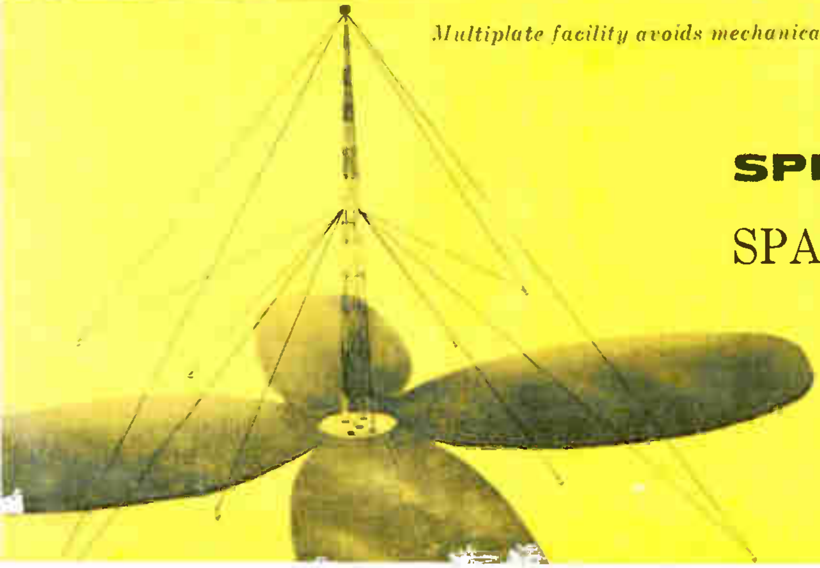
September 7, 1962

electronics

A McGraw-Hill Publication 75 Cents

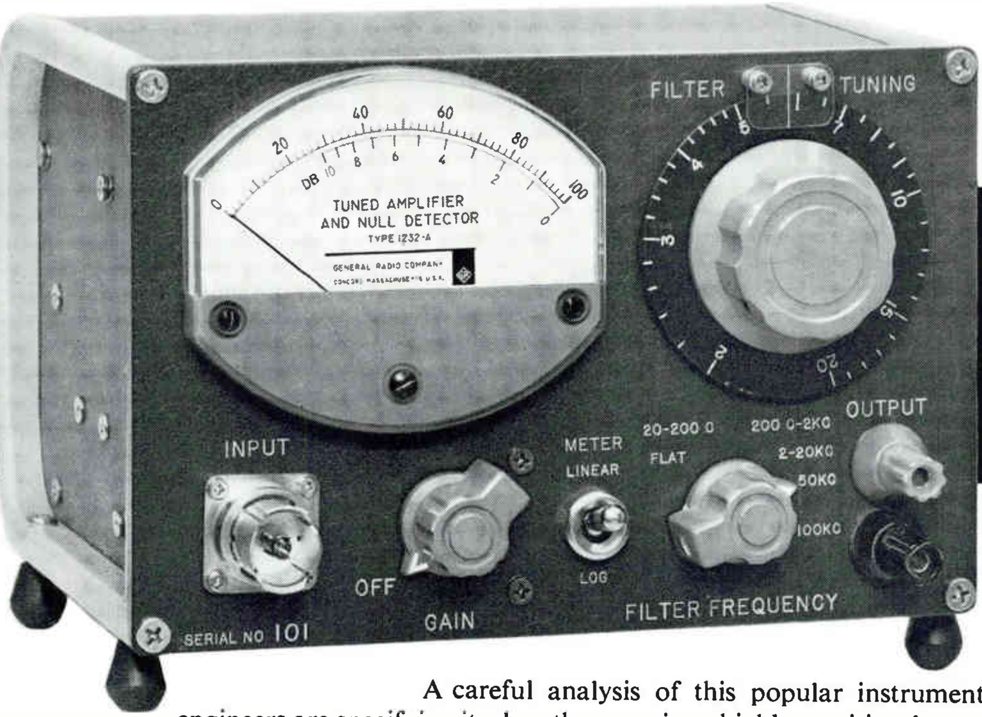
Multiplate facility avoids mechanical problems of steerable dishes, p 39



SPECIAL ANTENNAS IN SPACE COMMUNICATIONS

Looking for a Null?

This Detector's 1μv Sensitivity Will Find It



Fully Transistorized

Type 1232-A
Tuned Amplifier
and Null Detector
$360

A careful analysis of this popular instrument will reveal why engineers are specifying it when they require a highly sensitive, low noise, continuously tunable null detector. Extremely high sensitivity is attained by new circuits that stem from the application of a simplified noise theory* developed by GR engineers. Continuous tuning is provided by an RC null network that contains a potentiometer as its single variable element. This unique feature eliminates the alignment and tracking problems associated with conventional null networks using three variable elements. Other major features are listed below.

Although designed primarily as a bridge detector, the 1232-A can be used, as well, as a detector of high-frequency modulated signals (with a crystal demodulator), audio-frequency wave analyzer, and general-purpose tunable amplifier.

- **EXTREMELY HIGH SENSITIVITY** — one microvolt or better, full scale, over most of the frequency range.
- **EXCELLENT SELECTIVITY** — bandwidth at any frequency is about 5%. Second harmonic rejection is at least 35 db. Above 200 cps, 60-cycle rejection is at least 60 db.
- **LOW NOISE LEVEL** — less than 0.2 μv for most of the tuned range.
- **CONTINUOUSLY TUNABLE** — from 20c to 20 kc in three 10:1 ranges.
- **TWO FIXED-TUNED FREQUENCIES** — at 50 kc and 100 kc.
- **HIGH GAIN** — 120 db for tunable settings; 100 db for flat 20c to 100-kc position; 106 db at 50 kc; and 100 db at 100 kc.
- **CONSTANT OUTPUT** — ±3 db from 20c to 100 kc (FLAT position).
- **LINEAR OR LOGARITHMIC RESPONSE** — provided by meter switch. Compression adds 40 db to upper portion of meter scale for null measurements; does not affect sensitivity at bottom end of meter scale.
- **SMALL, COMPACT, AND LIGHTWEIGHT** — fully transistorized, unit measures 8 inches wide x 6 inches high x 7½ deep, and weighs 5¾ pounds.
- **FRONT LEGS EXTEND** — permits tilting for easier viewing of panel.
- **LOW POWER REQUIREMENTS** — 12 volts dc, from 9 mercury cells. Estimated battery life is 1500 hours at a cost of about 0.4-cent per hour.
- **RACK MOUNTING PROVISIONS** — panel extensions available for rack mounting.

*Available on request, reprint of "A Simplified Noise Theory, and its Application to the Design of Low-Noise Amplifiers", by A. E. Sanderson and R. G. Fulks, IRE Transactions on Audio, July — August, 1961, and NEREM 1960 Record

GENERAL RADIO COMPANY
WEST CONCORD, MASSACHUSETTS

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electronics

A McGraw-Hill Publication 75 Cents

W. W. MacDONALD, Editor

Contents Continued

electronics

September 7, 1962 Volume 35 No. 36

Published weekly, with Electronics Buyers' Guide and Reference Issue as part of the subscription, by McGraw-Hill Publishing Company, Inc. Founder: James H. McGraw (1860-1948).

Executive, editorial, circulation and advertising offices McGraw-Hill Building, 330 West 42nd Street, New York 36, N. Y. Telephone Longacre 4-3000. Teletype TWX N.Y. 212-640-4646. Cable McGrawhill, N. Y. PRINTED IN ALBANY, N. Y.; second class postage paid at Albany, N. Y.

Subscriptions are solicited only from those actively engaged in the field of the publication. Position and company connection must be indicated on orders. Subscription rates: United States and Possessions, $6.00 one year, $9.00 two years, $12.00 three years. Canada, $10.00 one year. All other countries $20.00 one year. Single Copies, United States and Possessions and Canada 75¢. Single copies all other countries $1.50.

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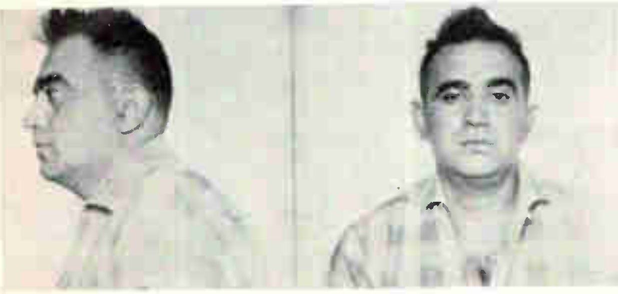
CONTENTS continued

DEPARTMENTS

Something for Nothing



IN ELECTRONICS, as in every other business, charlatans sometimes get into the act, claiming "breakthroughs" and offering to share the secret —for a consideration.

The type of man who sold gold bricks in the last century, and pills that turned water into gasoline in the early 20th century, is now apparently turning to electronics.

The man in the FBI photos above is allegedly just such a person. His name is Anthony Romano, alias Tony Castollano, age 35. He was indicted by a Federal Grand Jury at Miami in March and is now a fugitive.

Romano is accused of using an interstate wire in bilking a group of Florida businessmen of $35,000. He allegedly showed them what appeared to be a transistor radio and claimed it operated without batteries, drawing its power from the air. They put up the money to form "Castollano Electronics."

Frequent attempts were made by the investors to have the "power pack" examined by an electronics expert, but Tony reportedly would stalk off, carrying it with him and muttering that the electronics man was attempting to steal his invention.

What is significant about this case is that the investors were not housewives. They were businessmen. They invested money without technical tests or verification, thought about checking later.

No knowledgeable electronics man would be caught like that, you say? Don't be too sure.

A well-known authority told us recently that the bunco element which attempts to exploit any spectacular new field may now be trying to cash in on the laser business.

How does he know? His company bought some highly-touted components from a supplier who had claimed "breakthroughs" while refusing to be specific.

The components were worthless.

VARACTORS. There are a variety of advanced components that behave much like everyday versions of the same device, except for a special feature, a technological twist analogous to a quantum jump in their level of usefulness.

To name a few: zener diodes that break down at a fixed voltage. semiconductor thermoelectric elements that unlike metallic devices prevent heat from rushing back to the region being cooled, and electrochemical integrators that put out signals proportional to the integrated quantity instead of indicating the quantity by a color change.

One of the outstanding examples of this addition of a new parameter to a component is the varactor diode, whose capacitance changes with applied voltage. This feature has made the parametric amplifier possible.

However, every rose has its thorns. New devices require new and equally ingenious test equipment and techniques. A varactor cannot be checked out with a simple capacitance bridge, because it has a whole range of variables all interrelated—capacitance-voltage relationship, variation of capacitance with frequency and dependence of capacitance on ambient temperature.

Recently we published (p 60, March 9, 1962) an article telling how to test varactors by applying a sawtooth bias voltage to the varactor and probing with a fixed high frequency. This week, on p 49, F. P. Chiffy and J. L. Gurney, Jr., of GE, describe how readings for bias voltage can be obtained by injecting a high-freqency signal into the varactor.

Next week—shifting from tests to applications of varactors—we will publish an article whose headline some reader may want to challenge: "Is this the Simplest Paramp Ever Built?"

The amplifier circuit, for use at vhf and lower microwave frequencies, contains only one varactor, a butterfly resonator and coupling loops for signal and pump frequencies, yet is tunable over a 2:1 frequency band. The author is R. J. Mayer, of Boeing, who provided us last year with a report on an earlier parametric amplifier (p 74, Dec. 15, 1961).

Other articles on parametric amplifiers using varactors, published this year, include a design for a troposcatter system paramp preamplifier for a military system using a circulator (p 38, March 2, 1962) and one that lowers noise by eliminating circulators (p 58, March 16, 1962).

COMMENT

Ancient History

I have noticed in several issues of ELECTRONICS that you have published a drawing of an old carbon filament light bulb, which has the same base as our present-day lamps, the screw base.

Enclosed is a picture of the first base used on the carbon lamps, with its socket. The lamp base is porcelain. A later model had a brass base with the same screw center and contact ring.

Later, the base was changed to the same as our modern bases, and adapters were sold to convert to the new type. These were screwed onto the old sockets to accept the new bases.

Thought you might be interested. Many people I have showed these to have never seen or heard of them.

C. E. HOOVER

Ames, Iowa

The lamp engraving is part of an advertisement for this magazine, and appeared most recently on page 67 of the July 27 issue. The lamp, as well as the electric chime (see p 174, Aug. 10), are both taken from a fascinating two-volume book, "Experimental Science," by George M. Hopkins, published by Munn & Co., New York, 1906. The edition we have, the 25th, was brought up to date from previous editions by adding "a full explanation of the Polyphase Generator, Induction Motors, and Rotary Transformers," and also describes "Edison's New Storage Battery."

The vacuum tube is not included in this book's index, and is mentioned only briefly in one paragraph, along with an engraving of "Figures Formed by the Electric Discharge in Vacuum Tubes." showing strings of arrow-head and elliptical shapes.

Capacitor Standards

Reference is made to Mr. William Clink's letter of August 3 (p 4) commenting on mine of June 15 (p 4).

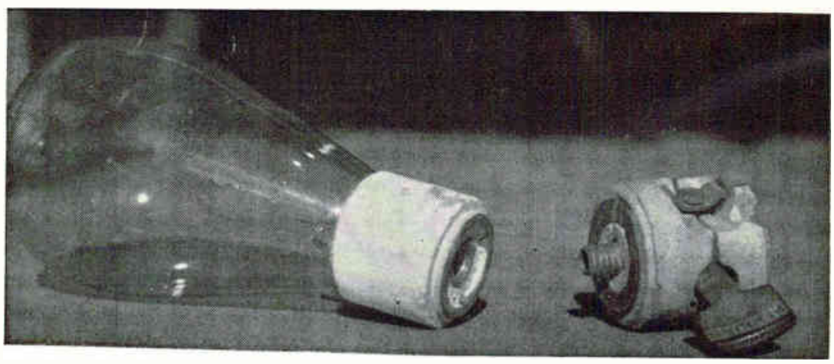
I do not maintain that 0.004 mfd is an officially standard value, but it certainly is a standard practice. Mr. Clink has only to look on page 77 of the 1962 Allied catalog 201A to find three cases where the 0.004 value replaces the "standard" 0.0039 size, and three instances where 0.04 is used instead of 0.039. This, of course, does not reflect on the Allied Radio Corporation or the manufacturer, as they must stock their inventories according to the practice of the field rather than its standard.

As to the acceptance of the pf designation for values below 1 mfd, why must 0.39 mfds be shown as 390,000? I don't think 390K would be ambiguous, especially since the K symbol is already widely used in resistor designation.

In conclusion, I suggest that one way to bring the practice in line with the standards is for design engineers to use only capacitor values whose sizes are also available in the corresponding resistor group; that is, for ±10% capacitor tolerance, see ±10% resistor table, etc. As the demand for the odd values slackens, I think capacitor manufacturers and distributors will be glad to abandon them in favor of fewer stock numbers with larger quantities of each.

A. HEMEL

The Hallicrafters Company
Chicago, Illinois



New Bourns Subminiature Relay— Its Reliability Is as High as Its Size Is Small

You can see that it's little, and you can bet that it's reliable. Only .2" x .4" x .6", but a steady performer even at 40 G, 55-2000 cps, this subminiature SPDT relay is designed to meet all environmental requirements of MIL-R-5757D. Its features include single-coil design, rotary balanced armature, hermetically sealed case and self-cleaning long-life contacts. Efficient coil design and packaging improve sensitivity to just 100 mw maximum.

By subjecting every unit to a 5000-operation run-in, Bourns precludes the possibility of relay "infant mortality." To further ensure consistent quality, Bourns conducts 100% final inspection for all important relay characteristics including mass spectrometer leak testing. The last and most punishing test of quality is the trip taken by monthly samples through the Bourns Reliability Assurance Program. This is one of the most extensive series of electrical and environmental tests in the electronics industry, and has long been the reliability double-check for the famous Trimpot® potentiometer. With Bourns relays, as with Bourns potentiometers, every possible step is taken to see that the quality you specify is the quality you get.

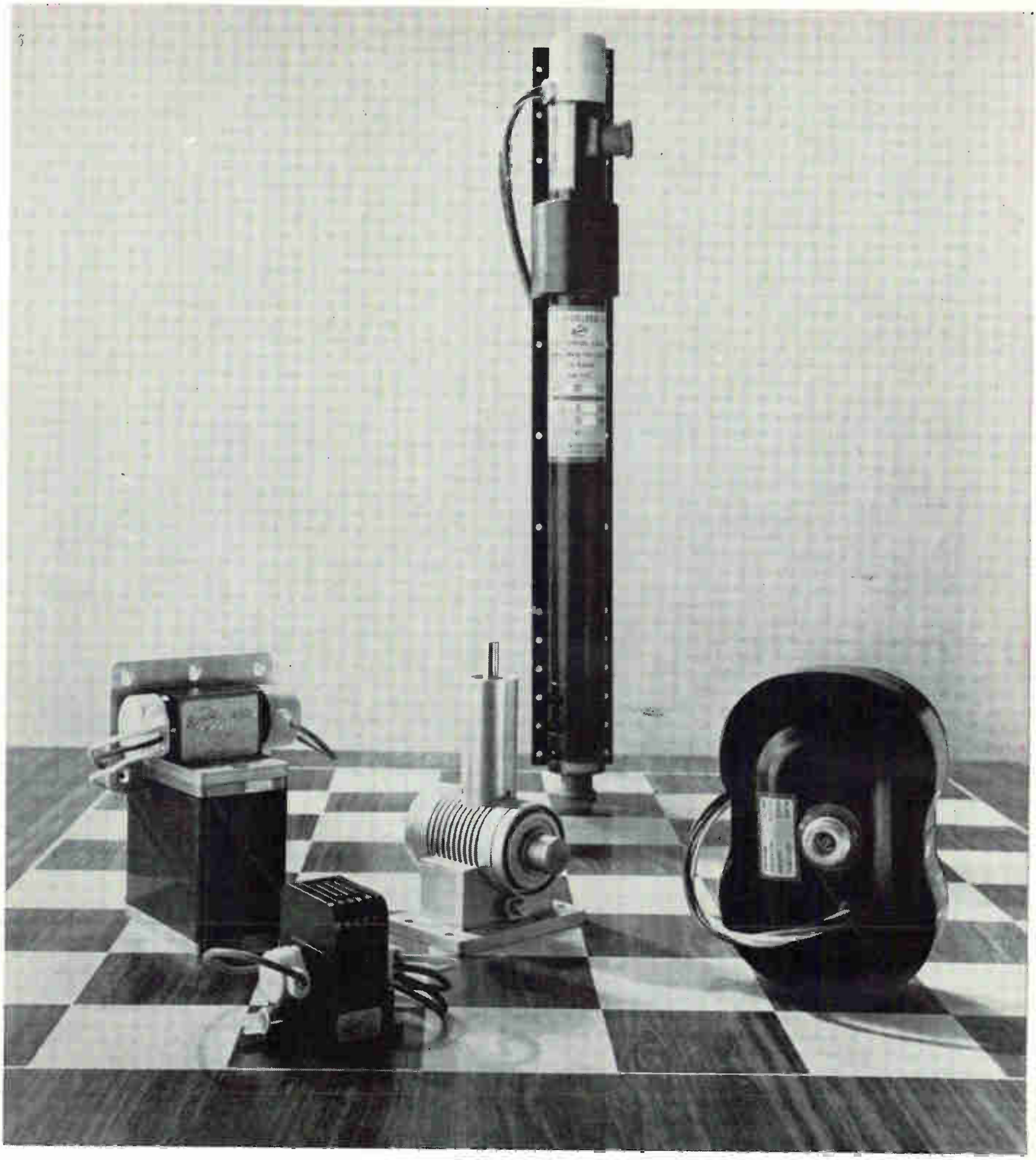
Units are available now from the factory, and will soon be available through Bourns distributors as well. Write for complete technical data.

Size: .2" x .4" x .6"
Maximum operating temperature: 125°C
Contacts: SPDT; Rating: 1.0 amp resistive, 26.5 VDC
Coil resistances: 50Ω to 2000Ω
Pick-up sensitivity: 100 milliwatts
Vibration: 40 G standard, 60 G special
Shock: 150 G

ACTUAL SIZE

Manufacturer: Trimpot® potentiometers; transducers for position, pressure, acceleration. Plants: Riverside, California; Ames, Iowa; and Toronto, Canada

CIRCLE 5 ON READER SERVICE CARD



ELECTRONICS NEWSLETTER

Army Going into Production on Micromodules

CHIEF SIGNAL OFFICER said last week that the micromodule program begun in 1958 is a success and that it is going into production of micromodule equipment and systems. The Army anticipates spending $8 million on the program in fiscal 1963, double 1962, and production will be stepped up to 250,000 units a year by next March.

Production of 1 million micromodules a year is expected by June, 1964, and the rate will reach 3 million to 5 million in 1965. Micromodules are composed of small wafers carrying components (see p 62, May 15, 1959, and p 51, May 22, 1959). Production facilities have been set up by RCA, prime contractor, P. R. Mallory & Co., and Paktron division of Illinois Tool Works. Some 61 other firms supply elements.

Among the Army's 1962 micromodule contracts are orders for 350 portable transceivers and a mobile computer employing some 10,000 micromodules, from RCA, and 400 i-f amplifiers, from Mallory. Chosen for R&D in 1964 are an airborne h-f, single-sideband radio, a hand-held radar, gun-flash detection and ranging set, an electronic typewriter and a production version of a small field computer that is now being built in prototype by RCA.

Two Big Antennas Near Completion After Delays

BOSTON—Advanced Research Projects Agency's ionospheric observatory at Arecibo, Puerto Rico, originally scheduled for operation in late 1961, is now due to be completed next spring. It is a 1,000-foot reflector made of wire mesh placed in a natural bowl.

The line-feed mechanism, to be suspended 435 feet above the reflector, has just been shipped to Arecibo. It was built by Technical Research Group (for details, see p 46, July 7, and p 43, this issue).

In other antenna news, a 150-foot steerable dish will be hoisted next week to its tower at Air Force Cambridge Research Labs' radio astronomy facility at Sagamore Hill, Hamilton, Mass.

This project, delayed many months by lack of funds, and its twin at Stanford take on added significance since the Navy cancelled the 600-foot telescope at Sugar Grove (p 22, Aug. 3). The two antennas are now the nation's largest-aperture steerable antennas. However, a 300-foot antenna is under construction at Green Bank, Va., for use by the National Science Foundation.

Quick Photos of Radar Help Ship's Navigators

P&O-ORIENT liner *Canberra*, which made its first cruise last month, uses a radar photo projector to simplify navigation plotting. The equipment automatically makes successive films of a 3-inch radar screen, then projects a 2-foot diameter image onto plotting paper. Time lapse between radar scanning and display is adjustable between 3.5 seconds and 1 minute.

P&O says the system simplifies navigation. The display can be black-on-white or white-on-black, is bright enough for viewing in normal lighting, can be used to amplify weak signals or show movement of targets by having the camera photograph successive radar sweeps on one film, and provides a permanent record of the ship's movements. P&O said the equipment was made by British Kelvin Hughes.

Central Monitors Will Check Polaris Naviation

NAVIGATION systems in 10 new *Lafayette* class Polaris submarines, scheduled to join the fleet by the end of 1964, will be checked out by consoles to be produced by Sperry Gyroscope. Sperry said the consoles will enable monitoring of the navigation systems at a central point and cut checkout time by 80 percent. The new submarines will carry the 2,500-mile version of Polaris, requiring greater precision in navigation. Sperry will build 14 consoles under a $3.1-million Navy contract. The other four will be used on shore for training, test and study.

Ring-Shaped Motor Can Double as Powered Gimbal

BALTIMORE—Martin's Electronic Systems and Products division has developed a toroidal-shaped motor that is, in effect, an electrical actuator. It has only two moving parts, including integral gearing, and a response time of 2 msec from stop to full speed. It can be built in sizes to 10 horsepower and can also be used in applications formerly restricted to small servo motors, Martin said.

Anticipated applications include as a torquer for inertial platforms

Free-Loader Swipes Power from Line's Field

DENVER—Bureau of Reclamation engineers have invented a device, nicknamed Free-Loader, that can by capacitive coupling collect electrical energy in the field surrounding high-voltage power transmission lines. The device is still experimental.

It is reported to offer a potentially inexpensive source of power for remote installations such as microwave relay stations, other communications equipment and aircraft warning lights.

The device has virtually no effect on transmission-line performance. It will collect only 1.9 Kw from lines carrying 150 Mw. Bureau engineers said it would be about $5,000 cheaper than conventional methods of tapping 230-Kv lines with even more savings when tapping the new 345-Kv lines or gyro gimbals. Because the housing is ring-shaped, it can also be used directly as the gimbal ring of a radar antenna, gyro, ir equipment, or rocket engine to simplify system design, Martin said. A pulse ratio controller provides a 1,000:1 speed ratio with linearity of 0.01 percent without feedback, and a variable reluctance circuit permits starting and reversing current to vary between 20:1 and 1:10, it was reported.

Telstar Synchronizes Clocks in U. S., Britain

DEFENSE DEPARTMENT'S master time clocks in the U. S. and England are being synchronized with Telstar. The first demonstration was made last Saturday. DOD said that the satellite provides greater accuracy —about 10 μsec—than can be obtained using conventional radio.

In another demonstration last week, the satellite was used to relay a transatlantic telephone call from TWA jet, flying over New York, to London. The route used was AT&T's Skyphone service (p 30, May 25), the Andover, Me., ground station, Telstar and the Goonhilly Downs ground station in England.

Mariner II Deep-space Experiments Turned On

HIGH GAIN antenna of Mariner II has been pointed toward the earth, the first step of midcourse correction maneuvers (p8, August 31). However, Jet Propulsion Laboratory scientists were not sure at press time Tuesday morning whether the spacecraft had locked on to the earth or the moon. This information is vital in determining what signals to send to Mariner II to change its Venus miss distance from 233,000 miles to 10,000 miles.

Signals sent from NASA's Johannesburg, South Africa, ground station have switched on the four deep-space experiments aboard the ship. The experiments include instruments to measure changes in interplanetary magnetic fields, intensity and distribution of charged particles, density and distribution of cosmic dust, and intensity and velocity of low-energy protons from the sun.

Ocean-Bottom Seismographs To Check on Bomb Tests

TEXAS INSTRUMENTS will build five more ocean-bottom seismographs and conduct a worldwide data collection program under a $496,529 extension of its Project Vela-Uniform (detection of underground nuclear weapons tests) contract for Advanced Research Projects Agency.

The new seismographs will be able to operate at a depth of 20,000 feet and withstand pressures of 10,000 psi—twice the capabilities of two earlier units (p 33, April 27). The seismographs digitally record data from four sensors, for later recovery and analysis.

Monitor for Snap System To Use 1,000-F Detectors

ATOMIC POWER EQUIPMENT department of General Electric is developing a monitoring and telemetering system for AEC's 500-watt Snap 10A, the first nuclear reactor power system for space. The monitor will include neutron and gamma detectors designed to operate at temperatures up to 1,000 F. If Atomics International, AEC's prime contractor, finds a prototype acceptable, the monitor will be tried out in space as part of a Snap flight test.

Eighth Cosmos Satellite Is Launched by Soviets

VIENNA—The eighth in the series of Cosmos satellites was launched by the USSR August 18. Tass, Soviet news agency, reported in the *Rabochaya Gazeta* that electronic instrumentation aboard the satellite included a multichannel radio telemetering system, radio instruments for measurement of the trajectory and a beacon transmitter operating on 20.00504 Mc and 90.02268 Mc. An on-ground coordinating computing center is receiving and processing information telemetered by the transmitter.

In Brief . . .

MASER OPTICS, Inc., of Boston, has announced a $995 laser. Timing of bursts depends on charging power buildup—up to 45 seconds for 400 joules. Nominal output is 0.5 joule.

TOSHIBA reports it has developed a ruby laser, also low-cost. The company said it also used the ruby in a three-level uhf maser and obtained amplification of 25 db.

GRUMMAN is giving a model of the Orbiting Astronomical Observatory a 1,000-hour test in a chamber simulating an altitude of 300 miles.

J. C. PENNEY is using a data-processing system based on an NCR 315 computer to coordinate replenishment of 20 million stock items in its 1,700 stores, expects to cut records-keeping cost by 70 percent.

SILICON TRANSISTOR CORP. has purchased all the stock of another New York power transistor maker, Secoa Electronics.

PURDUE and Indiana Universities are cooperatively presenting a new course in radio astronomy, using closed-circuit tv to link classrooms 100 miles apart.

AIR DEFENSE COMMAND'S bomb alarm system developed by Western Union is undergoing operational tests. ADC has activated a centralized troubleshooting center at Ent AFB, Colo.

VOICE OF AMERICA authorizations for radio facilities acquisition and construction totaled $96 million through June 30.

AVCO has received a $7.6-million contract from Army for AN/VRC-12 communications systems parts.

AIR FORCE has ordered $1.1 million in single-sideband modification kits for the GRC-26D radio sets, from Manson Labs.

COLLINS RADIO reports $1 million in orders for navigational equipment to be used on Boeing's new 727 jet liners.

NEW 2N2511

SOLVES LOW LEVEL AMPLIFIER PROBLEMS

(Min h_{FE}, 80 @ $I_C = 1\mu a$.
Min h_{FE}, 40 @ $I_C = 10\mu a$ & $T_C = -55°C$)

Other Amelco Silicon Planar Transistors:

Amelco also offers these transistors in production quantities:

2N709	**2N929**
2N760	**2N930**
2N760A	**2N1613**
2N2049	**2N1711**
2N2453	**2N1893**
2N998	**2N2060**

The 2N2511 is one of three new Amelco NPN silicon, planar transistors designed to provide useful current gain down to the microampere level in the temperature range of —55° C to +125° C. Other transistors in the TO-18 packaged, low noise, high gain series are the 2N2509 and 2N2510.

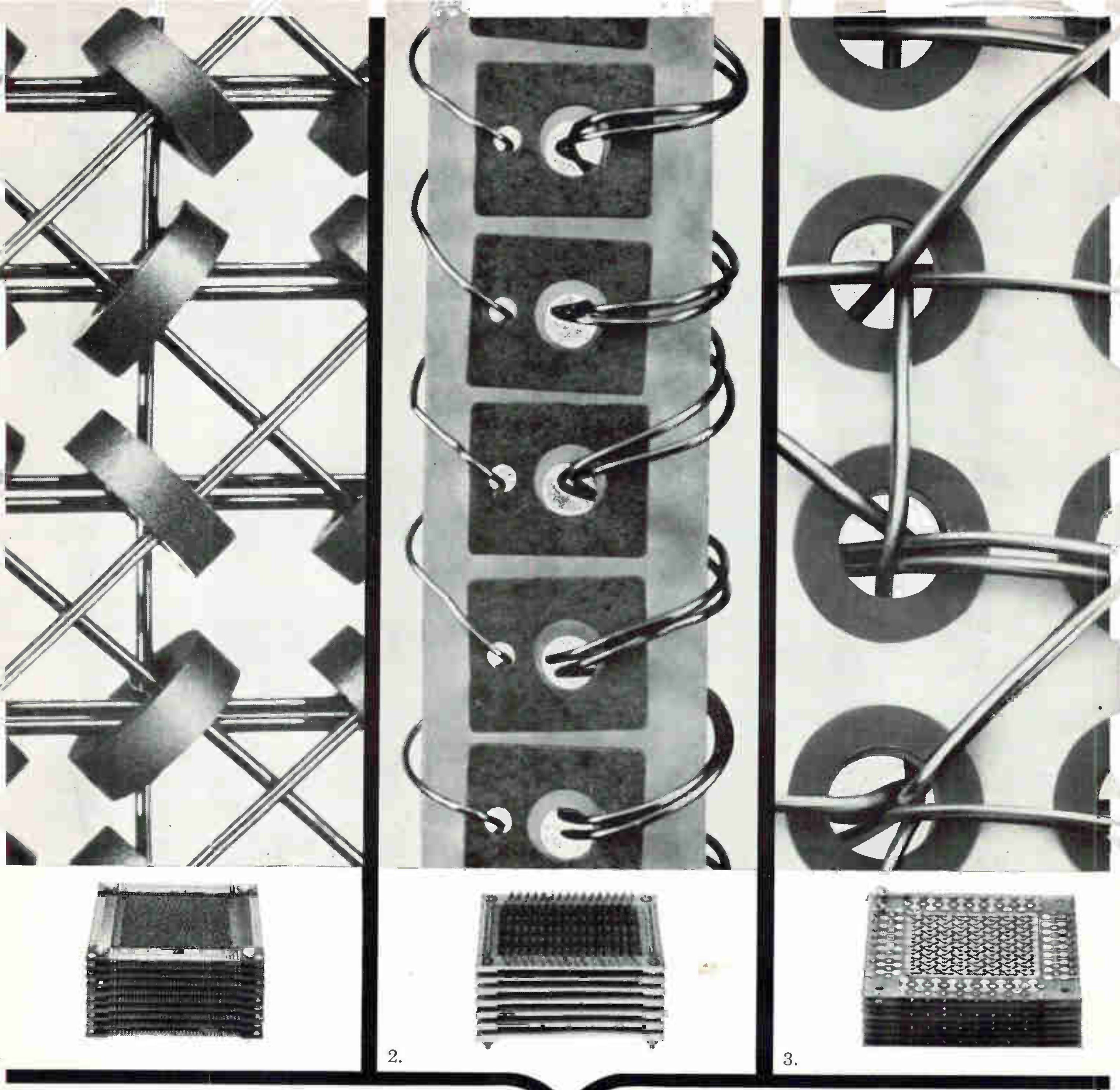
For differential amplifier applications, the 2N2453 is now available. This six terminal device contains two isolated very high gain NPN silicon planar transistors in a hermetically sealed TO-5 type case. Transistors are matched for current gain and base on voltage over the same temperature range (—55° C to +125° C). Typical noise figure for each transistor is 3 db with a current gain of 150 at a collector current of $10\mu a$.

		2N2509		2N2510		2N2511		2N2453	
Parameter	**Test Conditions**	**Min.**	**Max.**	**Min.**	**Max.**	**Min.**	**Max.**	**Min.**	**Max.**
h_{FE}	$I_C = 1\ \mu A$, $V_{CE} = 5V$					80			
h_{FE}	$I_C = 10\ \mu A$, $V_{CE} = 5V$	25		75		120		80	
h_{FE}	$I_C = 10\ \mu A$, $V_{CE} = 5V$, $T = -55°C$			25		40		40	
V_{CEO} (sust)	$I_C = 10$ mA, $I_B = 0$	80 V		65 V		50 V		30 V	
I_{CBO}	$I_E = 0$, $V_{CB} = 0.8\ BV_{CB}$		2 mμA		2 mμA		2 mμA		5 mμA
C_{ob}	$I_E = 0$, $V_{CB} = 5V$		6.0 pf		6.0 pf		6.0 pf		8.0 pf
Noise Figure	$I_C = 10\ \mu A$, $V_{CE} = 5V$, $Rg = 10$ k, $f = 1$ kc		4.0 db		4.0 db		4.0 db		7.0 db
h_{FE1}/h_{FE2}	$I_C = 1$ mA, $V_{CE} = 5V$, $T = -55°C$ to $+125°C$							0.85	1.0
$V_{BE1} - V_{BE2}$	$I_C = 10\ \mu A$, $V_{CE} = 5V$								0.003V

For technical and sales information, please write to
Amelco, Inc., Electron Devices Division,
341 Moffett Blvd., Mountain View, California,
(408) 739-0851, TWX: 415-969-9112

AMELCO, INC.
MOUNTAIN VIEW, CALIFORNIA

CIRCLE 9 ON READER SERVICE CARD



PRODUCTS PHOTOMACROGRAPHED APPROXIMATELY 30 TIMES ACTUAL SIZE

close-up of maximum reliability

Lockheed Electronics' in-house capability produces ferrite cores, multi-aperture devices, printed circuit boards, memory planes and stacks, plug-in circuit modules, and fabricated metal casings. Every step from design through test is under one management to assure maximum quality control and minimum cost.

The enlarged photos above show three of the many types of memory plane assemblies produced by Lockheed Electronics.

1. Standard commercial open frame ferrite core memory plane utilizing either coincident current or linear select wiring.

2. Lockheed designed memory array using multi-aperture cores to provide non-destructive readout. This unique method of mounting and wiring provides the necessary rigidity for severe environmental applications.

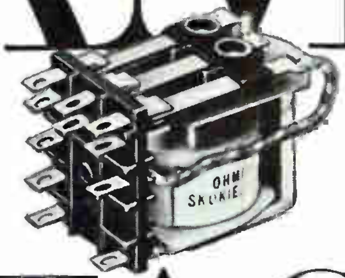
3. Memory plane with conventional ferrite cores using imbedded assembly and wiring techniques to meet exceptionally high environmental shock and vibration requirements of military specifications.

For further information on Lockheed cores, memory planes and stacks, or printed circuitry to fill your particular requirements, write: Lockheed Electronics Company, 6201 East Randolph Street, Los Angeles 22, California.

LOCKHEED ELECTRONICS COMPANY

A DIVISION OF THE LOCKHEED AIRCRAFT CORPORATION

10-AMP



CONTACTS

NEW INDICATOR LIGHT, TOO

now available in Ohmite GPR relays

■ Model GPR relays represent a fresh design approach in the field of good, economy-type relays. Construction is simplicity itself, and with the elimination of complexity has come compactness, versatility, and unusual ruggedness.

CONTACTS: 5 and 10 amps at 115VAC or 32VDC (non-inductive). Gold flashed, fine silver (5-amp); silver cadmium oxide (10-amp).

COILS: Up to 230VAC, 60 cycles, or 115VDC; DC, 1.4 watts; AC, 2 volt-amperes (AC latching type, 3.7 volt-amperes).

CONTACT COMBINATIONS: SPDT, DPDT, and 3PDT for single relays; 4PDT and 6PDT on latching relays.

ENCLOSURES: Clear plastic.

TERMINALS: Barrier type or octal plug.

LATCHING RELAYS: Enclosed with plug-in mounting; or unenclosed.

PLATE CIRCUIT RELAYS: Supplied in 2500, 5000 and 10,000-ohm coil resistances.

Write For New Relay Catalog 700

POPULAR "COST-SHAVING" FEATURES OF MODEL GPR RELAYS

CHOICE of below-chassis or above-chassis connecting in plastic enclosures.

MULTI-USE terminals allow soldering, insertion in printed circuit board, and use of AMP Style 110 push-on terminals.

ALL TERMINALS on *one* panel . . . permits insertion in printed circuit board.

OCTAL PLUG relays up to DPDT have recessed pin bases . . . meet UL spacing requirements to 150 V.

ALL ENCLOSED relays mount solidly on base . . . *not* on covers.

INTEGRAL plug-in base up to DPDT avoids wiring between contact terminals and pins.

