplies voltage either variable or regulated at 900, 1,000 or 1,100 volts. A 20-microampere movement meters the supply without excessive current drain. Regulation is accomplished by switching one of three corona-discharge tubes into the stabilizing circuit. At the same time the resistance in the oscillator bias circuit is changed to permit the proper regulation current through the regulator tubes. The supply circuit is shown in Fig. 1D.

The single-cell batteries are mounted for easy replacement, in clip holders just inside the back cover of the instrument. The 90-volt battery is mounted similarly. Because of the complexity of the battery connections, a 3-pole ON-OFF switch is provided. Pilot lights are used to indicate main power ON, high voltage ON and counting. While they introduce additional battery drain, these lights are desirable to lessen the possibility of leaving the instrument inadvertently turned ON.

The thermistor temperature-compensating element was added to the register-drive circuit as a result of the relatively wide range of operating temperatures encountered (50 to 110F). No other operational difficulties were encountered.

Chart permits determination of factor required for calculating effectiveness of radar in presence of jamming

Determining Radar Visibility

By NATHAN SLAWSBY,
Senior Engineer, Electronics Research Laboratories, Crosley Div., Avco Corp., Boston, Mass.

EFFECTIVENESS of a radar in the presence of jamming is usually measured in terms of its self-screening range. To define this quantity, consider the case of an aircraft with a white-noise jammer aboard flying a straight-line course which takes it directly over a surveillance radar.

Generally, the transmitted power of the radar is much higher than that of the jammer. At sufficiently short ranges, therefore, the echo received from the target at the radar antenna is greater than the signal produced by the jammer, and the target is clearly visible to the radar operator. However, the radar echo decreases in strength as the fourth power of the range and the jamming signal falls off only as the square. As the aircraft moves away from the radar, the advantage shifts from the radar to the jammer; at sufficiently great ranges, it is impossible for the radar operator to distinguish the target in the jammer noise. As the range increases, the probability of detection decreases from nearly unity to nearly zero.

At some intermediate range, the detection probability must be exactly 50 percent. This range is defined as the self-screening range, the range at which the radar and the jammer are evenly matched. Thus, a large self-screening range indicates that the effectiveness of a radar is not seriously impaired by a jammer.

The equation for the self-screening range, R_{ss}, is

$$R_{ss} = (P_r G_r \sigma / 4\pi P_j G_j \delta V)^{1/2} \quad (1)$$

Table I defines terms used in this and other equations.

Another quantity of interest is termed the screening range. Consider a situation in which a jammer carried in one aircraft attempts to prevent the radar from detecting another aircraft. In this case, the jammer generally radiates into a side-lobe of the radar radiation pattern at the time the main-lobe radiation illuminates the target. The screening range, R_s, which is the range at which radar and jammer are equally matched in this situation, is given by

$$R_s = (P_r G_r \sigma R_j^2 / 4\pi P_j G_j k \delta V)^{1/4} \quad (2)$$

In both of these equations, the visibility factor (V) is the one term which may not be readily determined. Visibility factor can be determined from Fig. 1 if the false alarm rate which the radar operator can just barely tolerate is known.

The requirement of 50-percent detection probability does not completely specify the visibility factor. It is also necessary to state the rate at which noise spikes can be allowed to exceed the detection threshold of the radar and generate spurious targets. Since the visibility factor is used to determine the range at which neither the radar nor the jammer has a clear advantage, this rate must be high enough to cause some distraction to the radar operator without confusing him completely.

The detection threshold is arbitrarily set to yield one false alarm per beamwidth in the self-screening case and one false alarm per scan in general screening case. The rates differ because in the self-screening case, the jammer is in the main lobe at the same time as the target, while in the general case, the jammer radiates into a side lobe.

The false-alarm probabilities are determined by

$$P_{ss} = \tau / 10.74\, R_M$$
$$P_s = n \tau f_s / 645\, R_M f_r$$

These equations assume that the radar display may be subdivided into a number of data positions with dimensions corresponding to the duration of the transmitted pulse and the half-power beamwidth of the antenna. P_{ss} is the reciprocal of the number of these data positions in a

TABLE I—GLOSSARY OF TERMS

P_r	radar peak power, w
G_r	radar-antenna gain
σ	mean reflecting-target area, sq m
δ	radar i-f bandwidth, mc
P_j	jammer power, w/mc
G_j	jammer-antenna gain
V	visibility factor, S/N for 50-% detection probability
k	average side-lobe/main-lobe level (ratio)
R_j	jammer range
n	hits on target/scan
τ	pulse duration, μsec
f_s	antenna rotation, rpm
f_r	prf, pulses/sec
R_m	max range displayed, statute miles
θ_H	half-power beamwidth, deg

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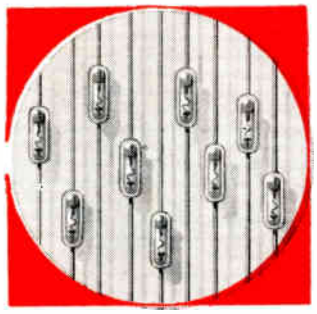

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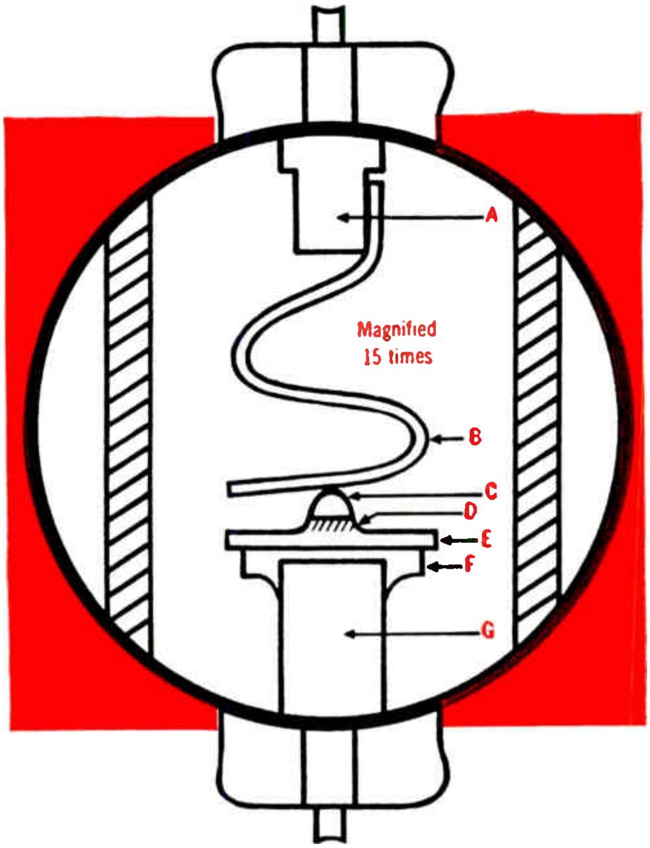

A – dumet, B – platinum, C – gold, D diffused region, E – N-type silicon, F – gold, G – dumet.

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FAST RECOVERY TYPES

Type	Min. Rev. Voltage @ 100 μA (volts)	Min. Forward Current		Maximum Reverse Current				Reverse Recovery Characteristics*	
				@ 25°C		@ 100°C			
		I_F (mA)	E_F (volts)	I_R (μA)	E_R (volts)	I_R (μA)	E_R (volts)	Zrec (Kohms)	t (μsec)
1N625	−35	4	1.5	1	−20	30	−20	400	1.0
1N626	−50	4	1.5	1	−35	30	−35	400	1.0
1N627	−100	4	1.5	1	−75	30	−75	400	1.0
1N628	−150	4	1.5	1	−125	30	−125	400	1.0
1N629	−200	4	1.5	1	−175	30	−175	400	1.0

*JEDEC 14.5-1 (Modified IBM-Y reverse recovery circuit with: I_F = 30mA, E_R = −35V, R_L = 2K ohms.)

HIGH CONDUCTANCE TYPES

Type	Min. Rev. Voltage @ 100 μA (volts)	Max. Fwd. Voltage @ 100 mA (volts)	Maximum Reverse Current				Max. Avg. Fwd. Current	
			@ 25°C		@ 150°C			
			I_R (μA)	E_R (volts)	I_R (μA)	E_R (volts)	@ 25°C (mA)	@ 150°C (mA)
1N482	−40	1.1	0.25	−30	30	−30	100	25
1N483	−80	1.1	0.25	−60	30	−60	100	25
1N484	−150	1.1	0.25	−125	30	−125	100	25
1N485	−200	1.1	0.25	−175	30	−175	100	25

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The number of hits per scan, which, for a point target, is equal to the number of pulses per beamwidth, is given by:

$$n = f_r \theta_H / 6 f_s$$

Use of Fig. 1 will be illustrated by finding the R_s of a target with a 1 sq-m mean cross-sectional area, screened by a jammer which has these characteristics: $P_J = 1$ w/mc, $G_J = 2$, $R_J = 1.61 \times 10^5$ m.

The radar has these characteristics: $\theta_H = 3$ deg, $f_s = 8$ rpm, $f_r = 400$ pps, $\tau = 2\mu$sec, $R_M = 200$ miles, $G = 316$, $K = 3.16 \times 10^{-3}$, $\delta = 600$ Kc, $P = 1$ Mw.

Solving for hits/scan, $n = 400 \times 3/6 \times 8 = 25$.

Calculating the false-alarm probability,

$$P_s = 25 \times 2 \times 8 / 645 \times 200 \times 400 = 7.76 \times 10^{-6}$$

From the chart, visibility factor is 1.15.

Inserting V into the screening-range equation,

$$R_s = \left[\frac{(1 \times 10^6)(316)(1)(2.6 \times 10^{10})}{(12.6)(1)(2)(3.16 \times 10^{-3})(0.6)(1.15)} \right]^{1/4}$$

Thus, $R_s = 1.11 \times 10^5$ meters.

Since the jamming signal is random noise, the method of computing visibility factor for various false-alarm probabilities and hits/scan involves the statistical nature of the detection process.

The envelope of a white-noise signal conforms to a Rayleigh probability distribution, given by

$$P(R_N)dR_N = (2/K^2)R_N \exp(-R_N^2/K^2)dR_N$$

where R_N is the instantaneous amplitude of the noise envelope and K is the rms amplitude of the noise envelope.[1] This expression shows the probability that the noise envelope exceeds any noise level, R_N.

When a continuous sinusoidal signal of unit magnitude is added to the noise, the S+N envelope conforms to a probability distribution given by

$$P(r)dr = (2/K^2)r \exp[-(1+r^2)/K^2] I_o(2r/K^2)dr$$

That is, this expression shows the probability that the signal-plus-noise envelope exceeds any level of signal plus noise, r. Here $I_o(x) = J_o(ix)$.

To find the signal-to-noise ratio needed to give 50-percent detection probability for any false-alarm rate at one hit per scan, the noise distribution function is used to determine the threshold voltage which corresponds to that false-alarm rate. The required signal-to-noise ratio is that which yields a mean value which is the same as this threshold level. This is found by applying the series approximations[2] for the signal-plus-noise distribution function.

The effect of integrating several hits per scan can be determined by applying the central limit theorem to the above distributions. Application of the theorem produces approximations for the probability distributions. The approximations have been used to generate the family of curves in Fig. 1. Derivation of the curves is based upon an ideal radar, and does not include such effects as lack of discrimination by the operator, antenna scanning loss, and mismatch of the i-f bandwidth to the pulse duration. Such effects, if they exist, degrade visibility factor V to an extent determined only by computing the losses in each case.

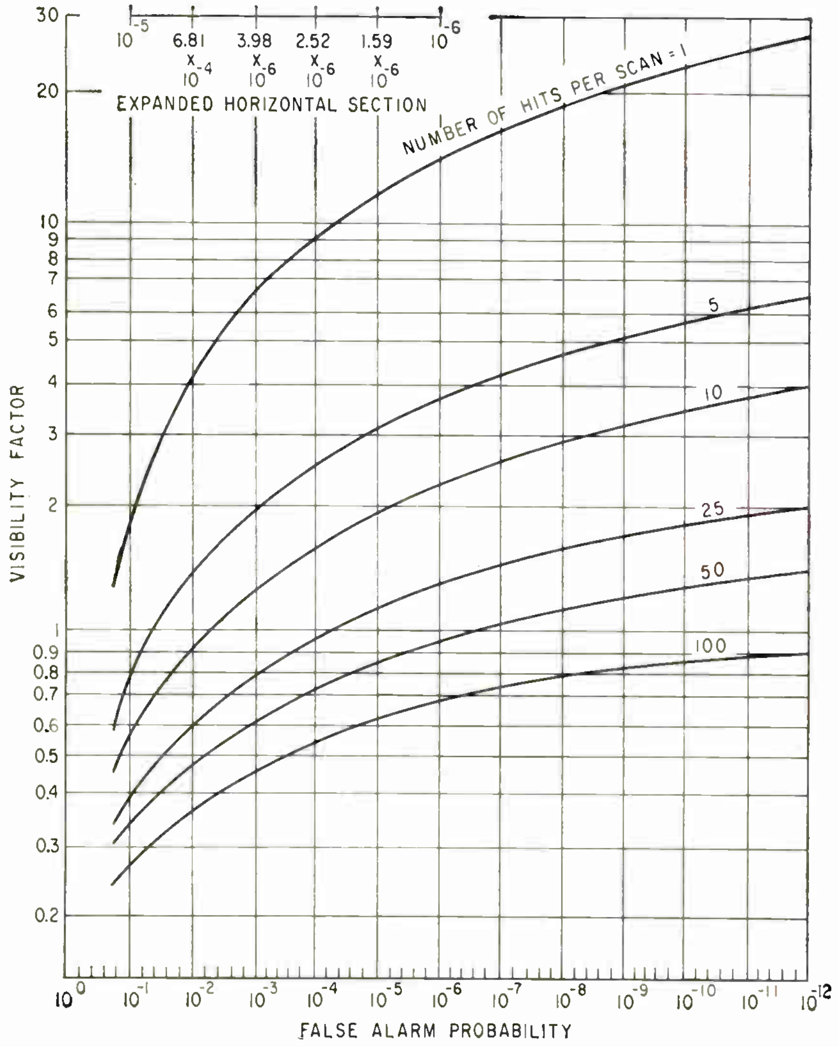

FIG. 1—To obtain visibility factor, compute hits per scan and false-alarm probability

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(1) S. O. Rice, Mathematical Analysis of Random Noise, *Bell System Tech J*, 23, p 282 to 332, 1944 and 24, p 46 to 156, 1954.

(2) K. A. Norton, L. E. Vogler, W. Y. Mansfield and P. J. Short, The Probability Distribution of the Amplitude of a Constant Vector Plus a Rayleigh-Distributed Vector, *Proc IRE*, 43, No. 10, p 1,354 to 1,361, Oct 1955.

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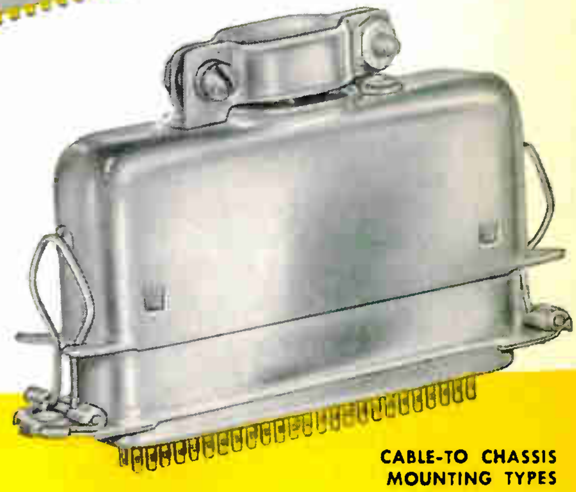
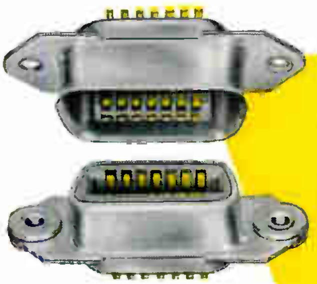
Bodies are molded of an improved diallyl phthalate with extremely high impact strength and excellent dielectric features. Contacts are gold-plated over silver. Shells are cadmium-plated brass with clear chromate treatment. Receptacle shells have floating bushings allowing a float of .020 in each direction.



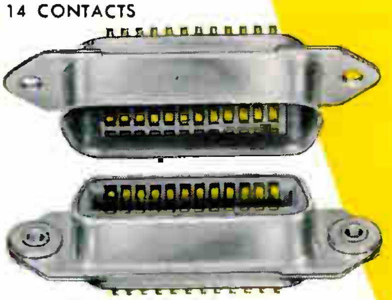
CABLE-TO CHASSIS MOUNTING TYPES

The compact housings are equipped with sturdy spring type latches on the receptacles which are guided and held by cut-outs in the plug flanges.

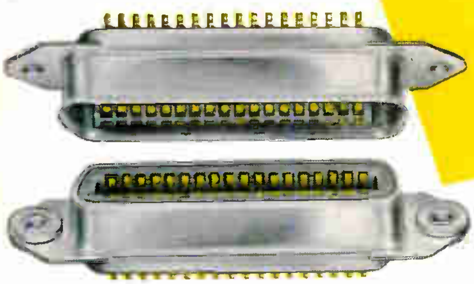
The shells are cadmium plated brass with clear chromate treatment. Receptacle shells have floating bushings allowing a float of .020 in each direction.