ENTIRE LINE STOCKED FOR FAST SERVICE FROM DISTRIBUTORS AND FACTORY

Rheostats • Power Resistors • Precision Resistors • Variable Transformers • Tantalum Capacitors • Tap Switches • Relays • R.F. Chokes • Germanium Diodes

OHMITE

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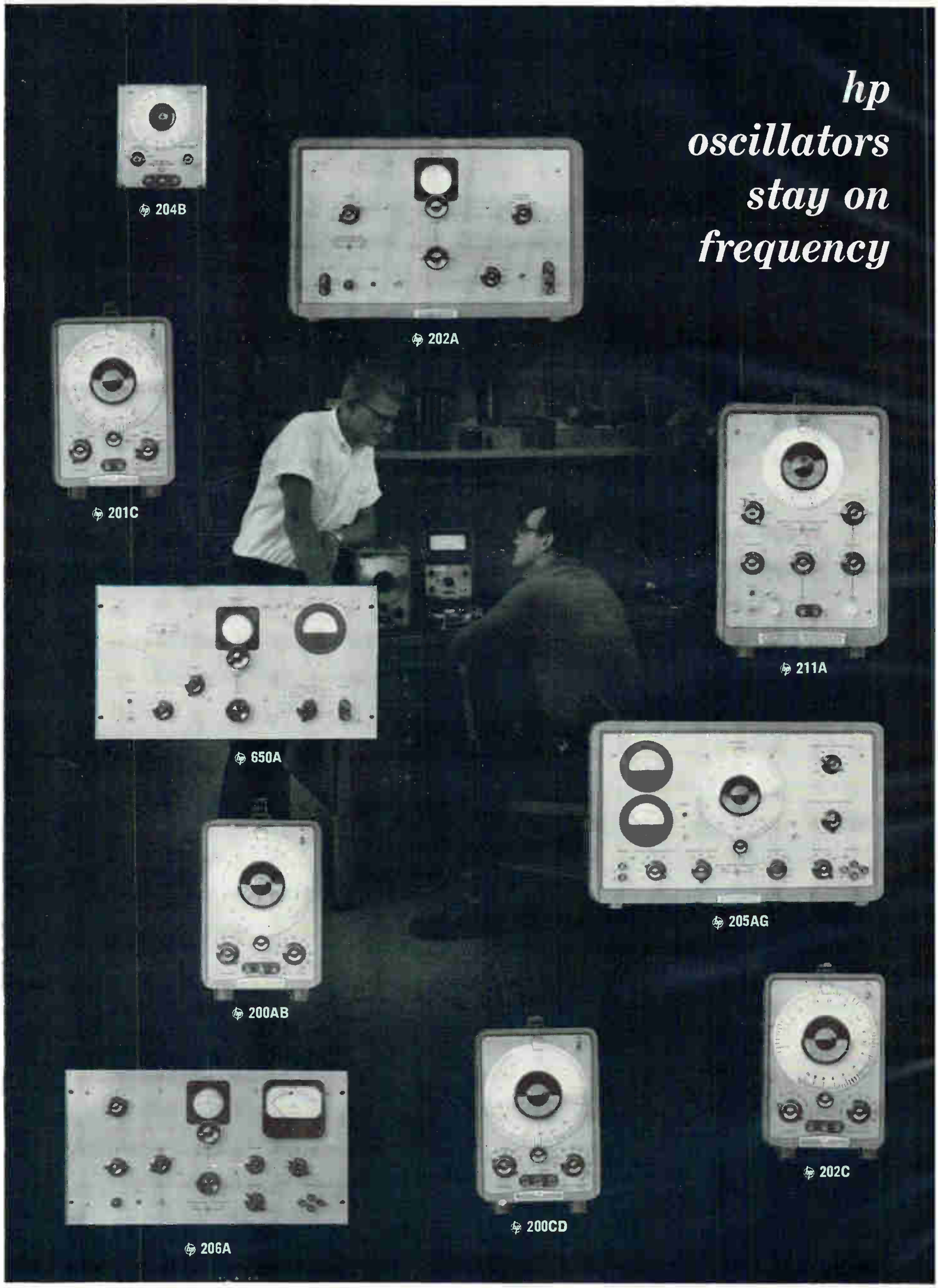
hp oscillators stay on frequency
204B
202A
201C
211A
650A
205AG
200AB
202C
200CD
206A

Accurate Test Signals 0.008 cps to 10MC

The resistance-capacity oscillator, pioneered and developed by Hewlett-Packard, provides simple operation with high stability and wide frequency range. Just select the signal you want on easy-to-read controls, and you get a dependable output without tedious resetting or adjustment. These oscillators give you low distortion, excellent frequency response and extreme amplitude stability. These instruments can make your test work easier, faster, successful, economical.

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Model	Frequency Range	Description, Features	Output	Price
200AB Audio Oscillator	20 cps to 40 KC, 4 ranges	Ideal for amplifier testing, modulating signal generators, testing transmitter modulator response.	1 watt (24.5 v/600 ohms)	$165.00*
200CD Wide Range Oscillator	5 cps to 600 KC, 5 ranges	Subsonic to radio frequencies, useful for testing servo and vibration systems, medical and geophysical equipment, audio amplifiers, video frequency circuits. Easy reading.	160 mw (10 v/600 ohms)	$195.00*
201C Audio Oscillator	20 cps to 20 KC, 3 ranges	High power, designed for testing amplifiers, speakers, crossover nets. ±1 db frequency response, entire range.	3 watts (42.5 v/600 ohms)	$250.00*
202A Function Generator	0.008 to 1,200 cps, 5 ranges	Source of continually variable, transient-free sine, square, triangular waves for electrically simulating mechanical, physical, medical phenomena. ±1% stability.	28 mw (30 v/4,000 ohms)	$550.00**
211A Square Wave Generator	1 cps to 1 MC, 1 range	Useful for audio, video testing. 0.02 μsec rise time. Full amplitude variation available on each of two outputs.	7 v p-p/75 ohms 55 v p-p/600 ohms	$350.00
202C Low Frequency Oscillator	1 cps to 100 KC, 5 ranges	Ideal for subsonic, audio, ultrasonic applications such as vibration, electro-cardiograph, electro-encephalograph. Low distortion and hum. Recovery time less than 0.5% above 5 cps.	160 mw (10 v/600 ohms)	$300.00*
204B Portable Oscillator	5 cps to 500 KC, 5 ranges	Solid state, portable, battery or optional ac operation. Output fully floating, will drive balanced and unbalanced loads referenced above or below ground. Highly stable. Distortion less than 1%.	10 mw (2.5 v/600 ohms)	$275.00***
205AG Audio Signal Generator	25 cps to 20 KC, 3 ranges	A single instrument for making high power audio tests, gain and frequency response measurements. Two VMs measure input and output of device under test.	5 watts adjustable/50, 200, 600, 5,000 ohms	$600.00**
206A Low Distortion Audio Signal Generator	20 cps to 20 KC, 3 ranges	Distortion less than 0.1%. Ideal for testing FM broadcasting units, high fidelity audio systems. Metered output, variable in 0.1 db steps.	+15 dbm/50, 150, 200 ohms	$900.00**
650A Test Oscillator	10 cps to 10 MC, 6 ranges	Ideal for measurements in audio, supersonic, video, rf ranges. Metered output flat within 1 db. Distortion less than 1%, 20 cps - 100 KC; less than 2%, 100 KC-1 MC; approx. 5% at 10 MC.	15 mw (3 v/600 ohms)	$550.00**

*Cabinet models; rack-mount models $5.00 additional. **Cabinet models; rack-mount models $15.00 less. ***AC operation optional, $25.00 extra. **Data subject to change without notice. Prices F.O.B. factory.**

7963

WASHINGTON OUTLOOK

IS THE SENATE SETTING UP COMPETITION FOR AT&T?

AN INCONSPICUOUS BILL perking along in the Senate could give Western Union Telegraph Co. a shove toward becoming a stronger international competitor of AT&T. The bill would let Western Union continue to operate internationally, by ending a long-standing order that Western Union sell its Atlantic cables. The firm has never found a buyer, and FCC has annually waived the order.

In little-noticed testimony in April to Sen. Estes Kefauver's Senate Antitrust Committee, a Western Union Executive, S. M. Barr, proposed that all the other international carriers merge, and then have this company link with Western Union's domestic facilities, forming a major company to compete with AT&T.

Last month, in Senate debate on the communications satellite bill, Kefauver unsuccessfully offered an amendment to end the Western Union divestiture order. But Sen. Warren G. Magnuson (D.-Wash.) introduced the measure, pushed it through Commerce Committee hearings and subcommittee approval. Barr's merger plans weren't discussed on the Senate floor, but his ideas seem to lie behind the sudden interest in letting Western Union pursue international business.

PROCUREMENT REGULATIONS ARE AMENDED

CONGRESS HAS PASSED the so-called Hebert bill amending the Armed Services Procurement Act. It calls for (1) more military purchasing through formal advertised bidding, (2) more detailed written justification when contracts are negotiated, (3) more competition in negotiated procurement, and 4) certification of cost estimates by firms with cost-plus contracts to bar inflated prices.

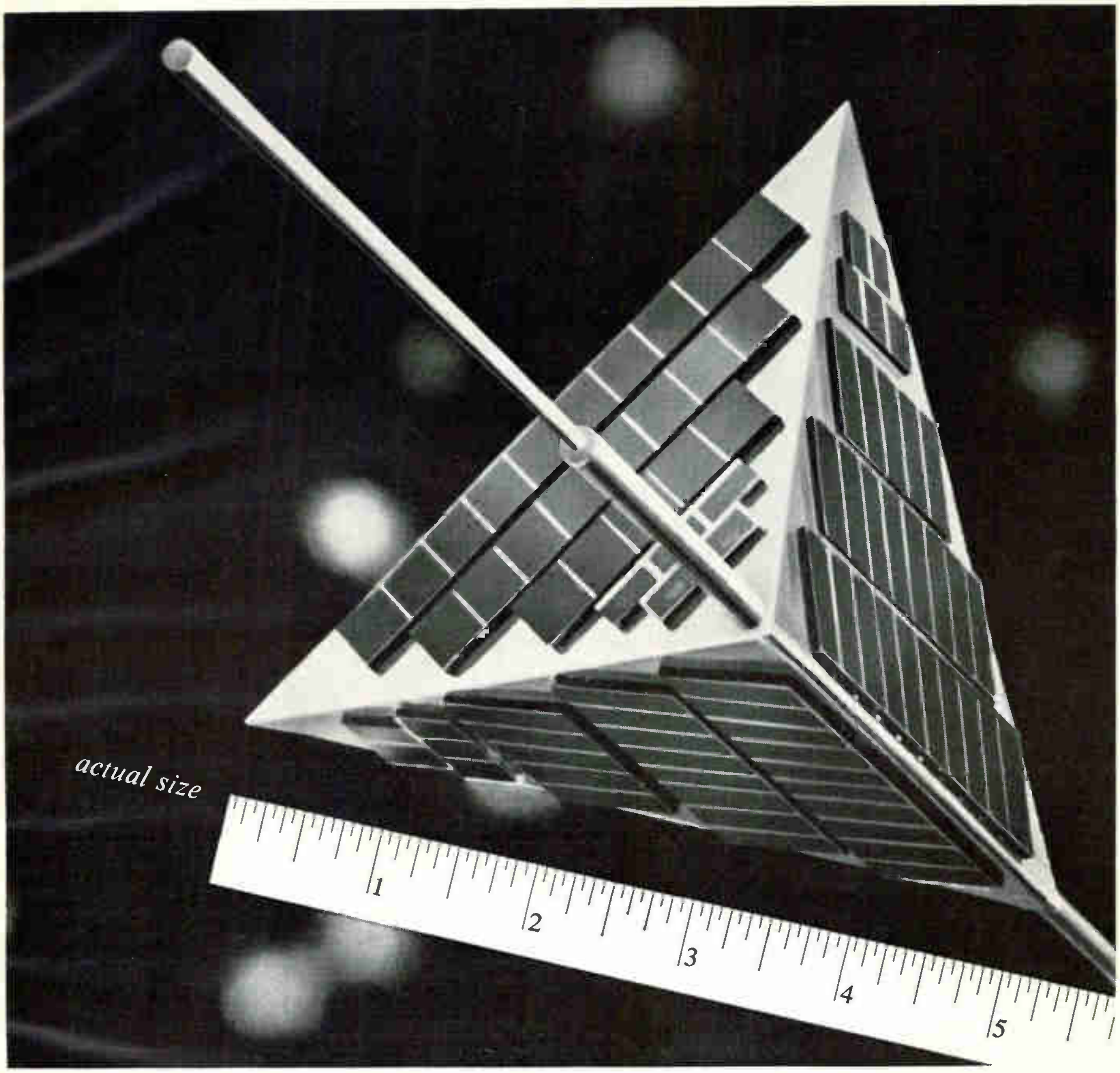
The final bill is milder than a version passed earlier by the House. A provision authorizing the General Accounting Office to review and invalidate negotiated contracts was dropped. The bill is not expected to have much impact on contracting procedures since its basic objectives are already covered by Defense Department regulations.

LABOR-SURPLUS AREAS GETTING MORE DEFENSE CONTRACTS

PENTAGON REPORTS a pick-up in the program to channel military contracts to companies in areas with high chronic unemployment. Total prime contracts awarded under a partial set-aside procedure during July, 1961, to March, 1962, were nearly double the dollar value for the entire fiscal 1961 and triple that in fiscal 1960.

In all, some $6.1 billion of procurement went to firms in labor areas in fiscal 1961, with $5.3 billion of that placed in the last six months of the year. In the first nine months of fiscal 1962, despite a decline in the number of areas designated as labor surplus communities, $5.8 billion in contracts were awarded to firms there.

But Sen. Hubert H. Humphrey (D.-Minn.), who presided over a recent Senate Small Business Committee hearing on the impact of defense spending on distressed areas, feels the Pentagon is not doing enough. He complains that Pentagon policies on contract awards and construction of new defense facilities have allowed "rich areas to get richer and poor areas to get poorer." He cites increasing concentration of new contracts and facilities in California and Florida and the continuing decline of defense business in the Midwest.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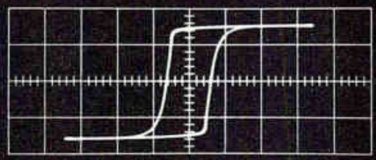
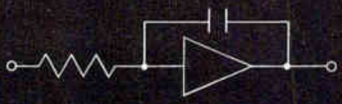
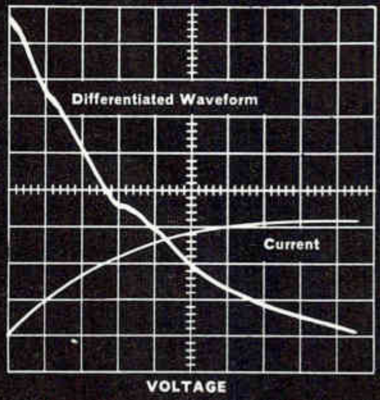


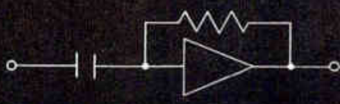
DISPLAY OF INTEGRATED WAVEFORM—transformer secondary voltage integrated and plotted against the transformer primary current—for enabling study of B-H loops of transformer cores.



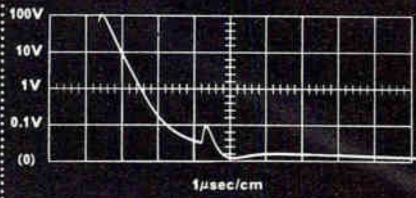
INTEGRATOR



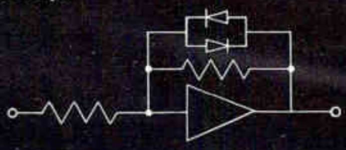
DISPLAY OF DIFFERENTIATED WAVEFORM—tunnel diode in liquid helium—for enabling detection of quantum phenomena at low temperature.



DIFFERENTIATOR

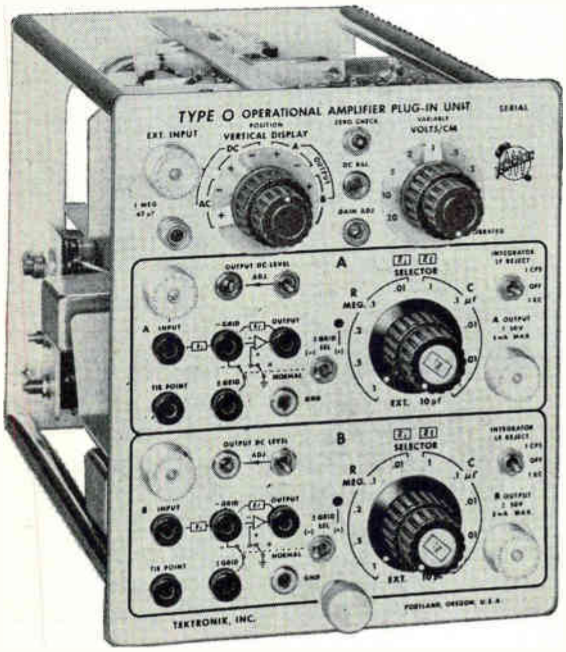


DISPLAY OF LOGARITHMIC RESPONSE—two pulses of widely varying amplitudes—for enabling observation of 100-volt pulse and 0.1-volt pulse in the same viewing area (simplified schematic shown below).



NON-LINEAR AMPLIFIER

New Operational Amplifier Plug-In Unit Permits Oscilloscope Measurements Under Dynamic Conditions



TYPE O UNIT U. S. Sales Price, f.o.b. Beaverton, Oregon $475

To arrange a demonstration of this highly-adaptable Operational Amplifier Unit in your Tektronix Oscilloscope, please call your Tektronix Field Engineer.

TYPE O UNIT—for Tektronix Oscilloscopes that accept letter-series plug-in units.

Using this new Operational Amplifier Unit in your Tektronix Oscilloscope, you can perform precise operations of integration, differentiation, function generation, linear and non-linear amplification.

You can accomplish many of these operations by simply manipulating the front-panel controls—for the Type O Unit features convenient *selection of precision input and feedback components.*

You can use the Type O Unit as a gated integrator . . . as a high-input-impedance amplifier . . . as a bandpass amplifier . . . as a constant-current-drive amplifier . . . as a peak-memory amplifier . . . as a function generator . . . as a capacitance-measuring device . . . as a low-current measuring device . . . and for many and varied other specialized operations—some performed *with* external circuitry and some *without.*

CHARACTERISTICS

The Type O Unit contains two complete operational amplifiers and one complete vertical preamplifier.

Each operational amplifier features 15 mc open-loop gain-bandwidth product, open-loop dc-gain of 2500, selectable input and feedback impedances, drift rejection for ac integration. The output of one operational amplifier can be applied to the input of the other for combined operations.

The vertical preamplifier can be used independently or to monitor the output of either operational amplifier. In a Tektronix Type 540-Series Oscilloscope, the passband is dc-to-25 mc, the risetime is 14 nsec, and the maximum calibrated sensitivity is 50 mv/cm.

Tektronix, Inc. *P. O. BOX 500 · BEAVERTON, OREGON / Mitchell 4-0161 · TWX—503-291-6805 · Cable: TEKTRONIX*

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THAT SET NEW STANDARDS OF RELIABILITY!

Here's a "twist-tab" electrolytic capacitor designed specifically for the rigorous requirements of instrument manufacturers. Check this list of advantages over conventional "twist-tab" electrolytics.

- LONGER OPERATING LIFE (at 85°C)
- LONGER SHELF LIFE
- LOWER LEAKAGE
- LOWER POWER FACTOR
- LOWER ESR
- BETTER TEMPERATURE CHARACTERISTICS
- BETTER HIGH FREQUENCY CHARACTERISTICS
- BETTER END SEAL

The new blue-cased Sangamo Type 505 capacitor has everything the instrument manufacturer needs in a dry electrolytic and . . . no other capacitor can match this performance.

Write today for engineering test data . . . convincing proof that the new blue Sangamo Type 505 does establish new standards of quality and reliability.

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INSTRUMENT

ELECTROLYTICS

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SANGAMO ELECTRIC COMPANY
SPRINGFIELD, ILLINOIS

LOW INDUCTANCE FAST DISCHARGE

SANGAMO ENERGY DISCHARGE CAPACITORS

If you need large quantities of energy delivered rapidly, Sangamo energy discharge capacitors should be your first consideration. The capacitor shown, for example, has a capacitance rating of 2 microfarads and a remarkably low inductance rating of 0.015 microhenries. Rated for operation at 50 kilovolts, this capacitor is designed for maximum energy content per case size. The result: exceptionally high energy content (2500 joules) discharged in the order of nanoseconds . . . more rapidly than ever before possible.

In maser and laser research, magnetohydrodynamics, magnetic-forming operations, thermonuclear fusion research and many other projects, there is a growing demand for large quantities of rapidly delivered energy. Sangamo has been a pioneer in the development of energy sources for these applications and through advanced research will continue to develop energy discharge capacitors that set new standards for performance reliability.

IN STOCK FOR IMMEDIATE DELIVERY

Although designed for specific applications, certain energy discharge capacitor ratings have been found to serve a wide range of applications. These ratings, as shown below, are offered by Sangamo from stock for immediate delivery.

CAPACITANCE MF	VOLTAGE KV	SIZE INCHES
14	20	7¼ x 14 x 24⅝
60	10	7¼ x 14 x 24⅝
240	5	7¼ x 14 x 24⅝
8	20	7¼ x 14 x 15⅜
35	10	7¼ x 14 x 15⅜
140	5	7¼ x 14 x 15⅜

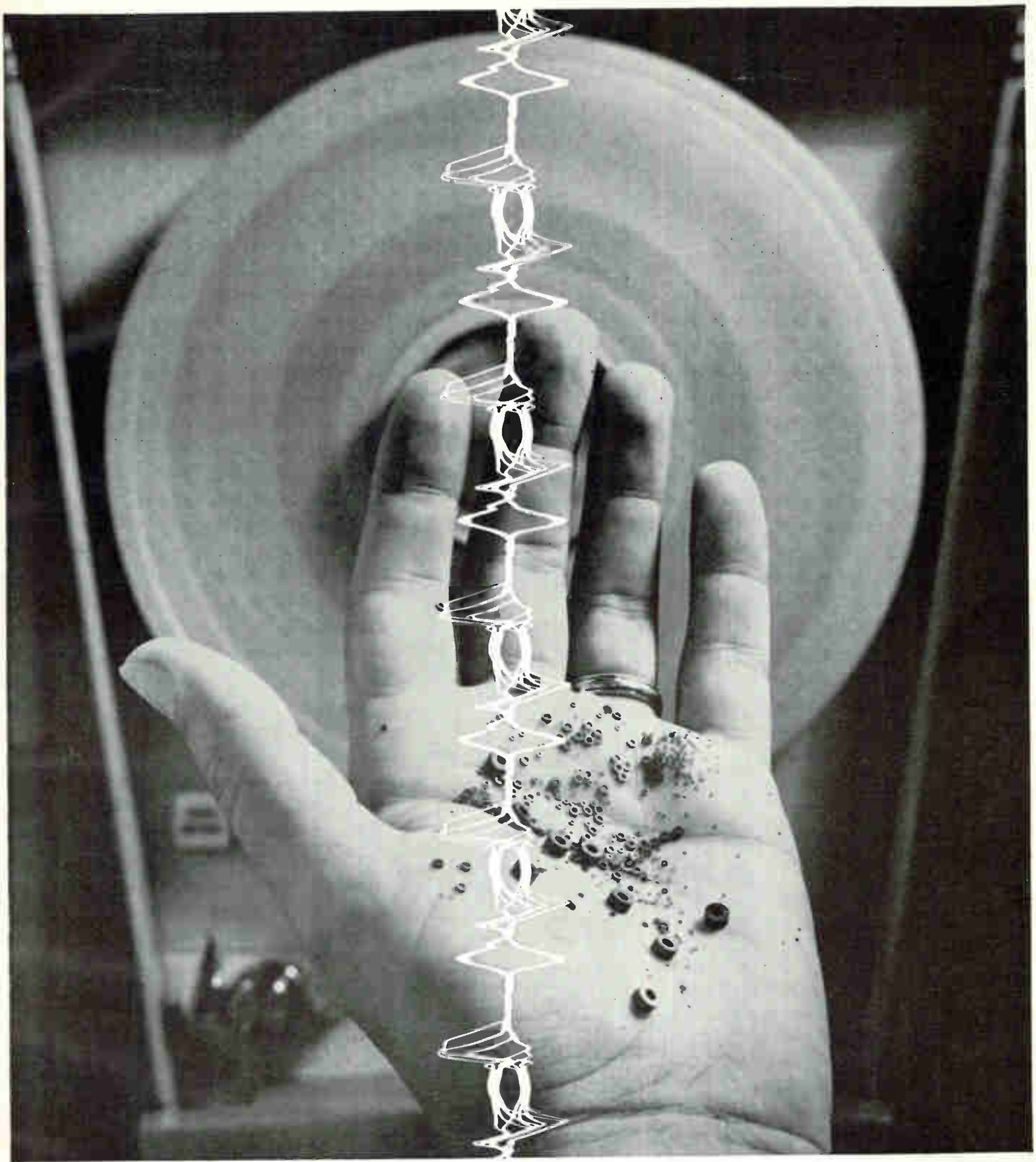
For more details on these and Sangamo's complete line of energy discharge capacitors, write for Bulletin TSC-208.

SANGAMO *ELECTRONIC COMPONENTS*

SANGAMO ELECTRIC COMPANY

SPRINGFIELD, ILLINOIS

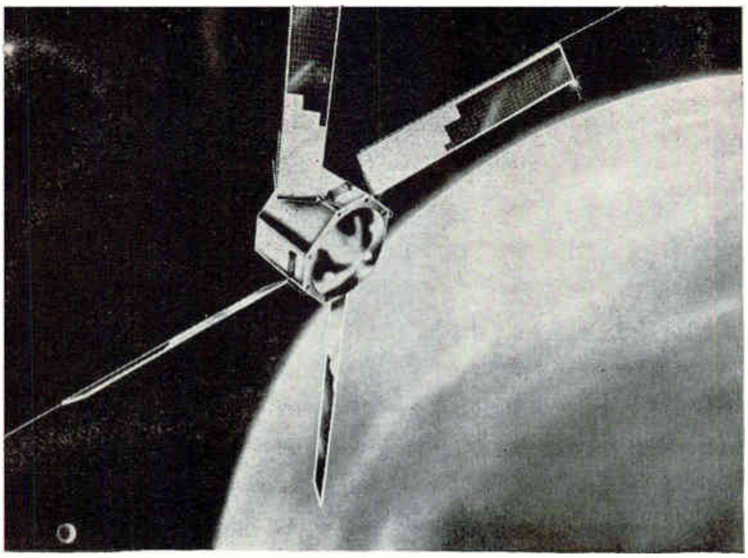
EC62-1



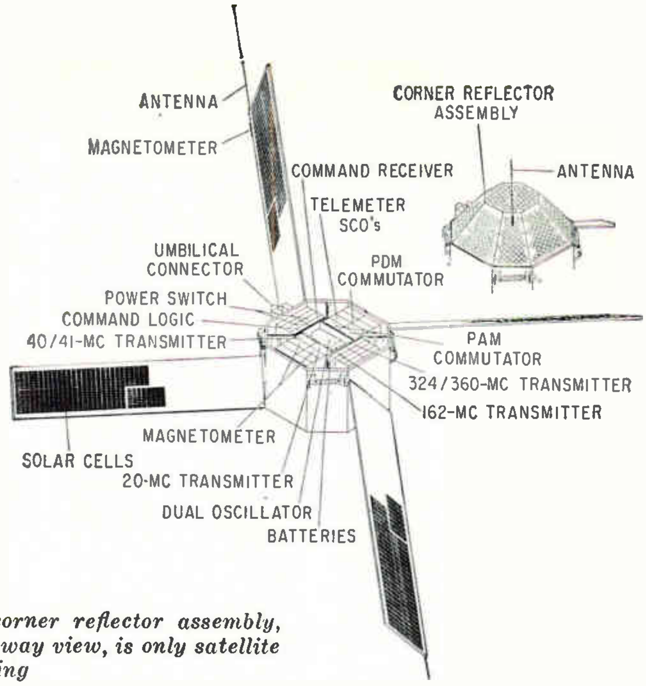
Who can hand you everything—from 30 mil cores to 60% of a computer? **AMPEX**

Want to string your own arrays? We can give you 7 sizes, 150 kinds of cores. Want arrays and stacks ready-made? Good. We can also supply every possible configuration and frame design—including word select and coincident current types. Don't want to fool around with do-it-yourself items? We can help you there, too. We've got the widest line of off-the-shelf core memories with random and sequential access operating modes. Plus the finest high and medium speed tape transports.

Plus computer tape. Plus the most extensive field engineering program today. In other words: when it comes to advanced, reliable computer components, Ampex has them. And the widest possible selection. Ampex Computer Products Co., Culver City, California. A division of the only company providing recorders, tape and memory devices for every application: Ampex Corporation, 934 Charter St., Redwood City, California. Sales and service engineers throughout the world. AMPEX



ARTISTS CONCEPTION *of S-66 in orbit shows extended blades carrying solar cells*



LASER TRACKING *system corner reflector assembly, shown in this S-66 satellite cutaway view, is only satellite component necessary for tracking*

Ionosphere-Mapping Satellite To Try Laser-Bounce Ranging

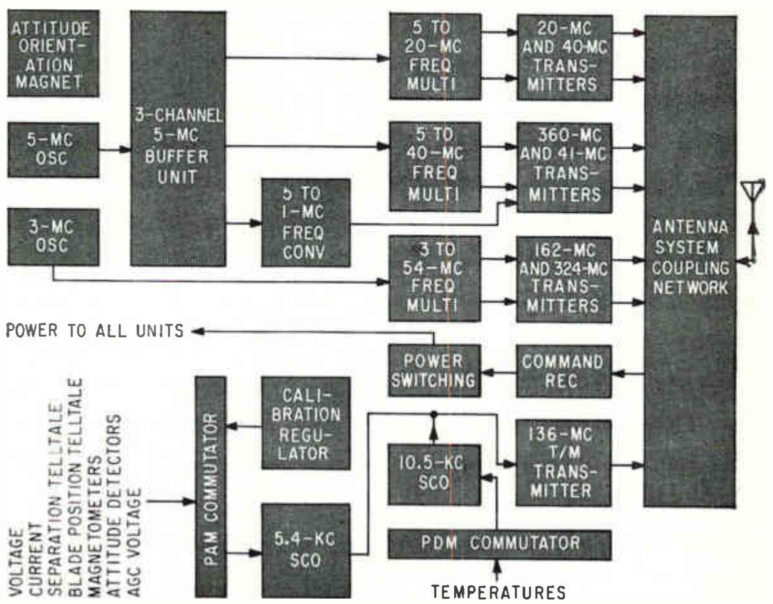
NASA is looking for answers to long-range communications problems

POLAR IONOSPHERE tracking satellite (NASA designation S-66), designed to make detailed studies of the ionosphere, will be launched from the Pacific Missile Range later this year. Fuller knowledge of the ionosphere gained through the satellite hopefully will aid in solving many long-range communications problems.

The satellite, planned as one of the Explorer series, will be launched in a polar orbit to provide total earth coverage and an opportunity for world-wide data acquisition. The satellite is one of eight projects planned as a part of a NASA ionospheric study. Two satellites, Explorer VIII and Ariel, have been launched. Three more will be launched in the future, in addition to S-66. A sounding rocket project and a probe project are also included.

A spokesman from NASA's Goddard Space Flight Center told ELECTRONICS that funding for the satellite is about $2 million.

TRACKING—The S-66 will also test a newly devised optical tracking system. A corner reflector will be carried by the satellite to reflect pulses from a ground-based laser. The laser will emit 1-μsec pulses with an energy output of about 1 watt-sec a pulse, and with beamwidth of 10^{-3} radian. Ground-based



DESIGN OF S-66 *systems will be modification of circuits proven in Transit satellites* detectors will be precision tracking cameras and image orthicons used with telescopes. A range resolution of 30 meters (10^{-7} sec) is expected.

NASA's Minitrack network will provide daily tracking fixes to help the lasers acquire the satellite. A 136-Mc transmitter will be used as a Minitrack beacon, and for telemetering.

EXPERIMENTS—Basic objective of S-66 will be to describe the bulk behavior of the whole ionosphere. Electron distribution between the spacecraft and earth will be measured as a function of latitude, and seasonal and diurnal time. Solar radiation, responsible for producing the ionization, will be related to the behavior of the ionosphere.

Studies will also include the effects of solar flares, the geometry and number of irregularities in the ionosphere, and radio-wave propagation characteristics through the ionosphere at frequencies of 20 Mc to 360 Mc.

Four coherent transmitters, for the ionospheric measurements, will operate at 20 Mc, 40 Mc, 41 Mc and 360 Mc. They will be designed for maximum short-term amplitude and frequency stability and for minimum differential phase jitter. A crystal oscillator, operating at 5 Mc plus 250 ppm, will control the transmitters (see diagram).

OTHER SYSTEMS—Power for S-66 will be supplied by nickel-cadmium batteries, with a capacity of 2 amp-hours. Silicon solar cells of the blue-sensitive type, generating a total of 10 watts, recharge the batteries.

Attitude controls will be, for solar orientation, six solar cell devices, and for orientation with respect to the earth's magnetic field, a three-axis flux-gate magnetometer. A mechanical despin device will reduce the 200 rpm spin rate of the final stage of the Scout launch rocket down to 10 rpm.

MANAGEMENT—Goddard Space Flight Center has overall project management and will process data. A GSFC spokesman said that up to 150 international participants may aid in tracking and data collection. A final project report will be made available to all participants.

Spacecraft system design, fabrication and testing will be managed by the Applied Physics Laboratory of Johns Hopkins University. Design, begun last April, will be based extensively on Transit V-A. Langley Research Center will manage launch operations.

X-Ray Telescope to Probe Moon and Stars

SAN FRANCISCO—An x-ray telescope—a collimator that can collect and focus soft x-rays of galactic origin—was reported at the recent international symposium on x-ray optics and microanalysis at Stanford University. The device is expected to aid in x-ray astronomy and in analysis of the moon's composition by measuring the intensity of lunar-reflected radiation.

The collimator is a paraboloid cone of high-reflectivity material. It was developed by Riccardo Giacconi, of American Science and Engineering, Inc., working with Air Force Cambridge Research Lab, and Bruno Rossi, of MIT. Giacconi is also working on an image-forming version for photography.

Tests showed that the efficiency of x-ray collection was inversely proportional to the angle of incidence, so the Giacconi-Rossi collimator was designed to operate with x-rays reflecting at one or two degrees. It has a resolution of 1/10 the solar disc.

Soft x-ray analysis of the moon can tell the ratio of elements, but not specific composition. For example, it could determine the oxygen-silicon ratio, but not whether a compound was Si0 or Si_20_4.

The first indication that x-ray astronomy in the night sky was possible, it was reported, was last June when a radiation-counter rocket probe discovered x-rays of much higher intensity than expected coming from the galactic center and around Casseopia-a. The probe was intended to detect x-ray reflections from the moon, hopefully leading to analyses, but the lunar reflections were obscured by the high-intensity sources.

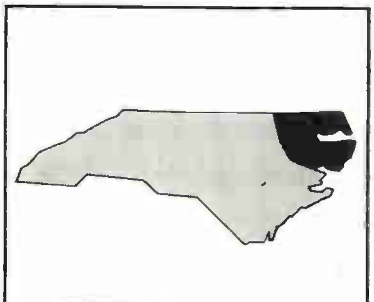
White Sands scientists will try again to determine the properties and origins of soft x-rays with another Aerobee probe on Oct. 2, concentrating on the Taurus-a area, another suspected strong source.

Single-Place Gyrocopter by Bensen Aircraft Corp.

Get a close-up of growing electric power in
Northeastern NORTH CAROLINA

By the time you read this, a 34-mile lake will be almost ready to form behind VEPCO's new Gaston Dam. And, before your plant in Northeastern North Carolina is complete, Gaston's big turbines will be turning. They'll pour 200,000 kilowatts into VEPCO's modern, interconnected power network . . . helping to build its present capability of 2,049,000 kilowatts up to 3,019,000 by 1964.

Yes, you'll find dependable, economical electric power aplenty to work with this area's abundant, willing and trainable manpower.



North Carolina home-grows two workers for every one who retires or moves. And the state's Industrial Education Program trains them for your plant's needs. Want more facts, or site information? Write, wire or phone VEPCO in confidence, without cost or obligation.

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New Design Principle. Con Avionics "Worst-Case" Analysis brings virtually failure-proof performance within the reach of everyone who uses power supplies. Here's why:

By special mathematical analysis, every Con Avionics supply is designed to reduce the probability of failure to near zero under "Worst-Case" conditions. Then the complete design is empirically verified with respect to regulation, overload and short-circuit protection, stability and all other operating parameters under "Worst-Case" operating conditions.

Before shipment, every Con Avionics Power Supply is given a 100-hour simulated operation under "Worst-Case" conditions. The result is a supply guaranteed to give you perfect performance under any and all conditions.

Shown above is the AC-DC "Modular" Power Supply designed for easy incorporation in many electronic assemblies and systems. It features all solid state . . . unique heat sink construction . . . voltages from 2.0 to 305 VDC . . . adjustable output . . . power to 30 watts . . . regulation 0.1%.

Learn more about Con Avionics complete line of Transistorized Power Supplies. Call your local Con Avionics representative, or write to address below.

*Mean time between failure

New Low Cost General Purpose Supply available with regulated and unregulated outputs. 0-60 VDC/o-1.5 Amp.

New "Switching" Power Supply makes higher current capacities possible at low cost. 10-32 VDC/10, 20, 50 Amp.

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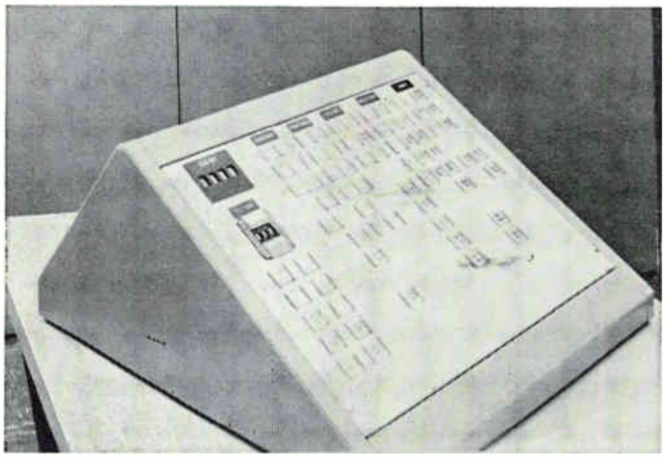
Increasing control efficiency... through digital conversion and telemetering

Unique advantages with usefulness in many applications are offered by The Peoples Natural Gas Company's data system that provides centralized, "fingertip" control of five remote regulating and measuring stations.

By TOM KURTZER
Regional Manager, Non-Linear Systems, Inc.
Chicago, Illinois

Automatic data acquisition and display gives true "fingertip" control to dispatcher J. H. Philips, enabling him to distribute peak day-loads up to 750 million cubic feet of gas to Peoples' 275,000 customers.



Dispatcher's console — through which he requests all data and remotely makes all valve position and controller set-point changes.

How THE Peoples Natural Gas Company, Pittsburgh, provided its highly-skilled dispatchers with fast, accurate data to economically meet complex situations may be of interest wherever remote, multi-station measuring and data acquisition are needed. The techniques, which center around digital conversion and telemetering, hold promise for such applications as electrical generation and distribution, pipeline networks, remote industrial processing, data collection from unattended meteorological stations, and similar operations.

Basic objective of the instrumentation system installed by Peoples to serve its 275,000 customers in western Pennsylvania is not unique:

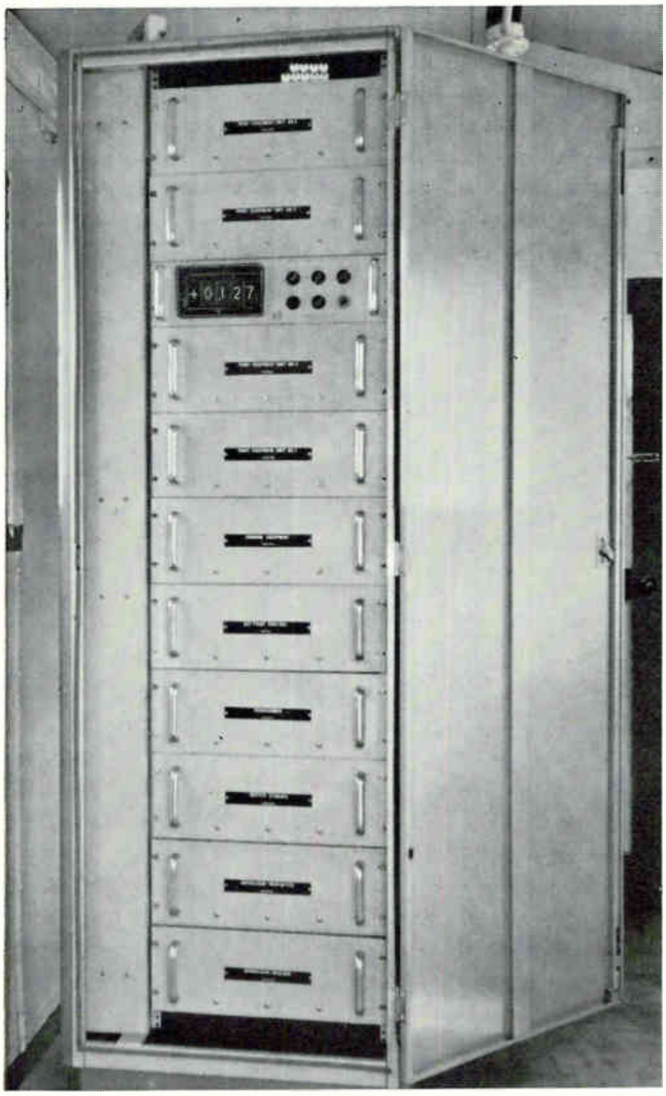
to provide highly accurate data from many sources quickly to enable skilled human beings to make intelligent decisions on complex problems.

In the case of Peoples Natural Gas, dispatchers must satisfy constantly changing customer gas volume demands, yet observe the gas purchasing contract requirements of several gas sources at the most economical rates at which gas must be withdrawn from each source.

Highlight of the system, in operation for more than a year, is digital telemetering between the dispatcher's office and the five remote stations. Analog measurements at the stations are converted to digital signals by four-digit digital voltmeters, manufactured by Non-Linear Systems, Inc., originator of the DVM. The data-acquisition, transmission and supervisory system was designed and built by the Westinghouse Electric Corporation. Measuring, recording, automatic controlling and alarm equipment was designed and built by The Bristol Company.

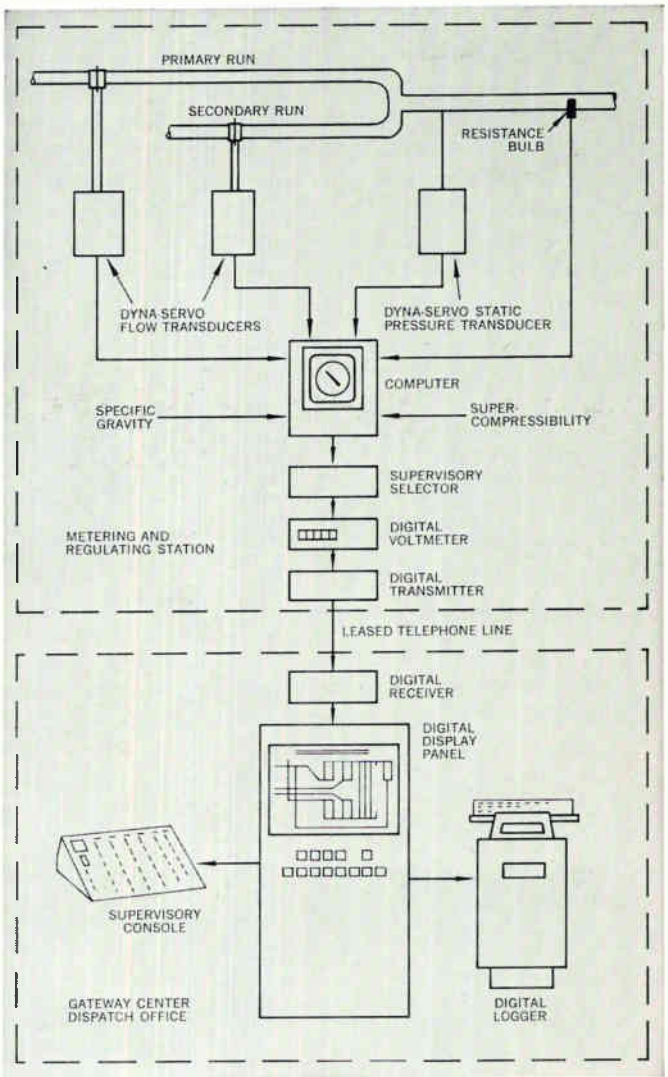
Why did Peoples use digital rather than analog telemetering which is so common in the gas industry? The company made its decision based upon these digital telemetering advantages.

- A digital signal suffers no loss of accuracy in transmission.
- In actual practice, it is difficult for a dispatcher to read an analog-type meter without close examination; thus human errors are likely. However, data in digital form, whether dis-



Basic instrumentation at each remote station. Note the easy-to-read display of the NLS digital voltmeter.

NLS V34A Digital Voltmeter. Five of these instruments are used in the Peoples system.



This diagram shows how two gas flows are totalized, corrected, converted to BCD code, transmitted, and displayed and recorded in the central dispatcher's office.

played visually or printed, is completely non-ambiguous. Therefore, it allows dispatchers to make faster, more accurate decisions.

• Indicators for each function automatically retain their latest readings instead of reverting to zero as in analog setups.

• With a digital code, it is possible to provide almost absolute security against false signals or issuance of commands to the wrong equipment.

Here's how data is telemetered:

1. Data from pressure, flow, and temperature transducers are simultaneously corrected and converted to millivolts by a servo-driven slidewire.
2. This analog millivoltage is, in turn, converted to a digital form by an NLS V34A four-digit voltmeter.
3. The digital signal from the digital voltmeter is converted to the 7-4-2-1 binary code used in telemetering by Westinghouse relay equipment.
4. The information is then transmitted serially over lowest-cost telephone circuits in 5 bits, with the last bit used as a parity check.

Every code transmitted must have the correct number of long and short bits and the correct total number of bits. If it doesn't, it will be detected as false by the receiving equipment and rejected. Once again, this is an advantage made possible by the use of digital-type telemetering.

For more information on how digital voltmeters and other digital measuring instruments might be of assistance to you, please contact one of the 19 NLS factory offices or write to Non-Linear Systems, Inc., Del Mar, California.

non-linear systems, inc.
originator of the digital voltmeter

CIRCLE 25 ON READER SERVICE CARD

Oceanographers Seek Exclusive

They ask for six 3-Kc channels for data and other communications

PARIS—A working group of the Intergovernmental Oceanographic Commission (IOC) has taken a first step toward eventual allocation of high-frequency radio bands for oceanographers.

The group's proposal, prepared for the late-September IOC session in Paris, would give oceanographers exclusive 3-Kc channels in each of the six existing ITU mobile marine bands. The channels would have multiple use—telephone, facsimile, c-w and the like—at full channel width, with the possibility of 300-cycle subchannels for digital data transmission.

SUBCHANNELS—The 300-cycle subchannels correspond to an international oceanographic telemetry standard also recommended by the working group. The standard calls for nominal 300-bit capacity messages with maximum transmission rate of 100 bits per second and limits antenna input power to 100 watts.

Automatic buoys are restricted to call-up or interrogated types, clock-programmed transmission by buoys is prohibited. The idea behind this provision is to get maximum utilization of telemetry subchannels through time sharing. Later on, the standard will set re-

---

Japanese Aim at Computer Market

Hope to capture growing market with joint-effort companies and tariffs

TOKYO—Informed sources close to the Ministry of International Trade and Industry (MITI) are predicting a rapid rise in the number of computers sold in Japan. Within five years, it is estimated, the number of computers in Japan will be more than 10 times that of this year and the dollar value of those computers will climb to $472.2 million.

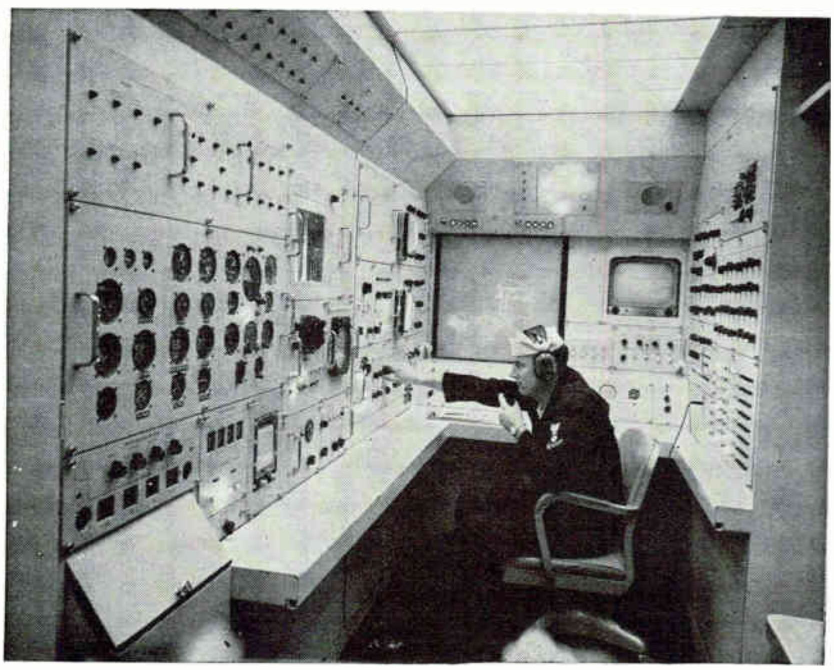
At present, Japan is importing computers from the U.S., but groups of Japanese companies have formed joint-effort companies in bids to capture the market here. Chances are they will be aided by tariffs on imported computers.

Larger computers can come into Japan free of tariffs until March 31, 1963, and punched-card systems until Sept. 30, 1962. About 90 percent of the trade with foreign nations is scheduled to be liberalized next month, but MITI has not come out with any definite plans to include electronic computers (except as mentioned above) on the free import item list.

The industry expects that the government will maintain a tariff rate of 15 percent on foreign electronic computers even after trade liberalization goes into effect.

NEW COMPANIES—One large joint-effort company, Japan Computer Co., was formed a year ago by seven companies: Toshiba, Hitachi, Nippon Electric (NEC), Fuji Communications, Oki Electric, Matshushita Electric Industries and Mitsubishi Electric. It started with a capitalization of $3 million, will double that this November. The company is headed by Naokai Murase, former deputy director of

Air-Sea Simulator Trains Navy ASW Crews



ANTISUBMARINE WARFARE *trainer built by ACF Electronics for the Navy simulates an S2F-3 aircraft, its electronic detection and countermeasures equipment and its armament. Some 32 computers are built into the system. Plotting board in control room, above, shows the instructor the path of the simulated aircraft and submarines*

Radio Channels in Marine Bands

quirements for trigger transmission so that automatic buoys can provide early warnings of hurricanes or typhoons.

Since obtaining international frequency allocation is a heel-dragging procedure, the communications working group will recommend that the forty member nations of IOC coordinate national frequency allocations as much as possible and at the same time move for formal ITU allocations, especially in the three mobile marine bands at 4.063 to 4.438 Mc, 6.200 to 6.525 Mc and 8.195 to 8.815 Mc.

POLAR CHANNEL—The working group also will propose that IOC member nations get together on a 3-Kc channel near the center of the 510 to 525-Kc band. This channel would be reserved for oceanographic purposes in polar regions, where auroral disturbances make higher frequencies useless. Russian oceanographers have already successfully experimented in the band. They reported that a 40-watt transmitter driving a top-loaded antenna 40 feet high had an effective range of 930 miles in the Arctic.

For the vhf and uhf bands, the working group will suggest that oceanographers try to obtain two channels from their national telecommunications authorities (like the FCC in the U. S.), a 20-Kc channel in the 40 to 60-Mc band and the lowest 10-Mc channel in either the vhf or uhf bands.

MITI during the Kishi government.

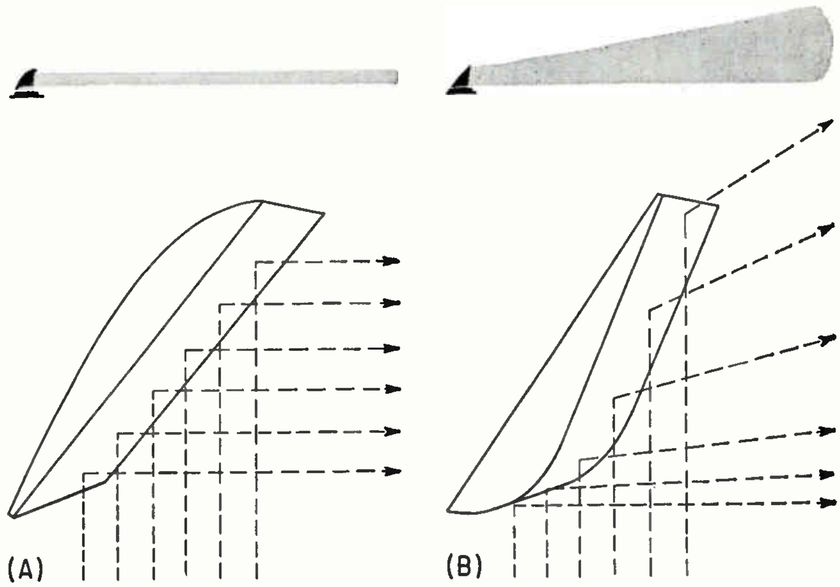
Japan Computer Co. was formed to rent domestic computers to companies that could not afford to buy them, to forestall imports of U. S. computers. The company began renting last October and had rented 27 domestic machines by March 31, 1962. Between April 1 and mid-August, 1962, it had 35 rentals, including eight computers still to be delivered.

The company's fees totaled $3 million during the 1961 fiscal year which ended March 31. During the 1962 fiscal year, it plans to do a $10-million to $12.5-million business.

Masanobu Kimura, business manager of the company, told McGraw-Hill World News that there are now about 300 electronic computers in operation in Japan, excluding punched card systems. About half of these are domestic makes and half foreign, with about 30 more foreign computers approved by the government but not yet delivered.

Last month, NEC, Fuji Electric Communication and Oki Electric formed another company to manufacture large computers (ELECTRONICS, p 7, Aug. 17).

(It was also announced, in New York, that Toshiba, the Japan Engineering Consultant Corp., Fuji Telecasting and Tosho Co. have organized another company, Japan Business Automation Co., to sell computers and lease computer time. The company will handle computers made by Toshiba.)



BEAM SHAPE *could be changed from pencil (A) to fan (B) by rotating two-sided mirror*

Mirror-Steered Radar Is Proposed

RADAR CONCEPT that would employ a bundle of radar beams reflected from a mirror to achieve extremely high total beam power has been developed by General Dynamics/Electronics. The company says it could be used to detect and track small cross-section targets at extreme ranges in space projects.

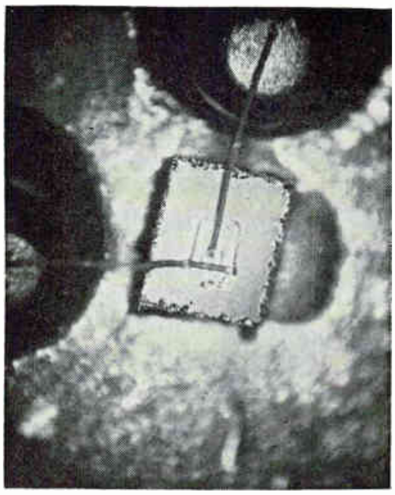
A fixed primary array could be installed below ground to provide a partially hardened radar site. The mirror would be above ground. The mirror would have two sides, one flat and one curved like a carnival mirror. As illustrated, the flat side would provide a pencil beam while the curved side would provide a fan-shaped beam.

GD/E says the concept would provide almost unlimited radiated power, eliminate electrical joint problems, make beam steering and shaping easier, be easier to maintain and more reliable than conventional systems.

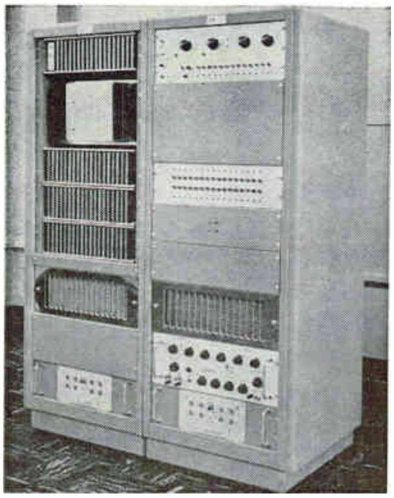
To feed the below-ground array, GD/E engineers propose multiple amplifier tubes in separate parallel transmission lines. A 1,000-element array, with each element radiating 1-Mw peak power for a total radiated beam of 1,000 Mw, is conceivable, it was stated.

WESCON Sets New Records

Show is judged the best yet, in technical interest and attendance



SILICON *planar epitaxial pnpn 3-terminal switch by Sylvania (see p 60, Aug. 10)*



HIGH SPEED *memory exerciser and 1-μsec memory consoles control unit having storage capacity of 4,096 56-bit words, introduced by Indiana General*

LOS ANGELES—As WESCON registration desks closed down last week, it was clear that the 1962 show was the largest yet. Attendance figures hit a new high of 46,184 and the general consensus was that the caliber of technical sessions and effectiveness of product display reached new peaks.

Two interesting trends were in evidence. Integrated circuits are being subjected to the same sort of price war that has plagued the semiconductor business over the past several months, and lasers are coming of age with the availability of reliable, commercially available, continuous-wave devices.

Hughes Aircraft's Malcolm Stitch told ELECTRONICS that the big news in lasers was "the emergence of the c-w laser as a commercial off-the-shelf item." Hughes and a couple of other companies announced new commercial models (p 7, Aug. 17). A dozen exhibitors featured laser displays.

Most of the companies exhibiting at WESCON announced their new products in advance (ELECTRONICS, p 30 and p 130, Aug. 10, and p 7, Aug. 17), but there were a few last minute entries.

SOLID-STATE—Motorola previewed a future line of off-the-shelf digital and linear integrated circuits by showing a 120-Mc transmitter-receiver developed under an Air Force contract and a 30-stage computer with a propagation delay reported as only 6 nsec per logic decision.

Motorola also displayed low-cost, germanium alloy-diffused *pnip* power transistors with breakdown voltage ratings up to 160 v. Improved characteristics are attributed to a relatively high-resistivity intrinsic region between the base and the collector. This region forms a voltage barrier contributing to breakdown voltage increases. A reduction in base width improved frequency response.

CORE MEMORIES—Two firms, Indiana General and Daystrom, introduced 1-μsec read/restore core memories. Daystrom's has a capacity of 4,096 56-bit words. A word-organized system, using partial-switching technique, it reportedly has an access time of 0.6 μsec, and is highly insensitive to stray noise.

IGC's unit has a capacity of 2,048 56-bit words, and features access times of 0.55 μsec for full-cycle operation and 0.50 μsec for half-cycle operation. High cycle speed is attributed to a more efficient terminal switching technique, in which pulse width is adjusted instead of pulse amplitude, and logic circuits using the NOR-logic technique exclusively.

FREQUENCY SYNTHESIZER—Another new product that attracted considerable attention was Hoffman Electronics' digital frequency synthesizer, capable of generating radio signals between 1.4 Mc and 35 Mc in increments as small as 10 cycles between 1.4 Mc and 7 Mc, and as small as 50 cycles between 7 Mc and 35 Mc.

The heart of the low-cost unit is a reference oscillator generating a comparator signal stable to one part in one billion per day. Output signal stability is one part in 100 million per day.

FIELD EFFECT—Four *p*-channel silicon planar diffused field-effect transistors were shown by Texas Instruments.

Parameters include input impedance greater than 5 megohms at 1 Kc, noise figure at 1 Kc from 1 db to 4 db, depending on which model transistor is used, operation in temperatures from −196 C to 200 C, and resistance to radiation effects up to 10^{15} neutrons/cm^2.

TI's new germanium alloy field-effect transistors have minimum input impedance of 1 megohm at 1 Kc and breakdown voltage of 60 volts at 100 μa. A grown-diffused tetrode audio transistor features minimum transconductance of 5,000 μohms with guaranteed minimum change of 20 db, higher gain control and a low maximum leakage of

80 na. A high-current solid-state d-c switch has a single gate element for both turn-on and turn-off.

TV DISPLAY—A character generator and display system, developed by A. B. Dick Co., permits alphanumeric data presentation on conventional off-the-shelf tv receivers. The system accepts data from punched cards, punched paper tape, magnetic tape and memories.

The input can be loaded at rates up to 250,000 characters a second. The output signal is a composite video signal: 0.5 v peak-to-peak into a 75-ohm impedance and a 4-Mc bandwidth. Display is in tabular form, with 64 characters.

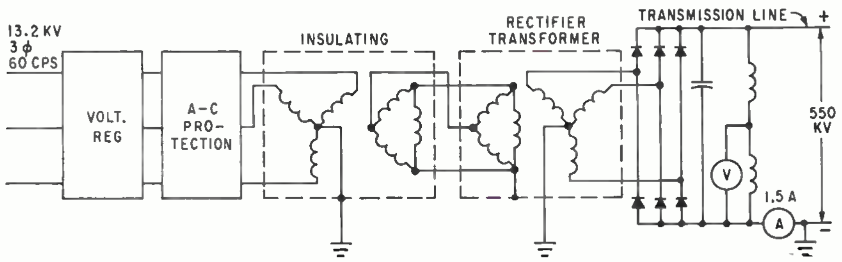
Voice-Analyzer Computer Aids Communications R&D

BOSTON—The speech research laboratory being completed at Air Force Cambridge Research Laboratories includes a computer, built by Melpar, that breaks down the human voice spectrum into 400 basic patterns.

The speech-analyzing computer is used in studies of complicated speech waveforms to help the labs' speech compression program. Objectives of the studies include determination of the minimum signal for transmission and reception of information.

Lunar Seismometer

SURVEYOR *moon probe, to be launched next year, will carry this lunar seismometer built by ITT Federal Labs and designed by Lamont Geological Observatory*



ONE-HALF OF A-C TO D-C *conversion circuit for d-c power line (1.1 Mv line to line, ±550 Kv to ground). Rectifier section will use about 13,560 silicon diodes*

Will D-C Power Cause Interference?

Answer is sought in tests with a 1.1-Mv power line in Oregon

POWER TRANSMISSION at 1.1 million volts d-c will be tested in a 5-mile section of the Bonneville Power Administration system in Oregon. A major objective of the tests will be the control of corona and radio noise.

The system will operate at ±550 Kv to ground, and radio noise must not exceed 250 microvolts when measured with a modified NEMA circuit. The system must also be essentially corona free at 900 Kv to ground. About 13,560 silicon diodes in a full-wave bridge will be used to convert the a-c to d-c (see diagram). Typically, an inverter circuit will be used to convert the d-c to a-c at the load.

For a given amount of copper and insulation, d-c lines can transmit about 40 percent more power with 29 percent less loss than a-c, but termination equipment is not as fully developed and is more expensive than for a-c. For overhead lines, d-c transmission is cheaper for distances greater than 300 miles; for land cables, d-c becomes cheaper at 30 miles, and for underwater cables at about 14 miles.

Equipment for the experimental line will be of American design and radio tests will be conducted with conventional equipment. Allis-Chalmers has received a $¾-million contract to supply equipment for the a-c to d-c conversion.

Japanese Firms Increase Electronic Output In '61

JAPANESE ELECTRONICS output increased 20 percent to a total of $1.4 billion in 1961, reports the U. S. Department of Commerce. Factory output in 1960 was $1.2 billion.

Television receivers, more than a third of the total 1961 output, rose 24 percent to 4.5 million units. Sound recorders and reproducing equipment increased 60 percent to $42.3 million and radio-phonographs increased 55 percent to $40 million.

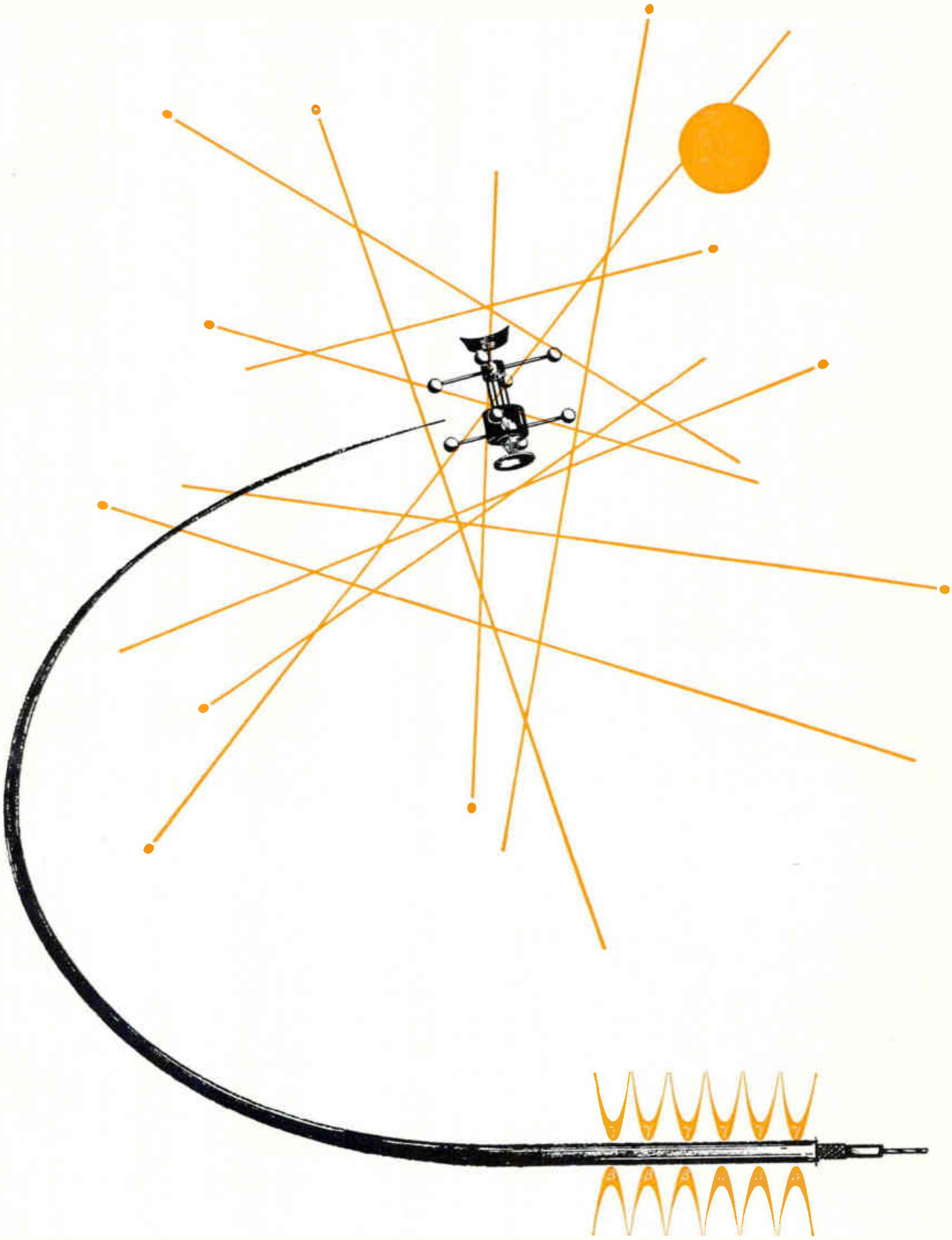
Output of radios with three or more transistors rose to 12.2 million units, with output of radios of one or two transistors estimated at 6 million units for 1961. Production of tube-type radios dropped 15 percent by volume and 26 percent by value from 1960 levels.

Other components showing an increase in unit production in 1961 include: transistors, up 29 percent; diodes, 40 percent; silicon rectifiers, 170 percent; resistors, 42 percent; capacitors, 35 percent, and transformers, 95 percent.

Japan Plans Satellite Broadcasts of Olympics

TOKYO—The Kokusai Denshin Denwa Co., Japan's overseas radio and cable system, is trying to rent from the Agricultural Ministry land in Juocho, near Tokyo. KDD wants the land to build a station for worldwide live broadcasts, by Telstar, during the 1964 Olympic Games in Tokyo. KDD announced plans and specifications for the station recently (p 22, March 23).

(It was also announced in New York that an IBM 1410 will be used to compute the results of events, transmitting them to scoreboards and to the teletypewriter facilities of news agencies.)



MEETINGS AHEAD

EIA FALL CONFERENCE, Electronic Industry Association; Biltmore Hotel, New York City, **Sept. 11-13.**

ENGINEERING MANAGEMENT, IRE-PGEM, AIEE et al; Hotel Roosevelt, New Orleans, La., **Sept. 13-14.**

ENGINEERING WRITING AND SPEECH SYMPOSIUM, IRE-PGEWS; Mayflower Hotel, Wash., D.C., **Sept. 13-14.**

ELECTROCHEMICAL SOCIETY MEETING; Statler-Hilton Hotel, Boston, Mass., **Sept. 16-20.**

RECTIFIERS IN INDUSTRY MEETING, AIEE; Desher-Hilton Hotel, Columbus, Ohio, **Sept. 18-19.**

INDUSTRIAL ELECTRONICS ANNUAL SYMPOSIUM, IRE-PGIE, ISA; Sheraton-Chicago Hotel, Chicago, Ill., **Sept. 19-20.**

TUBE TECHNIQUES NATIONAL CONFERENCE, Advisory Group on Electron Devices in the Office of the Director of Defense Research and Engineering; Western Union Auditorium, N.Y.C., **Sept. 19-21.**

BROADCAST ANNUAL SYMPOSIUM, IRE-PGB; Willard Hotel, Washington, D. C., **Sept. 20-29.**

VALUE ENGINEERING & ANALYSIS CONFERENCE, EIA; Statler-Hilton Hotel, St. Louis, Mo., **Oct. 1-2.**

COMMUNICATIONS NATIONAL SYMPOSIUM, IRE-PGCS; Hotel Utica and Municipal Auditorium, Utica, N. Y., **Oct. 1-3.**

SPACE ELECTRONICS & TELEMETRY NATIONAL SYMPOSIUM, IRE; Fointainebleau Hotel, Miami Beach, Fla., **Oct. 2-4.**

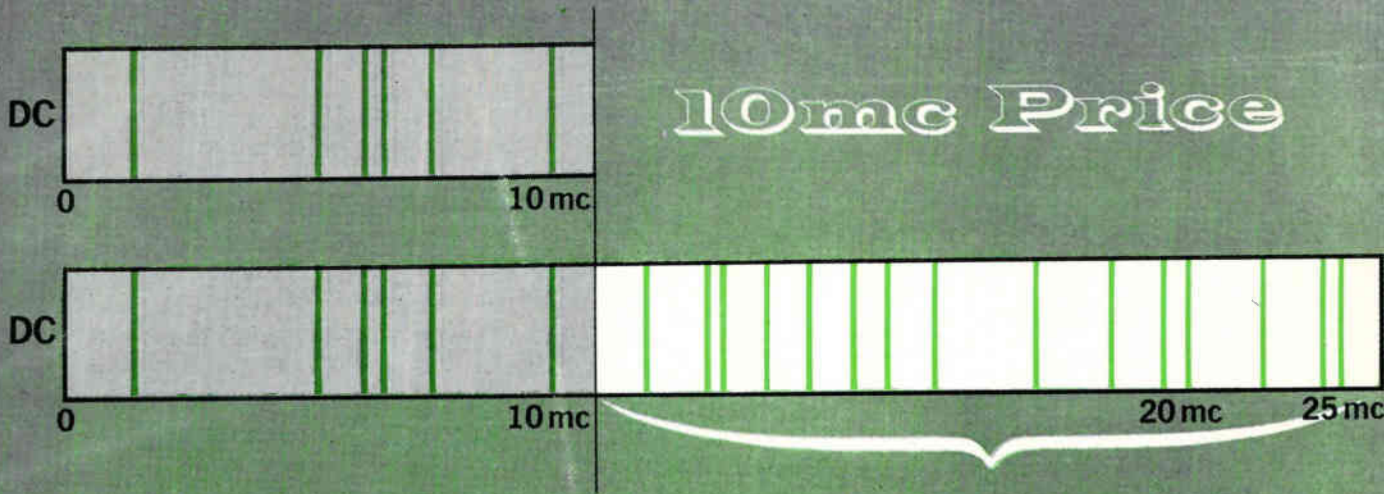
AEROSPACE SCIENCES NATIONAL MEETING, IAS; Dallas, Texas, **Oct. 4-5.**

ELECTRICAL ENGINEERS FALL GENERAL MEETING, AIEE; Pick-Congress Hotel, Chicago, **Oct. 7-12.**

NATIONAL ELECTRONICS CONFERENCE, IRE, AIEE, et al; Exposition Hall, Chicago, Ill., **Oct. 8-10.**

ADVANCE REPORT

SOLID-STATE CIRCUITS INTERNATIONAL CONFERENCE, IRE, AIEE, *U. of Pennsylvania; U. of Penn. and Sheraton Hotel, Philadelphia, Pa., Feb. 20-22, 1963. Nov. 1 is the deadline for submitting a 35-word abstract and a 300-500 word summary to: A. K. Rapp, Philco Scientific Laboratory, Blue Bell, Pa. Summary should highlight contribution to the art and include theorctical and experimental results when available. Fields of interest include: solid-state microwave amplification, oscillation; solid-state data storage and logic; circuit development providing improvement in bandwidth, gain, noise figure, stability, reliability; solid-state devices performing an integrated circuit function; micro-circuit techniques improving system performance and reliability; new devices and device characterization; solid-state techniques for adaptive systems; quantum electronics; cryogenics; optoelectronics.*



10mc Price

150% More Coverage

NEW CMC 25mc COUNTER

In other words, CMC gives you a high reliability, all solid state 25 mc Universal Counter-Timer at the same price you'd pay elsewhere for only 10 mc coverage.

Specifically: Our new Model 727B Series F Universal Counter-Timer, dc to 25 mc, costs $2,370 with inline Nixie readout, only $2,195 with vertical decade readout.

And, we're quoting 4 week delivery after your order arrives.

The 727B Series F provides direct digital readings of frequency, period and time interval measurements, performing seven basic functions from a front panel switch. Advanced computer-logic circuitry, decade count-down time base that ends divider drift once and for all, BCD output on rear for printers, etc., provision for remote programming and 2 year warranty are standard on this and all CMC universal solid state units.

CMC also offers a new 25 mc Frequency-Period Counter, Model 707B Series F. For details on both 25 mc units, please write Computer Measurements Company, 12970 Bradley Avenue, San Fernando, California.

Specifications

Model 727B Series F
Universal Counter-Timer

RANGE
Frequency
dc to 25 mc
Time Interval & Period
0.3 μsec to 10^8 seconds

ACCURACIES
±1 count ± oscillator accuracy
±0.1 μsec ± oscillator accuracy
(± trigger level error for period & TIM)

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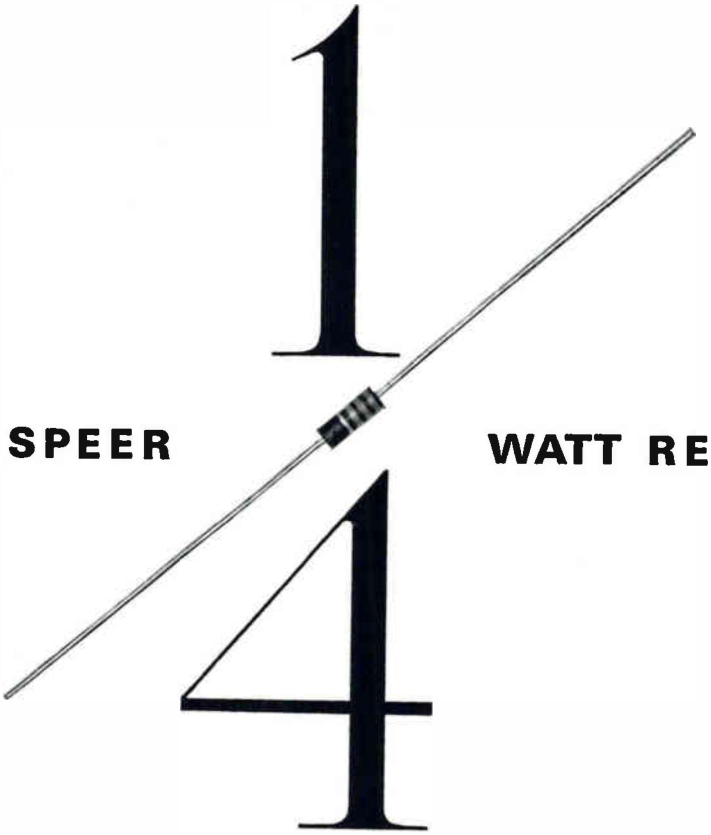
CIRCLE 33 ON READER SERVICE CARD

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

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

TORRINGTON

INTRODUCING

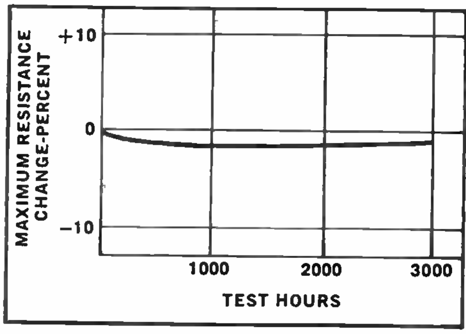


1/4

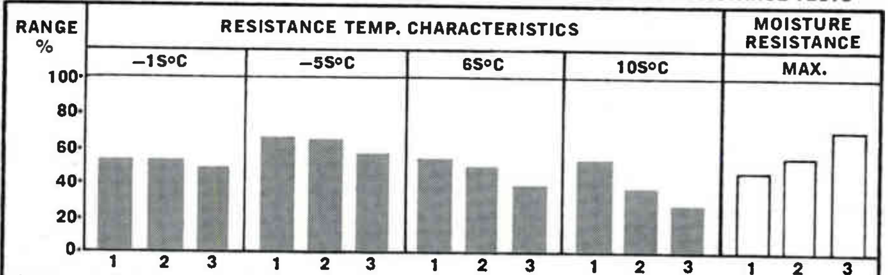
...THE SPEER 1/4 WATT RESISTOR

Speer's newly-developed RC 07 1/4 watt resistors—available in a range of values from 10 ohms and up—to meet or exceed all MIL-R-11D specifications. What's your chief concern—load life? Moisture resistance? Temperature coefficient?

TYPICAL LOAD LIFE RESULTS

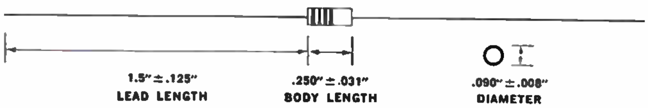


TYPICAL RESULTS OF TEMPERATURE COEFFICIENT AND MOISTURE RESISTANCE TESTS



Graphs depict Maximum % changes on ten units. 100% represents Maximum allowable change per MIL-R-11D. 1. 10 ohm 2. 270K ohm 3. 1 Megohm

How does Speer do it? All this is made possible by Speer's intensive research and development program and an **unsurpassed quality control and inspection system** that subjects resistors to rigorous control every step of the way from incoming raw materials to final shipment of finished product. Would you like to see certified test data? A request on your company letterhead will bring it. Have you seen "How a Speer Resistor Wins its Stripes"? Ask your Speer Representative to arrange a showing of this film of Speer's Q. C. & I. system. Ask your Speer Representative to arrange for samples, too. Most values available from stock right now.



SPEER RESISTOR DIVISION SPEER Carbon Co. BRADFORD, PENNSYLVANIA

SPEER CARBON CO. IS A DIVISION OF AIR REDUCTION COMPANY, INCORPORATED.

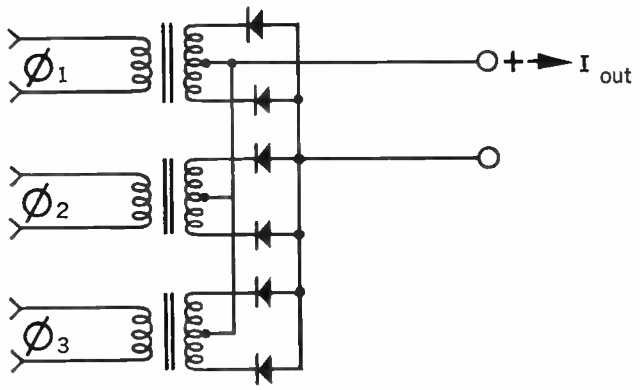
To Contractors and Subcontractors on U. S. Government Projects

PROVEN
HIGH-RELIABILITY RECTIFIER DIODES

Available from Western Electric's Laureldale Plant: the USA 1N1415, USA 1N673 and USA 1N947—developed and fully tested by Bell Telephone Laboratories. These diffused silicon diodes will operate efficiently at temperatures up to 200°C. and are useful in many general rectifier applications.

	ELECTRICAL CHARACTERISTICS						MAXIMUM RATINGS AT 25°C.		
	BV Min @ Vdc	I_R uAdc	V_F Max @ Vdc	I_F Adc	I_S Max @ uAdc	V_R Vdc	P Watts	I_F A	i_f (Surge) a
USA 1N673	400	10	1.0	0.4	2.0	320	0.4	0.4	3.0
USA 1N947	600	10	1.0	0.4	2.0	480	0.4	0.4	3.0
USA 1N1415	400	10	1.1	1.0	2.0	320	1.0	1.0	10.0

TYPICAL CIRCUIT DEMONSTRATING CAPABILITIES



Output ripple is ~ 4% without filter
6-PHASE POWER SUPPLY OUTPUT AT 65°C.

RECTIFIER TYPE	V_{out} (max)	I_{out} (max)
USA 1N673	200V	2A
USA 1N947	300V	2A
USA 1N1415	200V	5A

These rectifier diodes may be purchased in quantity from Western Electric's Laureldale Plant. For additional information, price and delivery on these and other W.E.-Laureldale devices, write to Sales Dept., Room 102, Western Electric Co., Inc., Laureldale, Pa. Or call . . . Area Code 215—929-5811.