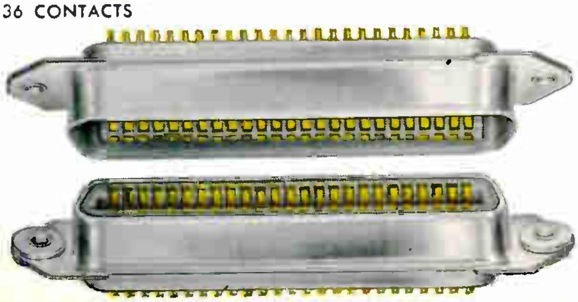
14 CONTACTS



24 CONTACTS

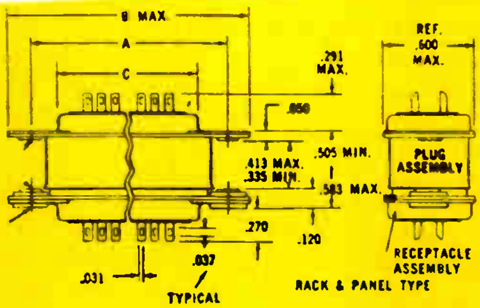


36 CONTACTS



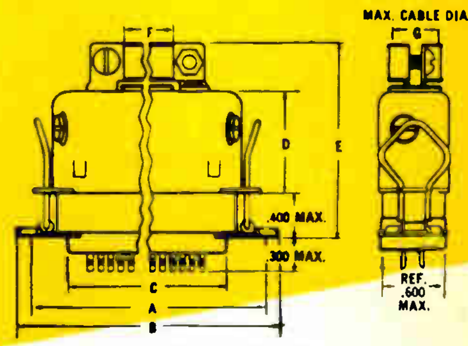
50 CONTACTS

RACK AND PANEL TYPES



DIMENSIONS

		14 Contacts	24 Contacts	36 Contacts	50 Contacts
BOTH TYPES	A	1.417	1.842	2.352	2.947
	B	1.750	2.175	2.685	3.270
	C	.908	1.335	1.845	2.440
CABLE TO CHASSIS TYPE ONLY	D	.843	.843	.905	1.000
	E	1.668	1.668	1.730	1.825
	F	.306	.473	.640	.766
	G	.422	.473	.473	.473



CABLE-TO-CHASSIS TYPE

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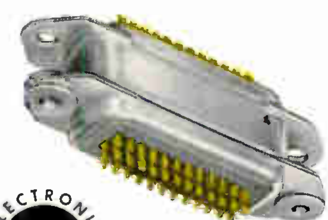

RACK AND PANEL . . . CODE NOS.

CONTACTS	PLUGS	SOCKETS
14	36-27114	36-27214
24	36-27124	36-27224
36	36-27136	36-27236
50	36-27150	36-27250

PLUG WITH CAP . . . SOCKET WITH LOCK

14	36-27314	36-27414
24	36-27324	36-27424
36	36-27336	36-27436
50	36-27350	36-27450

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Miniature Capacitor Microphone

DIMENSIONS of capacitor microphones have been reduced while retaining the desirable characteristics required for measurement applications and for use in tv and moving picture studios. A Mylar diaphragm 6 microns thick and 5 mm in diameter with gold deposited on it helped reduce size. The miniature microphone with 15-Kc bandwidth was described by C. Wansdronk of Philips Research Laboratories, Eindoven, Netherlands.

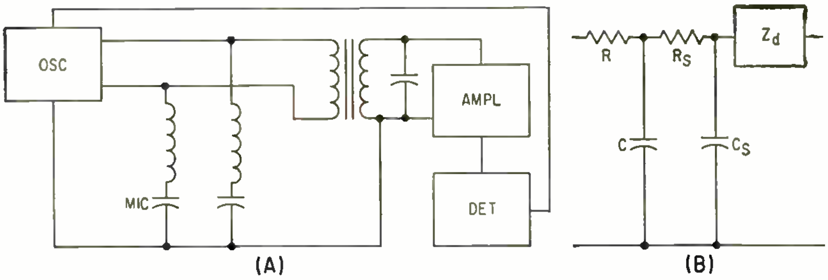

FIG. 1—Comparison circuit produces sidebands with changes in microphone capacitance that are amplified, recombined with the carrier and detected (A). Acoustical filter in equivalent circuit permits cardioid pattern over entire frequency range

Output of a capacitor microphone subjected to a given sound intensity is dependent on the ratio of change in capacitance to total capacitance. Total capacitance includes a parasitic capacitance that becomes proportionately greater as dimensions are decreased. Therefore change in capacitance should be made as large as possible by permitting as much diaphragm deflection as possible.

For omnidirectional capacitor microphones, deflection is about inversely proportional to stiffness, so stiffness should be as small as possible. However, bandwidth is limited at high frequencies by diaphragm resonant frequency, which in turn is dependent on diaphragm mass.

Decreasing diaphragm stiffness requires a decrease in diaphragm mass to maintain constant bandwidth. The Mylar diaphragm provided the reduced mass, but mass of surrounding air could no longer be neglected.

High-Frequency Detection

Smaller total capacitance increases internal impedance, resulting in increased preamplifier input impedance or a higher cut-off point for lower frequencies since microphone and preamplifier impedances form a high-pass filter. This problem can be overcome with high-frequency detection[1]. A coil is inserted in series with microphone capacitance to lower impedance near resonant frequency and permit connection of the cable directly to the coil. Coil and microphone are mounted in a casing 5 cm long.

Varying impedance of the microphone-coil combination in Fig. 1A is compared to a fixed impedance. Zaalberg van Zelst[2] proposed using the same elements in the fixed circuit, but the microphone was replaced by a capacitor.

Difference voltage contains only the side bands of the amplitude-modulated signal. The signal can then be amplified, mixed again with the carrier and detected. Low noise results, especially in silent periods. However, slight changes in the elements overload the circuit with carrier current. Also temperature changes between the two branches cause imbalance.

The fixed branch was replaced with a resistance (the resistance of the coil) to start with imbalance. The detector was inserted directly behind the transformer. A frequency was chosen in a straight part of the resonant curve not far from minimum to keep high S/N. Noise is mostly electrical and is probably caused by frequency and amplitude fluctuations of oscillator current. Measured constant noise level per octave was equivalent to sound pressure of 20 db/octave.

Directivity

To make the microphone directional, it is necessary to measure pressure gradient instead of absolute pressure. Sound is allowed to reach the diaphragm directly from the front and from the rear via holes in the side wall and in the fixed electrode.

In an equivalent electrical circuit, the side wall holes can be represented by an inductance and the cavity between the holes and the diaphragm by a capacitance. To a first approximation there is no phase difference between the holes and the rear of the diaphragm for frequencies below the combined resonant frequency of the holes and the cavity. Directivity characteristic is a figure 8. To obtain a cardioid, an acoustical filter was built that changes phase proportional to frequency. This can be done with an RC or L/R low-pass filter.

If length l is an indirect path from the front to the side holes and c is sound velocity, $RC = l/c$ or $L/R = l/c$. This relation must be fulfilled to get cardioid directivity. Effective detour l appeared as the distance between the front and the side-wall holes plus half the diaphragm diameter.

There is a problem with the frequency characteristic as well as the directivity characteristic at frequencies at which $\omega(l/c) > 1$. However, diffraction can largely compensate these problems. At lower frequencies where the electrical circuit forms a useful analogy, the cardioid shape becomes increasingly circular. As microphone diameter decreases, the frequencies at which this occurs are higher.

To control diaphragm resistance and obtain maximum effective capacitance, there is only the small slit between the fixed electrode and the diaphragm. From the theories of Crandall[3], this slit can be repre-

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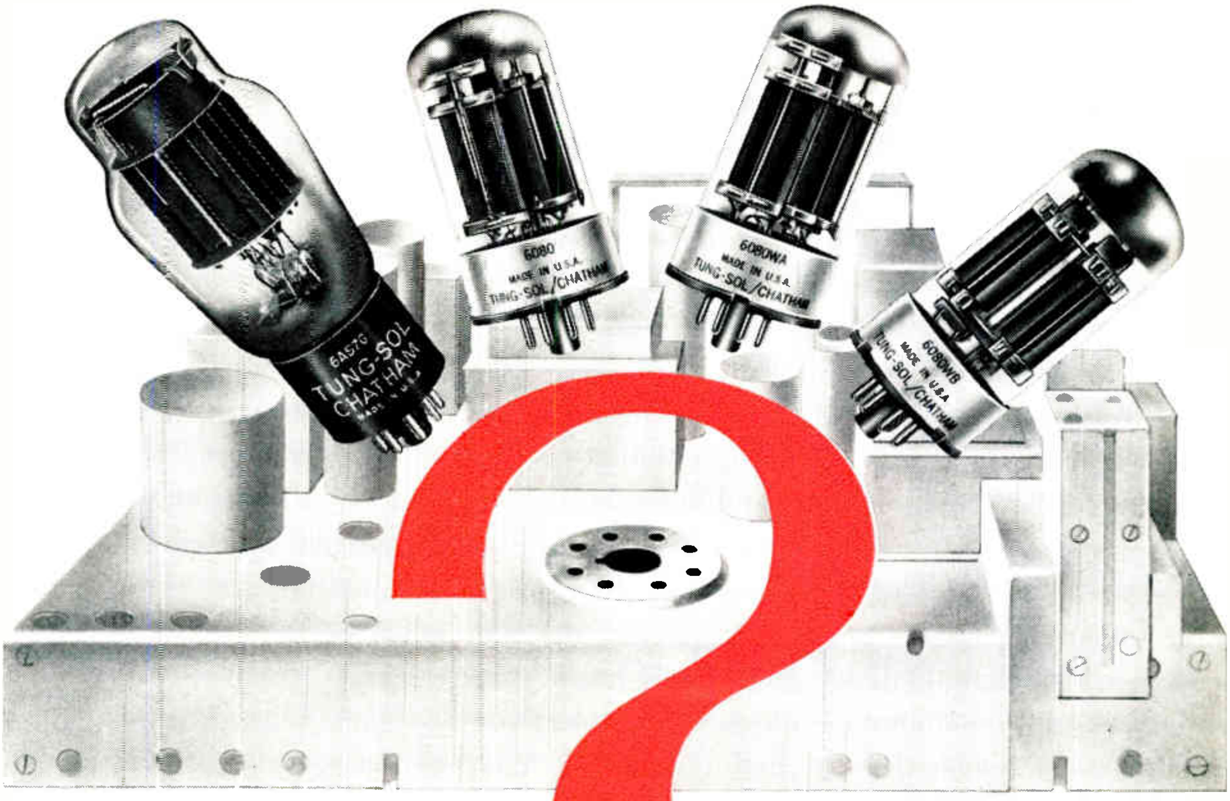

But which fits ? your application

Like most circuit designers, you're probably often confronted with a wide choice of tubes which meet the *electrical requirements* specified by your design. But depending on other factors, such as the kind of environment in which the tubes are expected to operate, your choice may be limited.

Consider the Tung-Sol/Chatham 6080 tube family, for example. The 6080, the 6080WA, the 6080WB and the prototype 6AS7G all fit the same socket. The electrical ratings of these series regulator tubes are the same. Would you know which to specify for your power supply? The differences are vital. Knowing them can make all the difference in the ultimate reliability of your design.

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And if you would like prompt and able assistance in selecting the correct tube for your application, get in touch with Tung-Sol tube experts. They'll be glad to study your design and recommend the tubes best for you. Tung-Sol Electric Inc., Newark 4, N. J. TWX:NK193

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sented by a resistance with a parallel capacitance. This resistance however is proportional to $(l/\omega)^{\frac{1}{2}}$. In the circuit in Fig. 1B, R and C form the artificial filter, R_s and C_s form the slit filter and Z_d is diaphragm impedance. In the middle range and for high frequencies, R_s does not exist and C_s is small compared with C. With $RC = l/c$, a cardioid results. For low frequencies, the two filters change phase too much. By eliminating the artificial RC filter, the microphone is a cardioid at low frequencies with a figure 8 for higher frequencies.

To keep the same cardioid characteristic over the whole frequency range, an artificial filter was made to operate only when R_sC_s has disappeared. The acoustical filter mounted inside the microphone acts like a damped resonant circuit functioning like the slit filter.

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(1) H. Riegger, Z. *Tech Phys*, 5, p. 577, 1924.
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Corner Reflectors for Low Back Radiation

DESIGN analysis of corner reflector antennas has been carried out by the National Bureau of Standards under USAF sponsorship. Results provide comprehensive information on high-performance, economical corner reflectors.

Corner reflector antennas have two plane reflecting surfaces joined to form a corner. The driven element is placed in the aperture between the two planes. These antennas offer high gain, broad frequency response, narrow beam width and low back radiation.

Ionospheric scatter stimulated interest in corner reflectors. Despite earlier use, performance was known only qualitatively. The present investigation was to determine how gain varies with width and length of reflecting surfaces, aperture angle and driven element position.

The antenna investigated had two lattice-type wooden frames 12.3 ft wide (five wavelengths at 400 Mc) and 12.3 ft long supporting the reflecting surfaces. The reflectors were overlapping strips of aluminum fastened to the frames. Removal of one strip would subtract 0.2 wavelength from the surface. Width could be varied by trimming strip length. The frames were pivoted along the same axis, and aperture angle could be varied from 20 to 180 degrees.

The driven element was a folded half-wave dipole. Its position could be varied from 0.07 to 2.5 wavelength from the apex of the reflecting surfaces. The dipole support also served as a balum to transform system impedance to about 50 ohms. An exact match to a 50-ohm line was provided by a two-stub tuning unit. Gain was measured at 400 Mc.

Although collinear arrays of four or more dipoles are used in scatter antennas to obtain gains of over 20 db, performance can be predicted from that of a single dipole.

Performance

Minimum reflector width is 0.5 wavelength for the smallest usable gain. Increasing width to 2 wavelength increases gain. Greater widths produce little or no increase and may actually decrease it.

For maximum gain, the dipole must be at one of several positions from the apex. Exact position is a function of aperture angle.

With the dipole at the first position, gain increases monotonically as reflecting surface length increases. At the second or third positions, the same relation holds except for surface lengths less than 1.5 wavelengths. For the shorter lengths the relation is too irregular for simple analysis.

Maximum gain along the forward axis seems to be achieved with the dipole in the second position and the reflecting surface more than two wavelengths long and about two wavelengths wide.

Ionospheric scatter antennas for low vhf should have low secondary lobes and minimal back radiation to avoid interference from multipath propagation. The corner reflector can be designed to have very low back radiation. The small back radiation that does occur results from diffraction around the edges and penetration through small openings in the reflector surfaces.

Electronic Tube Base Potting

BY KENNETH L. ROHRER,
Electronic Tube Division,
Westinghouse Electric Corp., Elmira, New York

ELECTRON TUBE performance at environmental extremes is only as good as the foundation itself, the base material. A base should have high electrical resistance, high electrical strength, and high mechanical strength; it should be low in moisture absorption and resistant to high and low temperatures as well.

A number of base materials are satisfactory for potted tubes. For example, glazed ceramics and some conventional molded plastic base materials; nylon, diallyl phthalate, and nylon-filled diallyl phthalate. Although not evaluated, orlon and polypropylene should have merit.

External leads of electronic tubes are protected by potting the volume surrounded by the molded base, glass stem, and glass exhaust tubulation. The potted resin completely surrounds the fragile, thin-walled tubulation through which the tube is exhausted and sealed.

When selecting and evaluating resins for base potting, the decision should be made to use either a flexible resin system or a system to match, as nearly as possible, the coefficient of thermal expansion of the glass. Typical coefficients of glasses used for electronic tube envelopes range from 46 x 10^{-7} in/in/deg C to 89 x 10^{-7} in/in deg C. The former corresponds to a hard glass; the latter relates to a soft glass. A wide mismatch of thermal expansions between glass and rigid plastics will cause glass breakage during temperature cycling.

Many natural and synthetic resinous materials have been evaluated to determine their suitability for base potting. They include epoxies and their modifications, epoxy-polyamide systems, castor-oil disocyanate resin mixtures, THIOKOL rubbers, silicone rubbers, and catalyzed tung-oil castor-oil mixtures.

Of all the flexible resin systems evaluated, RTV silicone rubber has been found to be most satisfactory. Supplied as a two-component system, RTV vulcanizes to a rubbery solid without pressure of temperature. In the cured state, it possesses unusually good electrical properties, resistance to moisture, and heat; it remains useful and flexible over a wide temperature range. Its published brittle point is about −100 F; the maximum serviceable temperature is 500 F.

RTV lacks one physical property which prevents it from being the ideal potting resin for bases—that is adherence to plastics. Fortunately, new and recent primers improve adherence to these surfaces. Properly applied, attempts to pull cured RTV from primed surfaces will cause cohesive failure in the rubber itself, leaving the rubber to primer and primer to base material bonds intact.

To obtain adherence to plastics, it is necessary to remove the gloss and to roughen their surfaces before a primer is applied. Vapor blasting followed by degassing in trichlorethylene is a good preparatory procedure. In every failure, the primer peels away from the plastic surface and adheres only to the cured RTV. Published linear shrinkage values range from 0.2 to 1.1 percent after cure, depending upon the supplier.

Major deficiencies in most semiflexible or flexible resins seem to be excessive moisture absorption and a severe increase in flexural modulus at extreme low temperatures. RTV is superior in both aspects.

Frequently, moisture absorption and flexural modulus of a given resin system seem to be closely related. A decrease unfortunately, in flexural modulus usually will increase a resin's ability to absorb moisture. Flexural modulus is inversely proportional to the amount of flexibilizer or modifier in a flexible resin system.

Inadequate adherence of RTV to unprimed plastic surfaces suggest two possible sources of trouble during service of potted tubes: penetration of moisture between nonadherent silicone rubber and the plastic base to form an electrical leakage path between the base pins; and shrinkage of the rubber away from the base walls to provide a very small air gap which may ionize at high voltages and high altitudes. On the contrary, however, experience has shown that the presence of such a gap during humidity cycling has presented no problem during electrical leakage tests or during altitude tests using applied voltages of 2,800 v at a pressure of 2 inches of mercury. Higher voltages and altitudes may require use of an RTV primer.

Although bases potted with silicone rubber without benefit of a primer to promote adhesion have passed humidity cycling, it was thought that additional detterents to moisture penetration should be used. After potting, bases can be hermetically sealed by use of a lead-foil tape with a pressure sensitive backing. Its rate of transmission of moisture vapor is 0.10 g per 100 square inches per 24 hrs at 100 F. The tape is applied and formed to the outside diameter of both the plastic base and glass envelope, over the crevice between envelope and base. The W1-7198 makes use of such a tape. Finally, as an additional safeguard, the base, tape and glass area one-fourth of an inch above the tape are sprayed with a special epoxy-polyamide enamel designed to resist deformation and cracking between −65 C to 100 C and deterioration during humidity cycling.

Pressure filling methods have been found to be the most satisfactory for obtaining completely filled, voidless potted bases.

Inclusion of a magnetic shield in the design of the WL-7268 makes it necessary to pot, in addition to the base, the space between the metal shield and the glass envelope. Here the RTV cushions the glass envelope and shields against vibration during airborne operation. To facili-

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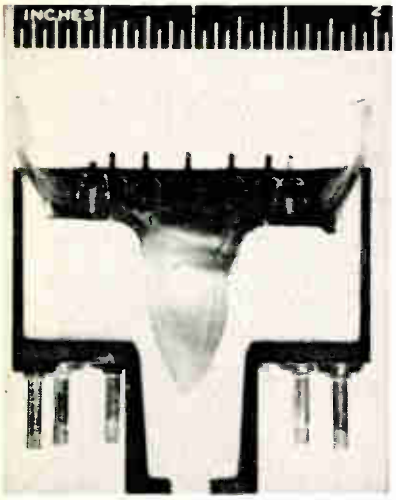

Cross-sectional area of a potted base. The potted resin completely surrounds the fragile, thin-walled tubulation through which the tube is exhausted and sealed

tate and speed the potting operation, and at the same time to provide a more resilient cushion, a thinned version of RTV is used. Thinned with 25 percent by weight of a high-dielectric silicone fluid, the cured resin shows no significant change in electrical properties and little change in other properties.

Ceramic-to-Metal Bonds

A NUMBER OF methods of metallizing ceramics for brazing into ceramic-metal assemblies have been devised. According to L. W. Coughanour of the General Electric Power Tube Department, Palo Alto, California, the two most widely used are probably the molybdenum-manganese method developed by Nolte and Spurk, and the titanium hydride vacuum process of Bondley. Each method has its advantages, and each is capable of giving excellent results when properly applied.

Regardless of the method used, the formation of reliable, vacuum-tight ceramic-metal seals depends upon a number of factors. Among these are: a good bond formation between the ceramic and the metallizing material; proper design of the ceramic-metal subassembly, including the choice of ceramic and metal members to give the best thermal expansion match possible; and sound brazing techniques in forming the subassembly.

On cooling a brazed concentric

ceramic-metal seal, the joint will normally be in compression. If the assembly is heated, however, the differential expansion of the ceramic and metal members may result in the generation of tensile stresses and shear stresses at the interface, with the tensile stresses being predominate. In a butt-type seal, shear stresses are more important on thermal cycling of the assembly.

Ceramic Circuit Boards

PRODUCTION of large ceramic pieces that serve as circuit boards could signify a major breakthrough in bringing the environmental specifications of printed circuits up to par with other electronic components. High alumina base and metal circuits of molybdenum and manganese can be subjected to temperatures in the 1,500 F to 2,000 F range. Mitronics, Inc., Hillside, N. J. feels that it has overcome the major obstacles in producing a ceramic printed circuit of respectable size. Their marketing efforts have been limited to select conversations with principal electronics manufacturers, and until more specific requirements are known, no general sales effort will be launched.

The company has just completed a six months investigation and development program which resulted in the production of ceramic bases for printed circuits that can be manufactured in mass production.

Shaping Tungsten

PURE TUNGSTEN can now be made into intricate shapes by special machining techniques. Parts can be fabricated to close tolerances with holes, threads, shoulders, tapers and other physical configurations. Melting point of this tungsten is over 3,000 C. It is finding use as inserts, nozzles, electrodes, bolts, screws and throats. Porous tungsten of controlled particle size and porosity can also be manufactured for filters and ion sources. Semicon of California, Inc., Watsonville, California is thought to be the only processors of this tungsten of the West Coast.

Control Makes Test Safe, Accurate

By F. J. CLOUNIE, P. M. DEGROAT and E. M. SZYMANSKI, IBM Federal Systems Division, Owego, N. Y.

MANUALLY-OPERATED dielectric strength testers are hazardous to work with. The operator who places both hands on the tester risks high voltage grounding; consequently, 2 operators are needed. Also, human errors occur when instantaneous meter readings are taken and the controls manipulated.

To rectify these problems, an automatic control unit for such testers was developed. A single operator can safely and continuously make measurements over an extended period and while the components under test are operating in an environmental chamber. If plugs are used to disconnect the control unit, it can also be used for other applications requiring a variable voltage control over a fixed period of time.

Testing is automatic except for initial pretest settings. The operator sets the maximum voltage desired with the voltage arm (Figs. 1 and 2), which sets the high limit switch S_1. He then adjusts or inserts the time delay desired, switches on the high voltage with S_2 (circuit breaker), depresses the start switch, S_3 and observes the test to completion. S_4 is a stop switch.

To develop a dielectric strength tester that would have the needed capabilities, the following design objectives were established: low cost and portability; a high degree of accuracy, reliability and repeatability; immediate visual indication of test progress and failure warning; manual override of the automatic features, and elimination of physical contact between the operator and equipment after a test was started.

Low cost and portability were achieved by replacing the manual controls of an available tester with the automatic controls. The compact new unit attaches directly to the original cabinet.

The knob and scale were removed from the original tester's autotransformer. A calibrated dial disk, gear train, reversible motor, appropriate control stops and a readout indicating pointer were installed. The dial disk is calibrated to the same degree of accuracy as the voltmeter in the tester circuit.

Compact control unit attached to tester maintains set's portability

The readout becomes more accurate because of expanded scales, one for d-c reading and the other for a-c reading. The smallest readable increment on the original scale was 200 v. With the expanded scales, readings of less than 50 v are accurately obtained. The motorized gear drive provides a constant test voltage buildup which is repeatable within ¼ percent for successive tests. The voltage pointer indicates the maximum voltage obtained. Voltage is increased via the reversible motor.

Immediate visual indications of test progress and failure warning are given by the maximum voltage indicating arm and a high-voltage indicating light. The operator overrides the automatic features after the start of any test by using S_6. This switch immediately reverses

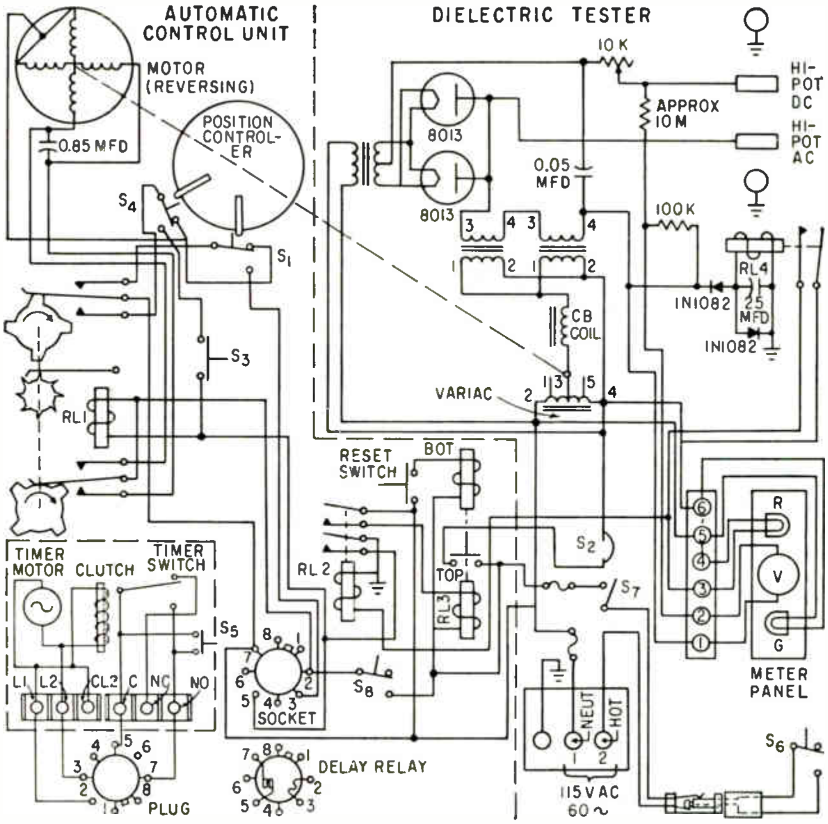

FIG. 1—Complete wiring diagram of automatic control unit and typical test set

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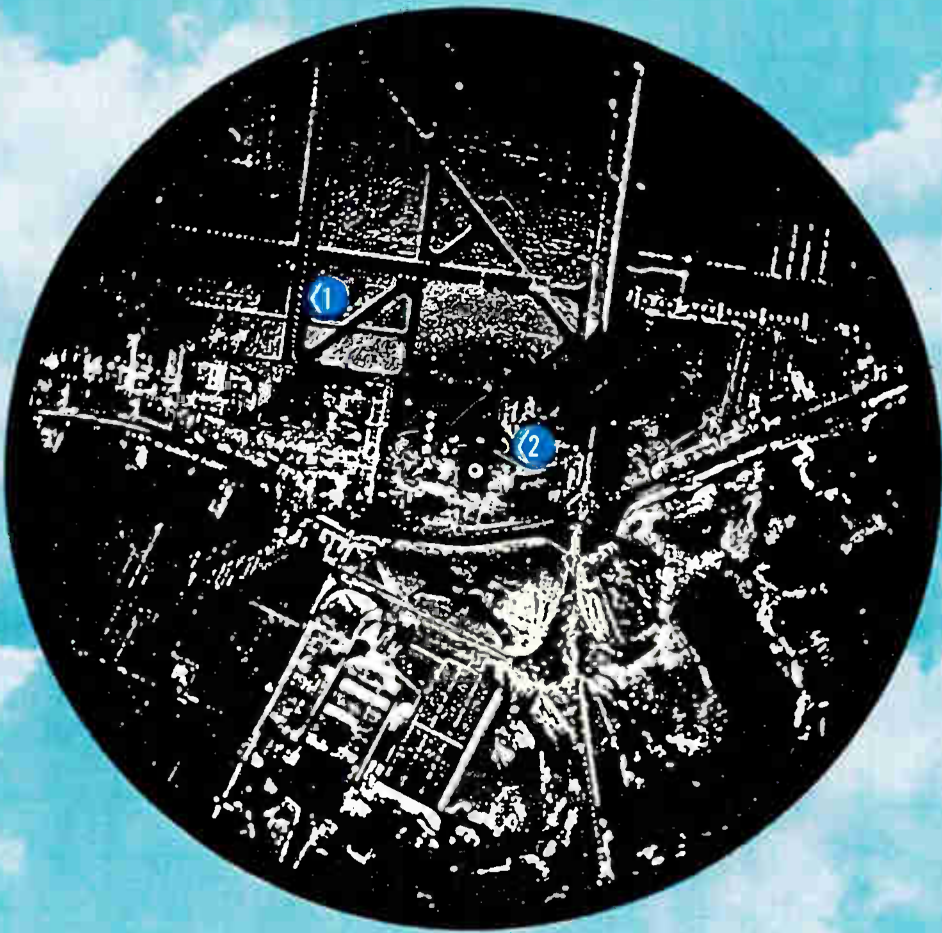

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2 *slow moving vehicles and people walking.*

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- Cathode: Philips dispenser-type
- Immediately available in production quantities.

CIRCLE 89 ON READER SERVICE CARD

ask Amperex

about microwave tubes for microwave applications

AMPEREX ELECTRONIC CORPORATION
230 Duffy Avenue, Hicksville, Long Island, New York

the drive, thus returning the auto-transformer to the zero position.

S_5 reverses the control disk if a human error in the pretest settings is detected. S_2 must be manually turned to the off position during any change to the apparatus or in the settings. If breakdown of the test component does not occur before required voltage is reached, the test continues until the S_1 is actuated, starting the time delay. After the time delay, the drive mechanism reverses, returning the system to the starting point. If the sample breaks down before the required voltage is reached, current flows through the coil of RL_1, closing the contacts which actuate RL_2. This pulses RL_1 and releases the mechanical hold on RL_3. This action opens the power to the high voltage section. When RL_1 pulses, it reverses the motor, causing the motor to drive to the off position. If RL_4 is inoperative, a slightly larger current draw on a test-sample breakdown will cause the circuit breaker coil to kick out, shutting off the power to the high voltage section.

As a safety feature, the test equipment interlock S_6, the cabinet interlock S_7, and the door interlock

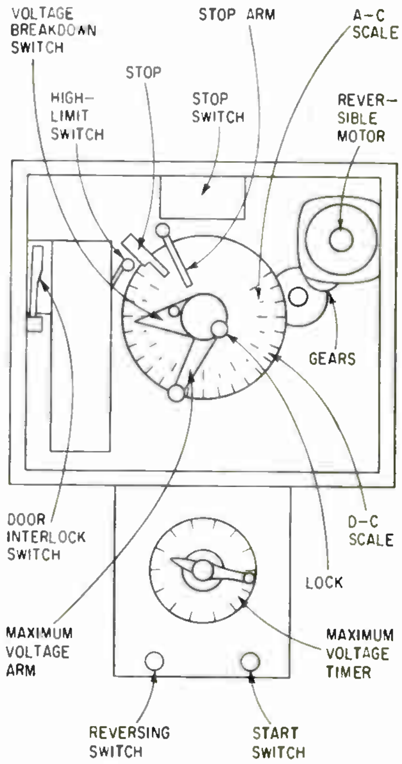
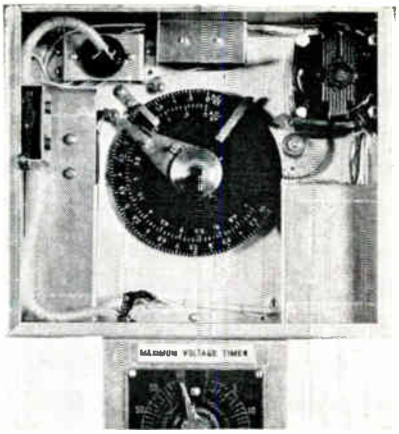


FIG. 2—Outline drawing of control unit



Closeup of control. Here, maximum voltage arm has contacted high limit switch

S_8 were added. Power is shut off if the test equipment or cabinet interlocks are opened.

Another safety feature is the modification of the high voltage lead. Previously, the hot lead and ground lead were separate, resulting in high voltage leakage through the insulation of the lead. This shock hazard was eliminated by using a coaxial cable to make a self-contained grounded high voltage lead. High voltage is shielded to a few inches of the part tested.

The control may be inserted in the circuitry of any commercially available high-potential tester. RL_3 has ben substituted for the connection between the circuit breaker and interlock switch of the tester. The only other change to the manual tester is the tie-in of RL_1 via an octal socket to the 115 volt, a-c line of the tester.

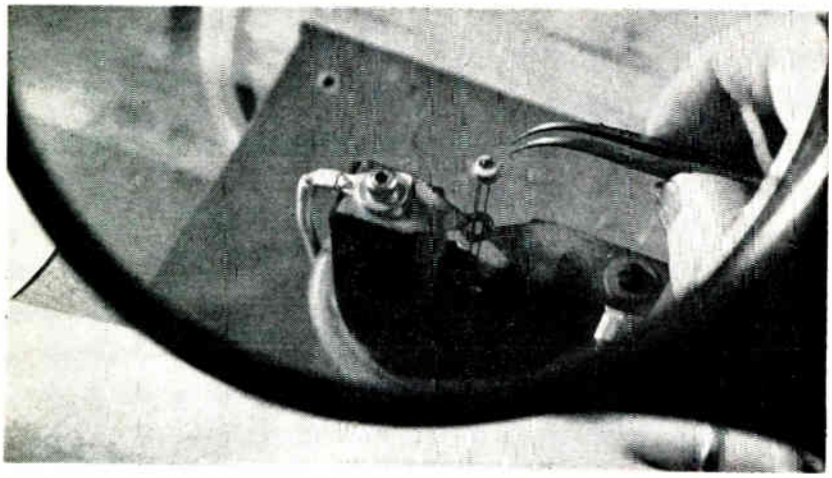
Protect Beryllium With Electroplate

METHOD of protectively coating beryllium metal is described in a patent (2,901,408) assigned the Atomic Energy Commission, by R. G. Townsend.

The steps in the process are: etching the metal in acid, briefly immersing the etched beryllium in a sodium zincate solution, immersion in concentrated nitric acid, immersion in a second solution of sodium zincate, electroplating a thin layer of copper over the beryllium, and finally electroplating a layer of chromium over the copper.

CIRCLE 91 ON READER SERVICE CARD

New On The Market



Tunnel Diode

LOW INDUCTANCE AND RESISTANCE

DEVELOPMENT of a technique for mounting a tunnel diode tab of triangular shape by the Philco Corp., Lansdale Division, Lansdale, Pa. has resulted in a diode with a series inductance of one millimicrohenry and a series resistance of one ohm.

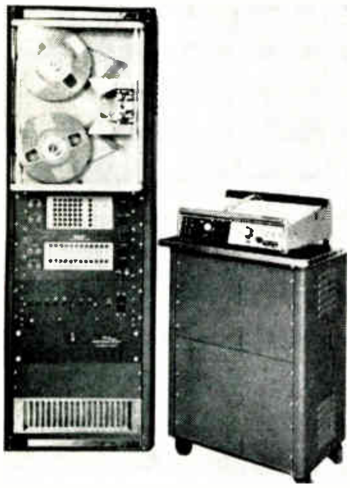
Uniform peak current of one milliampere plus or minus 2.5 percent with most units within one percent has been achieved. Peak to valley current ratios are 5 to 1 and 10 to 1.

Typical performance shows peak voltage of 55 millivolts and valley voltage of 320 millivolts. The diodes have a capacitance of 5 micromicrofarad while their negative resistance is 120 ohms.

Measured oscillation frequency is over 1,500 Mc. The units are packaged in a shortened, hermetically sealed transistor case with thin base and small alloy contact.

The tunnel diodes are available in prototype quantities at $10.00 each.

CIRCLE 301 ON READER SERVICE CARD



Magnetic Tape Plotter

FOR DIGITAL COMPUTERS

PLOTTING digital computer results on an x-y recorder is accomplished by a new plotting system developed by F. L. Moseley Co., 409 Fair Oaks Ave., Pasadena, Calif. The type 575 system includes digital tape transport, magnetic tape translator, tape control unit, record-playback amplifiers and an Autograf x-y recorder.

Subroutines for data and commands are recorded on tape at a computer tape speed of 75 or 112.5 in. a second. Tapes are played back at 3 in. a second for plotting.

The system's digital magnetic tape translator model 44 permits plotting continuous curves at up to 4 in. a second when these curves are generated by a computer interpolating routine where the points defining the curve are infinitesimally close together. When continuous curves are drawn, information changes 100 times a second.

In point plotting, the speed is 100 points a minute at ½ in. spacing.

Accuracy of the unit's digital-to-analog conversion is better than plus or minus 0.1 percent of full scale. The translater is completely transistorized and features illuminated visual display, automatic parity checking and automatic search mode.

CIRCLE 302 ON READER SERVICE CARD

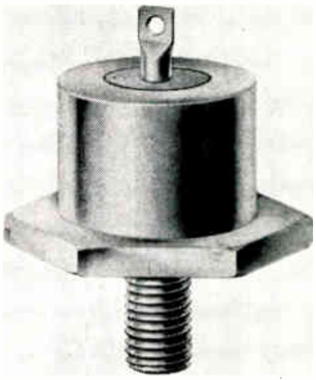
Thermistors in Diode Cans

GOOD THERMAL CONTACT

GOOD THERMAL contact with sink surfaces is assured with disk thermistors packaged in diode cans. The thermistors are made by Fenwal Electronics, Inc., 51 Mellen St., Framingham, Mass.