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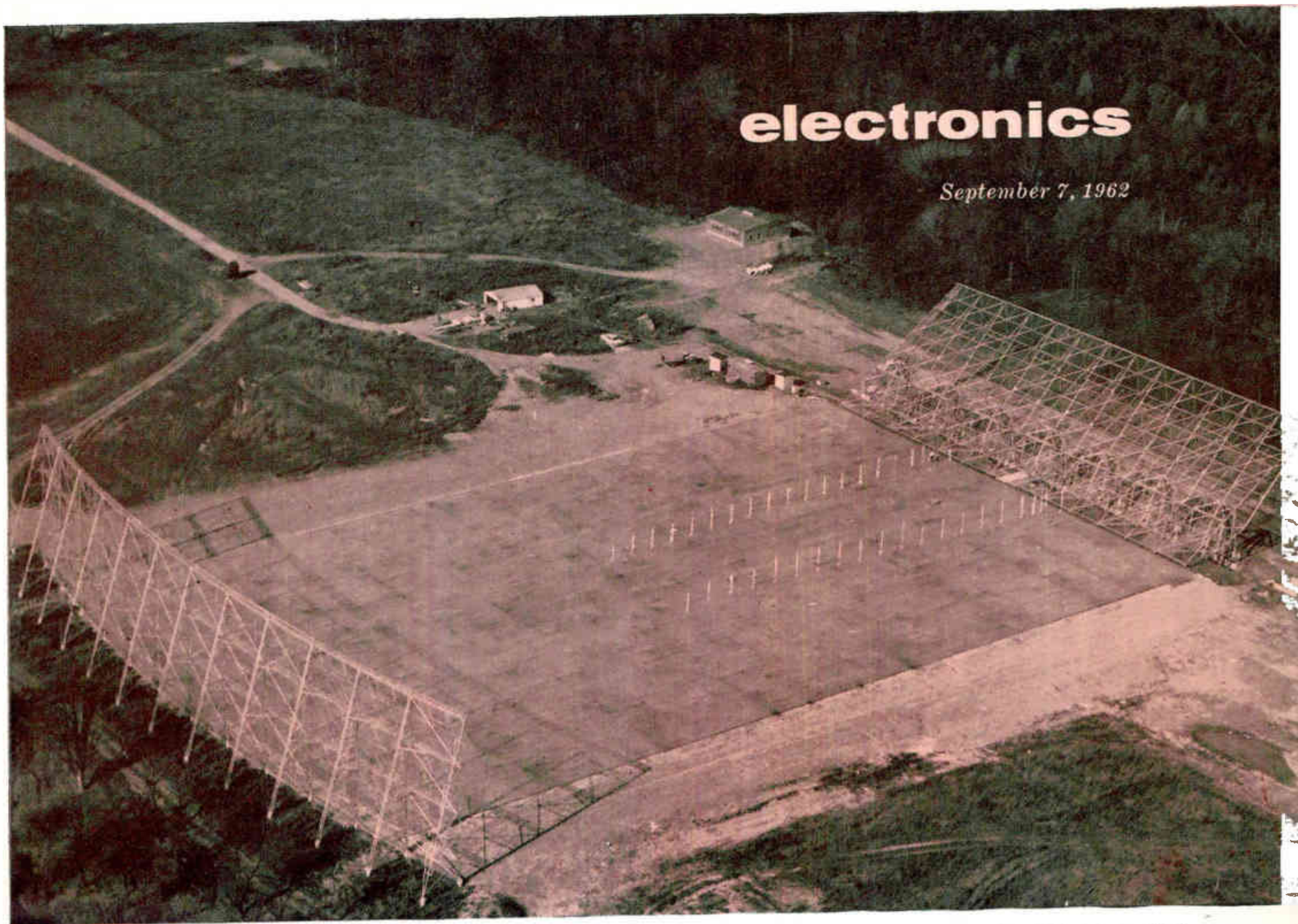


360-FOOT FIXED PARABOLOID *over ground plane, scanned by tilting flat plate at right, at the Ohio State University Radio Observatory, Delaware, Ohio—Fig. 1*

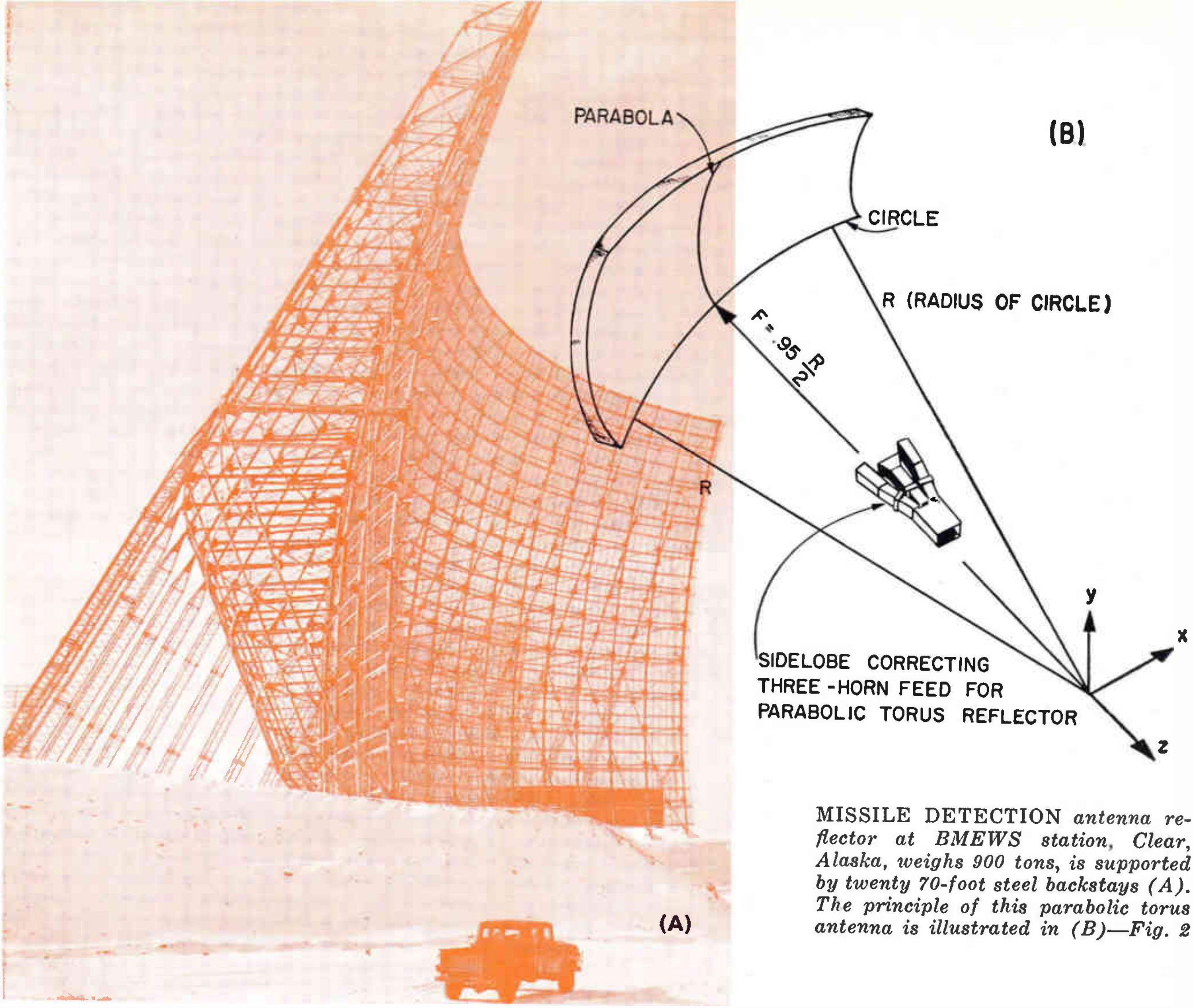
Modern Antennas in Space Communications

Space-vehicle tracking and communications require antennas with greater resolving power, higher gain and improved scanning capability; here is how some new designs measure up

By CARLYLE J. SLETTEN
Air Force Cambridge Research Labs.
L. G. Hanscom Field,
Bedford, Mass.

ANTENNAS with ever increasing range and resolving power are needed for locating and communicating with space vehicles. Strange, noisy signals emanating from cosmic processes in our solar system and in interstellar space are of interest to physicists and radio astronomers. Powerful radars capable of reflecting detectable signals from distant planets also require extremely large antennas. For all these purposes, the premium is on increased antenna aperture size.

Aperture size, frequency, and dimensional tolerance all affect antenna performance or capability to penetrate deeply into space.[1, 2] Antenna size cannot be increased without encountering severe engineering as well as economic constraints. A method for distributing radiation to or gathering radiation from large antenna



MISSILE DETECTION *antenna reflector at BMEWS station, Clear, Alaska, weighs 900 tons, is supported by twenty 70-foot steel backstays (A). The principle of this parabolic torus antenna is illustrated in (B)—Fig. 2*

apertures with low losses and coherent phase must be available. Below frequencies of about 500 Mc, transmission lines may be used efficiently to feed radiating elements directly; above these frequencies, shaped reflector surfaces fed through the air by techniques similar to optical reflectors are usually best. The physical position of most portions of the reflector surface must be held to within about $\lambda/8$ of the design dimensions to make effective use of such reflector antenna apertures.

Fortunately, space antennas do not require rapid beam steering capability, for objects in deep space cannot have large angular velocities relative to an earth observer. The principal scanning problem is to counteract the rotation of the earth. Such space antennas should have horizon-to-horizon scan in the east-west plane with modest scanning ability in north-south directions, since most of the scientific investigations will be done in the plane of the ecliptic. A more vexing problem is to measure the true bearing of the extremely narrow antenna beams and to search and map the vast heavens. The frequencies available for this space function are restricted by the losses, refraction and scintillation caused by the earth's atmosphere and ionosphere. The random fluctuations in these veiling gases may set an upper bound to antenna size much as seeing does for optical lenses. For the foreseeable future, however, the fundamental constraint is one of aperture cost.

THE UPWARD LOOK—Air-breathing vehicles must remain relatively near the surface of the earth. The elevation angles of interest for radar detection and communication with aircraft are therefore concentrated near the horizon. Communication with ground stations through the ionosphere requires antennas with beams concentrated along the horizon with, perhaps, provision for azimuth scanning. These conditions have led to development of antennas on high towers for azimuth scanning at low-angle elevation coverage, circular arrays or Wullenweber antennas for azimuth scanning, and $\csc^2\Theta$-shaped patterns on search radars looking along the earth's surface.

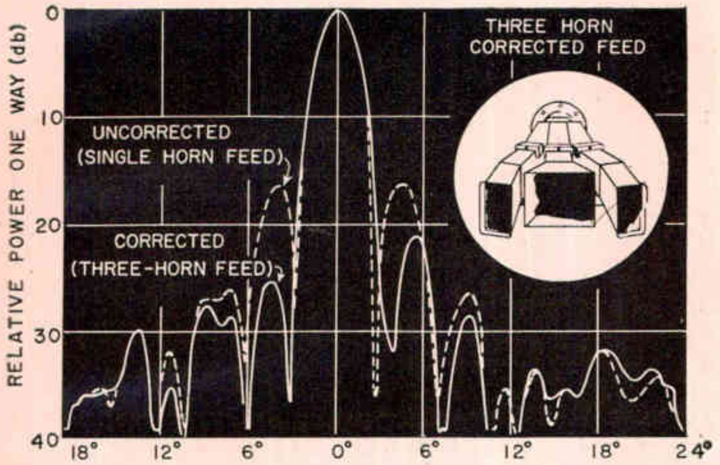
Ballistic missiles, satellites and space ships can be located at great distances from the antenna at high elevation angles as well as low. Hemispherical cover is now needed in addition to good horizon coverage. Missiles, satellites and space rockets in general have basically changed the antenna's physical attitude as well as enlarging the interesting regions of angular coverage. The demands of the space era require bigger antenna apertures in new configurations relative to the earth.

ANTENNAS FOR LOW-NOISE RECEIVERS—Although recent advances in rocketry and space technology

The Eyes and Ears of Modern Systems

ANTENNAS play a dominant role in the technological revolution sweeping the earth, because they are the eyes of the giant systems of search and communication man is using to augment his own biological senses. Most modern systems have no other sensory organs than the antennas, and, especially in space, intelligence can be conveyed only through antennas.

The forces pressing for better antennas are both scientific and economic. Economic pressure will inevitably steer us to simple, direct answers. "Ultimate Systems" with great versatility and high cost will usually be replaced by simpler antennas performing the diverse antenna functions more economically



SIDE-LOBE REDUCTION *due to corrected feed of antenna in Fig. 2—Fig. 3*

have profoundly affected radiating systems, one electronic discovery has had an important effect on antenna design. The maser or modern low-noise solid-state receiver has reduced the noise figure of the communicator or radar receiver below that of the antenna and its environs. Antenna surfaces are really cold in that they produce very little of the thermal noise entering the receiver. However, part of the antenna's job is to protect the receiver (antenna terminals) from thermal sources radiating from unwanted directions. It is common practice to measure antenna patterns on especially clean antenna ranges that approximate free space and then locate antennas near buildings, towers, or hills which cause serious spurious lobes and pattern distortion. The problem of thermal noise injection through the antenna cannot be so easily ignored as other aspects of antenna siting have been. The total spherical angular response of the antenna must be controlled to protect the maser from hot sources on the earth or in the sky. All lossy paths leading to the receiver must also be eliminated. In particular, the large-aperture antennas built from necessity on the earth suggest the attractive possibility of smoothing the nearby terrain so that it will act as a perfect reflector at the low angles seen from the antenna.

VARIABLE FOCUSING ANTENNAS—It is not generally appreciated that focused aperture antennas can transmit power with efficiencies of over 50 percent when located in the near field of each other. Remembering that near field regions are usually defined as

$$R = \frac{2D^2}{\lambda}$$

where R is the range within near field, D is the aperture size and λ is wavelength, there are antennas today that have near-field regions extending several hundred miles.

It might become practical to transmit electrical energy between points on earth or from earth to space by focused microwave antennas.

Another functional requirement is the need to resolve and identify missiles and other targets populating space and the atmosphere. An antenna focused on a target in the near zone (or Fresnel zone) can resolve the target's angular position much more accurately than when, as is usually the case, the antenna is focused at infinity.

INCREASED INFORMATION RATES—Compounding the difficulties confronting the antenna designer is the need to gather more information in a shorter time. The number of objects orbiting the earth is increasing rapidly. Faster missiles and aircraft accompanied by debris and decoys require more data capacity. Additional bandwidth is desirable to permit more channels per antenna for communication. Not only is frequency shifting necessary to keep pace with the daily vagaries of the ionosphere, but many military missions require the use and search of large chunks of the radio spectrum.

Other antenna design goals implicit in the quest for more information-gathering ability involve volume search of space suited to the functions being performed. One simple, favored solution is to make the antenna omnidirectional or as near to covering all directions in space as is theoretically possible. Obviously, it yields no angular position data on sources of radiation. From here on the game is played by systems designer and antenna engineer in trading off antenna beam shape, antenna gain, signal and antenna bandwidth, time on target, and multi-terminal or several antenna operations, against the functional needs or knowledge of source distribution.

Finally, not only technological and economic considerations influence antenna design, but also certain social and stylistic forces come into play. Each bureau, agency and company scientist likes to invent new antenna methods and designs. The tendency to build the ultimate antenna or system to solve a large class of problems usually leads to large contracts and disappointment in holding to schedules or performance specifications. Simplicity of antenna principle and structure usually leads to the greater satisfaction.

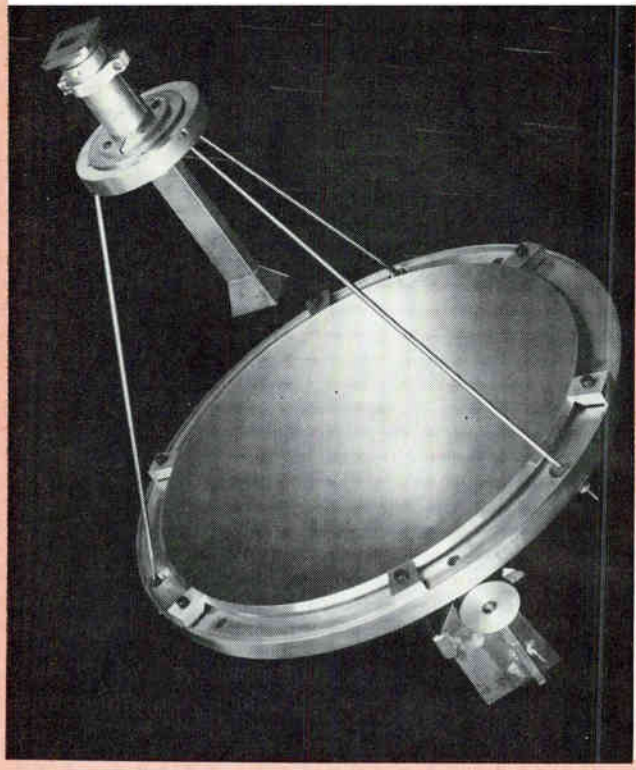
THE ROTATABLE PARABOLOIDAL DISHES—For both optical and radio wavelengths, the parabolic reflector has been developed to produce the greatest aperture gains and narrowest (or smallest) pattern beamwidths. The 200-inch Mt. Palomar optical telescope has a theoretical gain of 147 db and beamwidth of 5.7×10^{-6} degree at 5,000 A and the 50-ft K_A-band radio telescope at the Naval Research Laboratory has a gain of 72 db and beamwidth of $5{,}000 \times 10^{-6}$ degree (or 3 minutes). No design is simpler, for only a single reflector surface is needed which focuses perfectly to a point. For all wavelengths of interest the aperture size of the paraboloidal surface has been pushed to the limits of the materials used. The effective gain or electromagnetic-wave-gathering ability of the reflector depends on choosing shape and maintaining tolerances so that energy is collected in phase at the focus. The fact that materials bend when rotated in the earth's gravitational field is a fundamental obstacle to increasing the size of dishes relative to operating wavelengths beyond present sizes.[3]

The paraboloid has received a lot of design attention to increase its aperture size. One approach has been to compensate mechanically for the flexure deformation caused by weight.[4, 5]

A good method for achieving some scanning with a fixed paraboloid is shown in Figure 1. This design,[6] used by Kraus of Ohio State University, is scanned in the north-south direction by tilting a flat plate or mirror in front of a fixed paraboloid mounted over a ground plane on the earth. The antenna feed is also moved to get limited sean in the East--West plane.

WIDE ANGLE REFLECTORS—The surprising aspect of single-surface and paraboloidal reflector design is that more attention has not been given to enlarging the focal plane to permit scanning by feed motion only. One notable success in improving the wide-angle capability of reflector antennas is the parabolic torus antenna pioneered by Naval Research Laboratory.[7] This reflector surface (shown in Fig. 2A) is formed by rotating a parabolic curve about a point on the parabolic axis approximately 2 focal lengths from the vertex of the generating parabola. Figures 2B and 3 illustrate a method of side lobe reduction based on the successful application of the "transverse correction" technique which is strongly advocated below. This reflector has a wide focal region in one plane which makes it convenient for azimuthal scan or generation of elevation search pattern. This antenna has several interesting variants. The generating curve can be swung in a 360-deg arc forming a closed concave surface and when the reflector mesh is composed of rods inclined 45-deg with a plane through the focal region, 360-deg scan is possible for radiation polarized 45-deg from the vertical. An exterior parabolic torus produced by rotating a parabolic curve in a circle with the focus directed outward from the center of the circle is also a useful antenna requiring a phased line rather than a point source feed. Because these torus designs are not perfectly focused in the optical sense their usefulness as big antennas is limited.

CYLINDRICAL REFLECTORS—Another approach to big-dish design makes use of parabolic cylinders.[8] The designer reasons that he can afford to design one scanning line source to obtain beam steering in one plane with a singly curved reflector surface. One of the first big antennas using this principle was called VOLIR.[9] Here a wide-angle lens radiating from a line in the focus of a parabolic cylinder provides an attractive multilobe pattern. The success of such designs depends largely on the source design. Slotted waveguide arrays scanned by linear variation of phase velocity along the feeding guide is the usual approach at microwaves. An open structure like the trough guide[10] is attractive because phase velocity and radiation coupling can be independently adjusted with low ohmic losses and good impedance qualities as the beam is scanned through broadside. At uhf frequencies, moving dipoles coupled to a two-wire line[11] might be a logical scanning line source.

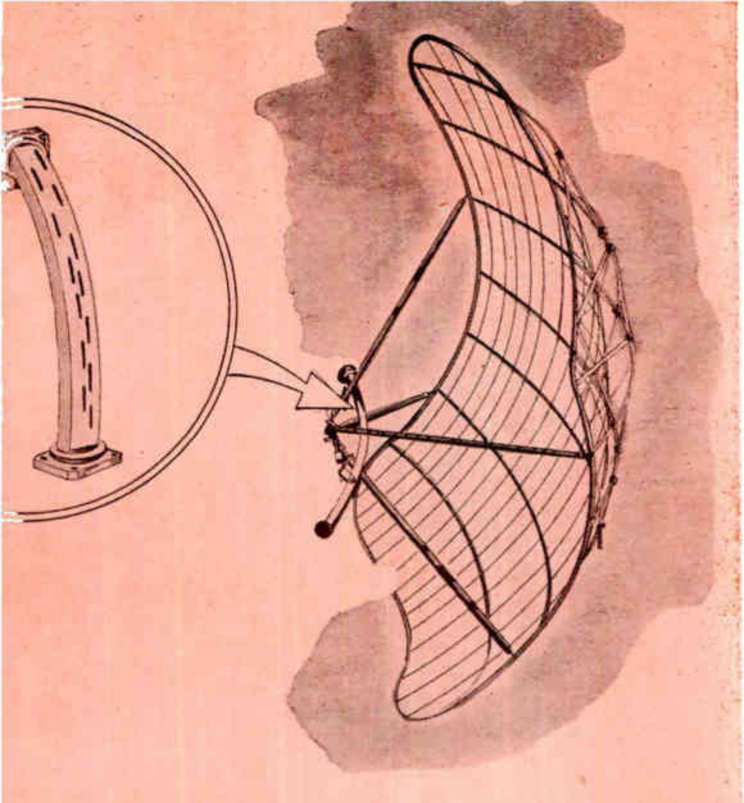


GREGORIAN CORRECTOR *for use with spherical reflector antenna to correct spherical aberrations—Fig. 4*

THE MULTIPLATE ANTENNA—The most recent reflector system and the one that appears likely to provide the biggest of all antenna apertures is the multiplate antenna.[12] This design involves building up a focusing reflector using many flat plates located on the ground along an arbitrary surface. Energy is collected in phase by proper rotation and translation of each reflector surface corresponding to pointing the beam in a desired direction. The cover shows a drawing of an antenna designed along these principles. The great advantage of this antenna for building colossal apertures is that the tolerance and motion problems are solved piecewise for flat elemental reflectors firmly fixed to the earth. Cost per unit area is low, instructions for positioning each reflector are simple and progress regularly across the aperture, and the inertia of each element is small so scanning can be done rapidly.

A large cone angle of the sky (half cone angle exceeding 45-deg) can be scanned with little loss of aperture efficiency. The antenna can be variably focused to improve angular discrimination in the near zone, which can easily extend out an earth radius or more. Fan-shaped beams can be produced by position instructions to the plates. Substantial amounts of r-f power can be fed to the antenna through multiple horns on a feeding tower. Difficulties exist in screening the radio receiver from the warm earth seen through the interstices between reflectors, and in preventing the regular stepped segments from building up far-outside lobes or grating lobes.

The multiplate antenna is related to several other designs which are also contenders for the big antenna class. A spherical mirror[13] can be corrected by stepping in $\lambda/2$ steps and making each radiating rim flat. Another diffraction type antenna based on the Fresnel zone plate is



CURVED-LINE *source feed for tricoordinate radar antenna, using phase-in-space principle—Fig. 5*

suited to making big apertures for millimeter wavelengths. A millimeter wave lens designed at ECI[14] gets good aperture efficiency by using λ/2 phase reversing steps.

SCANNING THE FIXED SPHERICAL REFLECTOR —The wide-angle or broad focusing capability of a concave spherical cap has excited the interest of optical designers for many years. To correct the spherical aberration of this mirror for operation at optical wavelengths, correcting dielectric lenses have been designed for use both in front of and behind the approximate or paraxial focus located one half radius from the surface. Perhaps the most successful corrector is the Schmidt lens[15] with the Mangin mirror[16] also receiving recent attention from microwave lens designers. Roy C. Spencer noted[17] in 1949 that the caustic or focal plane of a sphere has a degenerate line along the radius directed toward the main beam. He suggested that at microwave frequencies the phase and amplitude distribution along the radius could be controlled by antenna array techniques. When such arrays are fed near the paraxial focus, a phase velocity greater than the velocity of light is required. So various waveguide feeds with slot or dipole radiators and variable phase loading have been tried to achieve a one-dimensional or line source corrector for the spherical cap. A representative successful design[18] produced good quality patterns with 15 minutes of arc beamwidth. Phasing is achieved using a channel guide[19] with outboard feeds in the paraxial region to provide proper amplitude taper across the aperture. A circularly polarized feed was designed by Technical Research Group for the 1,000-ft antenna at Arecibo, Puerto Rico.[20, 21, 22] The literature contains further details on line source design.

The line source corrected fixed sphere can be scanned in a half cone of 20 to 45 deg with a small amount of aperture loss or sidelobe deterioration. The correction works perfectly in the optical sense as $\lambda \rightarrow 0$ so the beamwidth or gain limit depends on tolerances in the reflector screen an dthe ability to support and locate the feed with precision. Pattern bandwidth is restricted by most waveguide feeds which do not keep the phase along the feed according to Spencer's curve (a rigorous solution to the fields along a sphere radius has been achieved by A. C. Schell) for large departures from the design frequency. Because most feed designs are traveling-wave arrays with matched loads, the impedance bandwidths are good. By building in compensating line lengths to each of the radiation elements, Wiley[23] is producing a broadband solution for phased line sources.

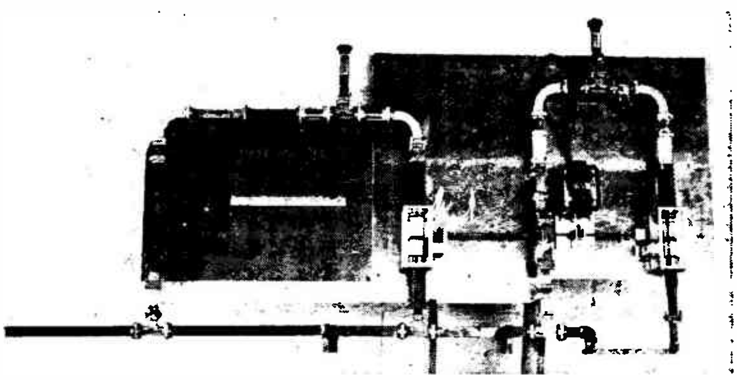
Another approach to broadband feeding of a sphere makes use of a Gregorian or auxiliary reflector.[24] This correcting system is also perfect in the small wavelength (narrow beamwidth) limit and an example of such a corrector is Fig. 4. In fact a line source distribution of fairly arbitrary phase can be produced by a generating curve fed by a point source. When the feed position and reflector size are adjusted for minimum aperture blocking and compactness, the corrector tends to produce an inverse aperture taper on the large spherical mirror. This high sidelobe (−10 to −15 db down) pattern is near optimum[25] for radio astronomy purposes but not so good for radar scanning.

There are one-dimensional (line sources), two-dimensional (Gregorian corrector reflectors), and three-dimensional structures (Schmidt lenses for example) available for feeding and scanning large spheres. These provide a variety of correcting schemes. However, a method of transverse correction that lends itself to multiple feeds (multiport) use may eventually win out.

REFLECTORS WITH HIGH INFORMATION RATES —Focusing antennas can produce shaped beams by extending the feed source or sources in the focal plane. It is convenient to form a $\csc^2 \theta$ pattern, where θ is the elevation angle, by extending the feed source along a line of sharp azimuth focus. By using a portion of the paraboloid reflector surface above the vertex, an off-axis or no-aperture blocking solution can be obtained. It turns out that the proper location for such a feed is along a straight line passing through the focus parallel to a tangent to the midpoint of the paraboloidal section. Although positioning the line source below the focus results in low aperture blocking and improved impedance characteristics, extending the feed sources in a line in front of the reflector aperture gives better patterns from each source. In fact it can be shown that an off-axis section of a paraboloid has two focal points—a true focus and a zero astigmatism focus. Good antenna patterns over a 60-deg sector can be obtained using the proper focal region. Radiating elements such as slots on a waveguide should be phased with respect to each other to focus the array energy at the midpoint. Because of the rotational symmetry of the paraboloid, two or more beams can be rotated about the focus to form V-beams in space from a single reflector.[26]

These shaped beams are formed by feeding the appropriate power to elemental radiators in the focal region of a focusing lens or reflector. The image of this object distribution is formed at infinity or, practically speaking, in the far field of the antenna. In optical systems, the relative phase of sources in the focal region is usually not controllable on a point-to-point basis. The beam-shaping on a paraboloid is best accomplished by focusing (phasing) the line source toward a central spot on the reflector. On certain wide-angle lenses and reflectors like the sphere or parabolic torus, this focusing or phasing relation between feeding radiators can be relaxed and good patterns are still produced. Under these conditions, relative phase between sources in the focal region can control the phase-in-space of the antenna patterns. This result can be achieved by connecting together a row (or any regular configuration) of point sources in the focal region by a traveling-wave feed line with terminals at either end. Now the signal received by a given point source, corresponding to a given beam direction, will arrive at different terminals of the feeding line with different phases. Thus the angular direction of an arriving plane wave received by a broad-shaped pattern can be measured with considerable accuracy. If the point-source radiators are progressively phased δ degrees apart, the change in phase between the two terminals will be 2δ degrees as the angle of plane-wave incidence changes from focusing one point source to an adjacent point source. Figure 5 shows such an antenna operating as a radar.

FLAT ARRAYS—All the big antennas discussed so far have the disadvantage that they require a feed structure remote from the reflector surface to achieve the optical illumination or feeding. Such feeding is cheap and requires only optics and air (free space) to distribute the power. However, a tower or feed suspension is usually needed to view the radiators or reflectors that can for convenience be arranged along the ground. Flat arrays fed by transmission line offer competitive solutions when the feeding transmission line is low loss and some form of variable phasing or feeding can be accomplished. Distributed power sources and receivers are considered under scanning. Below 500 Mc, two-wire transmission lines or coaxial cable can be used efficiently to distribute power and correctly phase dipole radiators. The really big antennas of the Mills cross[27] variety and billboard[28] type are constructed using feeders and power splitting (impedance transforming) junctions. Although a large variety of manual and solid-state phase shifters exist, the prospect of stationing and controlling one such device at each of the radiators in a large mattress-type array has discouraged most workers so far. Gain is proportional to the number of square wavelengths in the antenna aperture. To maintain and scan the antenna beam both on transmission and reception, elements must be about $\lambda/2$ apart. A flat array with n elements per row and m elements per column requires $m \times n$ phase shifters to scan in more than one plane. This means approximately 320,000 phase shifters and radiators for 60 db antenna gain.



DRANE-DAVENPORT *interferometer using nonlinear processing of received signals—Fig. 6*

One solution combines the phase shifter and radiator. Marston of Naval Research Laboratory[29] has shown that by rotating spiral antenna elements, flat arrays capable of beam scanning with circularly or linearly (variably) polarized patterns can be achieved, and that such arrays can be fed with a horn or point source, like a lens, as well as by transmission line techniques.

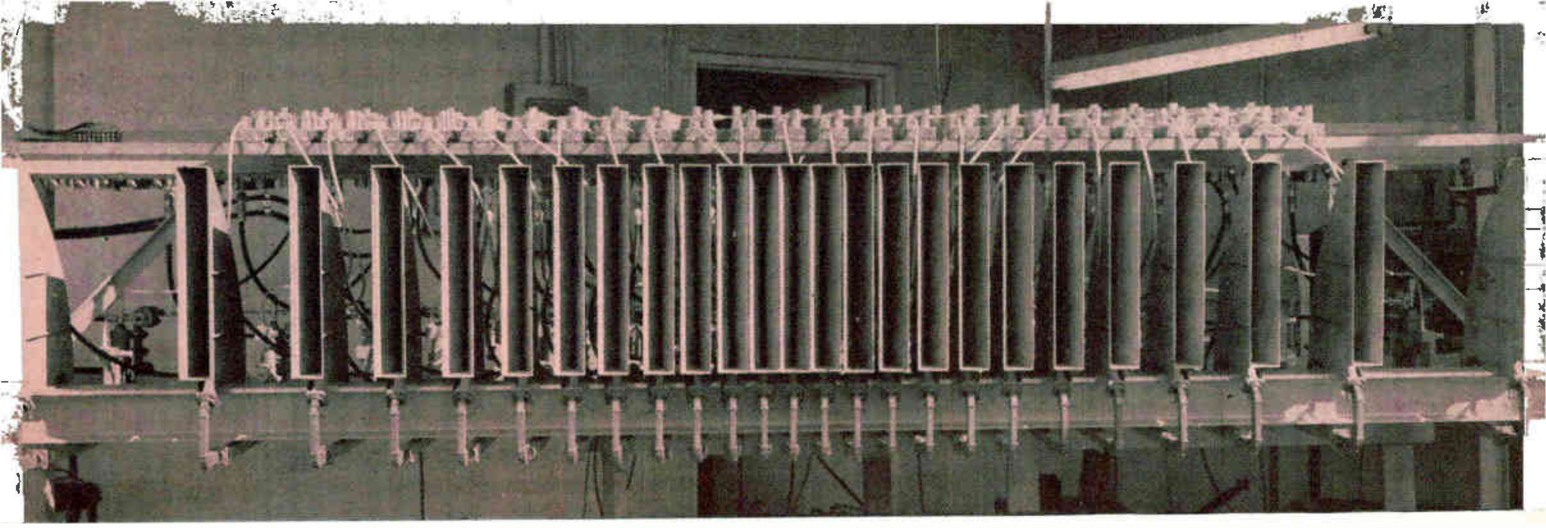
The problem of scanning a rectangular planar array is simplified (only n not $n \times m$ phase shifters are needed) if phase shifters are used only along columns. The El Campo, Texas solar radar uses this approach; its giant antenna is scanned in the east-west plane by phase shifters and in the north-south plane by manually changing the phase to each dipole radiator.

Dipoles can be excited by proximity-coupling to a two-wire line. This reduces the problem of controlled radiation to its essentials, for two-wire line, dipole rods and proper geometry are all that is required to build a linear array. Controlled radiation from a transmission line[30] only has been achieved with some success and eliminates the need for dipoles.

The proximity-coupled dipole can be scanned over 50 deg from the normal to the array by motion along the two-wire feeders.[11] If transmission and reception is accomplished by feeding from both ends of the array, a ± 50 scan angle can be achieved. Dual-terminal feeding[31] allows scanning of very large arrays using corporate structure phase shifters along the columns and by feed motion on the rows resulting in large sector of solid angle coverage. The most attractive means for achieving the motion of the dipoles appears to be either by relay-controlled trolleys or by mounting them on a rubber belt. Such antennas are contenders for the space era in that power handling, pattern quality and gain, bandwidth and scan rates are all acceptable for, say, satellite communication in the 50 – 500 Mc band. Cross or variable polarization is not possible, however.

INTERFEROMETERS—There is a class of antennas with large overall dimensions whose apertures are not completely filled with radiating elements. Usually the designer of such antennas is more interested in angular resolution than antenna gain. The gain of an antenna array is proportional to the number of radiating elements in the array assuming uniform distribution of power to the elements and the beamwidth is related to the overall dimension of the antenna in the plane in which the beamwidth is measured. To some extent the virtues of high-gain aperture antennas and high resolving interferometers can be achieved by separating two large aperture antennas a long distance apart and producing fine interferometer lobe structure within the broader beams of the aperture antenna. This technique is being used at Big Pine, California by California Tech. and near Great Malvern by the Royal Radar Establishment in England. Sometimes interferometers take the form of many moderately sized apertures regularly and widely spaced to produce many grating lobes. This approach is used by Stanford University[32] and the Mendon Observatory, France.[33]

A number of ingenious methods have been advanced for operating on the multilobe pattern characteristics of interferometers to produce a single unambiguous beam.



ADAPTIVE ANTENNA *array of unequally spaced horns covering 100 wavelength aperture, capable of automatically radiating the conjugate of a received wavefront to produce a focus at distant source. Developed at Research Division, Electronics Communications, Inc., under contract with USAF Rome Air Development Center—Fig. 7*

This goal can only be achieved on the receiving patterns and it usually involves some nonlinear operation on the signals. Walsh and Bond[34] achieved this result by multiplying together the two interference patterns produced by interlaced gratings of different spacings. The net result is an array of radiating elements much more widely spaced than $\lambda/2$, but with only one main beam. This pattern is electronically steerable in azimuth and the condition for nonambiguous pattern is maintained over a large bandwidth. The Drane-Davenport[35, 36] antenna, a further development of the Covington and Broten array, is also a linear array of nonuniformly spaced elements producing a single antenna beam (Fig. 6). This interferometer is made up of a continuous section of $\lambda/2$-spaced elements augmented by a regular progression of widely separated radiators. The signals received by these radiators are phase-modulated, correlated, and then multiplied together to produce a single beam. Another successful geometric arrangement was devised at Stanford Research Institute[37] to produce a single-beam widely-spaced interferometer. Workers at Hughes Aircraft[38] have succeeded, through time modulation and nonlinear processing, in getting beam scanning, multilobe generation and pattern control.

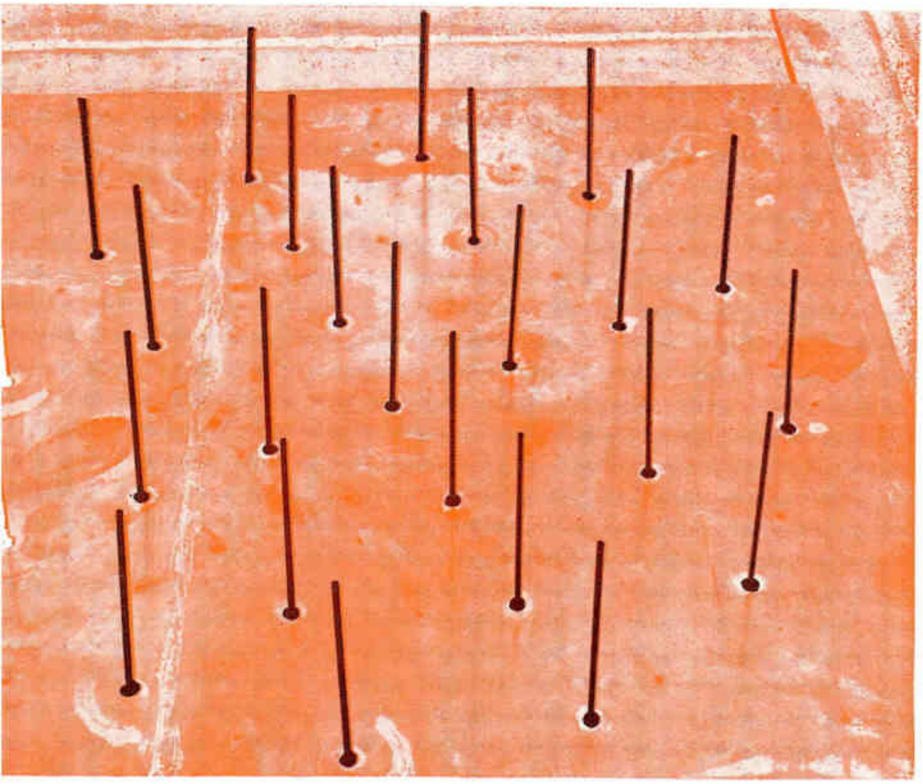
One of the better conceptual studies showing the relation between antenna pattern and bandwidth of signals received was accomplished at RADC[39] by N. J. Nilsson, et al. When the spectrum and modulation of the radiated signal can be controlled, as with a radar system, antenna patterns can be significantly controlled by interferometer configuration and signal modulation.

There is much active research going on in nonlinear antennas.[40] These antennas produce cross products which can distort the information or target image when several coherent or partially coherent signals are received. They often lack gain, and signal-to-noise levels are not always improved by the multiplication and correlation performed to produce the antenna patterns. When interferometer elements are spaced too far apart, random variations in the atmosphere or ionosphere may reduce the seeing as on large optical telescopes. This effect, of course, affects large aperture antennas also. Very little reliable data on medium effects at various frequencies exists, but for angles near the earth's horizon, there are probably existing antennas whose performance is degraded by lack of coherence across the large antenna dimension. The nature of the linear and nonlinear antenna performance under conditions of partial coherence is available through the work of Parrent, Skinner, Shore and Drane.[41, 42, 43]

VOLTAGE AND CURRENT CONTROLLED PHASE SHIFTERS—Replacing mechanical phase shifters in planar arrays by current or voltage controlled phase shifters offers the most obvious method for speeding up scanning. A great deal of effort to produce ferrite phase shifters has not resulted in completely reliable, temperature-insensitive, inexpensive components. Research on voltage-controlled ferroelectric devices has been less extensive and one of the first successful voltage-controlled scanning arrays[44] was reported in 1959. This antenna array used varactor diodes as voltage-controlled phase shifters. Research is continuing on materials for electronic phase control in the transmission lines or guides feeding antenna arrays. Perhaps some day it will be possible to scan a large array carrying high r-f power with low loss by simple voltage variation on the feed lines.