The disks are available in resistance values from 5 to 11,000 ohms.

Besides providing fast surface temperature sensing, the units can



be mounted near transistors to compensate for their thermal limitations.

The thermistor mount can be electrically and thermally insulated from the mounting surface and provide easy mechanical attachment for other applications.

CIRCLE 303 ON READER SERVICE CARD

Miniature Varactor Diodes

UP TO 120,000 MC CUTOFF

MINIATURE pill varactor diodes for use in traveling-wave broadband parametric amplifiers at frequencies through X band are available in experimental quantities from Microwave Associates, Burlington, Mass. The diodes can be supplied with plus or minus 10 percent ca-

new system for flight safety

Uses Hughes TONOTRON tube to combine radar screen with pilot's field of view

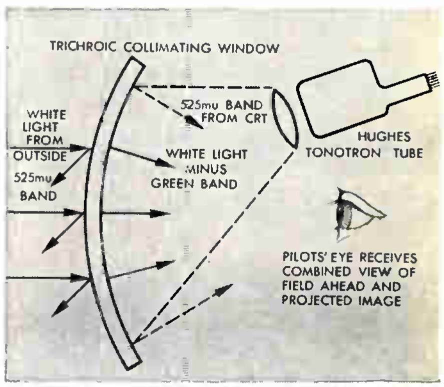
Aptly called the "Magic Window," this new pilot display system developed by Autonetics Division of North American Aviation, presents any luminous pattern produced by a Hughes TONOTRON* tube as an image painted in front of the pilot's normal view. Day or night, in any weather, the pilot can avoid obstacles, maintain attitude, safely accomplish difficult landings.

The grid shown is just one typical application. Any radar mode—terrain, fire control, weather, etc.—can be projected on the "Magic Window." In the ground mapping mode, the TONOTRON tube provides high fidelity reproduction of any desired information with high picture brightness and controllable persistence.

Hughes TONOTRON tubes are ideal for a wide range of applications including: Sector Scanning, "B" Scan Radar, Weather Radar Readout, Armament Control Radar, Plan Position Indicator information and Slow Scan TV.

TONOTRON tube models are available for your use in sizes of 3, 4, 5, 7, 10 and 21 inches—with electrostatic or electromagnetic deflection.

For detailed information and application data on TONOTRON tubes, write or wire: HUGHES, Vacuum Tube Products Division, 2020 Short Street, Oceanside, Calif. For export information, write: Hughes International, Culver City, Calif.



A narrow band of light in the green spectrum is prevented from coming through the "Magic Window." The TONOTRON tube projects a green pattern back onto the screen to form the image.

Creating a new world with ELECTRONICS

HUGHES

HUGHES AIRCRAFT COMPANY
VACUUM TUBE PRODUCTS DIVISION

*TRADEMARK OF HUGHES AIRCRAFT COMPANY

pacitance tolerance.

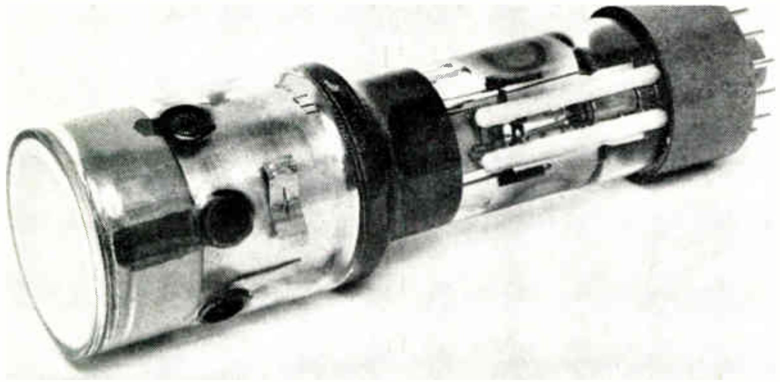
The firm is offering a series of five diodes with outside dimensions of $\frac{1}{8}$ by $\frac{1}{8}$ in. The units have minimum cutoff frequencies ranging from 30 to 120 Gc.

The pill varactors have ceramic to metal seals to insure ruggedness. The package shunt capacitance is approximately 0.2 $\mu\mu$f. Series lead inductance is approximately 0.8 x 10^{-9} henry.

Stray susceptance is kept to a minimum by close tolerances maintained in fabrication. As a high-frequency harmonic generator, power outputs up to 20 milliwatts are reported in tripling X-band power to the 35 Gc region.

The diodes are being used as high-efficiency subharmonic generators in microwave computers. Other uses are as low-loss r-f switches in resonant cavities at microwave frequencies and for doppler radar sideband modulators through 16 Gc.

CIRCLE 304 ON READER SERVICE CARD



Electrostatic Storage Tube

2$\frac{3}{4}$-IN. DIAMETER; 9$\frac{15}{16}$ IN. OVERALL

NARROW-BANDWIDTH video transmissions at radio frequencies, telephone line transmissions, equipment monitoring and freezing of transients are applications for a new small electrostatic storage tube developed by Allen B. Du Mont Laboratories, Inc., 750 Bloomfield Ave., Clifton, N. J.

The tube measures 2$\frac{3}{4}$ in. in diameter and 9$\frac{15}{16}$ in. overall. It uses a conventional 14-pin base. The tube is designed for direct viewing.

Connections to the target assembly, collimator and screen are made through recessed contacts on the tube body. The tube uses two glass rodded guns.

The write gun is a high-current, high-velocity electrostatically focused and deflected type. The modulated beam writes information onto the storage target.

The view gun is a high-current, low-velocity type producing a flood of electrons that transfers stored information onto a storage screen for viewing.

Writing speed as high as 100,000 in. per second and a resolution of 50 lines per in. are attainable. Storage time is of the order of two minutes, erase time of 50 milliseconds and brightness level of 3,000 ft lamberts at 8 Kv.

CIRCLE 30S ON READER SERVICE CARD

Multiheaded Transistors

TWO OR MORE IN A CAN

ANOTHER approach to subminiaturizing transistor circuits is the use of multiheaded transistors. The units are being made by Electronic Transistors Corp., 9226 Hudson Blvd, North Bergen, N. J.

A multiheaded transistor combines two or more currently used types in the same can. This combination is said not to cause interference. The individual transistors have no contact with each other in the can.

Combinations of transistors include *pnp*, *npn*, audio, amplifier, computer, converter, general purpose, high frequency, low frequency, intermediate frequency, low noise, matched pair, medium frequency, mixer, oscillator, radio frequency, subminiature and switching.

The units are priced 25 percent less than the combined prices of the individual units.

The following types are immediately available in combinations of two in a JEDEC 30 package: 2N428 switching; 2N404 switching and computer; 2N43 audio; 2N302 high frequency; 2N482, 2N483 and 2N484 high-frequency entertainment types and 2N1372 and 2N1374 general purpose transistors.

CIRCLE 306 ON READER SERVICE CARD

Depth Sounder Transducer

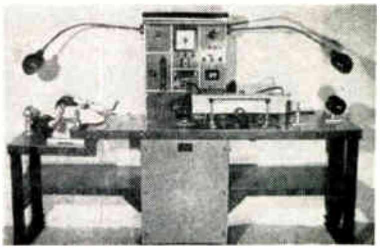
FOR SMALL BOAT USE

BUSINESS END of small boat depth sounders may be the new transducer DS-1 developed by Clevite Electronic Components division of Clevite Corp., 3405 Perkins Ave., Cleveland, O.

The unit radiates in a conical pattern. It measures 1 by 3 by 4.13 in. and is made of shatterproof material. The transducer is mounted on a 5$\frac{1}{2}$ in. long $\frac{3}{8}$-16 threaded shank and terminates in a 15-ft cable.

Capacitance is 2,300 micromicrofarad; receiving sensitivity minus 85 db against 1 volt per microbar pressure; transmitting sensitivity is plus 90 db against 1 microbar per yard per watt; beam width is 10 db down at 16 deg; impedance is 340 ohms (90 — j 330); and frequency is 195 Kc.

CIRCLE 307 ON READER SERVICE CARD

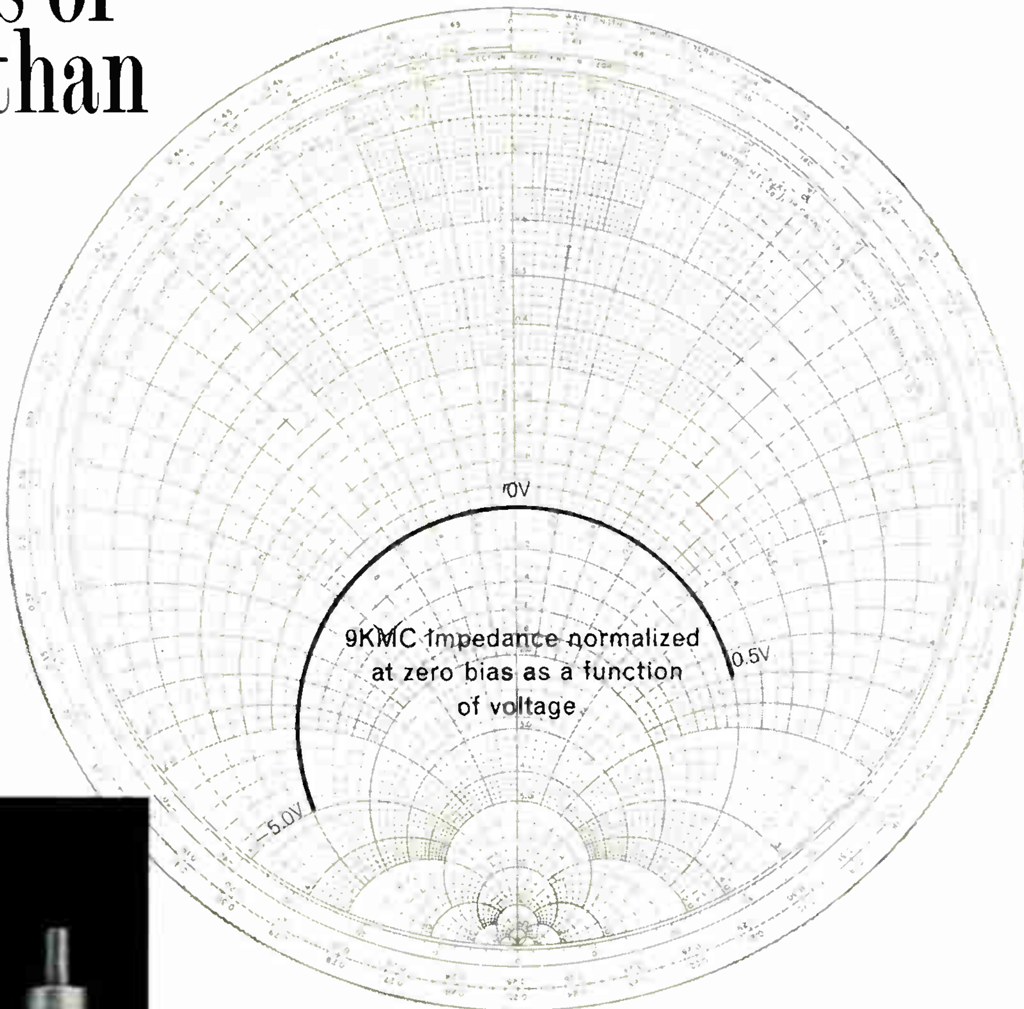


Furnace

FOR WIRE TREATMENT

MATERIALS FOR ELECTRONICS, INC., 152-25 138th Ave., Jamaica 34, N. Y., has available a furnace for annealing and straightening in protected atmosphere of molybdenum, tungsten, gallium (or any other rare metals) wires for which a very

for noise levels of less than 2 db



Characteristics:

Cut-off Frequency @ 9KMC at zero bias	30-70KMC
Capacity at zero bias	0.8 to 1.5μμf
Working Voltage @ 10μA	3.5 to 5.5
Lead Inductance @ 2KMC	3.5mμh

Hughes S and X Band Parametric Amplifier Diodes

Hughes has designed parametric amplifier diodes that can give you noise levels of less than 2 db at X band using double sideband operation. In addition to low noise, these HUGHES* diodes also offer a number of other advantages. First, their high cutoff frequency means that you can obtain higher amplification and higher harmonic generation. Their ceramic package reduces stray capacitance and makes for more dependable performance levels.

With these characteristics, Hughes S and X Band Parametric Amplifier Diodes are ideally suited to the following applications: radar preamplifiers, frequency converters, phase shifters and harmonic and subharmonic generators.

For additional information, please write: Hughes, Semiconductor Division, Marketing Dept., Newport Beach, California. *For export write: Hughes International, Culver City 5, California.*

Creating a new world with ELECTRONICS

HUGHES

HUGHES AIRCRAFT COMPANY

SEMICONDUCTOR DIVISION

accurate and uniform wire treatment is justified. The apparatus can easily handle molybdenum wires of diameter 0.0012 in. to 0.0079 in., tungsten wires 0.0008 in. and up, gallium wires 0.0016 in. and up. The furnace, which can be opened instantaneously to change the resistances or to pass wire, is tight and can be cooled by water. The control panel permits the easy control of protecting gas, cooling water, wire speed and facilitates the reading of meters. The equipment is easy to use and one operator can control six to eight machines.

CIRCLE 308 ON READER SERVICE CARD

Ferrite Isolators

8,200-12,400 MC

DEMORNAY-BONARDI, 780 S. Arroyo Parkway, Pasadena, Calif. New ferrite isolator is designed for high performance over the entire waveguide frequency range of 8,200 to 12,400 Mc. Insertion loss is 1.0 db maximum, with a minimum of 30 db isolation. Vswr is 1.15 maximum in either direction. Designed with a short insertion length of 5¼ in., the unit is equipped with RG-52/U size waveguide, and UG-39/U flanges. Price is $225.

CIRCLE 309 ON READER SERVICE CARD

Voltage Standard

STABLE, ACCURATE

SENSITIVE RESEARCH INSTRUMENT CORP., 310 Main St., New Rochelle, N. Y. Model STV is a reference source for use with null balance devices such as potentiometers and other infinite impedance comparators. It is 0.01 percent accurate, 0.005 percent stable. Accuracy is not affected by vibration from transportation, extremes of temperature or operating position. While the unit is essentially a zero

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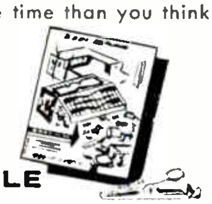
FREE COPY OF LATEST CATALOG... FREE SAMPLE OF "MINI-GATOR" CLIP



ILLUSTRATION
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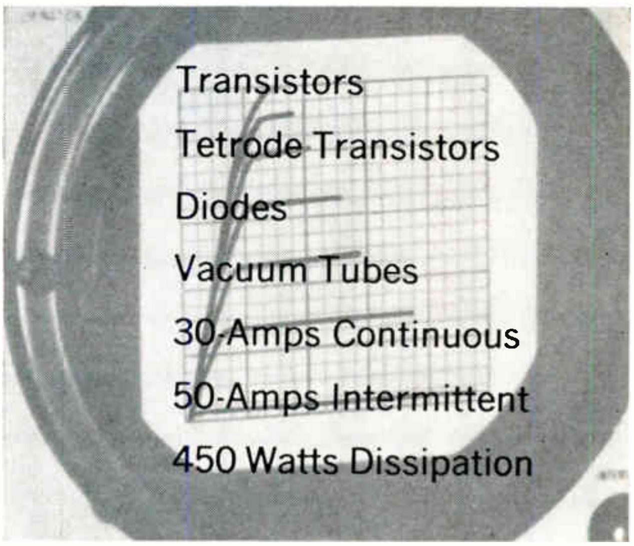
A Company With A Tradition... And A Future

Mueller Electric Co.

1582H EAST 31st STREET • CLEVELAND 14, OHIO

CIRCLE 201 ON READER SERVICE CARD

NEW CURVE TRACER with Tube Adapter



For complete information write for bulletin #TT108.

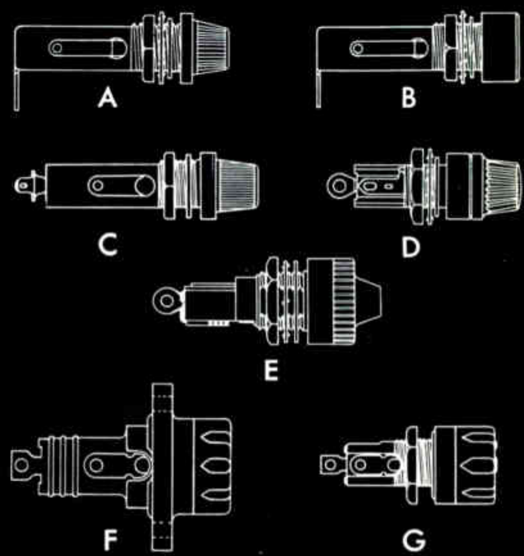
Baird Atomic

Baird-Atomic, Inc.
33 UNIVERSITY RD., CAMBRIDGE 38, MASS

CIRCLE 202 ON READER SERVICE CARD

OTHER FUSE POSTS MAY LOOK LIKE THESE... BUT ONLY LITTELFUSE HAS PDQ*

A Fuse Post to meet every application—every requirement.



EXTRACTING FUSE POST! Fuse is held in end of removable knob for quick, safe and easy replacement of blown fuse. Safe "dead front" fuse mountings assured. U/L Approved.

A—3AG Fuse Post (finger operated knob)—No. 342001

A—8AG Fuse Post (finger operated knob)—No. 372001

B—3AG Fuse Post (Screwdriver Slot)—No. 341001

B—8AG Fuse Post (Screwdriver Slot)—No. 371001

C—4AG Fuse Post (Finger Operated Knob)—No. 442001

D—3AG Miniature Fuse Post (Finger Operated)—No. 342012

E—NEW INDICATING 3AG FUSE POSTS! (344,000 series) It Glows When The Fuse Blows. Long life incandescent bulb for low voltage ranges—2½-7V; 7-16V; 16-32V. New high degree vacuum neon lamp for high voltage ranges for greater brilliance and visibility—90-125V; 200-250V.

WATERTIGHT FUSE POSTS Specially designed for use where excessive moisture is a problem.

F—5AG Watertight Fuse Post. Has flange mounting.—No. 571004.

G—3AG Watertight Fuse Post—No. 342006

G—4AG Watertight Fuse Post—No. 442006

For complete details on these items and quotations on special application requirements, write to:

*Precision Engineering
Design Know-how
Quality Craftsmanship

LITTELFUSE
DES PLAINES, ILLINOIS

CIRCLE 97 ON READER SERVICE CARD

current drain instrument, it can be operated without damage into any impedance. It can be short circuited indefinitely without affecting accuracy or life expectancy and it will almost instantaneously regain its original open circuit voltage when the short is removed. Input of the type A is 90-135 v, 60 cps, 25 va.

CIRCLE 310 ON READER SERVICE CARD

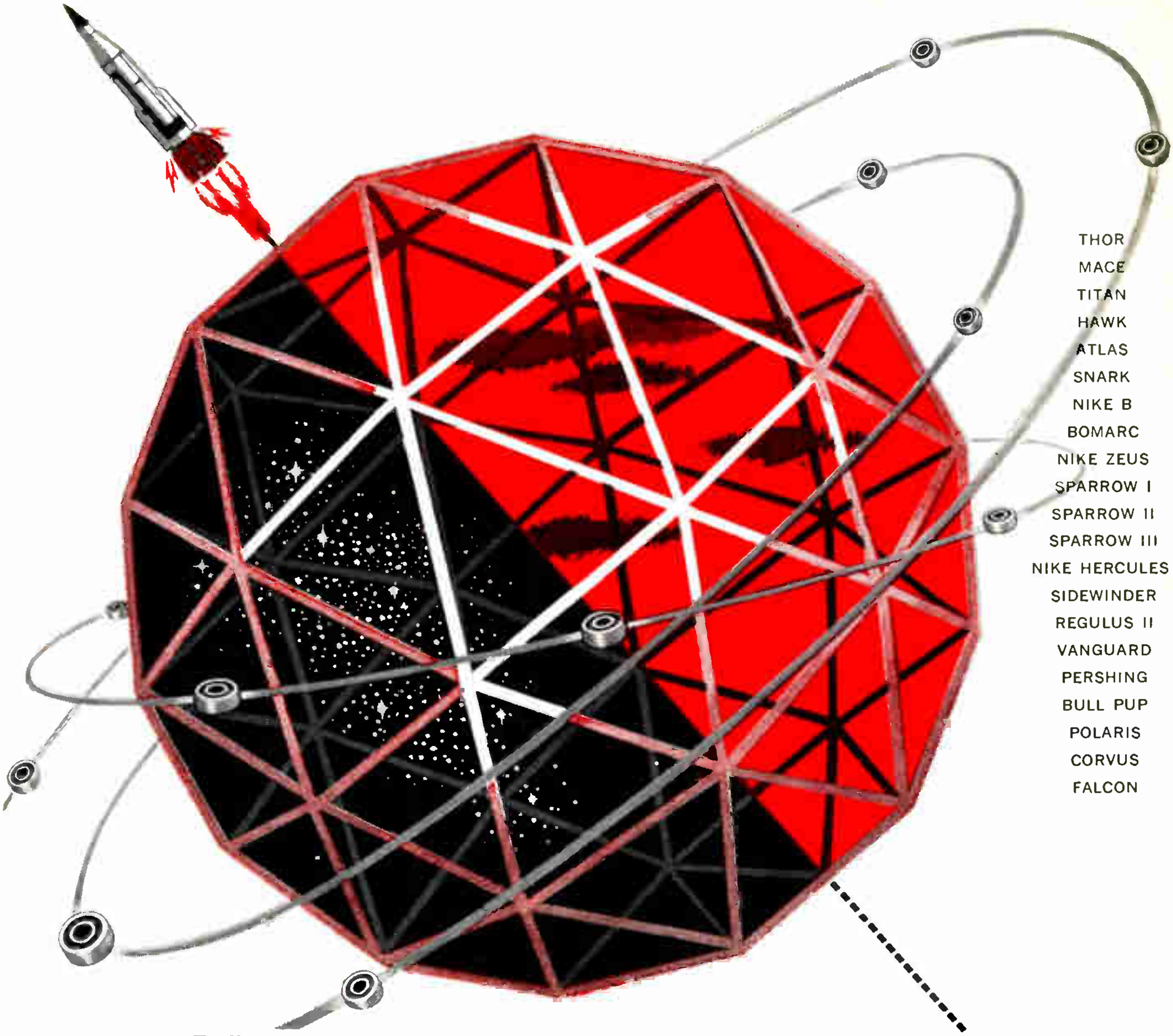
Oscillators
LOW DISTORTION

BURR-BROWN RESEARCH CORP., Box 6444, Tucson, Ariz. Transistorized, self-powered, and compact, the models 210 and 211 oscillators offer the user a reliable and isolated source of high purity sine waves. Line transients and ground loops are eliminated. Unusually low harmonic distortion is achieved by the use of high gain d-c operational amplifiers in a Wien bridge circuit. The d-c amplifier also permits tuning to very low frequencies.

CIRCLE 311 ON READER SERVICE CARD

D-C Amplifier
LOW-LEVEL

MAGNETIC RESEARCH CORP., 3160 W. El Segunda Blvd., Hawthorne, Calif., announces two new miniature low-level d-c signal amplifiers. Model 10-108-2 is designed to operate from 115 v 400 cycle power and model 12-105-0 is designed for 28 v d-c power. Both are ideally suited for temperature and strain measurements in industrial, military, and medical applications. Designed to accept an input signal in the mv range, the units produce an output signal ranging from 0 to 5 v d-c for use in telemetering, instrumentation and recording systems. Construction features reliable transformer type magnetic elements, which provide a high degree of isolation between the input and output



New ND Processes Improve Instrument Sensitivity!

In delicately-precise instrumentation, parts must react to relatively small rotive forces. Here . . . bearing torque is the highly critical factor. Separator selection, bearing finish and clinically clean assembly areas are extremely important.

It's here that New Departure is setting new industry standards! Special dies and in-process gauging of separators assure ball retention with improved torque and vibration characteristics. In addition, new N.D. honing processes and Talyrond gauging deliver uniform accuracy to millionths of an inch. Moreover, having originated the first bearing industry "white room", followed by continuous experience, New Departure's present day, modern assembly areas approach fantastic levels of cleanliness.

An everyday example of N.D.'s contribution to improved instrument sensitivity can be found in the Smithsonian Institution-selected Micro Clocks. These vitally important instruments are accurately tracking both U.S. and foreign satellite movements in time determinations of 1 milli-second . . . and better!

For new *performance* and *reliability* in your precision instruments, ask your N.D. Miniature/Instrument Bearing *Specialist* to sit in on early design level discussions. For further information call or write Department L.S., New Departure Division, General Motors Corp., Bristol, Conn.

NEW DEPARTURE

MINIATURE & INSTRUMENT BALL BEARINGS

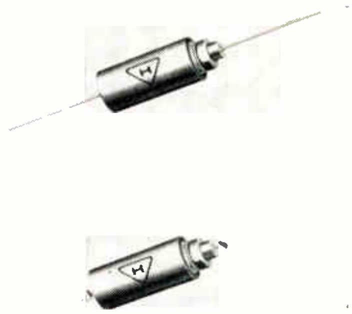
proved reliability you can build around and results in high common mode rejection. All components are completely encapsulated and both models will successfully withstand applicable portions of MIL-E-5272A.

CIRCLE 312 ON READER SERVICE CARD

Trimmer Pot
SUBMINIATURE

ATOHM ELECTRONICS, 7648 San Fernando Road, Sun Valley, Calif. The W-51 subminiature trimmer potentiometer, for virtually all general purpose applications, has a standard range of resistance from 10 ohms through 100,000 ohms, with tolerance ± 10 percent. These units, having 0.750 in. mounting hole centers, are available with 12 in. flexible insulated wire leads (W-51-F), solder lugs (W-51-L), end mounted printed circuit pins (W-51-P1).

CIRCLE 313 ON READER SERVICE CARD



Capacitors
FEED-THROUGH

HOPKINS ENGINEERING CO., 12900 Foothill Blvd., San Fernando, Calif., announces a complete line of miniature feed-through capacitors for use in radio interference suppression. Attenuation characteristics are excellent—the reactance closely matches the curve of a perfect capacitor through all frequencies up to 1,000 Mc. The units transmit through shields, bulkheads, or other ground potentials, and at the same time by-pass un-

CIRCLE 101 ON READER SERVICE CARD→

keep an accurate graphic record

OF RESEARCH, DESIGN, TEST DATA

two channels

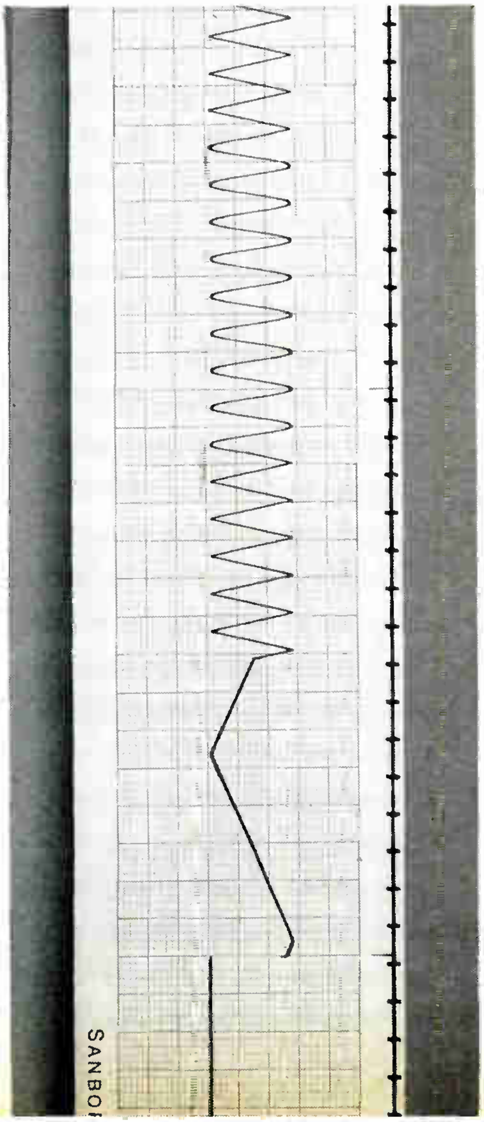
For General Purpose DC Recording — Model 320

For recording *two variables* simultaneously, the Model 320 provides a versatile, transistorized amplifier for each input signal. The rugged 2-channel recorder assembly has heated stylus recording on two *50 mm wide* rectangular coordinate channels, 4 pushbutton chart speeds, and 6 inches of visible chart. The Recorder can be placed vertically, horizontally or at a 20° angle.

MODEL 320 SPECIFICATIONS

Sensitivity: 0.5, 1, 2, 5, 10, 20 mv/mm and v/cm
Frequency Response: 3 db down at 125 cps, 10 mm peak-to-peak
Common Mode Voltage: ±500 volts max.
Common Mode Rejection: 140 db min. DC
Calibration: 10 mv internal ±1%
Output Connectors for each channel accept external monitoring 'scope or meter
Price: $1495

NEW SANBORN PORTABLE DIRECT WRITING RECORDERS FOR IN-PLANT, LABORATORY OR FIELD RECORDING



Two models of this 21 lb. brief case size recorder are available — Model 301 for AC strain gage recording, Model 299 for general purpose DC recording. Both provide immediately visible, inkless traces by heated stylus on 40 division rectangular coordinate charts . . . frequency response to 100 cps . . . 5 and 50 mm/sec chart speeds . . . approx. 4 inches of record visible in top panel window.

single channel

MODEL 301 SPECIFICATIONS

The amplifier section of the Model 301 is an all-transistorized carrier type with phase sensitive demodulator. The power supply and internal oscillator circuits are also transistorized.
Sensitivity: 10 uv rms/div (from transducer)
Attenuator Ratios: 2, 5, 10, 20, 50, 100, 200
Carrier Frequency: 2400 cps internal
Transducer Impedance: 100 ohms min.
Calibration: 40 uv/volt of excitation
Output Connector: for external monitoring 'scope or meter
Price: $750

MODEL 299 SPECIFICATIONS

Combines the dependability of transistors with the high input impedance of vacuum tubes for reliable broad-band DC recording.
Sensitivity: 10, 20, 50, 100, 200, 500 mv/div and 1, 2, 5 and 10 v/div
Input Resistance: 5 megohms balanced each side to ground
Common Mode Voltage: ±2.5 volts max. at 10 mv/div sensitivity increasing to ±500 volts max. at other sensitivities
Common Mode Rejection: 50:1 most sensitive range
Calibration: 0.2 volt internal ±1%
Output Connector: for external monitoring 'scope or meter
Price: Model 299 (with zero suppression) $700
Model 299A (without zero suppression) $650

All prices are F. O. B. Waltham, Mass., within continental U. S. A. and are subject to change without notice.

Contact your Sanborn Sales-Engineering representative for complete information, or write the main office in Waltham. Sales-Engineering representatives are located in principal cities throughout the United States, Canada and foreign countries.

SANBORN COMPANY
INDUSTRIAL DIVISION
175 Wyman Street, Waltham 54, Mass.

CIRCLE 101 ON READER SERVICE CARD

desirable frequencies. They have wide applications in radar, communications, and other electrical and electronic installations. The capacitors are hermetically sealed in nonmagnetic tubular cases with glass-to-metal end seals.

CIRCLE 314 ON READER SERVICE CARD

Power Supply
FOR NOISE DIODES

DEMORNAY-BONARDI, 780 S. Arroyo Parkway, Pasadena, Calif. The DB-2140 is designed to furnish starting and operating currents to a variety of gas-discharge noise diodes. Unit is equipped with a milliammeter which is connected to the heater circuit during the starting period, and to the anode circuit during the normal operating period. The meter provides continuous indication of beam current during operation. Beam current is heavily filtered for low ripple output. Unit features independent adjustment of heater current and beam current to accommodate different tube ratings—each adjustment being indicated by the panel meter. Both beam current capacity and heater current capacity are 400 ma.

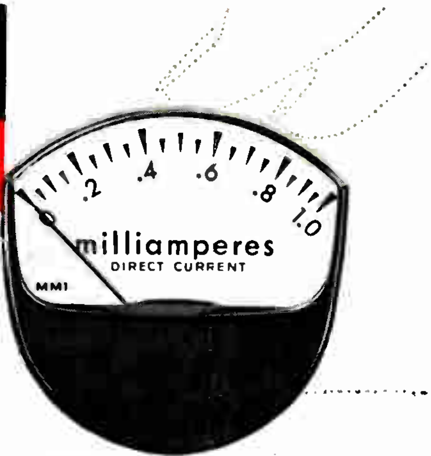
CIRCLE 315 ON READER SERVICE CARD

Transducers
ANGULAR POSITION

BALDWIN-LIMA-HAMILTON CORP., 42 Fourth Ave., Waltham 54, Mass. Designed to provide continuous and accurate measurement of angular displacement, this small, light-

marion

advancement in instrument design



ACTUAL SIZE

MM-1 MEDALIST* meter

Today's most readable, modern miniature meter. Shielded — no error from magnetic panels. Rugged Marion Coaxial mechanism. Max. weight 1.6 oz. In all standard ranges, various colors. Single hole mounting. Data on request. Marion Instrument Division, Minneapolis-Honeywell Regulator Co., Manchester, New Hampshire, U.S.A. In Canada, Honeywell Controls Limited, Toronto 17, Ontario.

Honeywell

75th YEAR PIONEERING THE FUTURE — H — First in Control — SINCE 1885

CIRCLE 203 ON READER SERVICE CARD

AVON GEARS

- "Specific" for electronic equipment, control components, small tools, motors, and UNCOMPROMISING SPECS.
- Exacting tolerances held . . . from commercial grade to ultra precision.
- Generated in wide range of steels, non-ferrous metals, and non-metallic materials.
- Capacity range: 12 to 200 d.p., and maximum O.D. of 7½".

Make AVON Your "Gear Department"

Avon is completely tooled to follow your specifications precisely, and to produce the very best precision or commercial grade Fine Pitch gears for your specific needs. At Avon you can get one gear . . . or a million of ALL types, ALL classes, from ALL materials.

Avon has a modern complement of the finest inspection equipment procurable . . . truly a setup tuned to the exacting tempo of the "Space Age." Your gear formula is followed with the utmost care. Result: Accurate assembly of your most critical units!

Avon's fifty years aggregate gear engineering experience guarantees an end product exactly as specified. We will be glad to work with you on any development project requiring Fine Pitch gearing . . . for either commercial or precision applications. You can depend on AVON. Send drawings or descriptions for free estimates.

PRODUCTION • EXPERIMENTAL • CONSULTING

SPECIAL Internal, external, helical gear tooth grinding; also shaved tooth gears and sub assemblies.

AVON GEAR AND ENGINEERING CO.

2009 RICE STREET • MELROSE PARK (Chicago Suburb), ILLINOIS

CIRCLE 204 ON READER SERVICE CARD

PRICES HAVE DROPPED!

on **low voltage** transistor regulated power supplies

- for critical commercial and military applications
- full five year warranty includes *all* components
- guaranteed to meet published specs.
- short circuit protected
- fit standard 19" rack

Specifications	Model PS4305	Model PS4315	Model PS4330
Voltage Range (VDC)	0-36	0-36	0-36
Current Range (Amps)	0-5	0-15	0-30
Regulation Against ± 10% Line change / 0 to full load	.025% / .05%	.025% / .05%	.025% / .05%
Impedance (Ohms) DC to 100KC	.1	.02	.02
Ripple (RMS) in Millivolts	1	1	1
Panel Height	5¼"	5¼"	8¾"
Price:	$545	$890	$1190

Write for complete specifications

Specify POWER SOURCES BY

POWER SOURCES, INC.

Burlington, Massachusetts

CIRCLE 103 ON READER SERVICE CARD

D-C AMPLIFIER EVALUATION *number 1 in a series*

AMPLIFIER NOISE

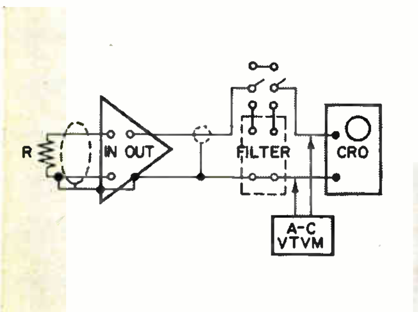
Accuracy is the basic objective in amplifier selection. When evaluating amplifiers for specific applications all errors must be considered. One such error, the noise level, determines the ultimate accuracy of the amplifier since the smallest observable signal cannot be less than the noise level. However, noise outside the frequency response range of the amplifier load can be filtered out or ignored with such read-out devices as galvanometer oscillographs.

Noise in an amplifier is any voltage component appearing at the output that has no counterpart in the input signal. Usually only the a-c component of the output is termed noise. The d-c component is called zero drift and its evaluation will be covered in another of this series.