FREQUENCY SCANNING—Several methods of scanning depend on the fact that as the frequency is varied on a traveling-wave-type linear array, the phase between elements changes, causing the beam to squint or move slightly. This can be the basis for scanning the beam by intensifying the effect through design. The desired antenna performance is usually a liberal amount of beam swing for a small amount of frequency change. Such arrays and their feeding lines are called dispersive, for they separate different frequencies into different beam directions, much as a dispersive glass prism separates the colors in white light. In fact, frequency-scanned arrays can be designed using waveguide type prisms, but it is usually simpler to use another nuisance effect—the long line effect—to produce dispersion. By connecting long equal lengths of transmission line between adjacent radiating elements, very satisfactory beam scanning is achieved with tolerable transmission losses.

PHASED ARRAYS—The main disadvantage of fre-



AMPLITUDE SCANNED *circular array of concentric monopoles over a ground plane, University of Tennessee, Knoxville—Fig. 8*

REGION I

PASSIVE, LINEAR, FIXED-GEOMETRY OPERATIONS PERFORMED BY INTERCOUPLING NETWORKS CONNECTING ELEMENTAL FEEDS LOCATED ON BEST FOCAL SURFACE.

FUNCTIONS:

(1) RESTORATION OF PATTERN TO ON-FOCUS AXIS QUALITY
(2) APERTURE ILLUMINATION AND SPILL-OVER CONTROL

REGION II

PASSIVE, LINEAR ELECTRONIC SWITCHING OPERATIONS

FUNCTIONS:

(1) VARIABLE NETWORKS AND SWITCHES TO INTERCONNECT BEAMS FOR BEST SCANNING AND SEARCH PATTERNS
(2) PHASING CHANNELS TO PERMIT FOCUSING IN NEAR ZONE OF ANTENNA APERTURE

REGION III

ELECTRONIC NONLINEAR PROCESSES (MIXING AND AMPLIFICATION)

FUNCTIONS:

(1) PHASE COMPARISON FOR EXTRACTING ANGLE DATA OUT OF WIDE ANTENNA BEAMS
(2) MONOPULSE COMPARISON FOR ACCURATE TRACKING
(3) OPTIMIZE RECEIVED PATTERNS DEPENDING UPON TARGET CHARACTERISTICS
(4) AUTOMATIC CONTROL AND SELF-ADAPTING TECHNIQUES

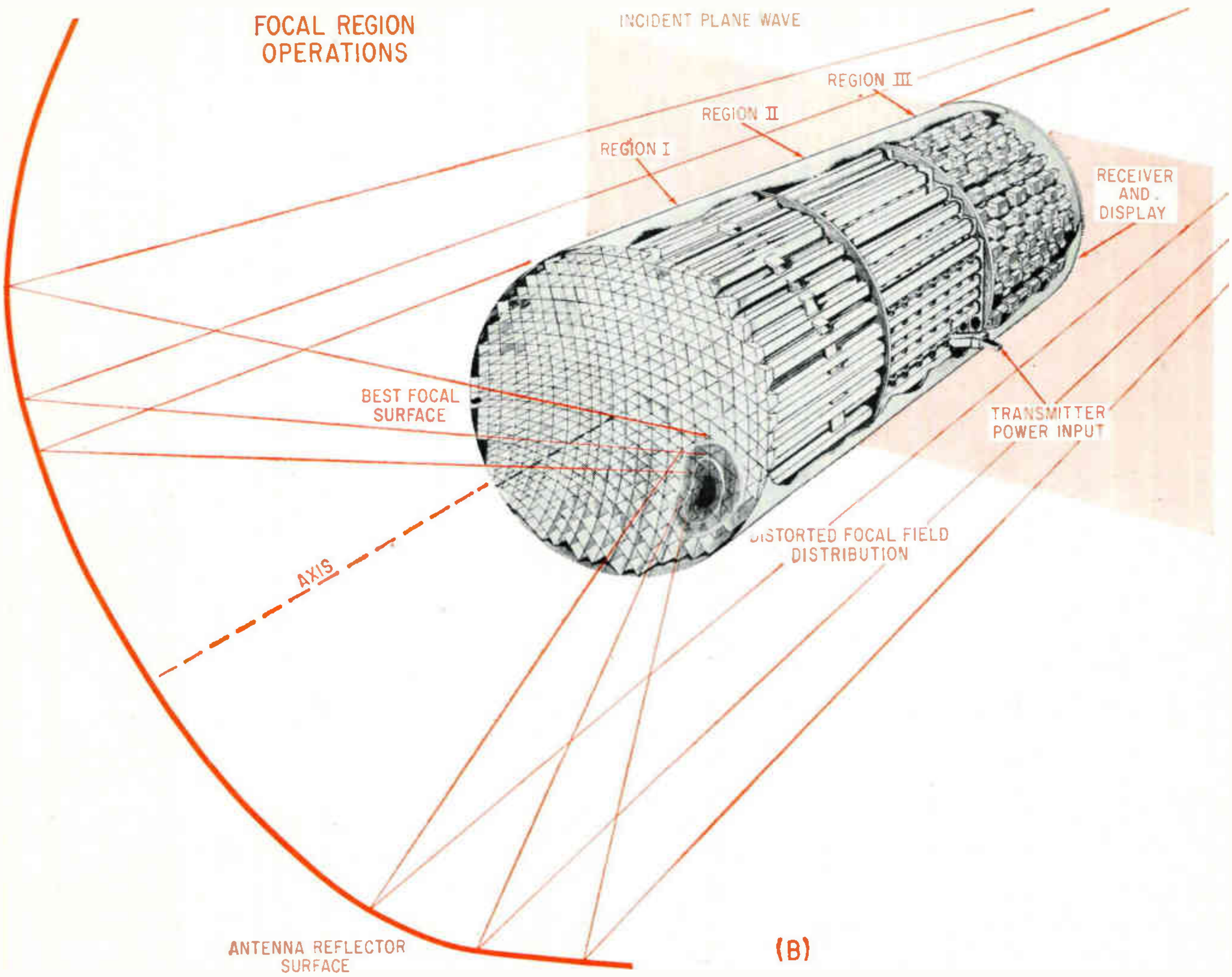
(A)

FOCAL-REGION PROCESSING *performs functions listed in (A); the operations are illustrated on antenna in (B) opposite page—Fig. 9*

quency scan is the need to transmit or receive a wide spectrum in order to scan the beam (or beams). This defect is corrected in the next scheme to be discussed which again makes use of dispersion in long lines to produce phase shifts. But, by two mixing operations, the proper increments of phase shift between radiators are generated without any change in radiated frequency external to the antenna.[45] As phase is preserved on mixing, it is possible to change the frequency of a control signal and run it through different lengths of dispersive line and then, by a further mixing operation, obtain the original transmitted frequency shifted in phase This is a successful way to scan electronically and has the advantage that good frequency stability accurately controls the beam position. These c-w control frequencies (sine waves) can be distributed around a large antenna system with good fidelity and in the presence of noise. However, now crystal mixers or other nonlinear elements are needed which add to the losses of the dispersive lines. The antenna is no longer reciprocal, so special accommodations must be made for scanning received and transmitted beams. This separation of the transmission and receiving function provides opportunity to generate high transmission power by assigning a power amplifier to each radiator element while simultaneously scanning the same receiving pattern or one different from the transmission pattern. The added versatility, including self-adapting capabilities and design flexibility (see Fig. 7) is obtained at a high cost per unit area of antenna aperture.

INCREMENTAL FREQUENCY SCANNING—A distinctly different kind of frequency scan was appreciated early by Roy C. Spencer at AFCRL, but has only recently been developed. Scanning a phased array means tilting a plane Huygens wave front from the antenna by linearly increasing or decreasing the phase along the array. When this is done at a uniform rate, the phase at each element changes uniformly. This is tantamount to a change in frequency at each element. Thus a phased array can be made to scan at a uniform rate by increasing the frequency at each progressive radiator by an amount Δf. Cottony at the Bureau of Standards has succeeded in producing the harmonics Δf, $2\Delta f$, $3\Delta f$, ... $N\Delta f$ (where f corresponds to the scan rate) and adding these to some higher r-f frequency. Of course f and its family of harmonics can be varied and the beam made to vary in sweep speed. Cottony[46] actually modulated the local oscillators on the receivers attached to Yagi antennas according to the $N\Delta f$ technique to provide a rapid beam sweep.

AMPLITUDE SCAN—Electronic scanning methods discussed so far for steering beams or patterns from a fixed array or aperture all depend on producing a variable phase at the radiating elements while keeping the amplitude or power at each radiator as constant as possible. Beam scanning can be produced by maintaining the phase fixed and varying the relative amplitude[47] from $+1$ to -1 to the radiators. It is convenient to vary the output of a balanced amplifier from $+1$ to -1 by changing grid voltages only. Such scanning methods can be adopted to circular arrays ($r-\theta$ geometry) where the equal phase elements easily developed by dispersive methods are not adequate. Electronic scanning of circular arrays by phasing methods can certainly be done. Mutual coupling effects can be included in scanning circular arrays (it is more difficult for linear or mattress arrays) and the University of Tennessee[48] has produced excellent sidelobes on



(B)

electronically amplitude-scanned circular arrays (see Fig. 8). Schell [49, 50] has also shown that concentric loops and corner reflectors can be scanned using amplitude scan principles. For disadvantages, more radiators are required than for phased arrays, and each amplifier is not used at full output at all times. It has been suggested that the output of each amplifier be combined in a junction to produce a variable phase output and thus eliminate ½ of the radiators. However, such a junction has intolerable reflection, or impedance, characteristics, and adding the amplifier outputs in space has a fundamental advantage. The second objection is not valid either because under rapid scan conditions, each tube can be used up to its full plate dissipation and the maximum rating from a common power supply can be utilized. Amplitude scan and the related synthesis method permit an alternate approach to scanning which has not been fully exploited.[51]

REFLECTOR ANTENNA AND FOCAL REGION— Most reflector antennas have an efficiency of about 50 percent. This represents a 3-db loss or an antenna gain of an ideal aperture one-half the size. This loss is due principally to spillover—that is, energy which never strikes the reflector in the optical method of feeding such reflectors. Such losses cannot be prevented by large directive feeds because severe amplitude tapering also causes loss in gain. In addition, spillover energy usually intercepts the warm lossy earth causing deterioration in the noise temperature of the antenna.

No one has found a cheaper and more satisfactory way to produce a large aperture antenna than by using a single metal reflector surface. As antennas get larger and their beams sharper, optical errors force operation closer to the focus. The total structures become harder to move and maintain in phase coherence while being moved. Although the gain and angular resolution become phenomenally good, the search or surveillance capability becomes poor. With the focal point and reflector in motion, it becomes uncertain where the beam is pointing when target acquisition is made.

What are the remedies? Both the optical telescope and the human eye give some hints. In antenna language, both photographic film and the retina of the eye are multilobe, high-information-rate antennas. The reflector telescope achieves its wide-angle capability by increasing the focal length (focal lengths are usually 3 to 5 times the aperture width for optical telescopes, whereas antennas usually have F/D of 1/4 to 1/2). It is believed that the eye achieves wide angle focusing by longitudinal receptors called rods and cones. The long focal length solution is impractical when extremely tall towers swinging over fixed reflectors are envisioned. However, the design used by Kraus[6] which has the focal axis on a metalized ground plane can make use of the magnification and improved wide angle performance of a long focal length. Using the analogy of the eye, Spencer[17] suggested a longitudinal corrector or line source for the spherical mirror.

Some effort to correct optical errors in the ubiquitous paraboloidal antenna was undertaken by calculating position of high intensity ridge lines and placing phased line sources along these curved longitudinally extending surfaces.[52] Unlike the spherical reflector, the paraboloid caustic surface does not degenerate into lines, so that while such correcting line sources markedly improve patterns at wide angle from the axis direction, they do not eliminate all optical errors and each beam direction requires a different length of phased corrector.

Possibly the answer to getting an angular acuity and information rate capability comparable to the eye or optical telescope does not lie entirely in optical designs suitable for incoherent light. In radio, there is the possibility of operating on the phase, amplitude and polarization of the fields in the focal region down to detail areas about $(3/4\ \lambda)^2$ in size. Since the focal energy distribution is a Fourier transform of the incident (or desired) energy distribution on the reflector aperture, it is possible to selectively rephase and collect the focal energy to correspond to a desired in-phase, amplitude-tapered aperture distribution that in turn will give rise to the required far field patterns. The question is: can the energy spread and phase distortion in the transverse focal region be processed out to restore the antenna patterns for off-axis directions to their on-axis quality? The experimental answer to date is a qualified yes. Remarkable success in reducing objectionable side-lobe levels over both wide angles and good frequency bands has been achieved by inserting auxiliary feeds in the focal regions (see Fig. 3) based on the location of the field distributions.[53, 54]

This possibility of transverse correction—design of compensating feed structures transverse to the axis of the reflector or in the focal plane—is recommended as a high payoff research topic. Figures 9A and B indicate the sequence of processing operations and the beneficial results to be obtained.

The author expresses his appreciation to the many people in Electronics Research Directorate and in the Electromagnetic Radiation Laboratory, AFCRL who helped with the manuscript, especially L. M. Hollingsworth, F. S. Holt, Charles Ellis, Allan Schell and Philipp Blacksmith, Jr. for their criticism and corrections.

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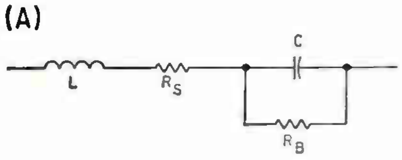

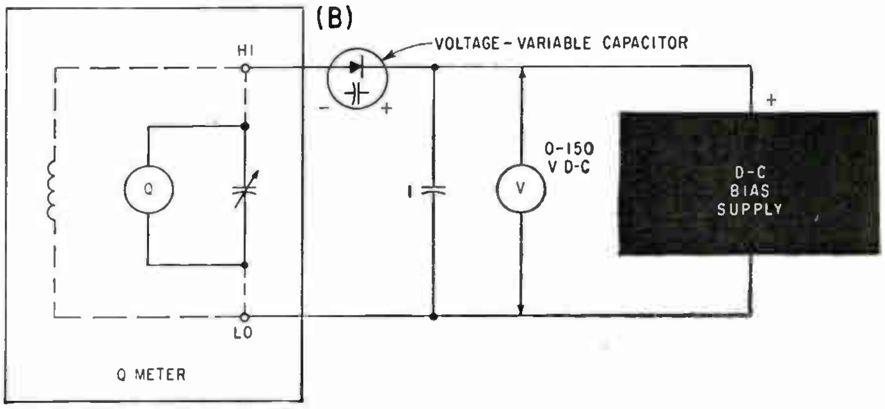

EQUIVALENT CIRCUIT *of the voltage-variable capacitor (A) and Q-meter test method (B). The Q-meter technique can measure capacitances up to 460 pf, which is higher than is available now in commercial devices—Fig. 1*

Three Ways to Measure VARACTORS OF THE FUTURE

Of three common techniques used to measure the parameters of voltage-variable capacitors, the Q-meter test is versatile and is accurate to ± 1 percent. The a-c bridge method is limited in frequency range but can provide somewhat higher accuracy. Maximum capacitance range with R-X meter method is 20 pf

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VOLTAGE-VARIABLE capacitors are formed in single-crystal silicon by the same techniques used to manufacture other semiconductor devices. With leakage currents of only a few millimicroamperes, the device acts like a perfect capacitor with a high shunting resistance; series resistance (due to semiconductor bulk resistance and lead connection resistance) is low. The low series resistance and high shunt resistance result in a Q high enough to fulfill the requirements of nearly all capacitor applications.

Figure 1A shows the equivalent circuit of the voltage-variable capacitor, where

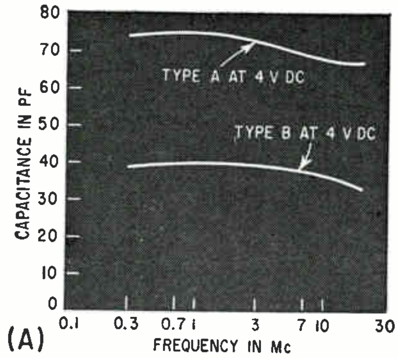
C = junction capacitance, R_s = series resistance due to bulk resistivity of the semiconductor base and connecting leads, R_B = leakage resistance and is the dynamic inverse resistance of the junction, and L = series inductance.

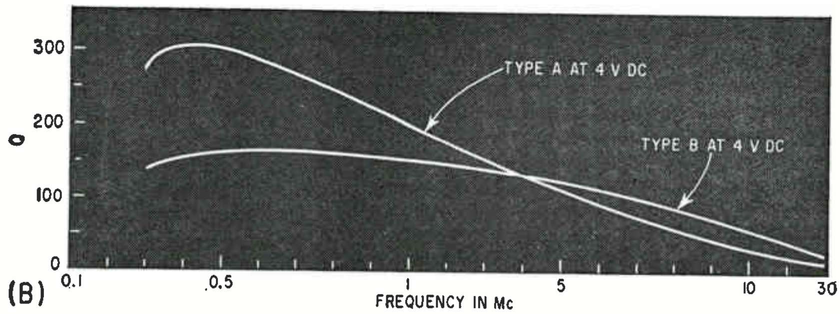
Typical ranges of parameters are: C (at 4 volts), 7 to 100 pf; R_s, about 5 ohms; R_B, 100 megohms and higher; L, about 5 nanohenrys; Q at 50 Mc (4 volts), 10 to 20; maximum operating voltage, 15 to 130 volts d-c.

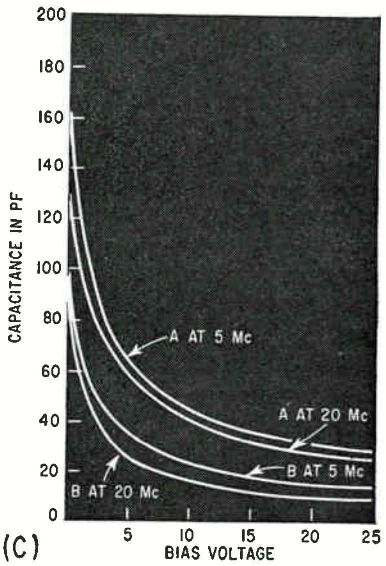
Major applications of voltage-variable capacitors are as control and tuning elements. As control devices they are generally placed in parallel with a conventional capacitor to control the total capacitance of systems such as automatic frequency controls, f-m modulators, and adjustable band-pass filters. As tuning devices they are used to supply all or nearly all the capacitance in receiver and transmitter tuning circuits, and in resonant-slope amplifiers.

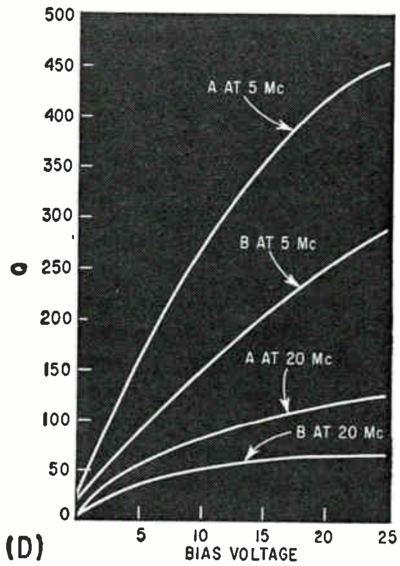
Voltage-variable capacitors function over a wide range of frequencies. Parameter measurements are usually taken at the operating frequency of the application, typically from 1.5 to 20 Mc. Measurements using a Q-meter can be made from 50 Kc to 50 Mc. Since a d-c bias voltage cannot be applied directly to the terminals of the Q meter, the capacitor is placed in series with the meter as shown in Fig. 1B. The 1-microfarad capacitor bypasses the Q-meter signal from the power supply. Both the voltage-variable and the bypass capacitor are mounted on a 2 × 2 × ⅛ inch Plexiglass plate, and are connected to the Q-meter through banana plugs. The capacitor under test is placed in clips mounted on the Plexiglass plate, and bias voltage is applied directly across the bypass capacitor. With the fixture the capacitance of the voltage-variable capacitor can be measured over its rated voltage range at any desired test frequency. To date, all voltage-variable capacitors have a minimum voltage rating

CHARACTERISTICS *of two typical voltage-variable capacitors for the usual range of operating conditions—Fig. 2*









of 0.1 volt d-c and maximum ranging from 15 to 130 volts d-c.

PARAMETER MEASUREMENTS—Measurements are made as follows:

(1) Select the test frequency and connect the corresponding work coil to the coil terminals of the Q-meter. Apply power and make the initial adjustments of the Q-meter.

(2) Place the test capacitor in the test clips, observing the polarity shown in Fig. 1B. The voltage-variable capacitor normally blocks d-c current and isolates the Q-meter from the bias supply. If the unit is connected with opposite polarity, the Q-meter will not be isolated and it will not resonate during operation; also, its thermocouple may be damaged.

(3) Lift the negative lead of the capacitor under test and position it approximately one inch above the top of the test clip.

(4) Adjust the Q-meter to resonance and read the initial values of capacitance and Q: (C_1 and Q_1).

(5) Place the negative lead firmly in the test clip and apply the desired test voltage.

(6) Adjust the Q-meter to resonance again and read the final values of C and Q: (Q_2 and C_2).

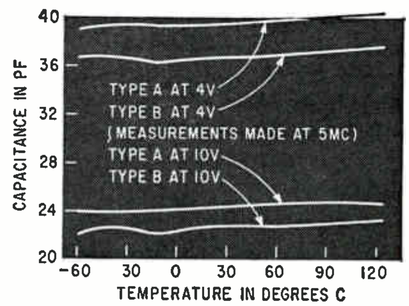
(7) The capacitance of the capacitor is $C = C_1 - C_2$ and the effective Q (Q_e) of the unit can be calculated from

$$Q_e = \frac{Q_1 Q_2 (C_1 - C_2)}{(Q_1 - Q_2) C_1}$$

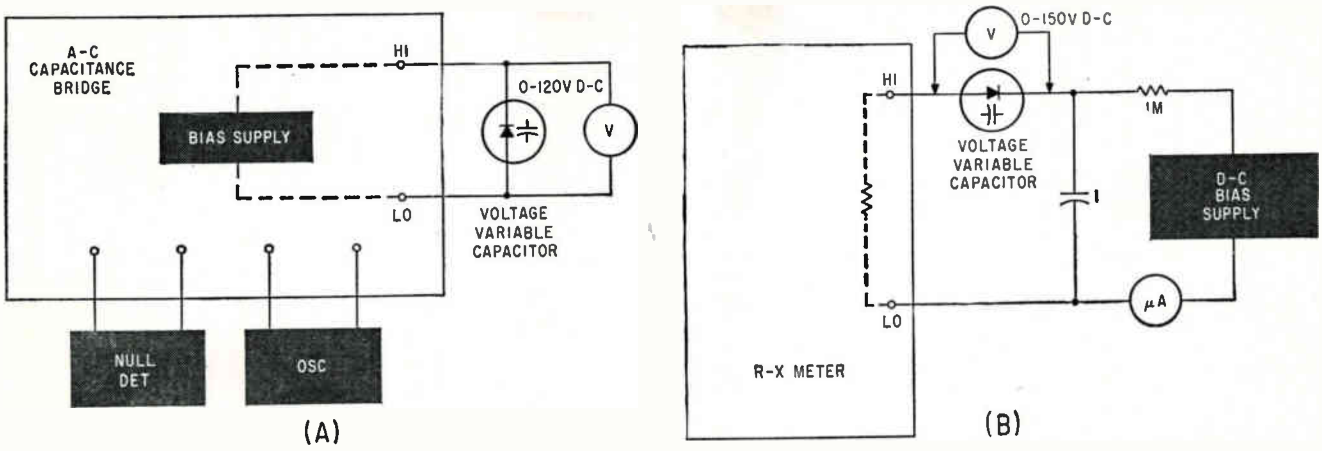
The Q-meter method cannot be used for measuring capacitances greater than 460 picofarads. However, since this value presently exceeds the maximum capacitance of commercial voltage-variable capacitors, the Q-meter technique has wide application. It can measure capacitance over the frequency range of 50 Kc to 50 Mc at any desired test voltage, and the corresponding change in Q can be calculated. Figures 2A and 2B show characteristics of some typical voltage-variable capacitors. All measurements were performed on the Q-meter at a test voltage of 4 volts d-c. Figure 2C is a plot of capacitance as a function of voltage at 5 Mc and 20 Mc. Figure 2D is a plot of Q as a function of bias voltage at the same frequencies.

Little change in capacitance occurs over the temperature range of −55 to +125 C., as Fig. 3 shows. The curves represent capacitance at 4 volts and 10 volts d-c, and at a test frequency of 5 Mc.

AUXILIARY COILS—Since capacitances are determined from the difference between C_1 and C_2, the value of C_1 obtained must be at least equal to the sum of the maximum expected capacitance of the variable capacitor, under test conditions, and the minimum scale reading on the Q-meter. Under some conditions, the work coils supplied with the meter may not permit readings high enough. To overcome this, the two auxiliary work coils described in the table can be constructed and used in place of the coils supplied with the meter. Both



TEMPERATURE VARIATIONS *do not affect capacitance significantly—Fig. 3*



FREQUENCY RANGE *of a-c bridge measurement technique (A) is extended by external oscillator and null detector. Range of R-X meter technique (B) is up to 20 pf—Fig. 4*

coils are made of 14-gage. tinned, soft copper wire, are mounted on Plexiglass sheets, or any similar, high-dielectric-constant material, and are housed in 2 × 2 × 4 inch aluminum boxes to shield them from stray fields. They are terminated with banana plugs, spaced to fit the meter.

AC- BRIDGE METHOD—To measure capacitance by the a-c bridge method, a capacitance bridge capable of measuring from 1 to 1,000 pf, and with provision for measurement at d-c test voltages is required. An external oscillator and null detector may be used, as shown in Fig. 4A, to take measurements down to 100 Kc.

The a-c bridge test is performed as follows:

(1) Select the desired capacitance range and zero-balance the bridge.

(2) Connect the voltage-variable capacitor to the insulated terminals, observing the polarity.

(3) Apply the bias voltage.

(4) Balance the bridge using the capacitance and conductance dials.

(5) The capacitance may be read directly from the capacitance dial; Q is calculated using

$$Q = \frac{2\pi f C}{G}$$

where C = capacitance in picofarads, G = conductance in micromhos, and f = frequency in Mc.

This technique works well only over the frequency range 100 Kc to 1 Mc. Bias voltages of −5 to +120 volts d-c are available.

Accuracy of measurement is

AUXILIARY WORK COILS

Length of Wire	Test Frequency	Expected Value of C_1
11 inches (Two 1.25 inch i-d loops)	20 Mc	395 pf
5 inches (Looped around terminals)	30 Mc	335 pf

from ±0.25 to ±0.75 percent, depending upon the capacitance range used during measurement.

R-X METER METHOD—The R-X meter measuring method is similar to the Q-meter method in that it employs the same test fixture, but with a 1-megohm resistor added to isolate the a-c supply from the R-X meter, as shown in Fig. 4B.

The test circuit of Fig. 4B can be used whenever the d-c biasing current is less than 50 milliamperes, and can be used on all commercial voltage-variable capacitors available so far. (The d-c leakage currents are less than 1 microampere.) The procedure for measurement is:

(1) Select the test frequency and adjust the R-X meter.

(2) Connect the circuit and adjust the meter and the bias supply to obtain the test voltage across the capacitor.

(3) Since the impedance of the voltage-variable capacitor is capacitive-reactive, adjust the C_P control for the initial minimum null; then adjust the R_P and C_P controls alternately to obtain final balance.

(4) The capacitance is read directly from the C_P dial; the Q can be calculated using

$$Q = \frac{R_P}{X_P}$$

where R_P is read directly from the dial and X_P is calculated from

$$X_P = \frac{1}{2\pi f C_P}$$

or, combining the two equations

$$Q = 2\pi f R_P C_P$$

This method of measurement can be used from 0.5 to 250 Mc and will measure voltage-variable capacitors with up to 20 picofarads at the bias voltage of interest.

The accuracy of measurement varies with frequency and ranges from ±0.5 to ±1 percent over the range from 0.5 to 50 Mc.

Of the three measuring methods, the Q-meter method is the most versatile. Capacitance can be measured at both varying frequency and varying bias voltage. Measurement accuracy is ±1 percent and is independent of frequency.

The a-c bridge method is limited to capacitance measurements over a narrow band of frequencies (100 Kc to 1 Mc), and no voltages in excess of 120 volts d-c can be used during measurement. This method does, however, offer the greatest measurement accuracy; depending upon the capacitance, the accuracy is from ±0.25 to ±0.75 percent.

The R-X meter method offers the advantage of measuring capacitance at varying frequency and at varying bias voltage, but is limited to a maximum capacitance of 20 picofarads. This method is similar to the Q-meter method, and offers the same measurement accuracy,

Simplified LOW-PASS FILTER DESIGN

New method for exact design of low-pass filters having maximally flat amplitude in the passband allows the point of infinite rejection to be directly chosen

By WILLIAM J. KERWIN, 1555 Mary Avenue, Sunnyvale, California

DESIGN of a Tchebysheff type II filter by conventional methods requires a considerable knowledge of network theory as well as the determination of the complex roots of a 6th degree polynomial. This is not only difficult and time-consuming, but the point of infinite rejection is not determined until after some preliminary work has been completed. If this result is unsatisfactory, another trial must be made.

This method not only simplifies the work but allows the point of infinite rejection to be directly chosen. This is useful in the design of a filter for use with a demodulator in which a specific ripple frequency due to the carrier must be filtered out. It is also valuable in obtaining a wider passband and better rejection of the unwanted frequency components than could be obtained by the usual Butterworth filter which has no rejection frequency.

Figure 1A shows the basic π-section filter to be considered. The addition of a capacitor (C_2 in Fig. 1B) is all that is needed to obtain an infinite rejection point at any specified frequency. Addition of this capacitor produces the improvement in filter performance.

FILTER FORM—The filter shown has no insertion loss and can be designed for flat response in the passband. The shape of the resultant filter curve is shown in Fig. 1C. The cut-off frequency is normalized to $\omega = 1.0$ (-3db) and the frequency of infinite rejection is indicated as ω_∞. The frequency of minimum attenuation beyond ω_∞ is designated ω_{max} and the amplitude at that point as A_{max}. An increased slope of cut-off is produced by reducing the value of ω_∞ and results in an increase in A_{max}.

An analysis of the circuit shown in Fig. 1B results in ($p = j\omega$)

$$\frac{E_{out}}{E_{in}} = \frac{L\,C_2\,P^2 + 1}{L\,(C_1\,C_2 + C_1\,C_3 + C_2\,C_3)\,P^3 + L(C_2 + C_3)\,P^2 + (C_1 + C_3)\,P + 1} \qquad (1)$$

Simplify this by letting

$$\frac{E_{out}}{E_{in}} \stackrel{\Delta}{=} \frac{\alpha p^2 + 1}{a p^3 + b p^2 + c p + 1} = \left.\frac{1 - \alpha\omega^2}{1 - b\omega^2 + j(c\omega - a\omega^3)}\right]_{p = j\omega} \qquad (2)$$

and the square of the magnitude is

$$\left|\frac{E_{out}}{E_{in}}\right|^2 = \frac{(1 - \alpha\omega^2)^2}{(1 - b\omega^2)^2 + (c\omega - a\omega^3)^2}$$

$$\frac{1 - 2\alpha\omega^2 + \alpha^2\omega^4}{1 + (c^2 - 2b)\,\omega^2 + (b^2 - 2ac)\,\omega^4 + a^2\,\omega^6} \qquad (3)$$

The necessary condition for flat response is that each term in the numerator be equal to the corresponding term in the denominator. Thus

$$c^2 - 2b = -2\alpha \qquad (4)$$

$$b^2 - 2ac = \alpha^2 \qquad (5)$$

In addition, to set cutoff (0.707 amplitude) at $\omega = 1.0$ rps

$$\left|\frac{E_{out}}{E_{in}}\right|^2 = (0.707)^2 = \tfrac{1}{2} \text{ at } \omega = 1.0 \text{ rps} \qquad (6)$$

Setting $\omega = 1.0$ in Eq. 3 results in

$$\left|\frac{E_{out}}{E_{in}}\right|^2 = \frac{1 - 2\alpha + \alpha^2}{1 + c^2 - 2b + b^2 - 2ac + a^2} = \tfrac{1}{2} \qquad (7)$$

Using Eq. 4 and 5 obtain from Eq. 7

$$a^2 = 1 - 2\alpha + \alpha^2; \quad a = 1 - \alpha \qquad (8)$$

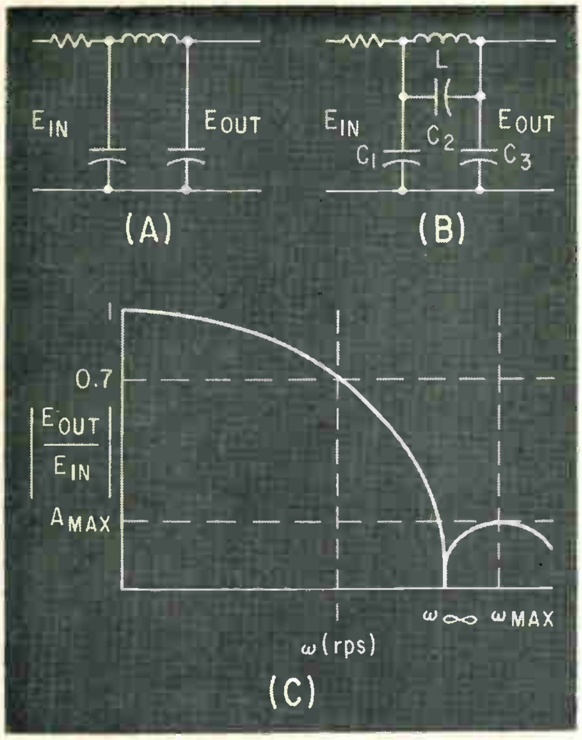
Note that the position of ω_∞ is determined by the value of ω at which the numerator of Eq. 2 is equal to zero. That is $1 - \alpha\omega^2 = 0$ at $\omega = \omega_\infty$. Therefore

$$\alpha = 1/\omega_\infty^2 \qquad (9)$$

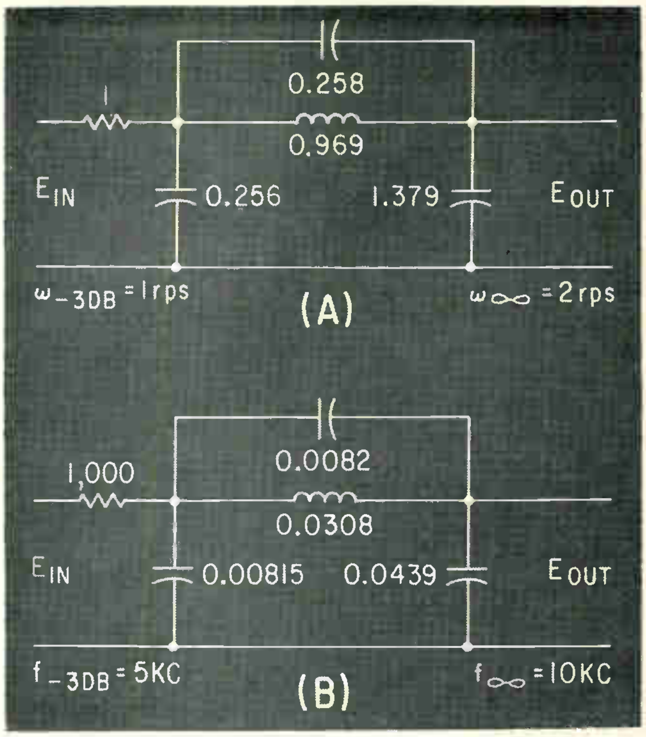
These are the necessary conditions to determine the coefficients of Eq. 2 for any desired ω_∞.

Step 1: Choose ω_∞ and find $\alpha = 1/\omega_\infty^2$.
Step 2: Solve for $a = 1 - \alpha$.
Step 3: Substitute the value of α from Step 1 and solve for c. (Choose + real root) $c^3 + 4\alpha c + 8(\alpha - 1) = 0$. This equation is a result of combining Eqs. 4, 5 and 8.
Step 4: Solve for $b = (c^2 + 2\alpha)/2$. (From Eq. 4.)

Having a,b,c and α, return to Eq.



BASIC *π-section filter (A), improved filter (B) and resultant filter curve (C)—Fig. 1*



RESULTANT FILTER *with normalized values (A) and final design result (B)—Fig. 2*

1 and compare it to Eq. 2

$$LC_2 = \alpha \qquad (10)$$

$$L\,(C_1C_2 + C_1C_3 + C_2C_3) = a \qquad (11)$$

$$L\,(C_2 + C_3) = b \qquad (12)$$

$$C_1 + C_3 = c \qquad (13)$$

Simultaneous solution of Eqs. 10 through 13 results in

Step 5: $C_1 = (a - \alpha c)/(b - \alpha)$

Solving Eq. 13 for C_3

Step 6: $C_3 = (cb - a)/(b - \alpha)$

From the above and a combination of Eqs. 10 and 12

Step 7: $L = (b - \alpha)^2/(cb - a)$

From the above and Eq. 10

Step 8: $C_2 = \alpha\,(cb - a)/(b - \alpha)^2$

As an example, assume the frequency of infinite rejection is to be at twice the cut-off frequency ($\omega = 1.0$ rps in the normalized filter—that is $\omega_\infty = 2.0$ rps.

Step 1: $\alpha = 1/\omega_\infty{}^2 = 0.250$
Step 2: $a = 1 - \alpha = 0.750$
Step 3: $c^3 + 4ac + 8\,(\alpha - 1) = 0$
$c^3 + c - 6 = 0$
$c = 1.635$
Step 4: $b = (c^2 + 2\alpha)/2 = 1.585$
Step 5: $C_1 = (a - \alpha c)/(b - \alpha) = 0.256$ f
Step 6: $C_3 = (cb - \alpha)/(b - \alpha) = 1.379$ f
Step 7: $L = (b - \alpha)^2/(cb - a) = 0.969$ h
Step 8: $C_2 = [\alpha\,(cb - a)]/(b - \alpha)^2 = 0.258$ f

The resultant filter with element values in normalized form is shown in Fig. 2A.

Assuming that a 5,000-cps cutoff frequency and an input resistance of 1,000 ohms are desired, these relations are needed

$$R = R_N Z \qquad (14)$$

$$L = L_N Z/\omega \qquad (15)$$

$$C = C_N/Z\omega \qquad (16)$$

The subscript N denotes the normalized element values, Z the increase in input resistance, and ω the increase in cutoff frequency from their normalized values of $R = 1.0$ ohm and $\omega = 1.0$ rps. For these conditions $f_{-3db} = 5{,}000$ cps (that is $\omega_{-3db} = 2\pi\ 5{,}000$) and R = 1,000 ohms: $\omega = 2\pi\ 5{,}000$ and $Z = 1{,}000$.

Thus

$R = (1.0 \text{ ohm})\,Z = 1{,}000$ ohms
$C_1 = 0.256\,f/\omega Z = 0.00815\ \mu f$
$C_2 = 0.258\,f/\omega Z = 0.00821\ \mu f$
$C_3 = 1.379\,f/\omega Z = 0.0439\ \mu f$
$L = 0.969\,(Z)/\omega = 0.0308$ h

The final filter design is shown in Fig. 2B.

ATTENUATION — To determine the minimum attenuation in the cutoff region, determine ω_{max}. Substituting into Eq. 3, Eqs. 4, 5 and 8

$$\left|\frac{E_{out}}{E_{in}}\right|^2 = \frac{1 - 2\alpha\omega^2 + \alpha^2\omega^4}{1 - 2\alpha\omega^2 + \alpha^2\omega^4 + (1-\alpha)^2\omega^6} \qquad (17)$$

Differentiating and equating to zero

$$\omega_{max} = \sqrt{3/\alpha} \qquad (18)$$

Substituting Eq. 18 into Eq. 17

$$\left|\frac{E_{out}}{E_{in}}\right|^2_{\omega max} = \frac{1}{1 + 6.75\,(1-\alpha)^2/\alpha^3} \qquad (19)$$

as the squared amplitude at ω_{max}. In the previous example $\alpha = 0.25$ so $\omega_{max} = 3.46$ and

$$\left|\frac{E_{out}}{E_{in}}\right|^2_{\omega max} = \frac{1}{244}$$

Thus, the attenuation is 23.9 db or greater for all values of ω greater than ω_∞. When the attenuation in the cutoff band is the critical design factor, α can be determined directly from Eq. 19 for any given attenuation minimum in the cutoff band, and the design continued with Step 2 of the design procedure. The low-pass filters designed by these methods can be converted to equivalent high-pass, bandpass or band-rejection filters by conventional methods.

It should be noted that a minimum value of 1.52 exists for ω_∞. An attempt to choose a lower value will result in C_1 becoming negative.