Internally generated a-c components must be evaluated as to amplitude and frequency range. Noise may be divided into two general classes and measured as described below. (a) *Random voltages* of a broad band nature arising from thermal agitation in resistors and random tube or transistor noise . . . measurements on a peak-to-peak basis are often 10 times or more larger than the measured rms value over the same frequency band. (b) *Narrow band voltages* induced within the amplifier by line voltage or chopper excitation . . . these voltages are generally sinusoidal so that peak-to-peak values are only about 2.8 times larger than the measured rms values.

Testing amplifiers for noise

If the input signal is zero, any voltage components detected at the



amplifier output can be identified as noise. A standard technique for measuring noise is shown.

The oscilloscope measures the peak-to-peak values, the VTVM in rms values. Equivalent input noise (eq. in) is the measured noise divided by the amplifier gain. For details write for Bulletin BE AN121.

Noise less than 0.03%

With a full scale input range of 30 mv, Honeywell's AccuData II Amplifier has a wide band (0-100 KC) noise specification of 8 μv (eq. in) and a peak-to-peak noise over a 0-10 cps band of 8 μv (eq. in) . . . less than 0.03% of full scale!

The AccuData II, a wide band differential input d-c amplifier with all transistor design, is especially useful for driving analog-to-digital converters, f-m magnetic tape systems and high speed oscillographs where low level signals such as thermocouple, strain gage and similar transducer outputs are to be accurately measured. Write for Bulletin BS DISA-1000 to Minneapolis-Honeywell, Boston Division, Dept. 7, 40 Life Street, Boston 35, Mass.

Honeywell

First in Control

SINCE 1885

weight unit has primary test application in servo systems on aircraft control surfaces, valve positioners, and radar scanners of limited travel. The internal element of the device is a high strength metal beam, onto which are bonded special SR-4 strain gages. The gages are electrically connected to form a balanced Wheatstone bridge. A constant voltage is applied across opposite corners of the bridge such that a change in angular displacement of the transducer's input shaft, changes the resistance of the gages and will produce a change in output voltage. This change in output voltage is measured by an indicator or recorder which can be calibrated in appropriate angular units. Transducers are available in three standard capacities, offering useful ranges of $\pm$30 $\pm$20 and $\pm$60 deg.

CIRCLE 316 ON READER SERVICE CARD

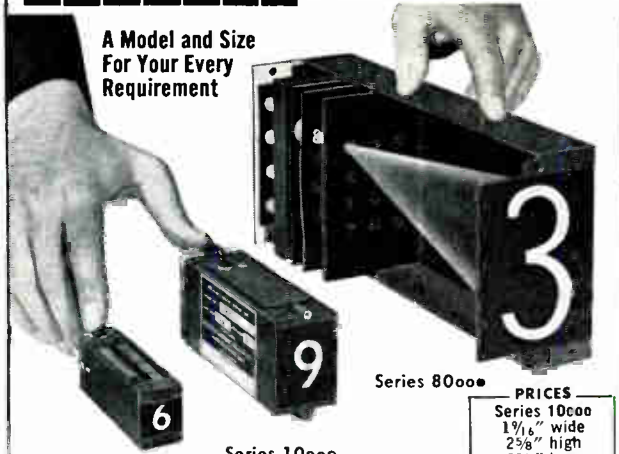
P-C Connectors
FOR 3/32 IN. BOARDS

PRECISION CONNECTORS INC., P. O. Box 96, Mineola, L. I., N. Y. Series 093 p-c connectors for 3/32 in. boards, feature Tri-Spring contacts, a new triple independent leaf spring action contact that firmly grips the p-c board over the entire contact area, assuring greater reliability, accepts maximum board tolerance variation with uniformly distributed contact pressure. Coined wiper spring provides positive redundant wiping action over entire contact surface, helper spring maintains uniform pressure over full length of contact, back spring insures contact wiping pressure immediately upon insertion of board. Scoring or other similar damage is eliminated. Contacts follow board displacement, prevent discontinuity caused by vibration or motion of the board. Contacts are self-aligning to residual warpage along the length of the board. Units are

PROVEN, DEPENDABLE...REAR-PROJECTION TYPE

IN-LINE DIGITAL DISPLAYS

A Model and Size For Your Every Requirement



Series 80000

Series 10000

Series 120000

OUTSTANDING FEATURES

- All digits displayed on front viewing screen
- All digits uniform in size and intensity
- High-contrast viewing screen
- Digit style of your choice
- Colored digits of your choice
- Individual units may be group assembled for panel mounting

PRICES

Series 10000
1 9/16" wide
2 5/8" high
5 5/8" long
$18.00 each

Series 80000
3 1/4" wide
5 1/4" high
11 15/16" long
$33.00 each

Series 120000
1" wide
1 5/16" high
3 7/8" long
$35.00 each

Quantity Prices On Request

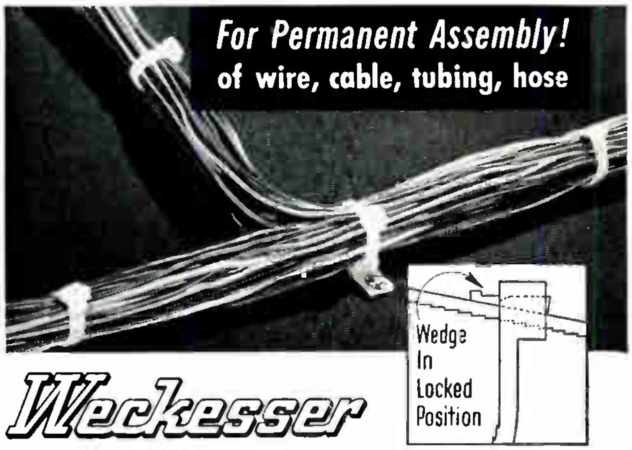
WRITE TODAY FOR COMPLETE DETAILED SPECIFICATIONS

Representatives in principal cities

INDUSTRIAL ELECTRONIC ENGINEERS, INC.
5528 Vineland Avenue, North Hollywood, California

CIRCLE 205 ON READER SERVICE CARD

For Permanent Assembly!
of wire, cable, tubing, hose



Weckesser

WEDGE LOCK BAND CLAMP...

once locked, it's got to be *cut* loose! Really permanent! Solid nylon. One size for diameters 1/8" to 1 3/4".

Separate Mounting Tab

...use only where and when needed. Can be pre-mounted for simplified planning. Solid nylon.

Try them...write for samples, prices, full information.

See Us At Booth 1124 Design Engineering Show—New York

Weckesser COMPANY
5701 Northwest Highway — Chicago 46, Ill.

CIRCLE 206 ON READER SERVICE CARD

here's a complete element of your block diagram... now available!

RPM*

*REGULATED POWER MODULE

All design, development and production work has been completed for you in these RPM power modules. Buy them as catalog items, and get these advantages:

16 standard models–125 to 425 volts...50 to 400 milliamps, plus 30 standard modifications with extended voltage and current ranges.

Excellent regulation–0.05% NL to FL, or 10% line change.

Compactness–RPM units are custom desgined and built with our own transformers for most efficient use of space.

Super-rugged construction includes one-piece, cast aluminum housings and MIL hardware. RPM modules can be mounted in any position.

High reliability–achieved by use of top quality components throughout, and rigid inspection during production.

All standard models or modifications thereof can be furnished to meet MIL-E-16400B.

Request ACDC Bulletin 400-A.

ACDC ELECTRONICS, INC.
2979 N. Ontario St., Burbank, Calif.

CIRCLE 105 ON READER SERVICE CARD

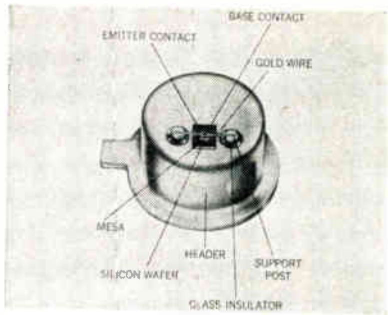
offered in over 90 sizes and mounting styles adaptable for every application.

CIRCLE 317 ON READER SERVICE CARD

Power Rectifiers
SILICON TYPES

VICKERS INC., 1815 Locust St., St. Louis 3, Mo. Types EA and DA silicon power rectifiers are 18 and 35 amperes respectively. They are available with piv ratings from 50 to 600 v, and feature excellent inverse characteristics at all temperatures, and high reliability and uniformity.

CIRCLE 318 ON READER SERVICE CARD



Mesa Transistors
DIFFUSED SILICON

NATIONAL SEMICONDUCTOR CORP., Sugar Hollow Road (Route No. 7), Danbury, Conn., is producing two new types of high quality, tightly controlled *npn* transistors. The NS200 is for switching applications in computer circuitry, and the NS300, for h-f amplification in video amplifiers, i-f strips, telemetering and other applications. Output capacitance of both is 5 $\mu\mu$f. Leakage current at 150 C is 3 μa for the NS200, 5 μa for the NS300. Guaranteed minimum gain-bandwidth product for both is 200 Mc. Collector saturation resistance of the NS200 is 35 ohms; of the NS300, 40 ohms. Beta linearity is excellent over a wide range of col-

PRECISION ILLUMINATION WITH A.C.M.I. MINIATURE LAMPS

All A.C.M.I. miniature lamps are made to the most meticulous standards of physical dimension and candlepower, and can be relied on for excellent illumination and reliable service.

Miniature lamps are available in sizes from .036" to 1.125" in diameter and in voltages from 1.5 volts to 48 volts.

We invite inquiries for all types of miniature lamps. You can be sure of precision illumination with A.C.M.I. miniature lamps.

American Cystoscope Makers, Inc.

Producers of the world's smallest miniature lamps

8 PELHAM PARKWAY
PELHAM MANOR, N. Y.

FREDERICK J. WALLACE, *President*

CIRCLE 207 ON READER SERVICE CARD

KEW

Around the world it's KEW

KYORITSU ELECTRICAL INST. WORKS, LTD.

NO. 120, Nakane-cho, Meguro-ku, Tokyo, Japan.
Cable Address "KYORITSUKEIKI TOKYO"

CIRCLE 208 ON READER SERVICE CARD

Over 2400 manufacturing concerns are now operating in Metropolitan Miami!

Electronics, aircraft and missile manufacturers can be sure of supplementary and sub-contracting facilities in this growth area. This, combined with a huge supply of skilled labor, can mean a profitable plant location for *your* firm.

SEND FOR 300 PAGE SURVEY OF THIS DYNAMIC AREA

This important study will be mailed to you, in strictest confidence, if you write, on your letterhead, to the address listed below.

Richard Y. Welsh, Director

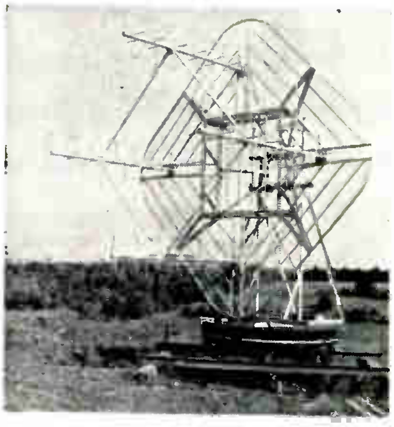
Dade County Development Department
345 Northeast Second Avenue
Miami 32, Florida

An Agency of the Metropolitan Miami Government

CIRCLE 107 ON READER SERVICE CARD

lector current. Beta fall-out from 1 to 100 ma is less than 35 percent of peak value.

CIRCLE 319 ON READER SERVICE CARD



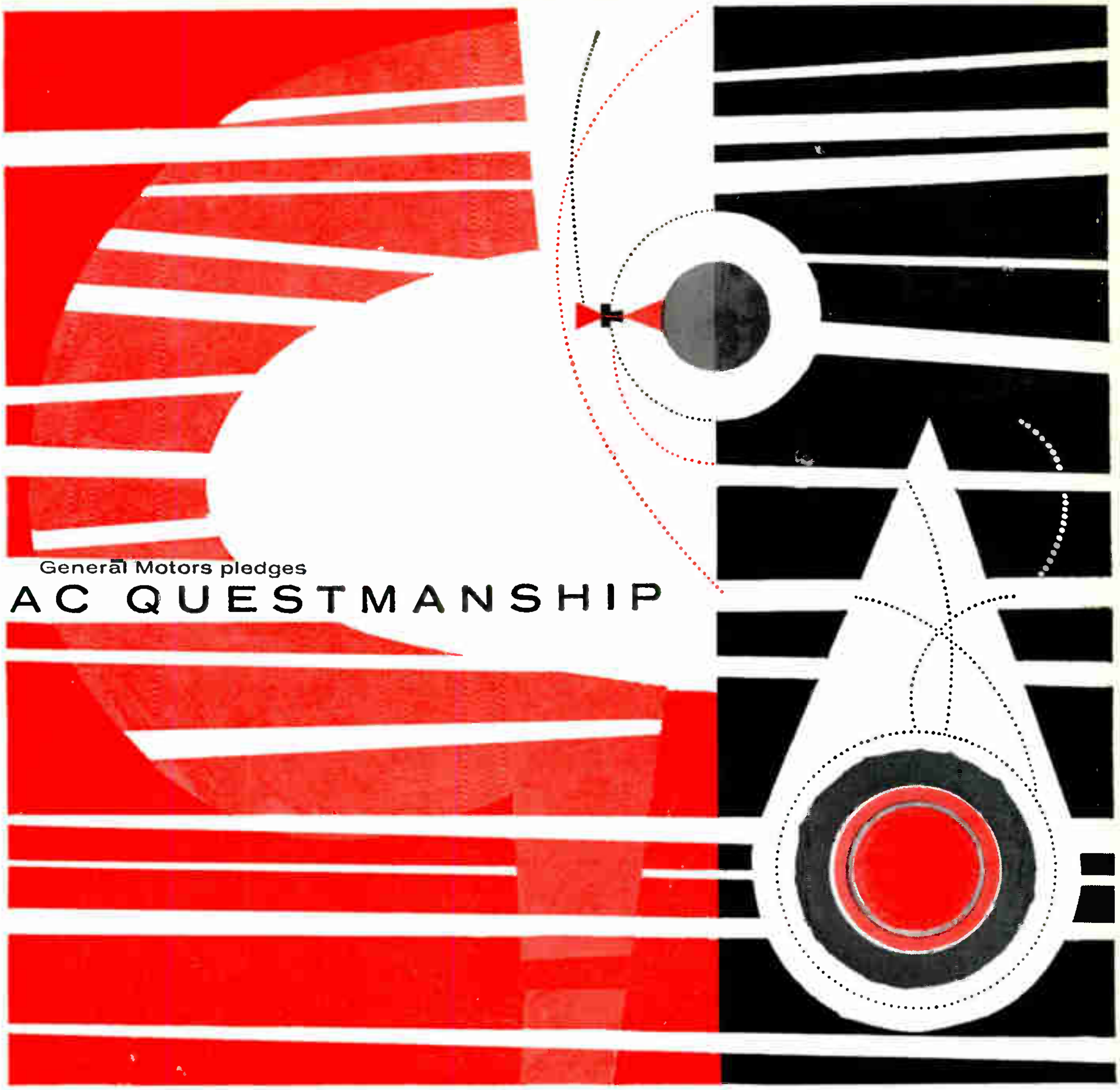
Helix Antennas
EXTENDED LINE

TECHNICAL APPLIANCE CORP., Sherburne, N. Y., announces a greatly extended line of antennas and matching reflectors of the helix configuration. Current models include 4, 6, 8, and 10 turn types, of various sizes. Complete units, with reflectors, are made in single, dual and quadruple assemblies for mounting on manual or mechanized mounts. The helix antennas and arrays are available in all popular communications and telemetering frequency ranges. Polarization is circular, making them ideal for orbital body telemetering, or other airborne communications.

CIRCLE 320 ON READER SERVICE CARD

Welding Tweezers
MINIATURE DEVICES

PACIFIC SCIENTIFIC INSTRUMENTS LABORATORY, P. O. Box 25115, Los Angeles 25, Calif Model WT-101 welding tweezer is capable of performing delicate and precise welding operations in areas not accessible by standard welding techniques. Unit features continuously adjustable pressure from 8 oz to 2 lb, detachable tips, excellent repeat-



AC Seeks and Solves the Significant—Because of GM's large contribution in the international race for technological superiority, AC accepts a challenge. AC Research is on a scientific quest for solutions to significant problems . . . for accomplishments even more advanced than AChiever inertial guidance for Titan. / We call this creative challenge . . . AC QUESTMANSHIP. It's an exciting quest for new ideas, components and systems . . . to advance AC's many projects in guidance, navigation, control and detection. / Right now Dr. Joseph F. Shea, AC's Director of Advanced Systems Research and Development, is drawing a group of competent men around him to build "the greatest R & D organization in the industry." And Dr. Shea adds strong support to the fact that AC offers "an excellent working atmosphere for a scientist or engineer who wishes to produce and progress." / You may qualify for our specially selected staff . . . if you have a B.S., M.S. or Ph.D. in the electronics, electrical or mechanical fields, plus related experience. If you are a "seeker and solver," write the Director of Scientific and Professional Employment, Mr. Robert Allen, Oak Creek Plant, 7929 So. Howell Ave., Milwaukee, Wisc.

GUIDANCE / NAVIGATION / CONTROL / DETECTION / *AC Spark Plug* ***THE ELECTRONICS DIVISION OF GENERAL MOTORS***

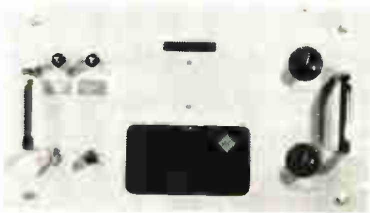
ability and a variety of tips that permit the welding of many metals, from aluminum to precious alloys. It is applicable to the welding of thermocouples and strain gages, honeycomb and metal sandwich structures, high temperature electronic assemblies and the welding of components designed for extremely high shock and vibration.

CIRCLE 321 ON READER SERVICE CARD

Tube Shield
ZINC-PLATED

THE STAVER CO., INC., 45 N. Saxon Ave., Bay Shore, L. I., N. Y. Zinc-plated Mini-Shield is finished in black for better heat dissipation. It increases the reliability and prolongs the life of miniature 7 and 9-pin electron tubes by as much as 5 times because of its heat dissipating qualities, reducing heat by as much as 5 C. It holds any miniature tube firmly in its socket with a grip that actually tightens against any force that tends to loosen the tube. A vertical seam automatically adjusts to proper tube diameter and four serrations on the base clip prongs compensate for tube length variations.

CIRCLE 322 ON READER SERVICE CARD



Power Supply
TRANSISTORIZED

MID-EASTERN ELECTRONICS, INC., 32 Commerce St., Springfield, N. J. Model 163 transistorized power supply is designed for high power output in a compact package. Dual outputs provide 6 v d-c at 30 amperes, and 18 v d-c at 30 amperes. Supply is line regulated, accurate to

Instantly, two million watts will blast the Navy's radio signal anywhere on earth: to our planes, ships and submarines on patrol . . . wherever they may be.
Continental Electronics
This new VLF transmitter is the world's most powerful. With it, the U. S. Navy again knows it is getting the best: from the specialists in super power radio!

±0.5 percent. Tap switches on the front panel permit the output to be regulated accurately to compensate for changes in load. Ripple is 5.0 percent maximum. Input voltage is 105-125 v a-c, 60 cps, single phase. Unit mounts in a standard 19-in. relay rack and the front panel measures $10\frac{1}{2}$ in. high.

CIRCLE 323 ON READER SERVICE CARD

Silicon Rectifier

DOUBLE DIFFUSED

SYNTRON CO., 241 Lexington Ave., Homer City, Pa. Style 33 silicon power rectifier is a double diffused diode rated at 30 amperes average at 25 C ambient on a 5 in. by 5 in. by $\frac{1}{16}$ in. copper heat sink. Peak inverse voltages range from 50 to 600 v, in 50 v steps. A typical forward dynamic resistance of 0.0035 ohm is achieved through conductivity modulation.

CIRCLE 324 ON READER SERVICE CARD

Tunnel Diodes

SILICON TYPE

HOFFMAN ELECTRONICS CORP., 1001 Arden Drive, El Monte, Calif. has available silicon tunnel diodes designed to operate from −85 C to +200C. They have applications in digital pulse circuits, gating, memory matrices, negative resistance amplifiers, and microwave oscillators. Units exhibit extreme resistance to nuclear radiation, a frequency handling capability in the 1,000 Mc range, and low power consumption. Differences in types

HT-1 through HT-10 are peak current and negative resistance. Typical negative resistance is 220 down to 39 ohms. Peak voltage is 65 mv and valley voltage is 420 mv at peak currents ranging from 1.0 to 5.6 ma. Minimum peak-to-valley ratio is 3.5:1.

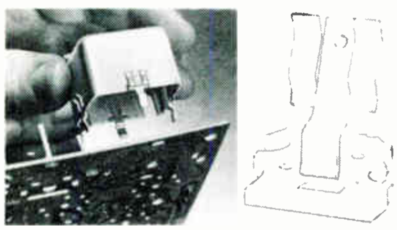
CIRCLE 325 ON READER SERVICE CARD

Precision Resistors

WIRE WOUND

DMETER MFG. CO., INC., 68 N. Broadway, Yonkers, N. Y., announces mini-miniature and printed circuit encapsulated precision wire wound resistors. Temperature: + 0.002 percent per deg C over the range of − 65 C to + 125 C. Wire terminals are 1¼ in. long heavily tinned copper wire. Tolerances: 0.05, 0.1, 0.5, 1 percent depending upon resistor style.

CIRCLE 326 ON READER SERVICE CARD



Spring Clips

IN CHAIN FORM

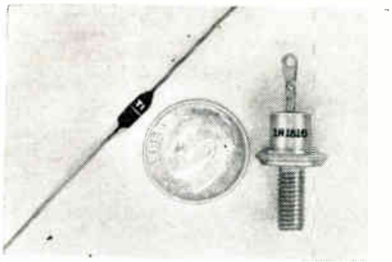
MALCO MFG. CO., 4025 W. Lake St., Chicago 24, Ill. New spring clips for attaching shielding cans to p-c boards easily, quickly and economically are now available in convenient chain form on reels for rapid machine application. This eliminates handling of loose clips, saving assembly time and cutting production costs. Made of 0.016-in. pretinned brass, the clips can be applied to any shape or size of can in a configuration compatible with p-c boards. Skilled labor is not required. Clips are fed, cut off and dimpled onto the can in one operation. They can be attached four clips per can at rates up to 500 cans per hr.

CIRCLE 327 ON READER SERVICE CARD

Silicon Rectifiers
FLANGELESS CASE

MOTOROLA INC., Semiconductor Products Division, 5005 E. McDowell Road, Phoenix, Ariz. A line of 750 ma silicon rectifiers featuring a new flangeless case (maximum diameter 0.28 in.) are designed to simplify manual connection to terminal strips as well as automatic insertion into p-c boards. Designed for operation at temperatures ranging from − 65 C to 175 C, they are especially suitable for use in power supply equipment, both military and commercial, computers, magnetic amplifiers, and communication equipment. They have very low reverse currents at high temperatures, feature a 30 ampere surge-current rating, are available for piv's from 100 to 600 v.

CIRCLE 328 ON READER SERVICE CARD

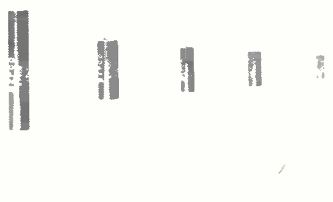


Silicon Diodes
REGULATOR/REFERENCE

TEXAS INSTRUMENTS INC., Semiconductor-Components Division, P. O. Box 312, Dallas, Texas. The USN 1N1816 series includes 42 standard types of silicon power regulator diodes with voltage ranges from 10 v to 150 v ± 5 percent, and dissipates 10 w at 50 C. The USN 1N746 glass reference diode series includes 14 standard types of silicon reference diodes with voltage ranges from 3.3 v to

12 v ± 5 percent, and dissipates 400 mw at 25 C. Both types meet MIL-E-1/1258 (Navy) and/or MIL-E-1/1259 (Navy).

CIRCLE 329 ON READER SERVICE CARD



Resistors
CARBON FILM

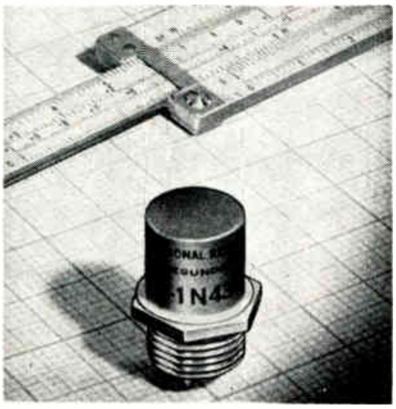
MEPCO, INC., Morristown, N. J., announces a new design in carbon film resistors to meet the environments required by Military Specification MIL-R-10509C Characteristic B. Due to a dry air space between the epoxy tube and the resistive element in this resistor, moisture which might be absorbed during extended storage periods under high humidity conditions, is prevented from being transmitted to the carbon.

CIRCLE 330 ON READER SERVICE CARD

Pressure Transducer
WEIGHS 6 OZ

SERVONIC INSTRUMENTS, INC., 640 Terminal Way, Costa Mesa, Calif. The H-143 high pressure transducer features all-welded construction, high vibration performance, and is available in a variety of pressure fittings and electrical connections. It meets a total dynamic error band of ±2 percent which includes linearity, hysteresis, resolution, static friction, temperatures between −65 and 320 deg and sinusoidal vibration of 20 g (50-20,000 cps) with simultaneous Gaussian random vibration of 0.6 g^2 per cps. Instrument measures 2½ in. by 1 in. and is available in pressure ranges between 1,000 and 5,000 psi.

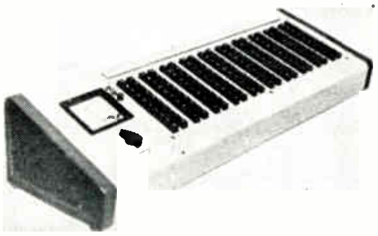
CIRCLE 331 ON READER SERVICE CARD



Reference Elements
STABLE AND RUGGED

INTERNATIONAL RECTIFIER CORP., 1521 E. Grand Ave., El Segundo, Calif. Silicon Zener voltage reference elements conforming to MIL-E-1/1060 (Navy) are now available. The USN-1N430 will provide a reference voltage of 8.4 v (average) at 10 ma bias current and a dynamic resistance of 11 ohms (average). Units will provide a stability of ±16 mv or better over a temperature range from — 55 C to + 100 C, with temperature coefficients of ± 0.002 percent per deg C. Also available, but not covered by individual military specifications are the 1N430A and 1N430B reference elements, selected to tighter temperature coefficient tolerances and higher operating temperature ranges than the USN-1N430.

CIRCLE 332 ON READER SERVICE CARD



Desk-Top Computer
FOR QUALITY CONTROL

BOONSHAFT AND FUCHS INC., Hatboro Industrial Park, Hatboro, Pa. This desk top computer gives an instantaneous solution to statistical quality control problems. The raw numerical information is fed into the computer by means of a conventional keyboard. Mean value and standard deviations are immediately indicated on a large panel meter. Accuracy is better than 2 percent. Construction features include all-transistorized circuitry.

CIRCLE 333 ON READER SERVICE CARD

Power Regulators
SILICON ZENER

HOFFMAN ELECTRONICS CORP., 1001 Arden Drive, El Monte, Calif. The 39 units making up the 50-w silicon Zener power regulator line range in voltage from 10 to 200 v. Designated as types 50H10Z through 50H200Z, the units operate at test currents ranging from 1,200 down to 65 ma, depending on voltage. Standard tolerance of the series is ±20 percent, although units with ±10 percent tolerance also are being made available throughout the entire line. In addition, units with ±5 percent tolerance may be obtained in voltages between 10 and 75.

CIRCLE 334 ON READER SERVICE CARD

D-C Power Supply
RUGGEDLY BUILT

SPELLMAN HIGH VOLTAGE CO., 3029 Webster Ave., Bronx 67, N. Y. Model 2045 is a ruggedly built r-f type d-c power supply used for capacitor charging, electrostatic paint spraying, insulation testing and electrostatic flocking, etc. Also used for spot knocking by tv tube manufacturers. Available with either positive or negative 40 Kv output. Voltage range is approximately 12 to above 45 Kv. Variance in voltage is controlled through a knob on the front panel. Size is 19 in. wide by 12¼ in. high by 13 in. deep. Price is $165 net; with h-v meter on front panel, $215 net.

CIRCLE 335 ON READER SERVICE CARD

CIRCLE 117 ON READER SERVICE CARD

Literature of

TRANSISTORIZED TRANSLATOR Datex Corp., 1307 S. Myrtle Ave., Monrovia, Calif. Bulletin No. 122 covers the TR-702, a compact, low cost, translator which enables design engineers to take advantage of the inherent reliability of Gray Code encoders and obtain a parallel binary output and its complement.
CIRCLE 380 ON READER SERVICE CARD

TRANSFORMERS and REACTORS Chicago Standard Transformer Corp., 3501 W. Addison St., Chicago 18, Ill. A 36-page catalog gives product specifications on over 550 transformers and filter reactors for military, industrial, and communications applications.
CIRCLE 381 ON READER SERVICE CARD

SYNCHROS John Oster Mfg. Co., Avionic Division, 1 Main St., Racine, Wisc. Catalog No. 4000 contains definitions of synchro parameters, dimensional drawings, circuit diagrams, and physical, electrical and mechanical characteristics of Oster's basic line of size 8, 10, 11 and 15 synchros for military, industrial and scientific applications.
CIRCLE 382 ON READER SERVICE CARD

AIRBORNE TELEMETERING Dorsett Electronics Laboratories Inc., 119 W. Boyd, Norman, Oklahoma. Company's facilities and capabilities for the manufacture of airborne telemetering components and systems are outlined in an 8-page 2-color brochure.
CIRCLE 383 ON READER SERVICE CARD

SWEEPING OSCILLATOR Kay Electric Co., Maple Ave., Pine Brook, N. J. A 4-page technical bulletin provides information on the circuitry and design considerations of the Magna-Sweep, a wide-band sweeping oscillator for use in S-band applications.
CIRCLE 384 ON READER SERVICE CARD

MICROWAVE COMPONENTS Radar Design Corp., Pickard Drive, P.O. Box 38, Syracuse 11, N. Y. A 16-page catalog illustrates a wide range of coaxial and wave-guide attenuators and termina-

tions—the latter available in medium power as well as low power models.
CIRCLE 385 ON READER SERVICE CARD

MODULATORS Burmac Electronics Co. Inc., 142 S. Long Beach Road, Rockville Centre, N. Y., has available literature describing three new modulators in detail—the 700, 402 and 223A. A helpful checklist for design data is provided to assist the engineer in obtaining quotations on his particular equipment.
CIRCLE 386 ON READER SERVICE CARD

VOLTAGE REGULATED SUPPLIES Kepco Inc., 131-38 Sanford Ave., Flushing 55, N. Y. Catalog B601 gives full descriptive data of active standard models in the transistorized, vacuum tube, magnetic and hybrid design groups of a wide line of power supplies. It is dual indexed by design group and output voltage range.
CIRCLE 387 ON READER SERVICE CARD

COAX TRIMMER CAPACITORS Marstan Electronics Corp., 204 Babylon Turnpike, Roosevelt, L. I., N. Y. Bulletin CW illustrates and describes high voltage 3,000 wvdc coax trimmer capacitors and insulating washers for commercial, industrial and military usage.
CIRCLE 388 ON READER SERVICE CARD

PRECISION RESISTORS Ohmite Mfg. Co., 3664 Howard St., Skokie, Ill., has issued a new edition of its bulletin 153, describing molded wirewound, power, precision resistors due to the introduction of 1-w and 7-w sizes to the line.
CIRCLE 389 ON READER SERVICE CARD

RFI MEASURING EQUIPMENT Stoddart Aircraft Radio Co., Inc., 6644 Santa Monica Blvd., Hollywood 38, Calif. A 4-page bulletin gives complete description, applications and specifications of the NM-52A radio interference-field intensity measuring equipment covering the frequency range of 375 Mc to 1,000 Mc, with a sensitivity of from 20 to 40 db greater than Mil-Specs require.
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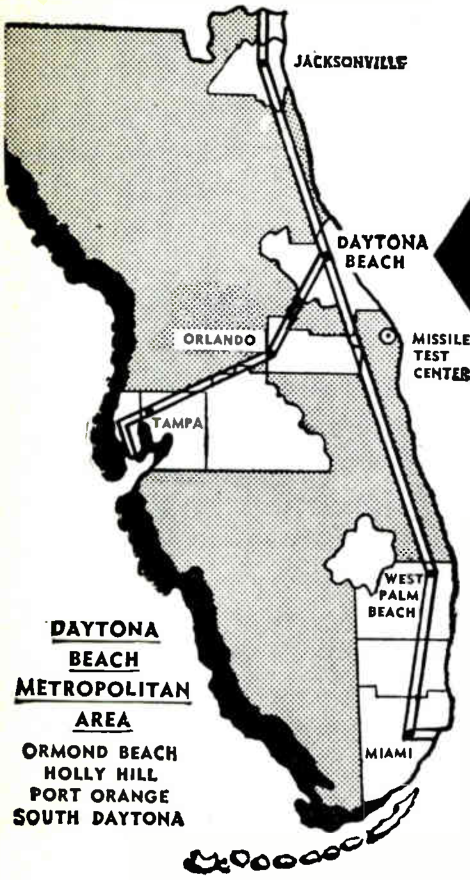

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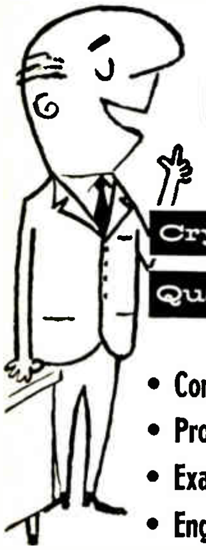

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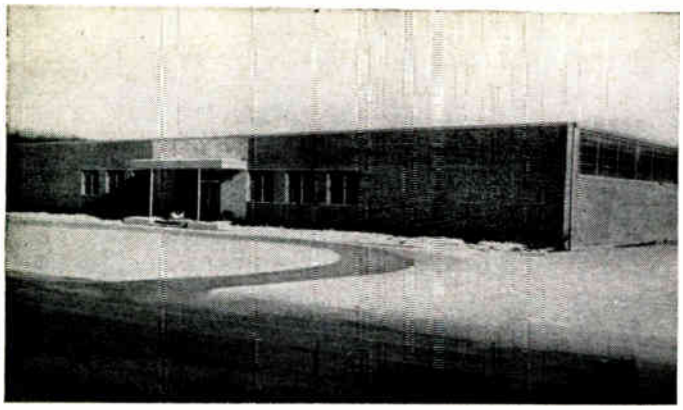

Hazeltine Opens R&D Center

HAZELTINE RESEARCH CORP., a subsidiary of Hazeltine Corp., has opened a new research and development center in Plainview, N. Y.

Three major departments have been formed at the Plainview laboratory. The Systems Research group is concentrating on advanced radar systems, military communications and space guidance systems. The Industrial department is working on electronic applications to photographic processes and other fields. The Apparatus and Circuit Research department is devoting its efforts to semiconductor applications, electroluminescence and microminiaturization.

Jennings B. Dow, president of Hazeltine Research Corp., is coordinating activities of the three groups. He is a director of the Electronic Industries Association, and during World War II was chief of the Electronics division of the U. S. Navy's Bureau of Ships.

R. K. Hellmann is technical director and vice president of Hazeltine Research Corp. Frederick R. Lack is a consultant to the Plainview laboratory and a director of HRC.

Establishment of the Plainview laboratory was planned to strengthen Hazeltine's position in the military and civilian electronics fields, says Dow.

Hazeltine was founded in 1924 to develop the radio inventions of Prof. Alan Hazeltine of Stevens Institute of Technology. He is currently a consultant to Hazeltine Research Corp.

GI Semiconductor Expands Staff

AS PART of an expansion and reorganization of General Instrument Corporation's Semiconductor Division, a series of promotions and engineering staff additions have been announced by Maurice Friedman, vice president and general manager of the division. They include:

William J. Feldman, appointed chief industrial engineer. He joined the company in 1958, after holding industrial engineering positions with Westinghouse Electric Corp., Federal Radio Co., and Sylvania.

Eric J. W. Evans, named chief germanium diode process engineer. He served as a supervisory semiconductor engineer with Edison Electric Co., in England, and CBS-Electronics in the U. S.

E. Thomas Middleswarth, chief glass technologist. He joined GI in 1959, and was formerly a glass specialist with CBS-Hytron Corp., Pittsburgh Plate Glass Co. and Corning Glass.

Ralph H. Garten, appointed senior industrial engineer. He previously was mechanical design and production supervisor with Clevite Transistor Products Co.