BIBLIOGRAPHY

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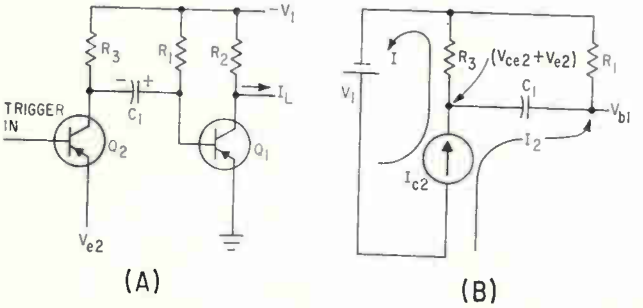
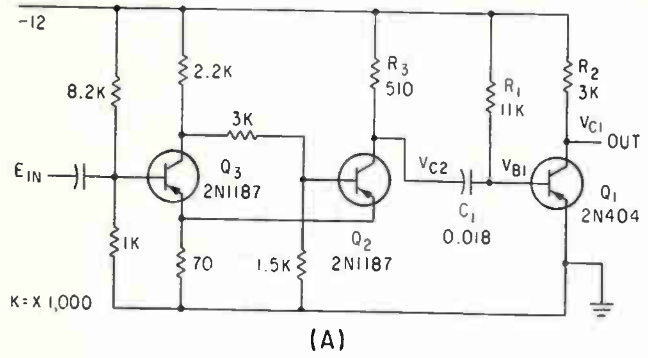
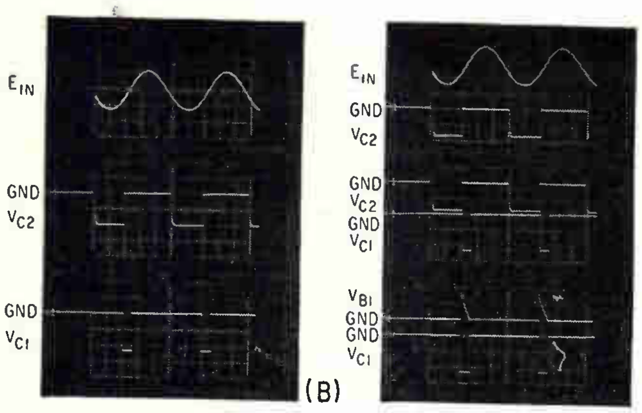
Eliminating the First Stage of a

How to economize on components by using the output stage of a circuit driving a monostable multivibrator as the first stage of the monostable multivibrator. Example illustrates use of design equations



BASIC *pulse-forming circuit (A) uses output stage (Q_2) of a driver as the input section of a monostable multivibrator (Q_2-Q_1). Partial equivalent circuit is shown in (B)—Fig. 1*





CIRCUIT DESIGNATIONS *of this pulse former (A) correspond to those shown in Fig. 1. Typical circuit waveshapes (B) have time scale of 200 μsec/cm and vertical scale of 5 v/cm—Fig. 2*

CONTROL or computing circuits often require a pulse of fixed duration at the output of a Schmitt trigger or other digital circuit. This requirement is most often met by a monostable multivibrator. The monostable configuration can be simplified with a saving in components by considering the output stage as part of the monostable circuit.

Consider Fig. 1A. In the quiescent state, transistor Q_1 is held in saturation by the current in R_1 while Q_2, the output stage of a Schmitt trigger, is off due to biasing. If $V_1 >> V_{be1}$, capacitor C_1 is charged to V_1 volts with the indicated polarity. When Q_2 is turned on, a positive voltage is applied to the base of Q_1, turning it off. If the instant that Q_2 turns on is $t = t(0)$, circuit timing is governed by

$$V_c(t) = (V_{e2} + V_{ce2} - V_1) + (2V_1 - V_{e2} - V_{ce2})e^{-t/T}$$

Where $T = R_1 C_1$.

$$V_{b1}(t) = -(V_{e2} + V_{ce2}) + V_c(t) = -V_1 + (2V_1 - V_{e2} - V_{ce2})e^{-t/T} \quad (1)$$

Transistor Q_1 will remain off until its base voltage reaches zero volts. From Eq. 1

$$0 = -V_1 + (2V_1 - V_{e2} - V_{ce2})\,e^{-t/T}$$

From which

$$t = -R_1 C_1 \ln\,[2 - (V_{e2} + V_{ce2})/V_1] \quad (2)$$

DESIGN CONSIDERATIONS—Since the assumption was made that $V_c(0)$ was equal to V_1, this condition must be provided for in the design of the circuit. This can be accomplished by restricting the recovery time R_3C_1 to be small compared to the minimum off time of Q_2. Capacitor C_1 can be assumed to be completely charged if the product $5R_3C_1$ is made equal to the minimum off time of Q_2 thus satisfying one requirement (Requirement 1). The off time of Q_2 depends on the firing points of the Schmitt trigger.

The accuracy and the repeatability of the pulse width are affected by leakage currents and the change of emitter voltage of Q_2 due to capacitor surge currents. Ignoring leakage for the moment, derive an expression for the collector current of Q_2 from the equivalent circuit of Fig. 1B.

$$I_1 = [V_1 - (V_{ce2} + V_{e2})]/R_3$$

$$I_2(t) = [V_1 - (V_{ce2} + V_{e2}) + V_c(t)]/R_1 = (2V_1 - V_{ce2} - V_{e2})e^{-t/T}/R_1$$

However, $I_{c2}(t) = I_1 + I_2(t)$

$$= \frac{V_1 - (V_{ce2} + V_{e2})}{R_3} + \frac{(2V_1 - V_{ce2} - V_{e2})e^{-t/T}}{R_1}$$

$$I_{c2}(0) = \frac{V_1 - (V_{ce2} + V_{e2})}{R_3} + \frac{2V_1 - (V_{ce2} + V_{e2})}{R_1} \quad (3)$$

Equation 3 shows that the forward base drive of Q_2 supports more than the d-c collector current when transistor Q_2 turns on. If this is not designed into the circuit the output pulse width may differ from the calculated value (Requirement 2).

The effect on V_{e2} and V_{ce2} of this surge current can

Monostable Multivibrator

By RUSSELL L. PAUL and ALLAN S. OTTENSTEIN
Seaboard Electronic Corp., New York, N. Y.

be minimized by making the collector current of Q_2 large with respect to the expected capacitor surge current (Requirement 3).

Transistor leakage currents affect the pulse width by producing an effective voltage change at the base of Q_1 due to I_{CO1} and at the collector of Q_2 due to I_{CO2}. By choice of current values in the elements, the error produced by leakage can be reduced to within the error due to normal component tolerances (Requirement 4).

DESIGN PROCEDURE—The first step in the design of a circuit is to choose the maximum value of collector current in transistor Q_1 for a load current I_L. Hence

$$I_{c1} = (V_1 - V_{ce1})/R_2 + I_L \quad (4)$$

For Q_1 to be saturated, R_1 must supply a minimum base drive current I_{bf}

$$I_{bf} = I_{c1}/h_{FE\ min} \quad (5)$$

To reduce the effect of I_{CO1} on pulse width, make $I_{bf} \geqq 10\ I_{CO1\ max}$. Then, choosing $I \geqq I_{bf}$, or $I \geqq 10\ I_{CO1\ max}$, whichever is greater

$$R_1 \leqq (V_1 - V_{be1})/I \quad (6)$$

This satisfies Requirement 4.

The emitter voltage of output stage Q_2 is determined primarily by the circuit. In the Schmitt trigger of Fig. 2A, the value of V_{e2} is determined by the desired threshold voltage and input impedance of the trigger circuit. If, on the other hand, the driving circuit is a flip-flop or inverter, the emitter voltage may be zero, or set at some other level as required by the application.

Obtaining the value of V_{ce2} from the manufacturer's data sheet, and given the pulse width, the value of C_1 is determined from Eq. 2. To insure that Eq. 2 is valid, make

$$R_3 \leqq 5\ (\text{minimum off time of } Q_2)/C_1 \quad (7)$$

This satisfies Requirement 1.

The effect of I_{CO2} on the pulse width is minimized when

$$R_3 \leqq V_1 - (V_{ce2} + V_{e2})/10\, I_{CO2} \quad (8)$$

This satisfies Requirement 4.

To prevent the capacitor surge current from affecting the emitter voltage of Q_2, make

$$R_3 \leqq R_1\, [V_1 - (V_{ce2} + V_{e2})]/10\, [2V_1 - (V_{ce2} + V_{e2})] \quad (9)$$

This satisfies Requirement 3. The choice of R_3 is governed by the smallest value resulting from the solution of Eq. 7, 8 and 9.

If V_{e2} equals zero, Eq. 9 need not be considered unless a transistor having a high saturation resistance is employed. A zener diode can be used if it is desired to keep this value constant.

To insure that transistor Q_2 is saturated and that enough base drive is provided to support the initial surge of collector current, see that for Q_2

$$I_{bf2}\, h_{FE\ min} \geqq (V_1 - V_{ce2} - V_{e2})/R_3 + [2V_1 - (V_{e2} + V_{ce2})]/R_1 \quad (10)$$

This satisfies Requirement 2.

In solving Eq. 7, 8 and 9 in the design example, the results of the first two equations appear to have little effect on the value of R_3. This is not always true. Equation 7 will dominate where long pulse widths are required as compared with the period of the operating frequency; Eq. 8 may be dominant if high-temperature operation is involved. All three equations may have considerable effect on the pulse width and all effects must be taken into consideration.

DESIGN EXAMPLE FOR FIG. 2A

TRANSISTOR DATA

For Q_1, a 2N404	For Q_2, a 2N1187
$h_{FE\ min} = 15$ at $I_c = 8$ ma	$h_{FE\ min} = 45$ at $I_c = 20$ ma
$I_{CO\ max} = 0.1$ ma	$I_{CO\ max} = 0.1$ ma
$V_{be1} = 0.15$ v	$V_{be2} = 0.47$ v
$V_{ce1} = 0.1$ v	$V_{ce2} = 0.175$ v

CIRCUIT REQUIREMENTS

Pulse width	125 μsec
Voltage V_{c1}	−12 v
Voltage V_{e2}	−1.5 v
Minimum off time of Q_2	200 μsec
Load Current	4 ma

CALCULATIONS

From Eq. 4
$$R_2 = (12 - 0.1)/(8 \times 10^{-3} - 4 \times 10^{-3}) = 2.97 \text{ kilohms}$$
Let $R_2 = 3$ kilohms

From Eq. 5
$$I_{bf1} = 8 \times 10^{-3}/15 = 0.53 \text{ ma}$$
Choose $I = 10\ (I_{CO1}) = 10\ (0.1 \text{ ma}) = 1$ ma

From Eq. 6
$$R_1 \leqq (12 - 0.15)/10^{-3} = 11.85 \text{ kilohms}$$
Let $R_1 = 11$ kilohms

From Eq. 2
$$125 \times 10^{-6} = 11 \times 10^3\, C_1 \ln [2 - 1.675/12]$$
Let $C_1 = 0.018$ microfarad

From Eq. 7
$$R_3 \leqq 5\ (200 \times 10^{-6})/0.018 \times 10^{-6} = 55.5 \text{ kilohms}$$

From Eq. 8
$$R_3 \leqq [12 - (0.175 + 1.5)]/1 \times 10^{-3} = 10.325 \text{ kilohms}$$

From Eq. 9
$$R_3 \leqq \frac{11 \times 10^3\, [12 - (0.175 + 1.5)]}{10\, [24 - (0.175 + 1.5)]} = 0.51 \text{ kilohms}$$

Let $R_3 = 510$ ohms

Checking Eq. 10 with a minimum h_{FE2} of 45
$$I_{bf2} \geqq \frac{12 - 1.675}{5.1 \times 10^2} + \frac{24 - (1.675)}{11 \times 10^3} \geqq 0.495 \text{ ma}$$

This condition must be met in the design of the initial circuit

---

Quick Way to Find Radar Range

Nomograph determines new range of radar set when a transmitter or antenna parameter has been changed, if old range is known

By E. T. MESERVE*
Vitro Laboratories,
Eglin AFB, Florida

THIS NOMOGRAPH gives a quick solution to the radar range equation when the old range and an absolute db value are known. The unit of range is immaterial, provided the old and new range have the same units. The radar equation gives the range R as

$$R^4 = \frac{P_t G_a^2 \lambda^2 A_t}{4\pi^3 (BW) (NF) L (S/N) K T_0}$$

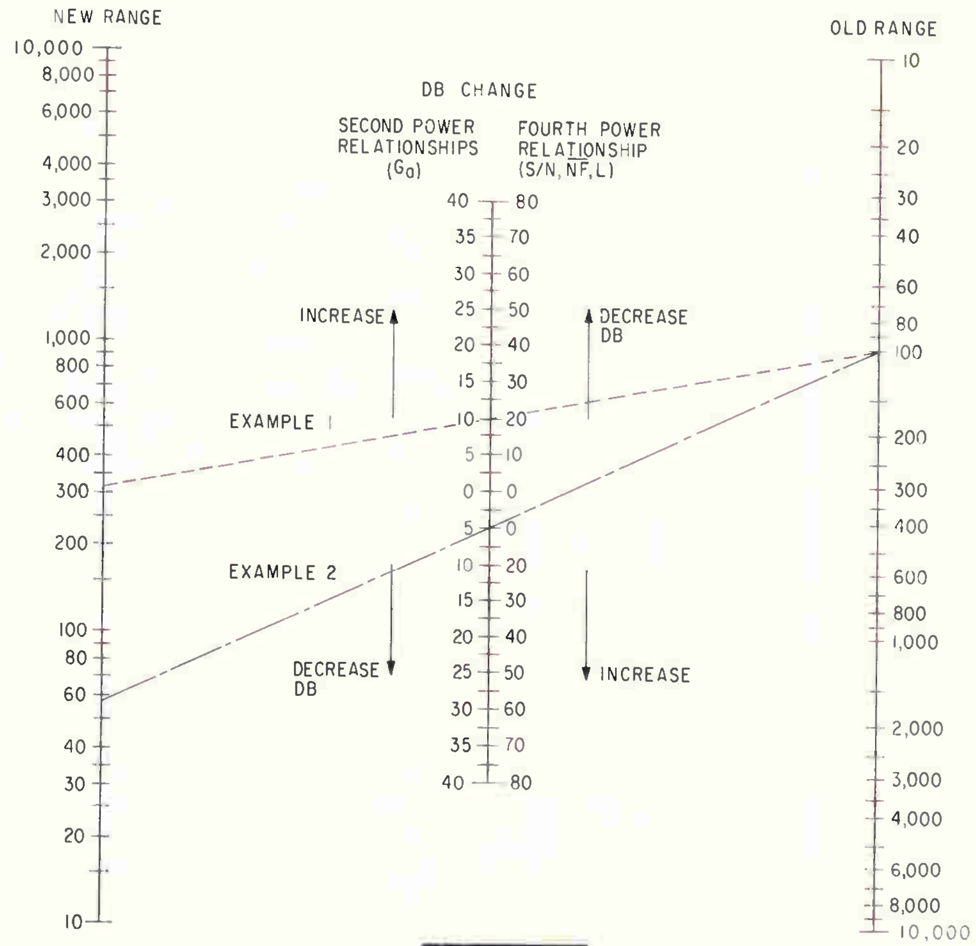
where P_t is peak transmitted power, G_a antenna gain, λ wavelength, A_t area of target, BW bandwidth, NF noise figure, L plumbing loss, S/N signal-to-noise ratio, and K and T_0 constants.

It can be seen that NF, L and S/N have a fourth-power relationship with range, and that G_a is a second-power function.

EXAMPLE 1 — Find the new range, when the old range is 100 nautical miles and the absolute increase in antenna gain is 10 db. Draw a line from the 10-db point above the 0-db mark (since an increase in absolute db is being considered) to 100 on the old range scale. An extension of the line intersects the new range scale at 320, giving the new range as 320 nautical miles.

EXAMPLE 2 — Find the new range when the old range is 100,000 yards and the absolute increase in noise figure is 10 db. Draw a straight line from the 10-db point below the 0-db mark (since a decrease in absolute db is being considered) to the 100 point on the old range scale. An extension of this line intersects the new range scale at 66, giving the new range as 66,000 yards.

* Now with Douglas Aircraft Co., Eglin Air Force Base, Fla.



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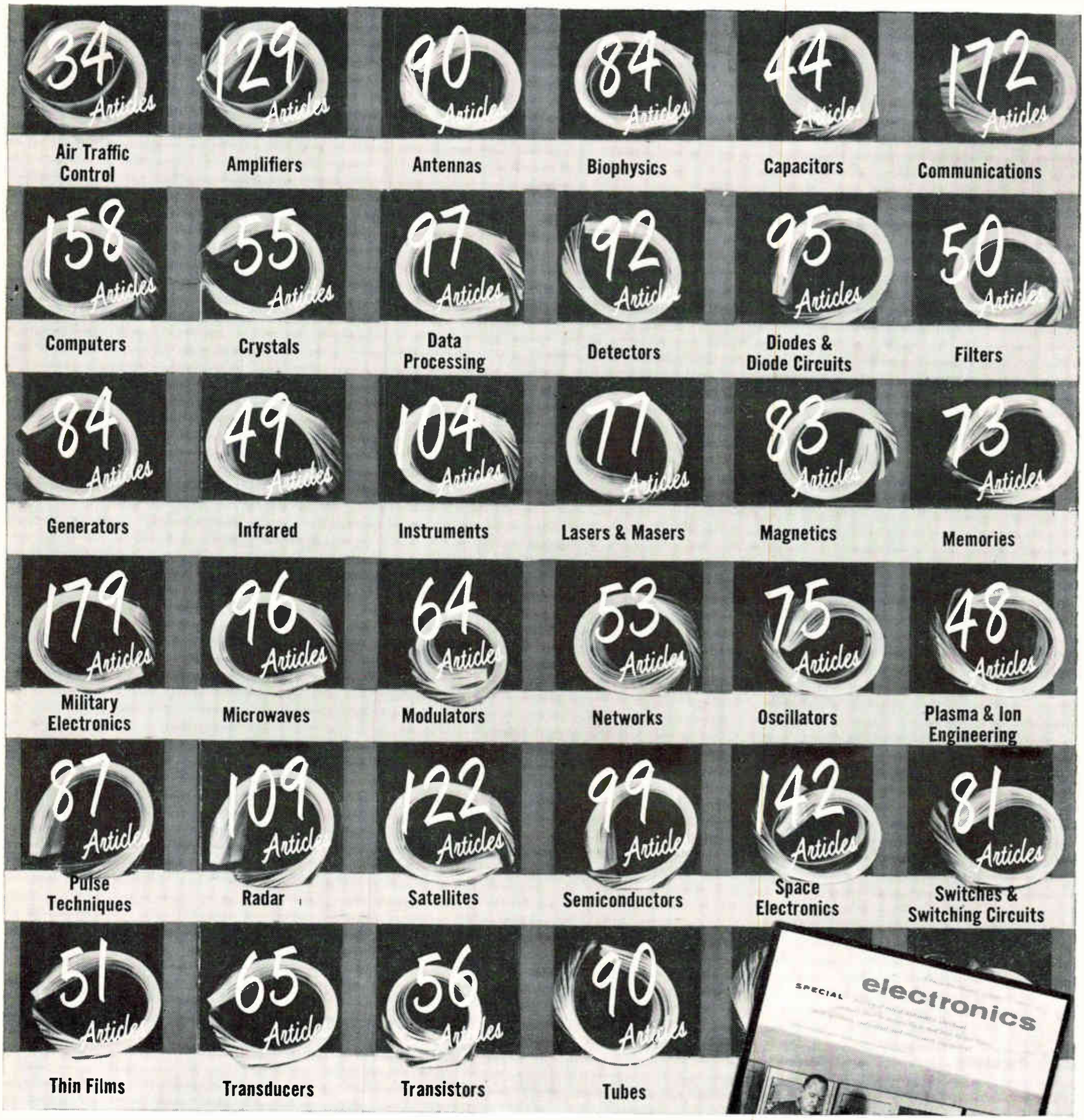


New Transformers May Bring Transistor Tv

Combined magnetostrictive-piezoelectric devices give high step-up ratios

By FREDERICK W. KANTOR

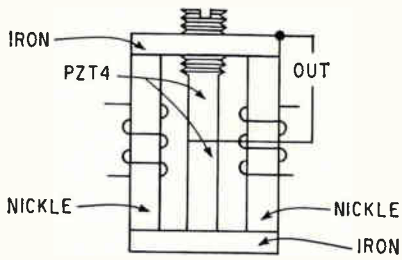
Integrated Research and Technology, Inc., Bellerose, N. Y.

MAGNETOSTRICTIVE element driving piezoelectric material can produce voltage multiplication ratios of several thousand. Such magnetostrictive-piezoelectric transformers might be used to make practical electrostatic-deflection transistor tv receivers. The devices are suitable for a variety of other high-voltage low-current uses.

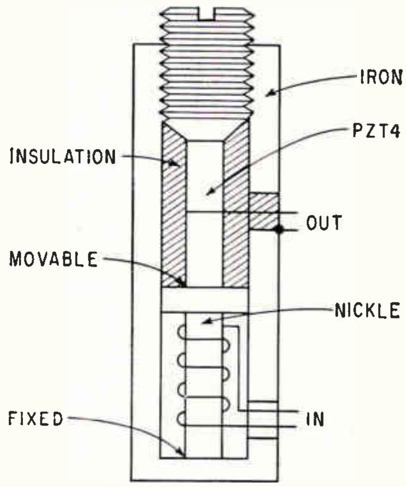
Small step-up transformers that will produce large voltage multiplication ratios and have low-frequency cutoff of a few cycles per second are difficult to make using conventional methods. However, recent advances in piezoelectric materials combined with continuing progress in magnetostriction provide a practical means for providing high voltage multiplication ratios.

Output of conventional transformers is proportional to the time rate of change of flux through the output coil, making it very difficult to obtain good low-frequency response from small units. However, the output force of a magnetostrictive transducer is proportional to current flowing through the coil around it. Also, voltage of a piezoelectric element is proportional to the applied force. Thus combining the two results in a transformer having an output proportional to input, rather than to its first derivative with respect to time. As a result, good low-frequency response is relatively easy to obtain.

CONSTRUCTION—The piezoelectric material selected was Clevite PZT 4, which was fabricated in rods ⅛ inch in diameter and ¼ inch long. Two rods were placed end to end as at A in the figure to reduce the voltage losses due to stray capacitance associated with single mounting. A modified 0 frame, with magnetostrictive elements of type A nickel 1/16 inch in diameter by 3/4 inch long forming the sides, was used to stress the ceramic elements. A setscrew takes up slack.



(A)



(B)

PIEZOELECTRIC *rods (A) are mounted in 0 frame with magnetostrictive elements forming sides. Tubular construction (B) provides greater rigidity*

Each nickel rod was wound with 45 turns of #22 wire, and coil resistance was less than 0.005 ohm. With 50 millivolts input, an output of 150 volts was obtained and used to operate an NE-2 neon bulb.

Another test model was designed to match the mechanical impedance of the magnetostrictive elements more closely to that of the piezoelectric material. Nickel rods 4½ inches long were used because of the low magnetostrictive coefficient of nickel. Using the same piezoelectric elements, a shimmed W frame was made, which resulted in an output of over 400 volts.

PERFORMANCE—It has not been possible because of the high output impedance and low efficiency of the ⅛-inch diameter piezoelectric rods to make reproducible measurements of transformer efficiency. However, overall efficiency is less than 20 percent, probably considerably less. Also, when working into a pure voltage load, such as crt deflection plates, low-frequency response is limited only by R-C decay resulting from leakage resistance. With ceramics and glass, this leakage is low enough to permit a low-frequency cutoff of about 1 cps. There is a mechanical resonance peak associated with each of the elements used and an overall peak caused by coupled mechanical oscillation. The separate peak would be eliminated in a production model by tighter mechanical bonding.

In constructing the transformers, the frame must be as rigid as possible so that the displacement will appear across the ceramic piezoelectric element. For this reason, one possible design is a tube, as at B in the figure. The magnetostrictive element is inserted from one end and bonded. The piezoelectric element is inserted from the other end and held in place by an adjustment screw. Because of the great rigidity possible with this design, the coefficients of thermal expansion of the various parts must be closely matched to reduce thermal d-c drift. For mechanical impedance matching, it may be desirable to use a magnetostrictive ferrite.

APPLICATIONS—Since substantially lower deflection power is required, the magnetostrictive-piezoelectric transformer might be used to make practical transistorized tv sets using electrostatic crt deflection. Suitable transformers would be about ¼ inch in diameter and about 1½ inches long. Magnetostrictive-piezoelectric transformers could also be used to provide the *for highest quality*

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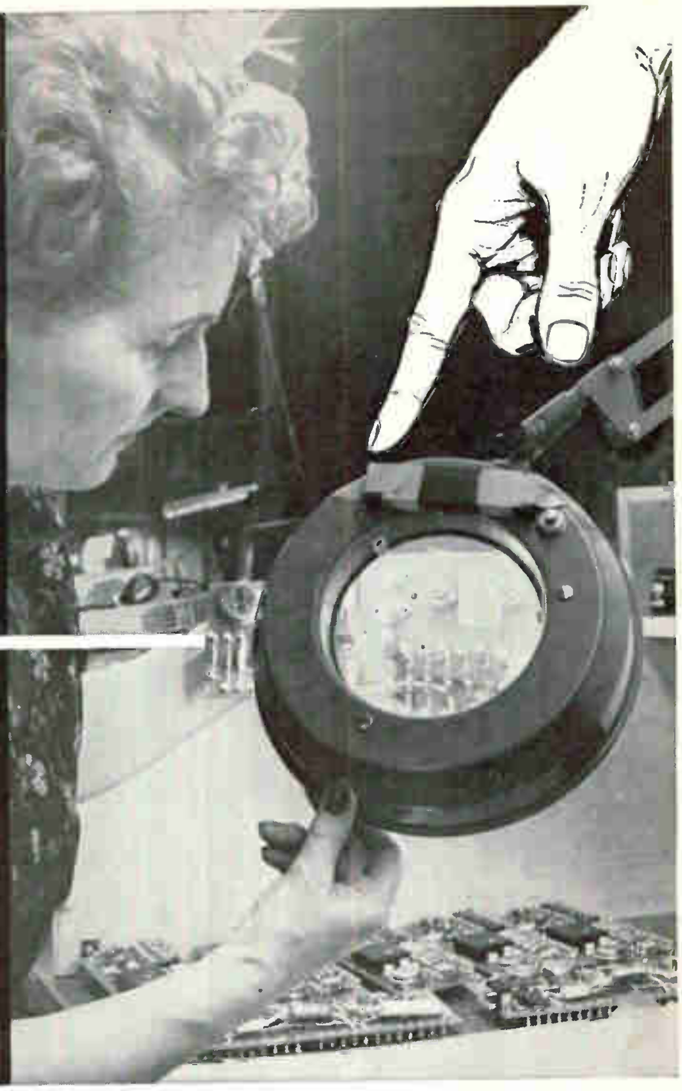

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high voltage required by Kerr cell shutters.

It might also be possible to couple the transformers with thermoelectric power-generating diodes to produce compact power supplies for low-drain devices. Such supplies would be ½ to 1½ cubic inches and could be used for multiplier phototubes, image intensifiers, geiger counters and infrared image converters.

The magnetostrictive-piezoelectric transformer might be combined with a fresnel lens. By mounting the assembly on a spinning satellite, high-voltage for low-current apparatus could be provided.

Shaft Resetter Reduces Loading

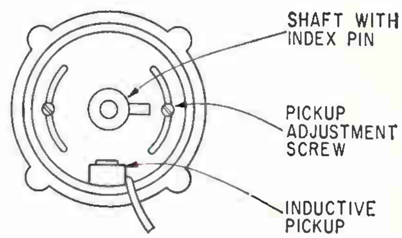
By FRED W. KEAR
Lytle Corp., Albuquerque, N. M.

SHAFT-POSITIONING device has been developed for applications in which available input torque is limited or in which shaft position is used as a precise analog representation of a measured quantity. The device resets a randomly positioned shaft to a predetermined reference position.

By avoiding brush-commutator arrangements in the design, mechanical loading of the shaft is limited. This approach also avoids brush noise, which can be damaging to transistor circuits unless it is controlled at added expense, size and complexity.

The general appearance of the shaft with its index pin and inductive pickup is shown in Fig. 1. One important consideration in fabrication of the inductive pickup and index pin is to keep the period of pulse generation to as small a portion of shaft rotation as possible. In this case, the most useful combination for position sensing proved to be an index pin of nonmagnetic material with 0.015-inch sheet magnetic material laminated in a slot at the tip of the pin. The core of the inductive pickup is constructed similarly. The pickup consists of a thin permanent magnet laminated between supporting layers of nonmagnetic material.

A substantial number of turns of insulated wire forms the coil around the permanent magnet to generate a voltage pulse each time the index pin passes the pickup. A large number of turns is necessary to provide optimum sensitivity without increasing size of the magnetic core. Magnetic flux must also be limited to prevent unnecessary torque loading of the shaft.



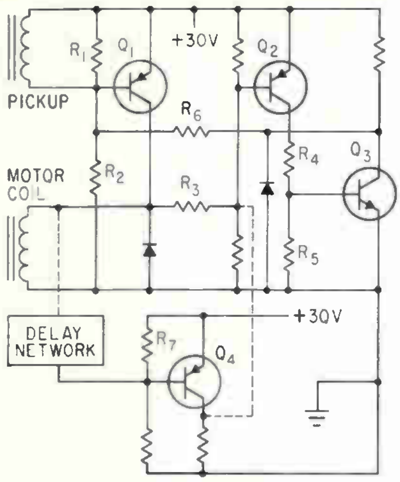
INDEX PIN *alignment with inductive pickup causes generation of voltage pulse—Fig. 1*

CIRCUIT OPERATION—The circuit at the top of Fig. 2 as activated by application of a +30-volt d-c command signal to the positive bus. Transistor Q_1 is forward biased by resistors R_1 and R_2, energizing the motor coil. The motor armature is mounted on the shaft being monitored so that motor torque rotates the shaft. As the shaft rotates, the index pin moves toward the magnetic core of the pickup. As alignment is reached, the inductive pickup generates a voltage pulse.

The output pulse from the pickup applies a reverse bias to the base of Q_1, de-energizing the motor coil. The motor should produce little torque so that overshoot is prevented, since one of the original requirements is for a device that will result in little mechanical damping or loading.

When the motor coil has been de-energized, a negative voltage is applied to the base of Q_2 through R_3, forward biasing the transistor. When collector voltage of Q_2 reaches about 30 volts, biasing resistors R_4 and R_5 forward bias Q_3. The voltage produced at the collector of Q_3 is fed through R_6 to maintain the reverse bias on Q_1.

As long as the command signal is applied to the 30-volt bus, the motor coil remains de-energized unless the locking voltage is removed from R_6. This locking voltage can easily



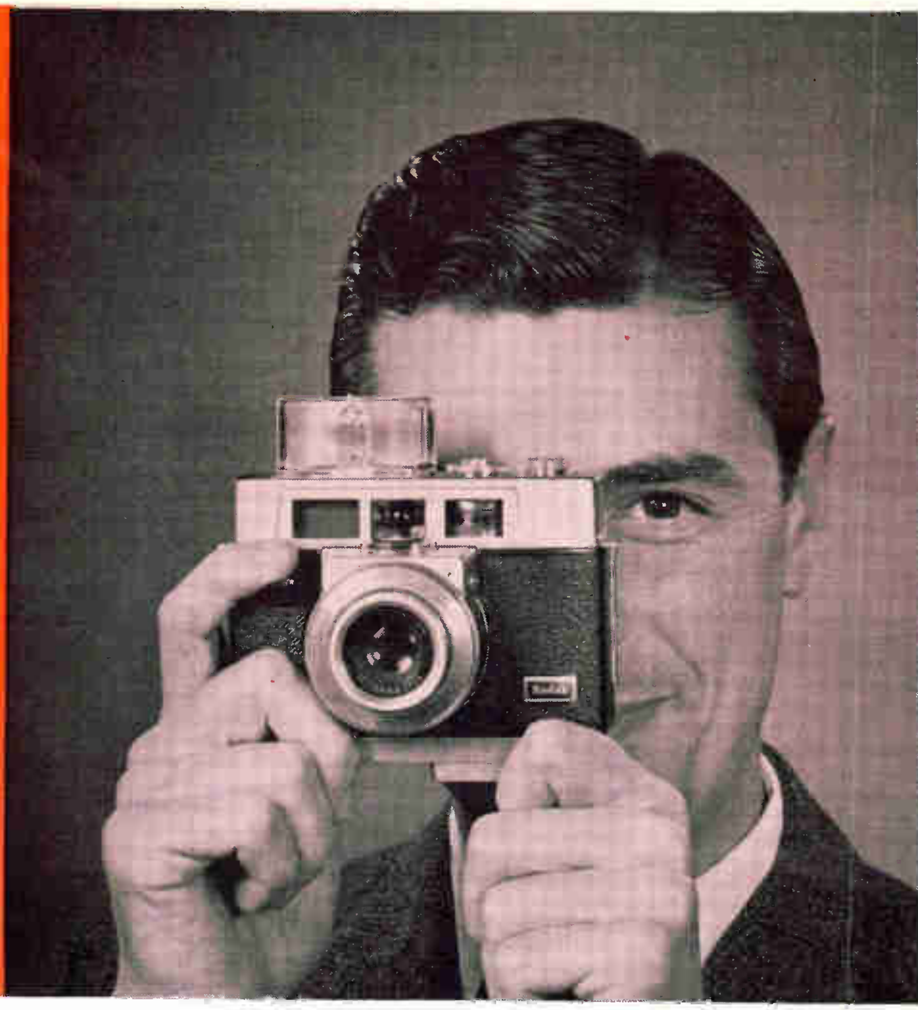
MOTOR COIL *is energized when command signal is applied and de-energized by pickup pulse. Auxiliary circuit delays shaft resetting —Fig. 2*

be removed by connecting the base of Q_2 to the +30-volt bus directly with a switch or remotely with a relay.

DELAYED RESETTING — The lower circuit in Fig. 2 is used for automatic shaft positioning after a preset time, determined by the time-delay network. This circuit causes the circuit above it to reposition the shaft index pin with the inductive pickup at the end of the time-delay period, which starts when the command signal is applied to the 30-volt bus. The negative pulse is taken from the emitter of Q_1, applied to the delay network and used to overcome the bias established by R_7 and R[illegible]. Thus Q_4 is forward biased, connecting the base of Q_2 to the 30-volt bus and allowing the motor to be energized again.

A typical application of the shaft positioning device is in orienting equipment in a vertical position. The inductive pickup is attached to a vertical-sensing device, and the equipment to be oriented vertically is attached to the shaft. A polarity-sensing relay is also attached to the shaft and is used to reverse motor current when the index pin passes through the reference established by the inductive pickup. The polarity-sensing relay makes it unnecessary for the motor to rotate more than 180 degrees to orient the shaft to the vertical position.

The polarity-sensing relay is also a low-torque device, producing negligible loading of the shaft.



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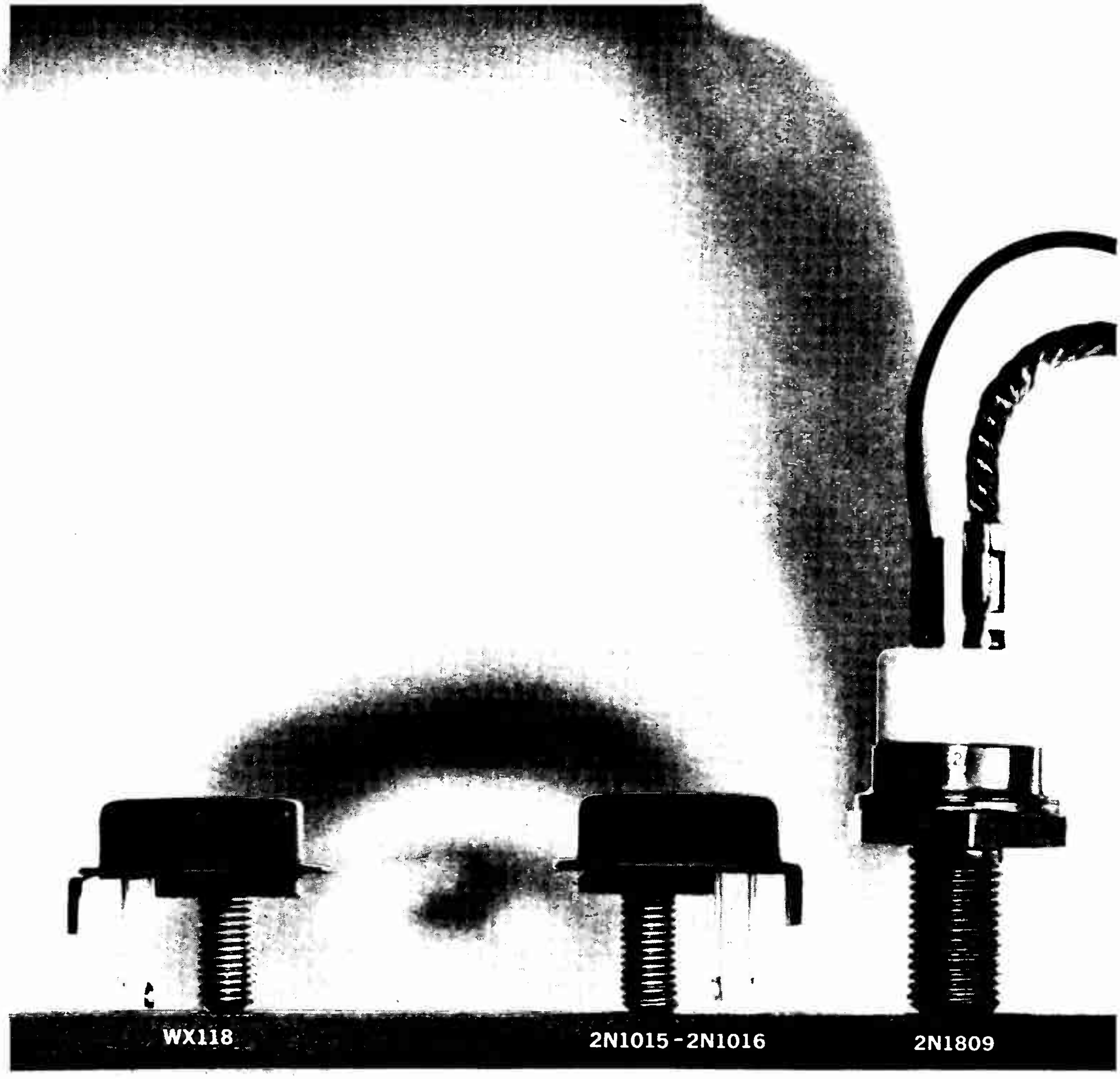
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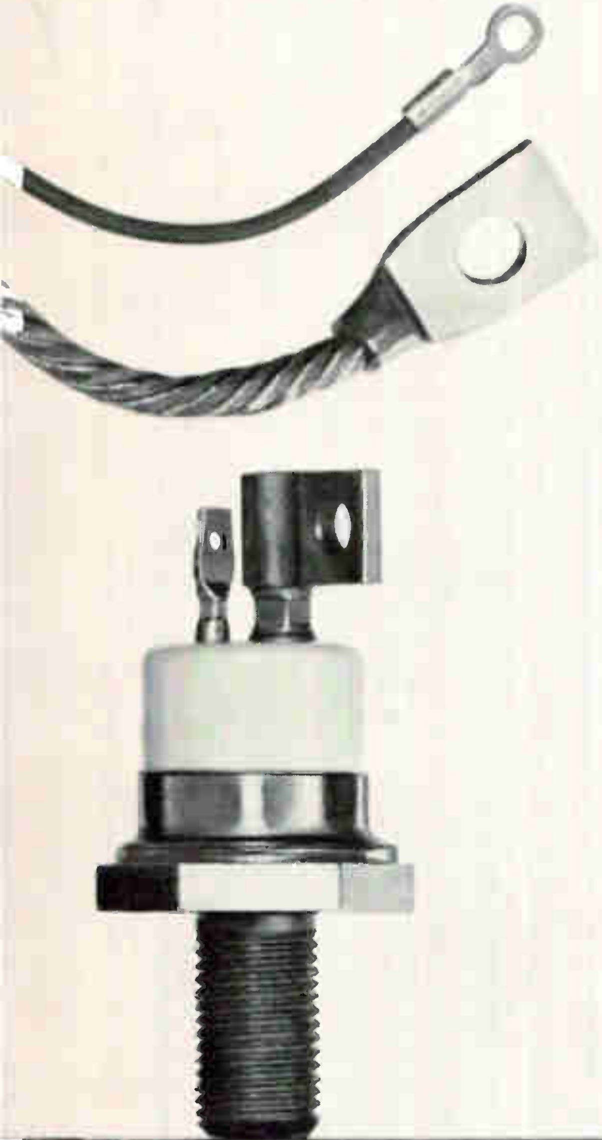
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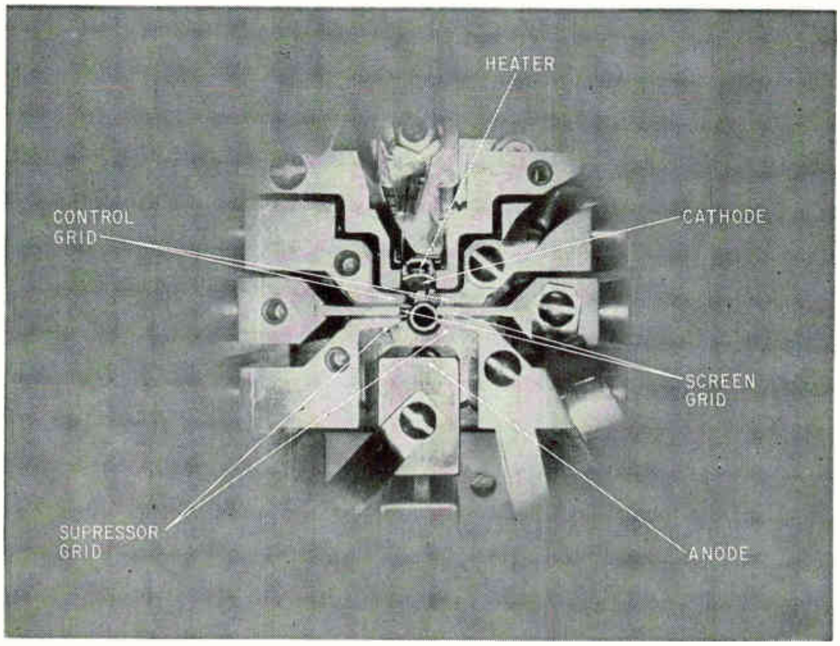


ELEMENTS *of movable-electrode analog are coupled to knobs which can move each grid independently, either closer to the electron beam, or away from the beam*

Tube elements can be manipulated to appraise space charge in vacuum

By STERLING McNEES
Manager, Advanced Power Grid Laboratory, Eitel-McCullough, Inc. San Carlos, California

A FLEXIBLE vacuum tube, that is, one in which distances between cathode, anode and grid elements may be varied during operation, now enables an investigator to change the position of all elements to determine optimum interelement configuration.

Formerly, designers of grid-type electron tubes have had to evolve designs with data gathered from crude electromechanical analogs, empirical formulation and hindsight.

The movable-electrode analog for power grid-type vacuum tube design, developed by Eimac's Advanced Power Grid group, is shown in the photo. Elements represent the cathode with its internal heater, the anode, and the grids which are actually vertical sections of two adjacent grid wires of each grid.

Eimac's present power-grid research is on the feasibility of half megawatt and one megawatt tubes. While the analog could be used in the development of nearly any grid-type tube, it is being used to determine what direction might be best taken toward half-megawatt and one-megawatt development.

DIALING THE CHARGE—Elements are mounted on blocks, which are coupled by rods to adjustment knobs. Knobs are equipped with micrometer dials and, when turned counterclockwise, push against vacuum-tight diaphragms. This moves the blocks and the associated elements closer to the center of the electron beam. When the knobs are rotated clockwise, springs in the back push the elements back out of the beam. The two elements for each grid can be moved independently.

Knobs can move the tube elements as little as one mil. After the ideal position has been determined for each element in a particular tube configuration, the elements can be moved to new positions representing manufacturing tolerances. The effect of these tolerances is then measured.

Operating voltages are fed to the elements through insulators in the bottom of the chamber.

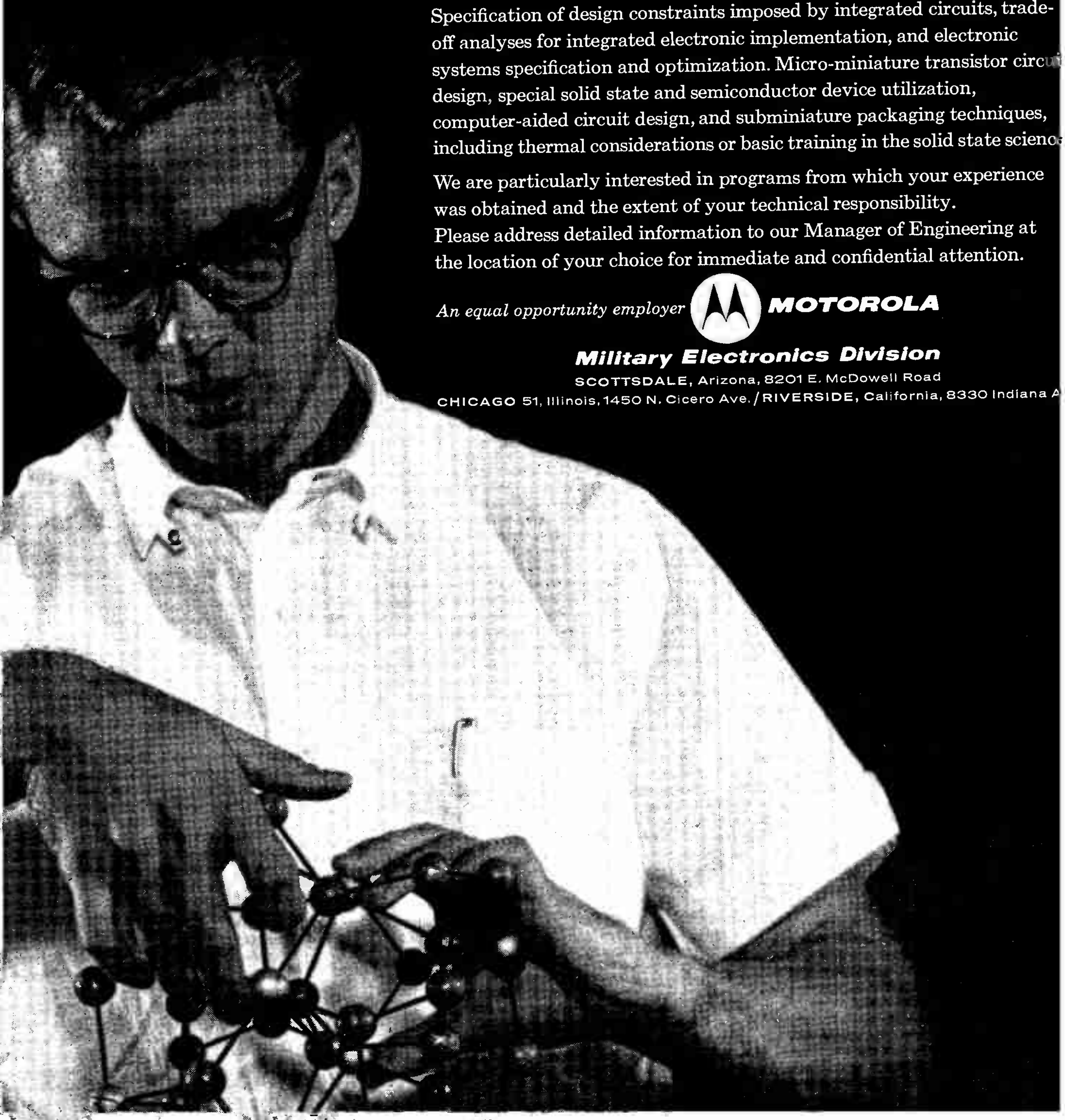
In operation, the chamber surrounding the analog is evacuated and voltage is applied to the heater to cause a chemical change in the cathode coating. Then voltage is applied to the other elements and the tube is pulse modulated. The duty cycle of the pulse modulation enables the investigators to operate the analog at higher power levels than it would tolerate in continuous operation. Typical operating voltages are 10 Kv on the plate and 3.5 Kv on the screen. Grid and anode currents are observed on an oscilloscope and photographed.

Because the elements can be removed from the mounting blocks, various shapes can be inserted and operated to establish their relative merits.

The window in the top of the chamber enables the investigator to verify the position of the elements with a measuring microscope. Although micrometer dials are quite accurate, they do not indicate element movement caused by thermal expansion. The window also permits visual examination of the model in operation.

SPACE CHARGE—Because electrons have a negative charge, they repel each other when tightly bunched. And bunching, or density modulation, is the operating principle of a grid-type tube. In other words, it's possible to staurate the electron beam and reach a point where additional modulation is not possible.

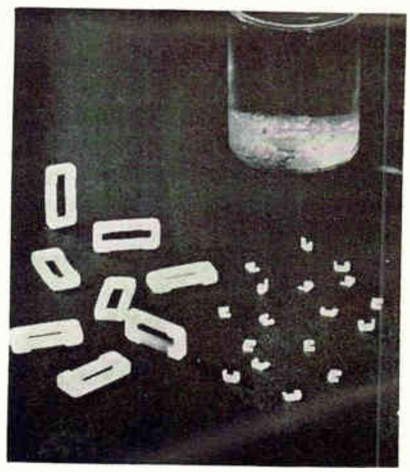
A tube may be space-charge limited, or its performance can be seriously modified, before its cathode emission limit is reached, or before anode dissipation limits appear. A small modification of the tube's in-



ternal structure can often overcome some of the effects of space charge; thus appears the importance of being able to move the tube elements while the tube is in operation.

Use of the movable-electrode analog can reduce substantially the time and cost required for the design of large power tubes. Previously, several prototypes had to be built before the designer could find a close approximation to optimum element shape and position. Data for prototypes came from measurements of potential distribution in a larger-than-scale model submerged in water, from the behavior of steel balls as they rolled over a contoured rubber diaphragm, or the distribution of voltage over resistance paper on which a drawing of the tube had been made with conducting ink. All these analogs were designed to determine electron flow, yet none of them could produce good information on the space-charge effect, which is so important in tube design.

Getters Adsorb Organic Contaminants



MOISTURE ***getters cut relay failures, remove contaminants***

USE OF a unique glass that adsorbs moisture and contaminants doubles the reliability factor of microminiature and subminiature relays used in missiles, aircraft and space satellites. The dessicant helps assure hundreds of thousands of miss-free operations in critical switching circuits under conditions of launch, reentry, ballistic flight or orbital flight.

Babcock Relays Division of Babcock Electronics Corporation of

Costa Mesa, Calif., said the dessicant is an activated getter made in molded form by Corning Glass Works. The material is Corning's Vycor brand porous glass—Code 7930.

With the glass getters, relays as small as 0.048 cubic inch and as light as 0.1 ounce exhibit relatively long life, high contact rating and high temperature capability, according to Babcock's Carl L. Martin. He said the porous Vycor getters were chosen for the high-reliability relays because of adsorption property in a relatively small matrix. They can be molded to close tolerances, space inside the relays can be utilized to the maximum. Martin said that forces of more than 100 G's have been withstood successfully by the relays without getter flaking or cracking.

THIRSTY GLASS—The getter is a porous, high silica material formed by leaching the fluxes from a special borosilicate composition. Average pore diameter is four millimicrons and void space is 28 percent of volume. Internal surface area is 150 to 200 square meters per gram. The apparent specific gravity of the glass, when dry, is 1.5.

Approximate chemical composition of dry Vycor thirsty glass is 96 percent SiO_2, three percent B_2O_3, less than one percent R_2O_3, and a trace of alkali.

Organic material contaminates glass exposed to air, so getters are shipped in glass containers of deionized water.

The getters are installed in relays by Babcock in a white room. The assemblies are subjected to a bake cycle at a temperature above 200 C and a vacuum below five microns of mercury for about one hour. The cycle, which is the second received by the relays, removes about 90 percent of the contaminants in the devices.

During operation, Martin said, the activated getters prevent relay contacts from being fouled by contaminants emitted at elevated temperatures. This contamination is the major cause of erratic performance and eventual failure of hermetically sealed relays. Up to 99 percent of organic contaminants remaining after production degassing are adsorbed by the dessicant.

Getter activation is a drying process performed under controlled temperatures, time periods and moisture ambient. Properly done, it removes water from the getters while maintaining their porosity and gettering effect.

Company began using activated getters as an outgrowth of an orderly investigation into the causes of relay failures. Started more than two years ago, the studies comprised what may have been the relay industry's first reliability program. Each test sample was subjected to hundreds of thousands of operations at loads varying from one micro-amp to 10 amps, temperatures from minus 65 to plus 125 C, vibration of five G's to 3000 cycles per second, and shock beyond 1,000 G's.

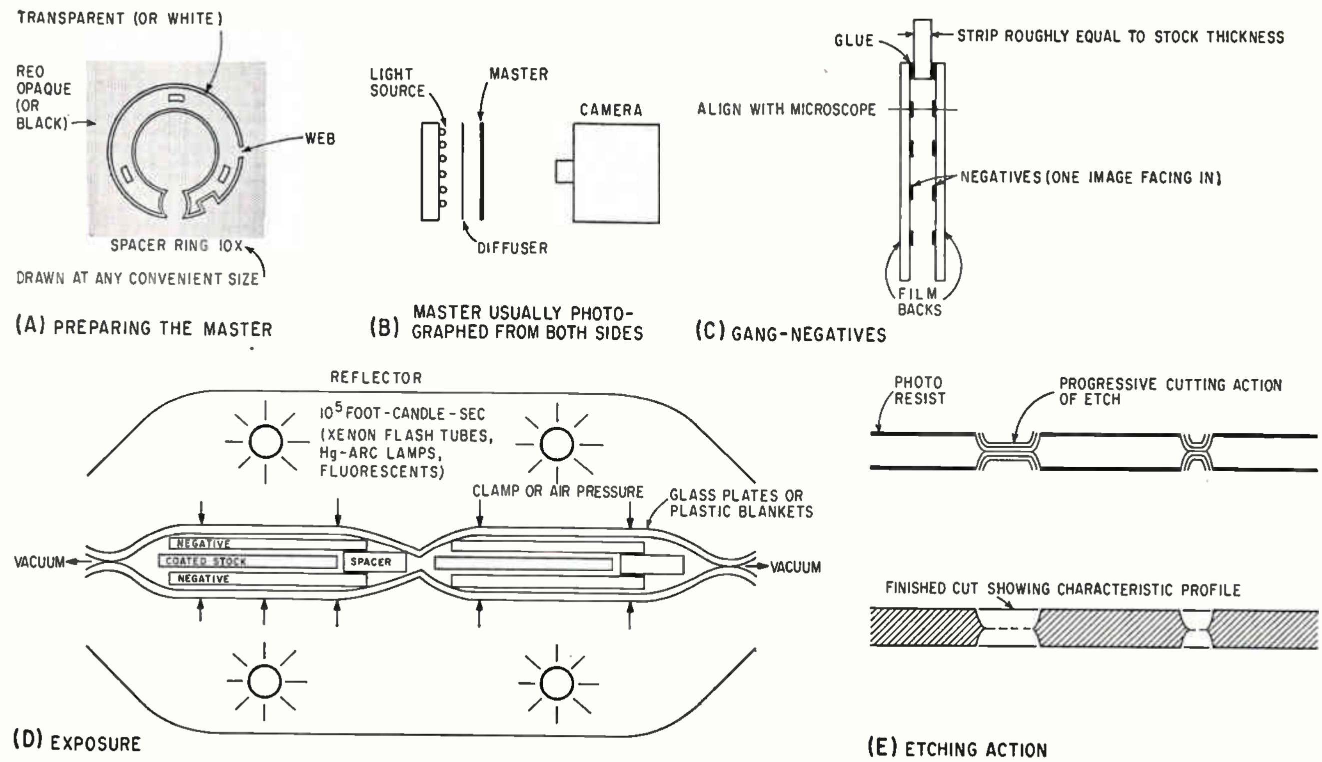
High-reliability relays are now made available with glass moisture getters. Various types are used in airborne, spaceborne, undersea and ground system applications, including the Polaris missile and a military satellite.

Delay Lines Utilize New Glass Medium

DIGITAL DELAY lines, because they are small, light, stable and reliable, have applications in missile and satellite guidance computers, in high-speed circuits requiring wide bandwidths and stability, in computer circuits requiring storage of high-speed video pulses, and in commercial devices where inexpensive but reliable lines are necessary in large volume.

A new glass, developed by Corning, provides storage capacity for delay lines used as buffers and memories in digital computers and processing equipment. Storage capacity of the improved glass is between 3,500 and 4,000 bits, temperature coefficient is zero ±1 ppm per deg C at room temperature. Variation of the temperature coefficient of time delay with temperature is 0.11 ppm per deg C.

Bit capacity is the product of frequency and delay time. New glass can be operated at frequencies from one megacycle to higher than 50 Mc, with delay times ranging from approximately 500 μsec to about one μsec.



NOTE SHARPENING *of corners in master drawing (A) and web to keep part from falling into bottom of etch bath. High contrast film is used to make the negatives (B); a vacuum film holder should be used for highly accurate work. Gang negatives (C) are useful for volume production. After the coated metal is exposed (D), it is soaked in developer, rinsed, then oven dried. After etching, the part is cleaned of resist in a hot stripper. Complex parts are stored in sheet form to prevent tangling; the holding web is cut through when the part is used*

Photofabrication Makes Intricate Parts Quickly

High volume output for production or one only parts for R & D

By NICHOLAS REINHARDT
RAYMOND FLUKE
HARRIS TRAIGER
Edgerton, Germeshausen & Grier Inc., Boston, Mass.

NEW PHOTOENGRAVING techniques using specially prepared high speed etching baths are producing intricate burr-free parts quickly and cheaply. Molybdenum, titanium, tungsten, soft nickel and copper, Hastelloy, and other tough-to-handle materials commonly used in electron tube manufacturing can be shaped with the acid etching technique. Gold is the only material noted so far that presents difficult problems in chemical etching although it can be handled with electrolytic etching.

A variant of photoetching for printed circuits and nameplates, the process was developed to produce a molybdenum heating element for a super power hydrogen thyratron tube. Attempts to machine the spiral from a sheet of molybdenum produced a strained, burred piece costing nearly $75 in labor.

With experimentation, it became possible to photofabricate perfect parts in only 30 minutes. Labor saving refinements such as gang-processing and etch bath improvements have cut the time to make similar parts to seconds in large quantity, or to a few minutes for small lots. Titanium, for example, can be gang etched at 7½ mils per minute from both sides.

PROCESS—The first step in the process is to make an enlarged view of the part to any convenience scale (see A of sketch). The allowance for undercutting during etching is usually about 0.4 times stock thickness; line weight is about the same as stock thickness. This master is then photographed on a reduced scale to yield negatives the exact size of the part. Great care and precision, with attention to small details of technique, is required for good negatives. To produce parts in reasonable volume, gang-negatives can be made, but for highly accurate work, first generation negatives must be used.

The metal to be etched is coated with photosensitive material according to the manufacturer's directions, tight control being exercised to obtain a blemish free film. The coated metal is then sandwiched between negatives and exposed to a cool, intense flash of light, which exposes all coating not

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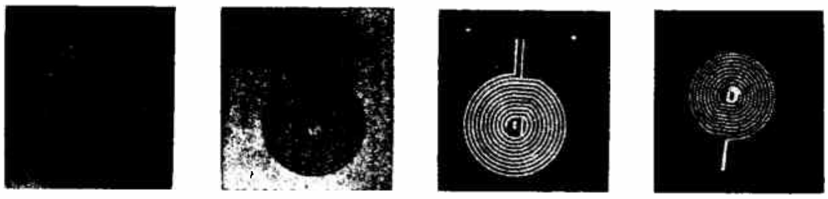

SPIRAL *heater for a high power thyratron tube; 0.005 molybdenum coated with resist, the part ready for etching, the part after etching, and the final part ready for special coating*

protected by opaque areas of the negative. The exposed pieces are developed and dried, then agitated in acid etching baths; etchants are proprietary variation of standard pickling solutions. Unexposed portions of the metal are rapidly eaten away, leaving an accurate part that needs only to be stripped of the exposed coating to be ready for immediate use. Careful control of etching time, temperature and cleanliness is required; heat buildup at etching points is kept under control by the agitation.

APPLICATIONS — Currently, more than 20 different thyratron and crt parts are being made to close tolerance. Many sizes of heavy spiral-strap heaters and serpentine structures are being made to resistance tolerances of ±1 percent and mechanical tolerances of ±0.001 inch. Throw-away masks for a flame-spray process are being produced in 0.020 inch stainless steel. Elaborately pierced titanium rings and plates are produced in thicknesses to 0.040 inch; double register techniques allow limited use of a third dimension to produce lands, grooves, ridges, lettering, and locating features. Maximum stock thickness is a function of the size of the smallest detail. For ordinary work, this is about 0.7 of stock thickness.

The process requires semi-skilled personnel and experienced supervisors. All steps must be closely controlled and safe practices followed. Costs depend mostly on labor utilization. Company developed exposure and processing equipment, for example, can produce accurate work as inexpensive as a few cents, depending on size and volume. Setup costs show a wide spread, but depend on part complexity and the precision required. But costs are always well under the costs for equivalent machining or die-work.

Photofabrication is especially useful in R&D work, where flexibility is important and where machined parts are expensive. The engineer is freer to design since restraints on machining feasibility and part complexity are much less.

Design changes often involve no more than changing a drawing and rephotographing it; in some cases the negative itself can be revised with india ink or by cutting. Once a final design has been made, the negative can be used indefinitely, with no variation in part as a result of changing from temporary to permanent tooling. Variations in stock thickness or other properties can be allowed for by revising drawings alightly.

The photofabrication process allows a new part to go from original idea to finished part in ½ a working day, when necessary.

Ceramics in Magnetic Cores Allow Extreme Environment

A CERAMIC laminating process for motor and transformer cores has been developed by Cerameo Inc., Chemists, Newark, N.J.

The process employs specially prepared frits with expansion coefficients closely approximate to those of the lamination metal. The frit is applied to individual laminations which are then stacked and fired above 1,200 F.

A second coating of frit is applied and fired to cover wire slots and end laminations. The result is a vitrified ceramic bonded core free of organic binders or insulators, and rigid and stable in high temperatures and under radiation. Electrical properties of the lamination metal are retained by careful application and removal of heat during the various steps.

Although the basic process was ready in 1955, lack of suitable wire

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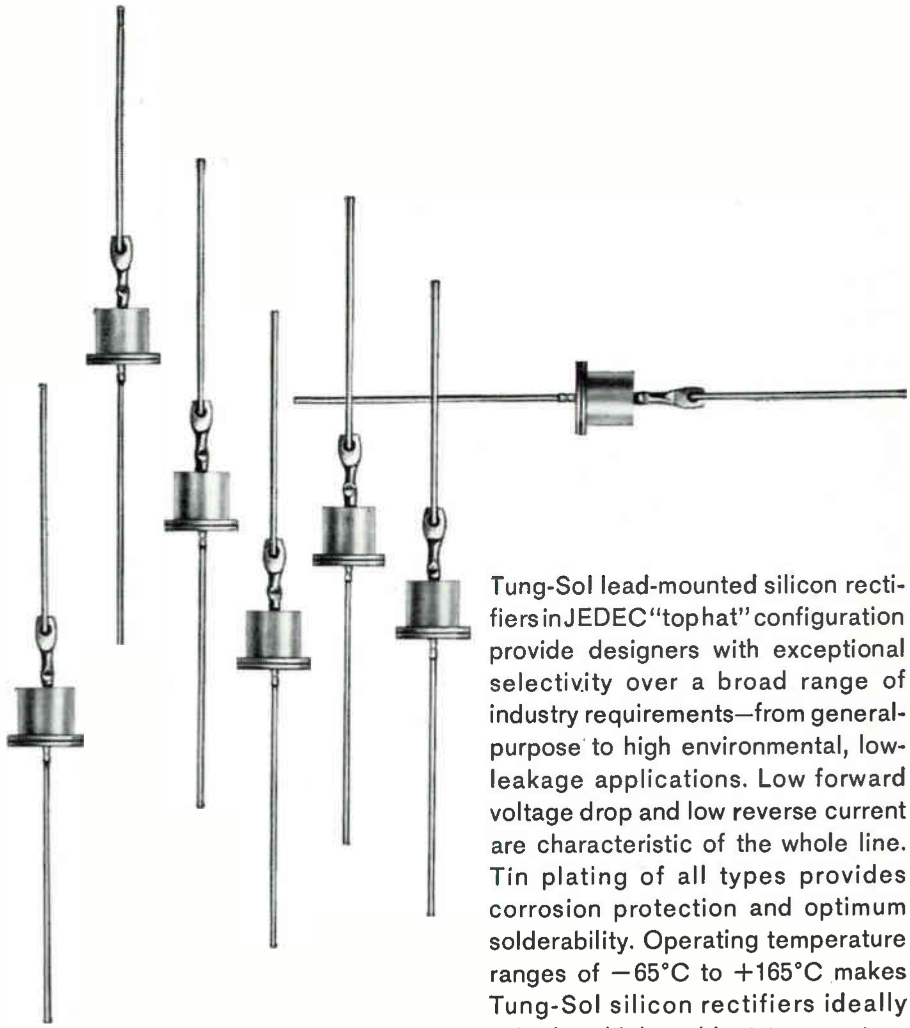

Tung-Sol lead-mounted silicon rectifiers in JEDEC "top hat" configuration provide designers with exceptional selectivity over a broad range of industry requirements—from general-purpose to high environmental, low-leakage applications. Low forward voltage drop and low reverse current are characteristic of the whole line. Tin plating of all types provides corrosion protection and optimum solderability. Operating temperature ranges of −65°C to +165°C makes Tung-Sol silicon rectifiers ideally suited to high ambient temperature applications.

Tung-Sol silicon rectifiers are available for immediate delivery in volume from the factory and locally from a nationwide network of distributors. Tung-Sol Electric Inc., Newark 4, N.J. TWX: NK193.

Send for this helpful comparison chart. The first comprehensive technical data guide enabling the designer to compare at a glance all the most widely used top hat types for the specific ratings and curves critical to his application. Write for a free copy.

Technical assistance is available through the following sales offices: Atlanta, Ga.; Columbus, Ohio; Culver City, Calif.; Dallas, Tex.; Denver, Colo.; Detroit, Mich.; Melrose Park, Ill.; Newark, N.J.; Seattle, Wash. CANADA: Montreal, Que.; Abbey Electronics, Toronto, Ont.; Prairie Pacific Distributors, Ltd., Edmonton, Alta.

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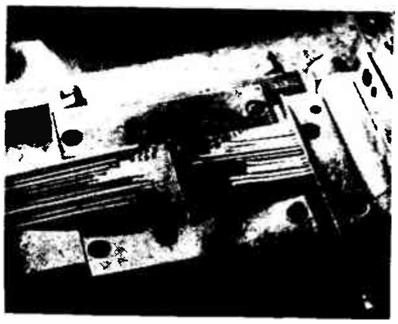
delayed further development. Recently, several ceramic coated wires have been made available and the process can now be applied to produce electrical equipment that can be operated under extreme environmental conditions.

Tolerances can be held as closely as with resinous materials. Grinding to finish dimensions presents no major problems, and excellent bonds have been achieved with inter-laminar thicknesses of 0.00025 to 0.001 inch.

Precision Cable Cutter For Missile Harnesses

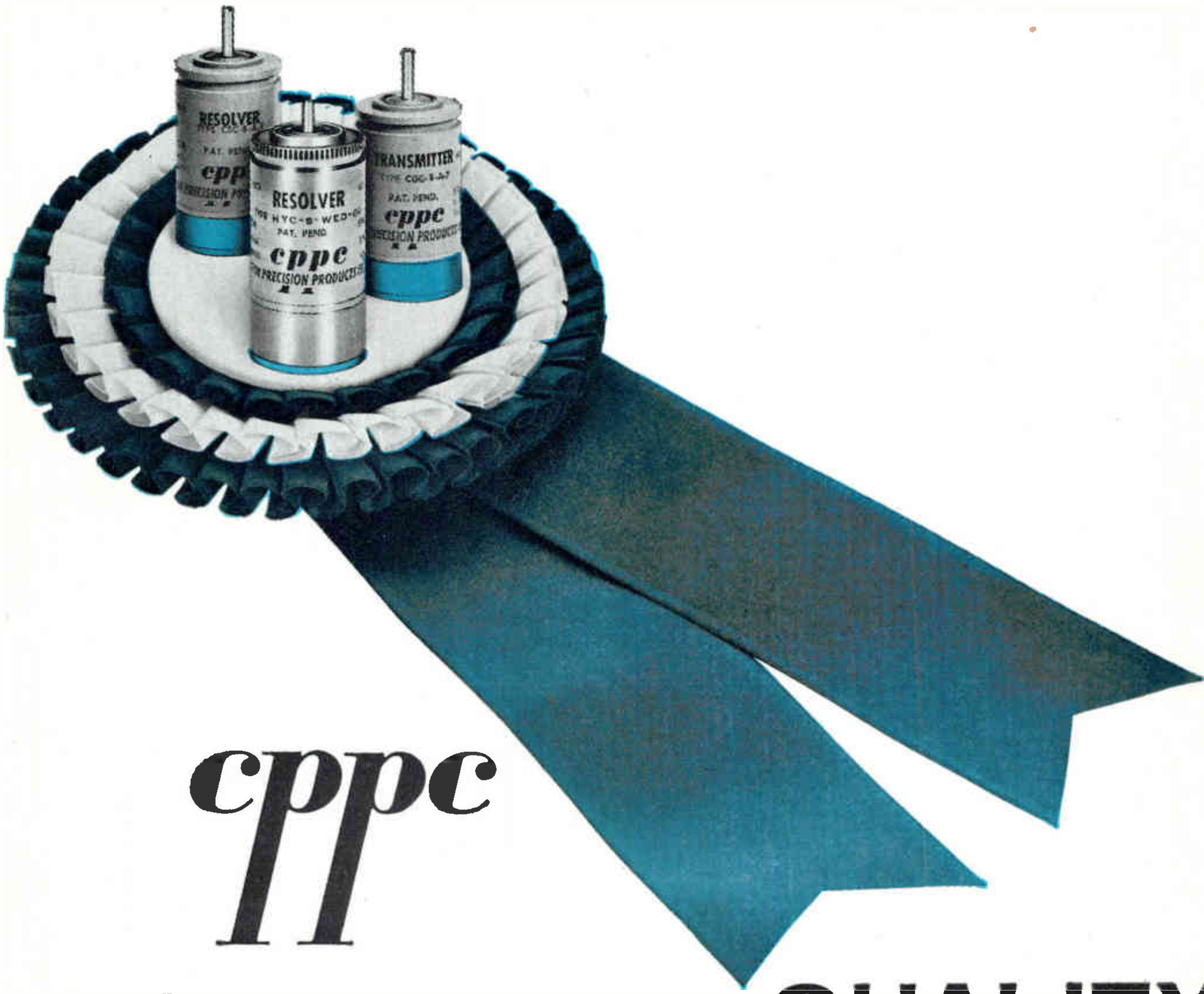


CUTTING and stripping ribbon cables for missile harnesses without damaging the conductor or insulation is being accomplished by General Dynamics/Pomona, Calif., with a special tool.

Because of the close tolerances involved in fitting the wiring into the missile (sometimes to within one-thousandth inch), precise cable dimensions are necessary.

Blades are carefully positioned at both top and bottom of the die. The ribbon is first split to separate wires ends, then placed carefully in the die. The blades cut the wires to the required depth, and, using an air pressure cylinder to separate the leads, the cables are stripped of insulation.

The process works through both an outer and inner layer of insulation as well as shield braiding.



cppc continues to stress QUALITY

The temptation is present in these days of lowering prices and shrinking profit margins to build a "cheaper" product. CLIFTON PRECISION CONTINUES TO STRESS QUALITY.

In fact, we list herewith some recent improvements which make our rotating components more expensive to build. But they give you a better product.

As pioneers in the synchro and rotating components field, we think our years of experience in building a QUALITY product continue to give buyers a plus factor that they will not want to overlook.

QUALITY FEATURES

1. Improved high temperature resistant magnet wire is used in all synchro construction. Standard units now withstand in excess of 125°C.

2. Improved high temperature resistant epoxy impregnation of rotors and stators is used in all synchros and servo motors.

3. Higher temperature resistant silicon lubricants are used in all bearings.

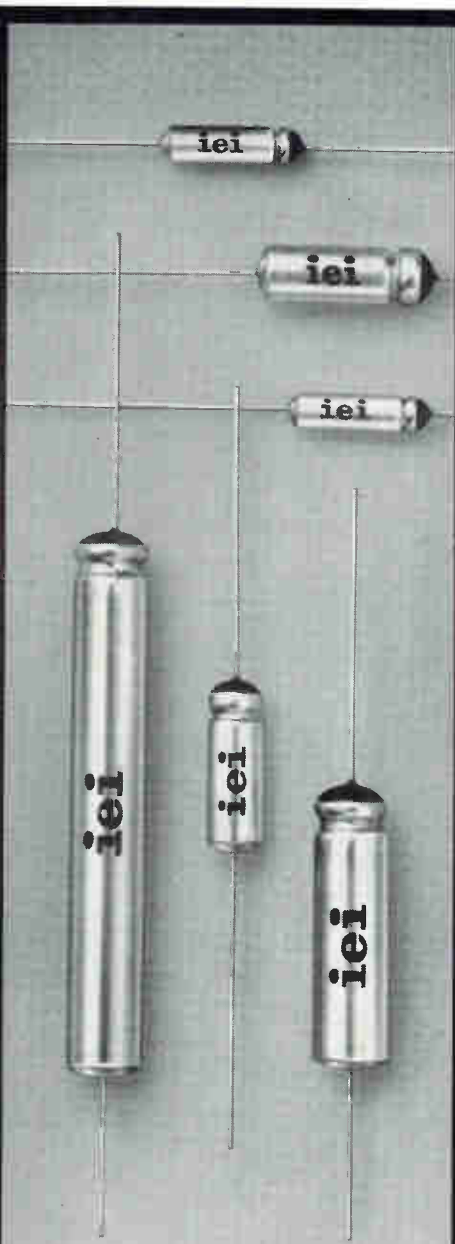
4. High temperature resistant slot insulation in all synchros and servo motors permits repeated high potential testing with no deterioration of insulating characteristics.

5. Completely solderless brush construction eliminates cold solder joints.

6. Improved interlaminar insulation techniques give our synchros and servo motors lower power consumption due to core losses thereby giving same or better electrical performance with a cooler design.

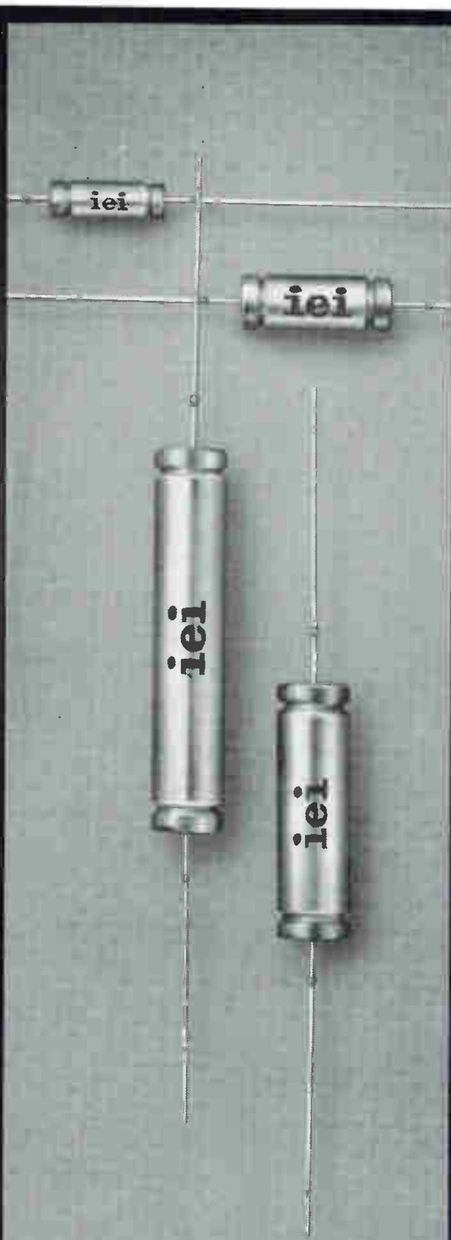
7. Increased usage of gold alloys in critical areas of slip ring construction (including increased thickness) improves reliability and permits versatility of slip ring design.

CLIFTON PRECISION PRODUCTS CO., INC. cppc Clifton Heights, Pa. Colorado Springs, Colo.



85°C Tantalum Foil
SUPER SERIES

Twice as much capacitance, lower dissipation factor and d-c leakage per MIL case size, for circuit miniaturization with safety. 15 to 150 WVDC; 2 to 1160 MFD. Write for Form 2850.

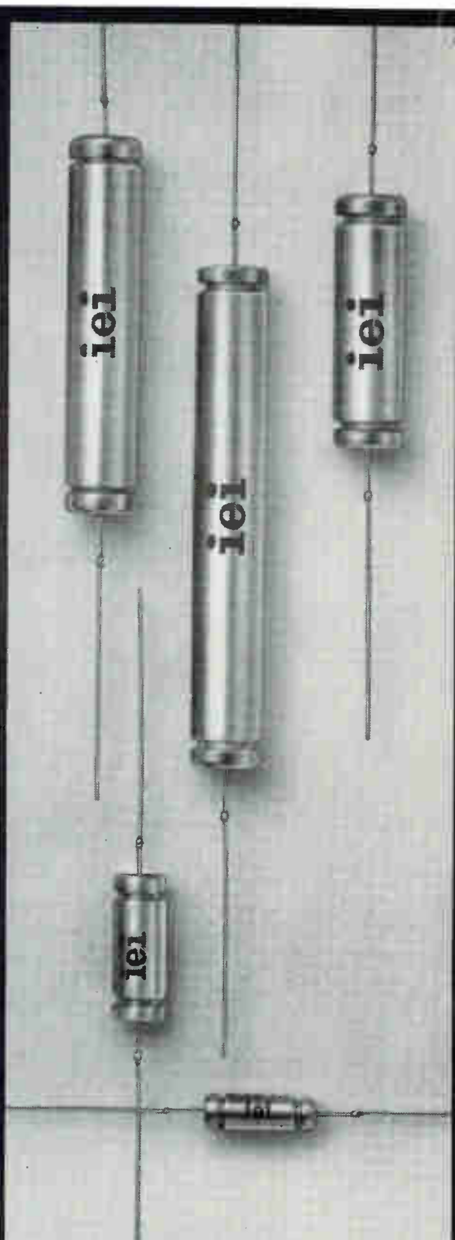


85°C Tantalum Foil, Standard

Equal or exceed MIL-C-3965, as confirmed in approved testing laboratory. Polar and non-polar.

Plain: 3 to 150 WVDC; 0.25 to 400 MFD

Etched: 15 to 150 WVDC; 0.5 to 580 MFD Write for Form 2864.



125°C Tantalum Foil

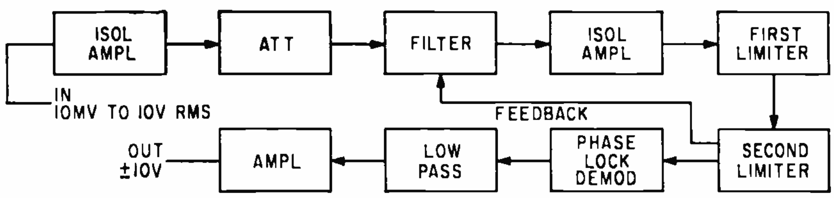
Long shelf and operating life at temperatures to 125°C. Polar and non-polar.