Lawrence P. Goetz, named senior process engineer. With GI since 1953, he formerly was production engineer with P. R. Mallory Co.

Kurt J. Sonneborn, appointed senior process engineer. A chemist by profession, he is experienced in silicon and germanium device development.

Morgan Heads Up New Company

HENRY MORGAN was recently elected president and general manager of Electronic Controls Inc., Stamford, Conn., a recently formed company engaged in design, manufacture and marketing of automation equipment and control systems for military and industrial applications.

The newly elected president served in management capacities for eight years with Burndy Corp. of Norwalk, and five years at Gorn Electric Co. of Stamford.

GE Announces Realignment

THE General Electric Co. recently announced an organizational realignment in its electronic and defense businesses.

The company's Electronic, Atomic and Defense Systems group has been renamed the Electronic and Flight Systems Group. The

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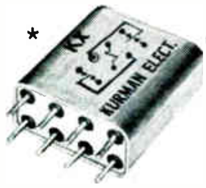

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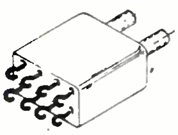

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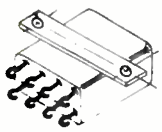

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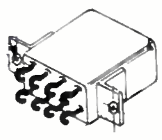

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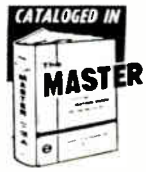

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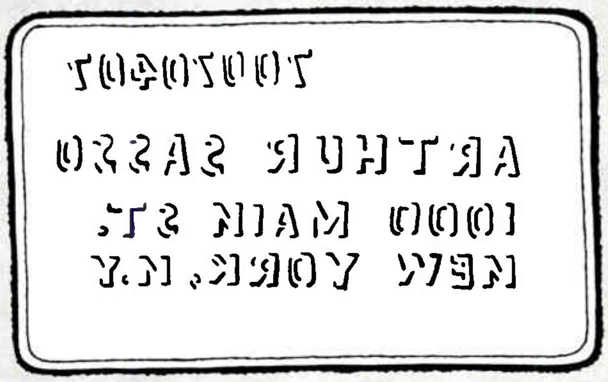

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group, under C. W. LaPierre, vice president and group executive, will now include: the Defense Electronics Division, Syracuse, N. Y.; the Electronic Components Division, Owensboro, Ky.; and the Flight Propulsion Division and the Aircraft Nuclear Propulsion Department, both in Cincinnati, O.

Concurrently, the company has transferred its Industrial Electronics Division to the Industrial Group, headed up by Arthur F. Vinson, vice president and group executive. The division, headquartered in New York City, had been a part of the former Electronic, Atomic and Defense Systems Group.

The Communications Product Department, formerly a part of the Industrial Electronics Division, has been reassigned to the Defense Electronics Division in Syracuse, N. Y.

Suomala Joins Gabriel as V-P

APPOINTMENT of John B. Suomala as vice president of engineering of the Gabriel Electronics Division of The Gabriel Co., Millis, Mass., has been announced. Formerly with the Instrumentation Laboratory at MIT, he has had over 15 years engineering and managerial experience in his field.

At MIT for five years, Suomala had staff and line responsibilities for many projects including: inertial guidance systems in connection with ICBM programs; automatic ground environment systems; and

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Ideal for fail-safe applications, the 6AR enables two separate circuits to be monitored without a common connection.

Lamp and switch terminals of the 6DR are brought out separately in a 4-pin socket.

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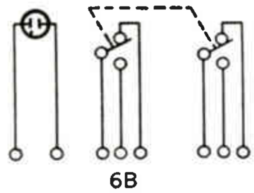

The miniaturized 6B is designed so the lamp and switch can be used separately or in combination with one another.

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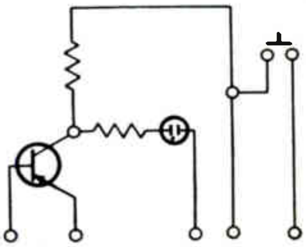
Incorporating a transistorized neon driver and switchlite made as a plug-in assembly, the 1ERX-DLA-T satisfies the need for low-voltage circuit triggering of neon indicators.



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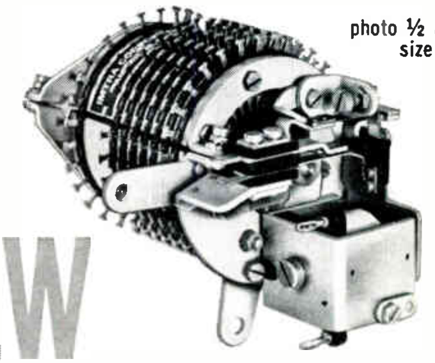

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antenna systems including a ground antenna for the Air Force and early warning radar antenna systems. He was engineering manager at D. S. Kennedy & Co., handling design and development of large steerable antennas, and chief engineer at Bendix Radio Division, Bendix Aviation Corp., where he directed development and production of antennas, antenna drive systems and control systems.

In his new position, he will be in charge of all matters in the engineering department of this division, reporting directly to Stanton L. Yarbrough, president and general manager of Gabriel Electronics.

Appoint Dole R&D Director

ACE ELECTRONICS ASSOCIATES, INC., Somerville, Mass., manufacturer of precision potentiometers, has appointed Fred E. Dole director of research and development of the corporation and its affiliates. His responsibilities include supervision of all matters of design, prototyping and production.

Dole has been a consultant to the electronic industry in the fields of precious metals, contacts, switches and other electromechanical component areas. For the past twelve years, he has acted as director of the Industrial Division of the J. M. Ney Co., Hartford, Conn. He served also as consultant for customer engineering for the Ney firm on a national basis, prior to establishing his own consulting firm.

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(Continued on pages 130-136)

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You should be a senior-level electronics engineer with a BSEE or equivalent and should have 5 years' applicable experience. Background in design of test equipment, high-power modulators, or commercial microwave equipment is especially useful, as is knowledge of magnetrons, underwriters' requirements and FCC regulations. Basically, we're looking for a top design and sales engineer (travel will be limited, however) so salary is commensurate—that is, excellent.

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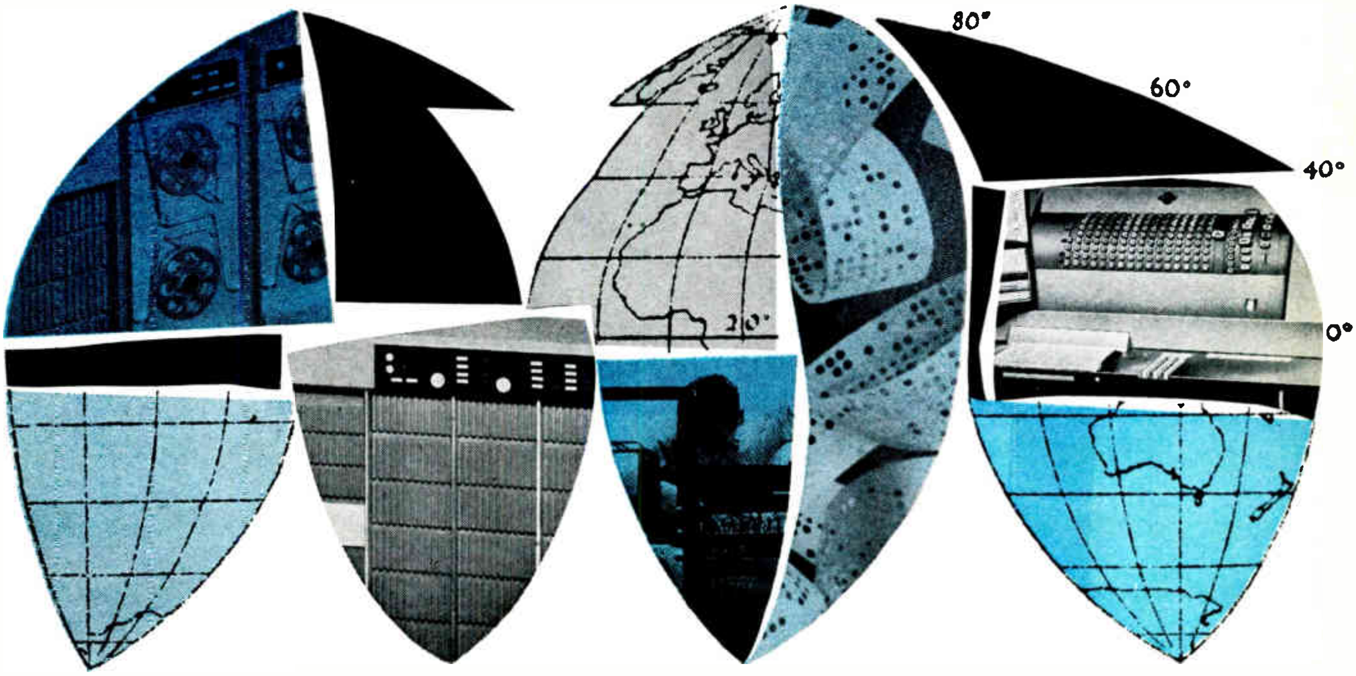

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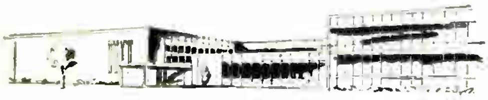

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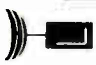

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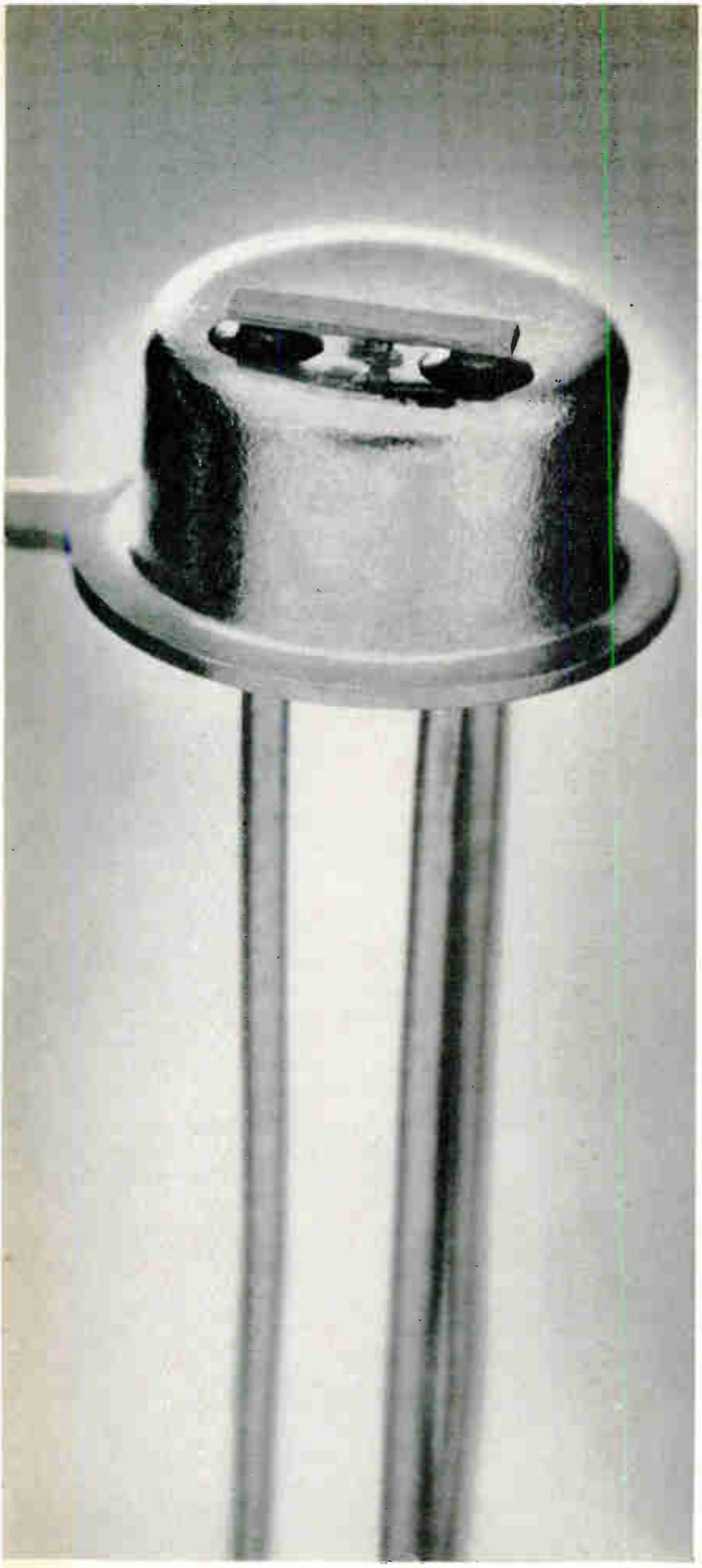

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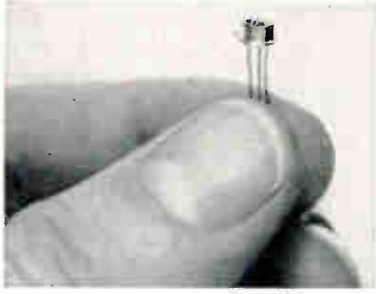

New developments in Esaki Diode technology at IBM

The Esaki Diode at left was made experimentally.

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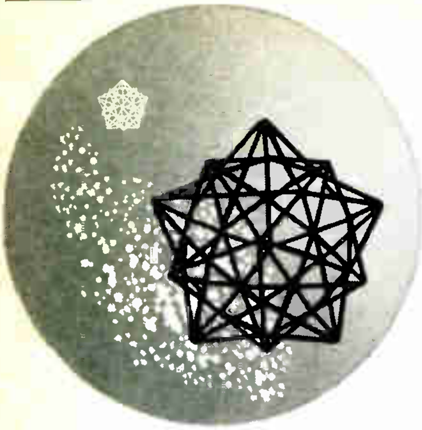

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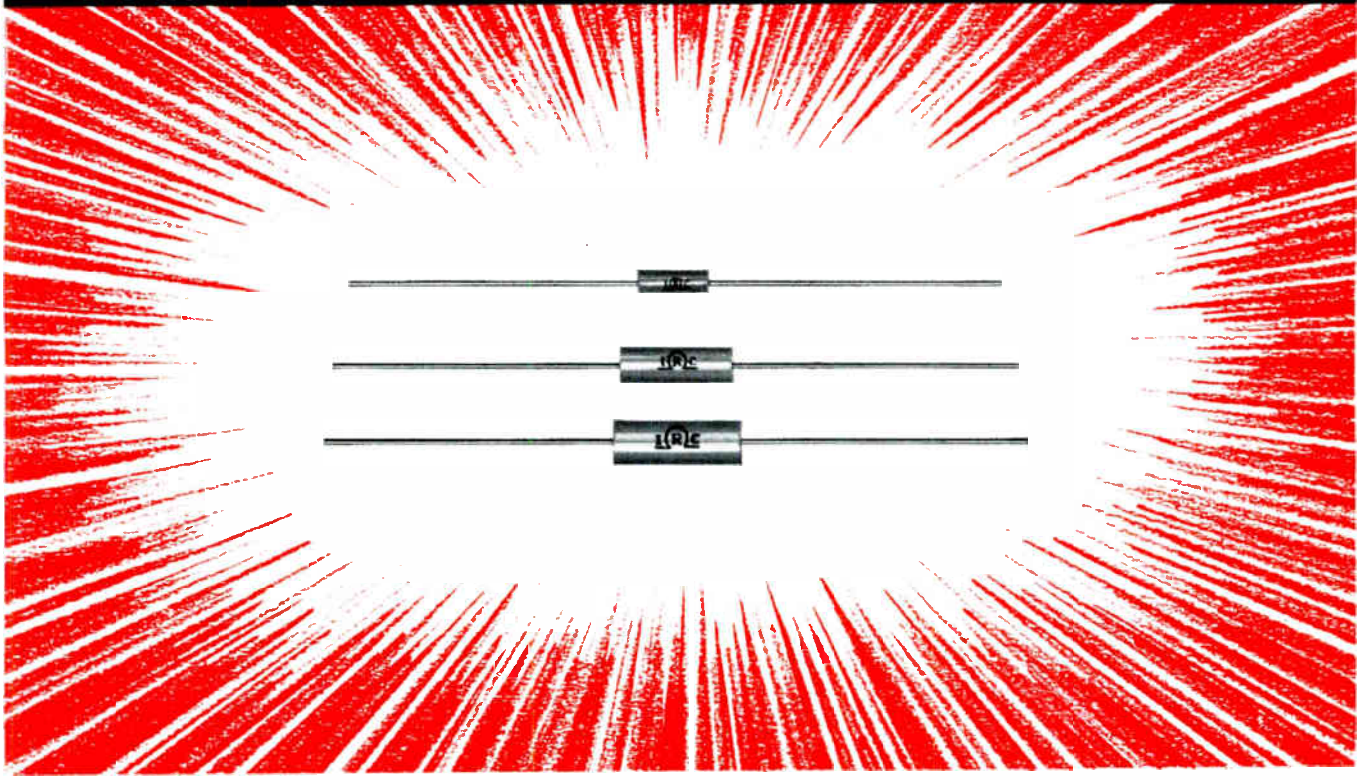

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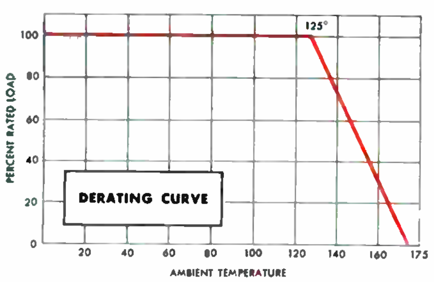

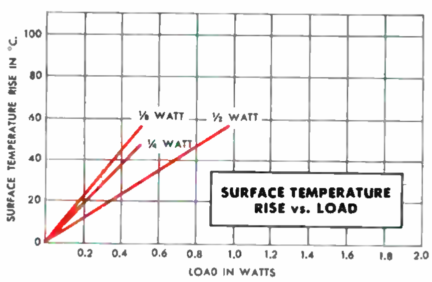

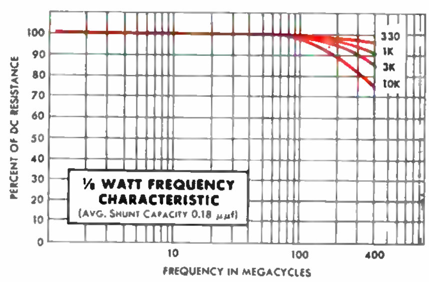

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