Plain: 10 to 150 WVDC; 0.15 to 160 MFD

Etched: 10 to 150 WVDC; 0.5 to 580 MFD Write for Form 2888.

iei = specialist in miniature Electrolytic Capacitors

DESIGN AND APPLICATION

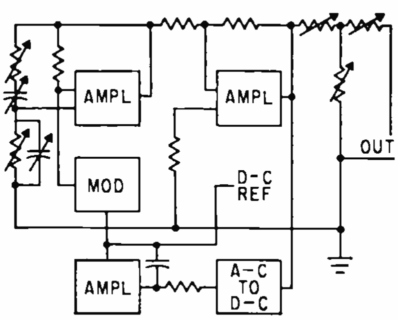


Predetection Playback to 150 Kc

Phase-lock principle allows control of bandwidth under poor signal-to-noise ratio

RECENTLY announced by Data-Control Systems Inc., East Liberty St., Danbury, Conn., the model GFD-4 transistorized predetection playback discriminator is a phase-locked, loop-type f-m discriminator designed to demodulate high frequency subcarriers or predetection recorded signals having demodulated frequency components as high as 300 Kc. Input level is between 10 mv and 10 v without adjustment with impedance of 1 megohm shunted by 50 pF. Channels are available with high band edge frequencies up to 1 Mc. Deviations from ±7.5 to ±43 percent may be used. Output is variable between ±1 to ±10 v for full bandwidth deviation with increasing frequency causing a positive output and decreasing frequency a negative output. Frequency response is d-c to 300 Kc. Loop filters are available for either frequency multiplexed or pulse-type data. The phase-lock system is used to allow control of video bandwidth when poor signal-to-noise ratio is encountered. Phase linearity of input, loop, and output filters are controlled to minimize errors in pulse systems due to transient response characteristics while amplitude linearity keeps harmonic and intermodulation products to negligible levels. The unit can drive combinations of tape recorders, and secondary demodulation equipment.
CIRCLE 301, READER SERVICE CARD

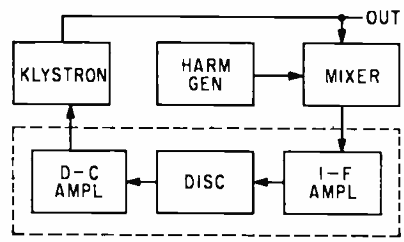
Reference Audio Oscillator Has 0.02% Stability



MANUFACTURED by Burr-Brown Research Corp., Box 6444, Tucson, Arizona, the model 9174B transistorized reference oscillator is continuously adjustable between 10 and 100,000 cps and produces sine waves with less than 0.02-percent amplitude stability and less than 0.05-percent distortion. Output is 3 v rms into a 600-ohm load. The circuit is an ultra-stable Wien bridge oscillator stabilized by applying the output to a precision a-c to d-c converter-integrator. The output is a d-c signal proportional to the amplitude of oscillations. This voltage is compared to a zener d-c reference. Any error signal is amplified, filtered and fed back to a modulator so as to maintain constant output amplitude. High-gain d-c amplifiers perform the various functions. Accuracy is ±1 percent and effects of temperature, jitter, hum, noise, line intermodulation, 20 v line changes and microphonics is less than 0.02 percent. (302)

Stabilizing Klystrons to 1 Part in 10^7

RECENTLY announced by Micro-Now Instrument Co., 6340 N. Tripp Avenue, Chicago 46, Illinois, the model 201 klystron frequency stabilizer will control klystrons to 25 Gc with the stability and accuracy of a crystal-controlled oscillator. Stability is 1 part in 10^7 and can be



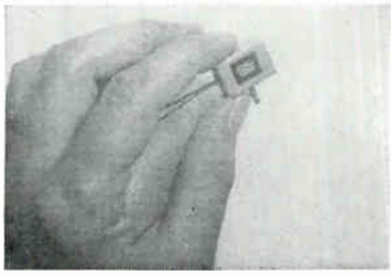
used with any klystron delivering more than 1 mw power. The unit is used with a microwave frequency calibrator and the only frequency limitation is the power output of the microwave harmonic multiplier. As shown in the sketch, the unit consists of an i-f amplifier, discriminator, d-c amplifier and network for coupling to the reflector of any klystron. Part of the klystron output is sampled and fed to a conventional microwave mixer. Harmonics from the microwave source are also fed to the mixer. The i-f frequency is 60 Mc. Variations in klystron frequency produce error signal that correct klystron frequency to that of harmonic generator. (303)

Overvoltage Device Arrests Extremely Large Transients

ANNOUNCED by Electro-Neutronics Inc., 1401 Middle Harbor Rd., Oakland 20, California, is a family of transient voltage arrestors for the elimination and/or isolation of voltage transients or overvoltage conditions from com-

munications systems or electrical equipment. One typical device, the model SX550x100, clamps between 2 and 50 v (preset) with a maximum protection of greater than 5,000 v, peak current is 10,000 amperes (20 μsec or more) falling off to 1 ampere in 100 ms. Response time is less than 0.2 μsec and recovery time is less than 10 μsec at 1 Kv pulse and less than 30 μsec at 5 Kv pulse. Input-output impedance is 600-ohms balanced, frequency response between 100 cps and 14 Kc is $\pm$0.1 db and between 10 Kc and 48 Kc, response is $\pm$0.2 db. Phase delay distortion is less than 50 μsec. Special models have been developed for computer inputs, d-c circuits and power supplies.

CIRCLE 304, READER SERVICE CARD

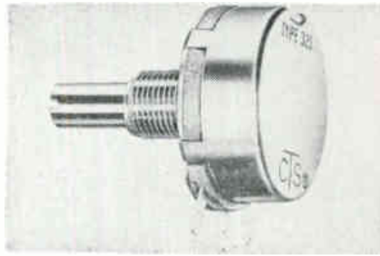


Miniature Choppers Withstand 100 G Shock

CAMBRIDGE SCIENTIFIC INDUSTRIES, INC., 18 Poplar St., Cambridge, Md., offers electromechanical choppers that withstand over 100 g shock and extreme environmental conditions. Measured into a 100 ohm load at either 60 or 400 cps, the units feature no noise. Designated 228 for 60 cps and 428 for 400 cps, they measure 0.525 by 0.750 by 0.350. Available at $50 each in quantities of 1 through 6. (305)

Mechanical Filters Offered in 5 Types

COLLINS RADIO CO., 19700 San Joaquin Road, Newport Beach, Calif. New family of mechanical filters include three 455 Kc center frequency filters with bandwidths of 800 cps, 2.7 Kc and 12 Kc and two 500 Kc filters with bandwidths of 200 cps and 800 cps. All have steep-skirted selectivity with 60 db to 6 db shape factors as low as 2.5 to 1. All are packaged in durable, high-impact phenolic cases and are suited for circuit board manufacturing techniques. (306)



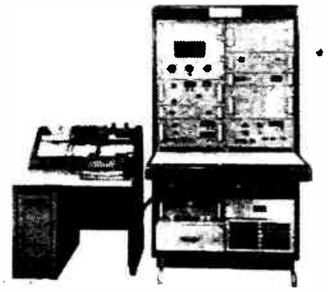
Variable Resistor Meets Mil Specifications

CTS OF BERNE, INC., Berne, Ind. Type 321 is a 1$\frac{1}{16}$ in. diameter military grade variable resistor with full 3-w rating at 70 C and highly reliable carbon-ceramic element. It provides reliability and stability of MIL-R-94B under extreme environmental conditions, but at the price of a conventional 2-w industrial control—55 to 65 cents in production quantities. The unit's resistance range is 250 ohms through 2.5 megohms linear taper and 2,500 ohms through 1.0 megohm audio taper. (307)

P-C Potentiometer Has Panel Mount Quality

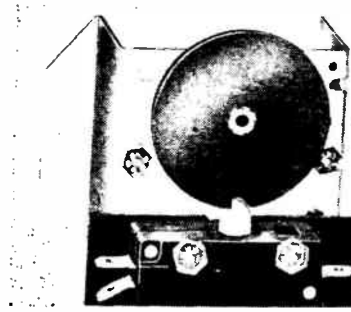
WATERS MFG., INC., Wayland, Mass. The JPD/2 is a ½-in. diameter p-c potentiometer with panel mount quality. Operational in a temperature range from −55 C to + 150 C, it has been thoroughly tested to meet and surpass MIL-R-19A requirements. When mounted on an insulated p-c board the JPD/2 dissipates 1 w at 85 C. Available in a resistance range from 10,000 to 20,000 ohms. For fast and accurate reading of the wiper position there are numbered positions on the housing with a scribe mark on the dial.

CIRCLE 308, READER SERVICE CARD



Capacitance Test System Features High Speed

OPTIMIZED DEVICES, INC., Pleasantville, N. Y. Model 1800 automatic capacitor data logging system provides capacitance and dissipation factor readings accurate to 0.5 percent of reading at a speed of less than 1 sec per measurement. Capacitors from 100 $\mu\mu$f to 1,000 μf can be measured and modules for either 1 Kc or 120 cps measurements are available. (309)

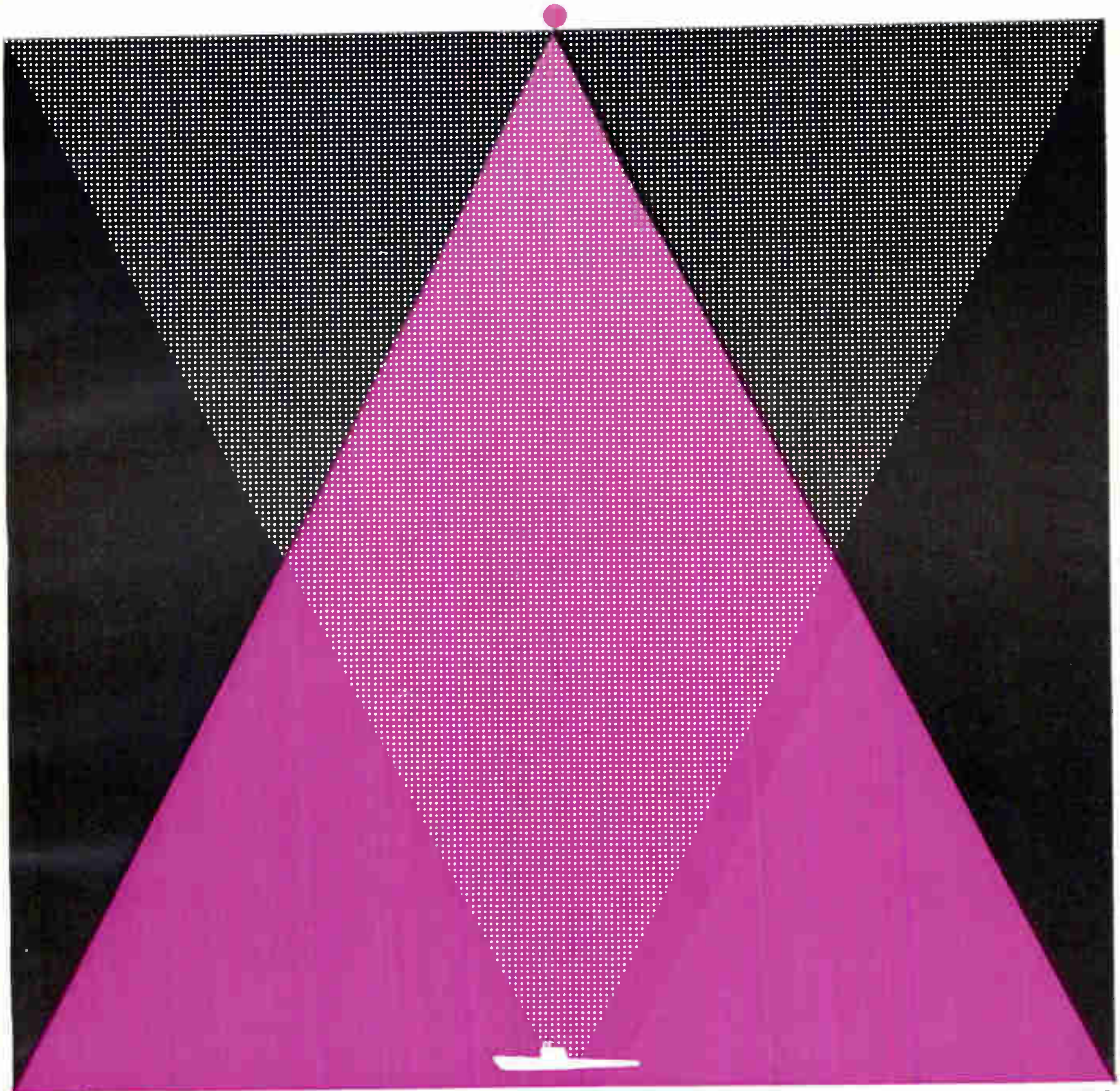


Low-Cost Cycle Timer Has Custom-Cut Cam

HAYDON DIV. of General Time Corp., Torrington, Conn. The RL71 is designed to fulfill the need for an inexpensive cycle timer on applications requiring speeds of not more than 1 rpm, and a minimum off time of 3 sec. Timer cam is cut to the specifications of individual applications. The RL71 employs one spdt combination quick disconnect and solder switch to repeat a set cycle or switching operation. (310)

Pressure Transducers

SEMTRAN INSTRUMENTS, INC., Route 73 Industrial Center, Maple Shade, N.J. Model 1000 pressure transducers designed and priced for



A QUESTION OF SUPREMACY: WHOSE EARS ARE KEENEST?

We make ears for the Navy at General Dynamics/Electronics-Rochester. So we're conditioned to the urgency of getting there first with the best in ASW equipment. ▲ And we go to unprecedented lengths to do so. Take the need to test SONAR gear in an operational environment—where wind, ice, weather and sailing schedules conspire to pile up frustrating delays. We've solved this problem by commandeering an entire lake—the only inland facility of its kind. Seneca Lake is the deepest of the picturesque Finger Lakes of Western New York State, with 600-foot depths and thermal gradients similar to the Atlantic Ocean. It is also the 35-mile long domain of a unique floating laboratory of our own design. Within this hydrojet, self-propelled barge, our engineers can reach deep water in minutes, and test even 35-ton transducers throughout the year. ▲

SUTEC—Seneca Lake Underwater Test and Evaluation Center—is one of several advantages we enjoy in ASW—including comprehensive indoor test facilities and a close working tie with Electric Boat and other General Dynamics' Divisions. ▲ If you have any ASW projects, remember: Every product we make started with a question. We solicit yours. ▲ Write 1419 N. Goodman St., Rochester 1, N.Y.

GD

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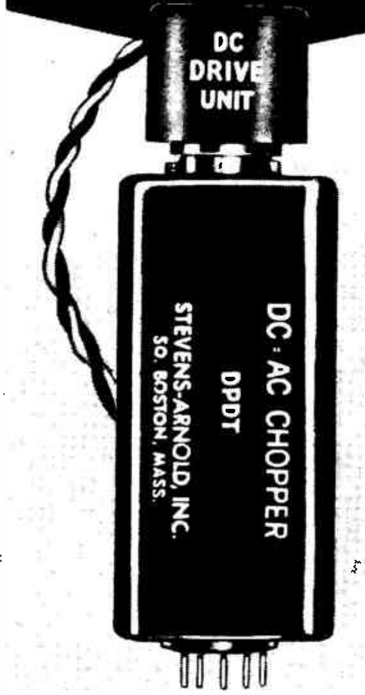
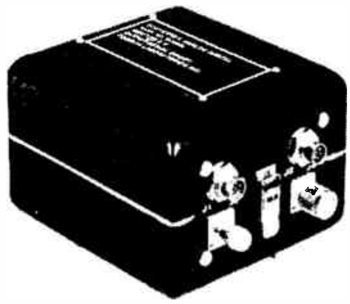
CIRCLE 87 ON READER SERVICE CARD



OEM and industrial applications feature an unamplified output of up to 2 v.

CIRCLE 311, READER SERVICE CARD

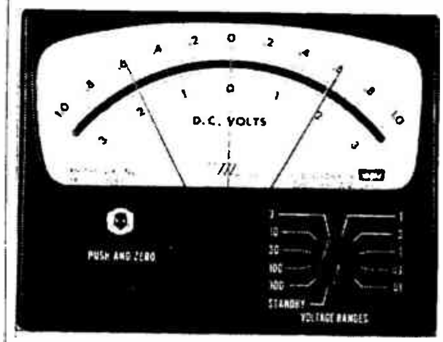


Airborne Converter Uses Few Components

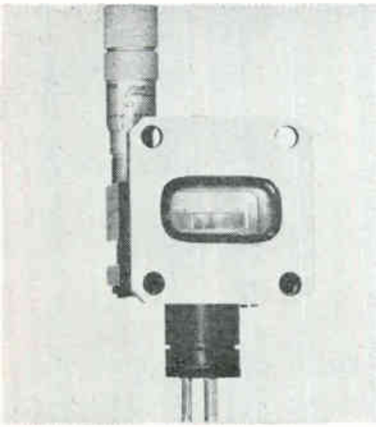
TOWSON LABORATIORIES, INC., 200 E. Joppa Road, Baltimore 4, Md. Model OC-1001 is an airborne model of capacitive charge transfer analog to digital converter. Units are capable of wide temperature operation and other environmental conditions typical of MIL applications. They offer high input impedance, sampling aperture of 1.3 μsec, $\pm$ 2.5 v full scale, 10 bit resolution plus odd count parity bit, 23,000 encodings or more per sec, serial binary NRZ output code format. It is approximately 3¾ by 6 by 5 in. and weighs 3.5 lb. (312)

A-C Line Regulator Gives Precise Control

ACME ELECTRIC CORP., Cuba, N. Y., announces an a-c line voltage regulator that provides precise, stepless voltage control for power loads up to 60 Kva (single phase), and 180 Kva (three phase). Designed for industrial application, the de-

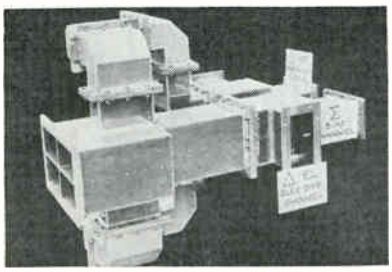


vice is suited for use with automated machinery, process control instrumentation, data processing machines, and other equipment with critical, voltage sensitive circuits. (313)



Reflex Klystron Equipped with Screw Tuner

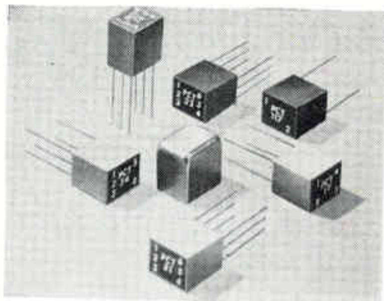
METCOM, INC., 76 Lafayette St., Salem, Mass. The 6310, designed for plug-in electrical operation, has a single screw tuner for ease in changing frequency. It offers rugged construction, tuning in the X band from 8.5 to 10.0 Gc with 70 mw power output over the entire range. Tuner is set for a uniform 60 in. oz torque over the range. Small lot price is $175. (314)



Monopulse Comparator Used at L-Band

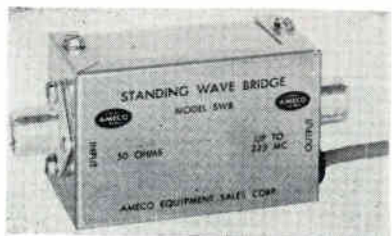
ANTENNA SYSTEMS, INC., Hingham, Mass., offers a compact, high-power, all-waveguide comparator for use at 1,250-1,350 Mc. Input vswr of the sum arm is less than 1.1, of the elevation difference arm is less than 1.12, and of the azimuth difference arm is less than 1.07. Isolation between the sum arm and elevation difference arm is greater than 40 db, between the sum arm and the azimuth difference arm is greater than 42 db and between the elevation arm and azimuth difference arm is greater than 42 db. Differential phase variation between any two outputs is less than 2 deg.

CIRCLE 315, READER SERVICE CARD



Transformers Are Color Coded

STANCOR ELECTRONICS, INC., 3501 Addison St., Chicago 18, Ill. Series of miniature transistor transformers are designed for p-c plug-in applications. They are called Polychromatrans because of the color coding technique used to differentiate their function. There are 22 different transformers in the line, covering most of the frequently used transistor applications. All are the same size, measuring 0.410 by 0.310 by 0.465 in. (316)



Standing-Wave Bridge Can Handle 1,000 W

AMECO EQUIPMENT CORP., 178 Herricks Road, Mineola, L. I., N. Y. Model SWB is an inductive type bridge that is continually left in the line. It reads swr's from 1.8 Mc to 225 Mc and can handle 1,000 w. It has negligible insertion loss. Contains two SO-239 uhf connectors. Size: 1⅝ in. by 2¼ in. by 4½ in. Net cost, $9.95. (317)

Retaining Rings

WALDES KOHINOOR, INC., 47-16 Austel Place, Long Island City 1, N.Y. New Truarc N-type retaining rings (basic, bowed and beveled) are said

THE NEW *SUPER* WEE-DUCTOR

An ultra reliable MOLDED SHIELDED r.f. subminiature inductor—available in inductances from 0.1 μH to 100,000 μH in 73 values.

The **SUPER** WEE-DUCTOR is shielded for minimum coupling in high density packaging and has extremely low dc resistance. Only 0.410" long and 0.157" in diameter, the **SUPER WEE-DUCTOR** meets all the requirements of MIL-C-15305B (Amendment #1), Grade 1, Class B, including moisture and immersion resistance and operation from −55°C to +125°C.

For complete engineering data, write Dept. WL-29, or phone 201-464-9300. All values available from stock.

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550 Springfield Ave., Berkeley Heights, N.J.

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LOW DRAIN, QUIET, LONG LIFE—LOW COST!
PRODUCTION—UP TO 2,500,000 PER MONTH
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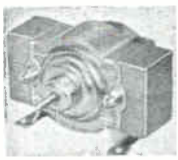
World's Leading Line

Large or small orders shipped on schedule. Over 30 sizes & types from 1½ to 12 volts. Modifications made to fit your needs. Also sub-assemblies.



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APPLICATIONS: Tape Recorders, Record Players, Clocks, Shavers, Music Boxes, Cameras, Turntables, Appliances, Toothbrushes, Displays, Toys, Hobbies, Etc.

Write for Catalog, Specs, Samples, Quotations. State intended use. Also—miniature & sub-miniature "grain of wheat" light bulbs. All voltages. Write for data.

FM-250R 1.5-6V

FM250N, 1.5-4.5V

RM-170S, 1.5-6V
RM-170SC, 3-12V
RM-170T, 1.5-3V

Supplying Midget Motor Needs for Over 25 Years

ARISTO-CRAFT Distinctive Miniatures (Dept. E-972)
314 FIFTH AVE., N. Y. 1, N. Y. — BRyant 9-9034

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Flame-Retardant laminated plastics for electrical and electronic applications

There are now 4 flame-retardant Synthane laminates to help the designers of computers, missile control equipment, transformers, circuit breakers or any other components subject to flame or heat.

These four grades FR-1, FR-2, FR-3 and FR-4 not only have excellent flame retardance but they combine many more properties desirable in an electrical insulation, such as low moisture absorption, low dielectric losses, mechanical strength and machinability. Supplied plain or copper clad. It will pay you to send for samples for your own evaluation and test . . . or write for information.

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GLendale 2-2211 TWX Valley Forge 735U

Synthane-Pacific, 518 W. Garfield Ave., Glendale 4, Calif. TWX GLDL 4417U

Synthane Corporation, 36 River Rd., Oaks, Pa.

Gentlemen:
Please send me your Engineering Bulletins on:
☐New Flame-retardant Grades ☐New High-temperature Grades

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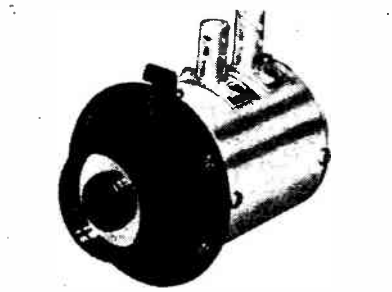
to provide approximately 20 percent higher thrust load capacity than conventional retaining rings of the same type and size.

CIRCLE 318, READER SERVICE CARD



R-F Attenuator Handles 1 W of Power

TELONIC INDUSTRIES, INC., Beech Grove, Ind. The TE-50 turret-type r-f attenuator has a range of 0-50 db in 10 db steps. It will handle 1 w of power, even in the 50 db position. Attenuating r-f signals from d-c to 1,250 Mc, it uses individual 50 ohm resistive pi-pads, mounted in a precision-machined rotor assembly. Accuracy is typically ±2 percent at 30 Mc and 5 percent at 400 Mc. Insertion loss, negligible to 300 Mc and not more than 0.2 db to 900 Mc; vswr, near unity. Price is $65. (319)

Duplexer-Limiter Compactly Packaged

SPERRY MICROWAVE ELECTRONICS CO., P.O. Box 1828, Clearwater, Fla., offers a three-port ferrimagnetic beacon duplexer-limiter package. The unit, operating from 5.4 to 5.9 Gc at power levels up to 40 Kw peak 40 w average with a max antenna mismatch of 2:1, uses modified type N connectors. It affords protection to mixers with 1N23 type crystals. The transmitter-to-antenna insertion loss is nominally 0.7 db, and the antenna-to-receiver loss is nominally 0.9 db. Unit also provides preselection to received signals. Price is approximately $1,200. (320)

INTEGRATING MOTOR GENERATORS are temperature compensated. Motors include standard 6-pole, and low inertia 4 and 6-pole units. Kearfott Div. General Precision Inc., Little Falls, N. J. (321)

DIGITAL VOLTMETER/OHMMETER for systems integration. The transistorized unit can measure d-c volts, d-c ratios and ohms. Electro Instruments, Inc., 8611 Balboa Ave., San Diego 12, Calif. (322)

AUTOMATIC RESPONSE PLOTTER is a high-speed, accurate unit. It covers 20-20,000 cps range in one continuous sweep. Hathaway Instruments, Inc., 5800 E. Jewell Ave., Denver 22, Colo. (323)

ELECTRONIC DATA PRINTER operates in high speed communication systems. It permits transmission and reception of 5, 6, 7 and 8 level codes. Kleinschmidt Div. of Smith-Corona Marchant, Deerfield, Ill. (324)

MAGNETOSTRICTIVE DELAY LINES in sealed or unsealed cases. Delay length is 3,500 μsec. Tempo Instrument Inc., Plainview, N. Y. (325)

BEZELS for Nixie tube displays. They are offered preassembled or as component parts. Burroughs Corp., P. O. Box 1226, Plainfield, N. J... (326)

A-C LINE REGULATOR is all solid state. Input is 45 to 70 cps, 95 to 135 v. Dressen-Barnes Electronics Corp., 250 No. Vinedo Ave., Pasadena, Calif. (327)

LINEAR ACTION SWITCHES meet MIL-S-6743 and MIL-S-22885. Available in spst through 6pdt, in either momentary or alternate action versions. Strader Corp., 21531 Strathern, Canoga Park, Calif. (328)

COSINE PHASE PLOTTER compares frequency standards from 10 Kc to 5 Mc. Price is $225. RMS Engineering, Inc., 486-14th St. N.W., Atlanta 13, Ga. (329)

D-C MICRO-VOLT-AMMETER has 1 percent basic accuracy. It covers 10 μv to 1,000 v and 10 $\mu\mu$a to 1,000 μa. Millivac Instruments, Box 997, Schenectady, N. Y. (330)

NOISE GENERATOR provides dual output. A solid state chopper provides the desired stable l-f spectrum. Elgenco, Inc., 1231 Colorado Ave., Santa Monica, Calif. (331)

CABLE CLAMPS can reduce harnessing time by 50 percent. Clamps may be applied before or after wiring. Panduit Corp., 17301 Ridgeland Ave., Tinley Park, Ill. (332)

CERAMIC MAGNET MATERIAL for d-c motors. Index II features high energy product and high intrinsic coercive force. Indiana General Corp., Valparaiso, Ind. (333)

OPERATIONAL D-C AMPLIFIERS are octal based. They are designed for analog simulator and servo drive applications. Embree Electronics Corp., West Hartford, Conn. (334)

STEPPING MOTOR is less than 1 cu in. It has speeds up to 800 steps/sec. Sigma Instruments, Inc., 170 Pearl St., So. Braintree, Mass. (335)

DECADE RESISTANCE-STANDARD SETS have 100 ohm and 1 megohm primary standard resistors. Stability is better than ± 0.0015 percent absolute. Julie Research Laboratories, Inc., 603 W. 130th St., New York 27, N. Y. (336)

DIGITAL COMPUTER of average transients. It is designed for use in field and lab. Mnemotron Corp., Pearl River, N. Y. (337)

ALL-PURPOSE PACKAGED TRIGGER CIRCUIT is hermetically-sealed. Units are for use with silicon controlled rectifiers. VecTroL Engineering, Inc., 85-85 Magee Ave., Stamford, Conn. (338)

A-C RELAY is a 4pdt device. It measures 1[illegible] in. high by [illegible] in. wide by 1[illegible] in deep. Potter & Brumfield, Princeton, Ind. (339)

SERVO CLAMPS are used to fasten the housings of components to mounting plates. Price is 10¢ each. Theta Instrument Corp., Saddle Brook, N. J. (340)

DIGITAL VOLTMETER has automatic polarity, automatic ranging. Price is $995. Beckman, Berkeley Division, Richmond, Calif. (341)

C-BAND RADAR TRANSPONDER is lightweight, high power unit. It is pressurized and designed for operation in typical missile environments. Aero Geo Astro Corp., Alexandria, Va. (342)

RESISTANCE DECADE BOX is compact and accurate. It is calibrated to a standard set of 3 ft test leads. Riedon Division, On Mark Engineering Co., 7929 Hayvenhurst St., Van Nuys, Calif. (343)

REFERENCE POWER SUPPLIES in component packages. Price is $300 to $600 in the up to 5 w power range. Glentronics, Inc., 748 E. Alosta Blvd., Glendora, Calif. (344)

DIODE TESTER has 0-1 Kv piv, 0-1.5 amp peak forward current. Price is $185. Disc Instruments, Inc., 3014-B S. Halladay, Santa Ana, Calif. (345)

BANDPASS FILTER automatically tracks signals. Bandpass is adjustable from 2.5 to 100 cps. Interstate Electronics Corp., 707 E. Vermont Ave., Anaheim, Calif. (346)

FLAT-DIPPED CAPACITORS with high moisture-resistance properties. Temperature range is from − 55 C to +85C. General Electric Co., Schenectady 5, N. Y. (347)

S-BAND PULSE KLYSTRON yields 200 Mc bandwidth. It is designed to operate at 6 Mw peak. Eitel-McCullough Inc., San Carlos, Calif. (348)

SILICON ALLOY TRANSISTOR with extremely low collector leakage. All are pre-aged at 200 C for 150 hr. Kearfott Div., General Precision, Inc., Little Falls, N. J. (349)

Literature of the Week

D-C AMPLIFIER Elco, Inc., 1225 W. Broad St., Falls Church, Va. Bulletin 43-562 gives complete specifications for the model DCA-50C wideband d-c amplifier...(350)

TWO-WAY COLOR MEASUREMENT Instrument Development Laboratories, Inc., 67 Mechanic St., Attleboro, Mass., has published a 12-page booklet describing the Color-Eye combined colorimeter and abridged spectrophotometer. (351)

SIGNAL TRACER Don Bosco Electronics, Inc., Littell Road, Hanover, N. J., has a flyer on the Stethotracer, a transistorized, pen size, self-contained signal tracer. (352)

BLOCK READERS Electronic Engineering Co. of California, 1601 E. Chestnut Ave., Santa Ana, Calif. Circuit advantages of employing block readers for punched tape programming are shown in a brochure. (353)

HALL GENERATORS Helipot Division of Beckman Instruments, Inc., 2500 Harbor Blvd., Fullerton, Calif. Data sheet presents a complete line of Halleflex solid state voltage generators. (354)

EARTH SATELLITE COMMUNICATIONS Lenkurt Electric Co., Inc., San Carlos, Calif. Vol. II, No. 5 of the *Demodulator* contains a well-illustrated article on earth satellite communications. (355)

ANALOG COMPUTER Electronic Associates, Inc., Long Branch, N. J. A 12-page brochure describes the PACE TR-10 desk-top size analog computer and its components and accessories. (356)

SERVO MOTORS Kearfott Div., General Precision, Inc., Little Falls, N. J. Catalog sheet contains data and a dimensional drawing for size 8 inertial damped servo motors. (357)

POWER TRANSISTORS Clevite Transistor, Waltham 54, Mass., has issued technical data sheets on its new 5 ampere and 15 ampere germanium power transistors. (358)

MICROWAVE COMPONENTS Guide Mfg. Co., 7602 San Fernando Road, Sun Valley, Calif., offers an easy-to-use product index and price list for waveguide and microwave components. (359)

RELAY PRODUCTION Swanson-Erie Corp., 814 E. Eighth St., Erie, Pa. How one machine processes, assembles and inspects 1,000 electrical relays in one hour is the subject of a 4-page brochure. (360)

ELECTRONIC PRINTER Hull Instruments, 726 Mission St., So. Pasadena, Calif. A six-page brochure describes a digital alpha numerical printer which, through the use of fiber optics, can print 6000 characters per sec. (361)

NEW BOOKS

Arrangement of molecules in a unit cell of anthracene material

Organic Semiconductors

Edited by J. J. BROPHY and J. W. BUTTREY

The Macmillan Company, New York, 1962, 243 *p*, $9.

This volume is based on papers presented at the inter-industry conference on organic semiconductors held in April 1961, which was cosponsored by the Armour Research Foundation and ELECTRONICS. It begins with a semitechnical survey of the field, followed by several groups of papers organized by subject matter in the order of increasing speculativeness.

The book will serve as a fine introduction to the subject for engineers in the semiconductor field; it is balanced to indicate the variety of directions in which research is proceeding. The last paper, by James F. Bourland, appraises the future of organic semiconductors from the point of view of management.—G.V.N.

Advances in Quantum Electronics

Edited by JAY R. SINGER

Columbia University Press, New York, 641 *p*, $15.

Collection of the 70 papers presented at the Second International Conference on Quantum Electronics. Topics covered include: masers, lasers, infrared-light detection, modulation and mixing; resonance phenomena such as cyclotron resonance, coherence and incoherence, and information-carrying capabilities in the presence of quantum effects. Although there is a wealth of information and ideas here, non-specialists will find the going rough since the authors are first-class physicists who have written these conference papers for their peers. —S. V.

Static Power Convertors

Edited by ROBERT WELLS

John Wiley & Sons, Inc., New York, 1962, 275 *p*, $7.

Static Power Converters is a useful book in that it brings together many topics normally found scattered throughout specialized texts on motors, controls, rectifiers and other aspects of a-c to d-c conversion.

Two aspects of the title are misleading: first, the book is largely about mercury arc rectifiers, which although not rotary, are not static in the modern sense. Only 17 pages are devoted to semiconductors, confined to the germanium diode, leaving a vast field of transistors, diodes, rectifiers, silicon controlled rectifiers etc. undiscussed. Secondly, the term converters connotes, at least to American readers, a device other than a plain rectifier. There is no mention of frequency converters or d-c to a-c converters. A better title might have been, Mercury Arc Rectifiers as Power Sources.

Since the book covers a great deal of ground, including supplies for powering d-c motors, it provides a very useful survey of basic principles involved in many branches of mercury-arc rectifier application.—S.F.

Information Theory

Edited by COLIN CHERRY

Butterworth, Washington, 488 *p*, $16.50

This volume contains the thirty-six papers presented at the Fourth London Symposium on Information Theory late in 1960. The first three symposia were held in 1950, 1952 and 1955. Despite the title, this symposium is not devoted purely to information theory, but covers a wide ground with papers on learning mechanisms, on sensory information and biological models, syntactics and semantics, and human reaction to information. This volume will not be of particular interest to design engineers and their ilk, but certainly will be to those who are farming the interdisciplinary areas that information theory has propagated. Ten years from now these areas may be sufficiently domesticated to provide design engineers a fair portion of their bread and butter work.—N.L.

Introduction to Microwave Theory

By H. A. ATWATER

McGraw-Hill Book Co., Inc., New York, 1962, 244 *p*, $8.75.

An outgrowth of notes used in a one-semester course in microwave theory given to upper division and first-year graduate students that supposes a background in electromagnetic theory, the book emphasizes the philosophy and methods of the analytical approach to in terms of electromagnetic fields.

The chapters deal with subjects such as transmission line theory, wave equations, discontinuities and impedances in waveguides, microwave resonators, klystrons and magnetrons, magnetic materials and millimeter waves. The appendix is well stocked with useful reference material, primarily mathematical—B.A.B.

Electroluminescence

By H. K. HENISCH

Pergamon Press, New York, 1962, 368 *p*, $12.50.

This is probably the first textbook published that is devoted to a comprehensive treatment of electroluminescent theory, including an outline of devices that use electroluminscent phenomena.

Fundamentals and techniques for achieving particular operating characteristics are generously treated in the first 250 pages; the rest gives a broad coverage of the uses of electroluminescence both as light sources and for coupling elements in electroluminescent-photoconductor logic systems.

Particularly valuable is the elaborate array of references, indexed by year of original publication. One is surprised to discover that electroluminescent phenomena were observed well before Destriau published his paper in 1936.—S.F.

Sprague Readies Basic Research Center

SPRAGUE ELECTRIC CO., 36-year-old electronic components manufacturer, will formally open on Oct. 11 the new Sprague Research Center, located across the street from the main entrance to its North Adams, Mass., headquarters plant.

James R. Killian, Jr., chairman of the corporation of MIT, will be principal speaker.

The 40,000-square-foot laboratory will be the focal point of Sprague's R&D program, currently pegged at $7 million annually. The new laboratory will concentrate on basic research, including such fields as solid-state physics, chemistry and the physics of dielectric materials. Development work will continue to be carried on in the North Adams plant and other product facilities.

Frederick M. Fowkes has been named director of research under Frederick R. Lack, senior vice president in charge of research. Fowkes, a physical chemist previously associated with the Shell Development Company, will administer the new research laboratory.

Sprague Electric reported 1961 sales of $77,650,168 and has nearly 30 manufacturing operations in the U. S. and five foreign countries. Sprague's American operations employ 8,000 persons.

In terms of sales, Sprague ranks 495th among the 500 largest U. S. corporations, but it ranked 65th among the 500 in terms of percentage earned on invested capital in 1961.

Hazeltine Research Elects Loughlin

B. D. LOUGHLIN has been elected vice president for research of Hazeltine Research, Inc., a subsidiary of Hazeltine Corp., Little Neck, N. Y.

Holder of the Vladimir K. Zworykin Television Prize of the IRE and the David Sarnoff Gold Medal Award of the SMPTE. Loughlin joined Hazeltine in 1939. In 1956 he was named chief engineer of the research division of Hazeltine Research Corp. The following year, he became a research consultant to Hazeltine along with other companies.

In his new post, Loughlin and his engineering group will continue to concentrate their efforts on the simplification of color television receivers.

PRL Electronics Names Charshafian

PRL ELECTRONICS, INC., Rahway, N. J., announces the appointment of former Curtiss-Wright vice president, J. O. Charshafian, as its new president.

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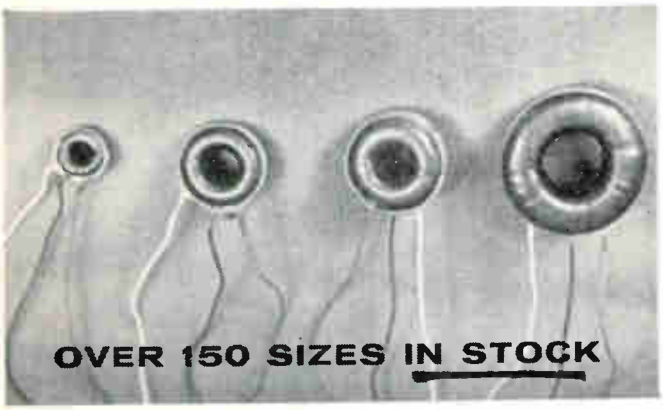

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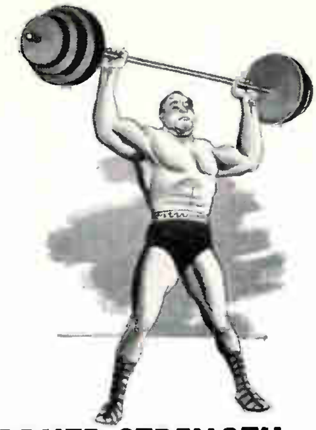

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CIRCLE 103 ON READER SERVICE CARD

commercial and industrial applications and special electromechanical devices.

General Electric Names Hodges

DAVID J. HODGES has been appointed manager of voltage-tunable magnetron engineering at General Electric's Power Tube department, Schenectady, N. Y. A department project engineer since 1954, Hodges succeeds M. Weinstein who recently left the company.

Rixon Electronics Hires Miller

J. WILLIAM MILLER has joined Rixon Electronics, Inc., Silver Spring, Md., as a project manager for communications subsystems.

Before coming to Rixon, Miller was with Page Communications Engineers, Inc., for over seven years as project manager and engineer.

Technical Materiel Appoints Shalag

THE TECHNICAL MATERIEL CORP. of Mamaroneck, N. Y., announces the appointment of W. C. Shalag as executive vice president to head up operations of its wholly owned subsidiary, TMC Systems, in Alexandria, Va.

Prior to this appointment, Shalag has acted in the capacity of vice president in charge of operations at TMC Systems for the past several years.

TRW Promotes Paul McGarrell

PAUL H. MCGARRELL has been named chief engineer in the electrical products department of Thompson Ramo Wooldridge's TAPCO division, Cleveland, O. Since joining TRW in 1956, McGarrell has had responsibility for key programs.

PEOPLE IN BRIEF

Richard H. Tuznik, formerly with Westinghouse Electric Corp. and Bliley Electric Co., joins Systems Inc. as a senior engineer. General Instrument Corp. promotes **John L. Herre** to v-p/government relations of its Radio Receptor div. **Robert T. Campion** and **John J. Burke** advance at Lear Siegler, Inc., to senior v-p's. **Charles M. Price** moves up to associate head of the Astrodynamics dept. of the Research and Planning div. of Aerospace Corp. Bendix-Scintilla ups **Donald S. Jones** to asst. g-m. **Robert H. Johnson** promoted to quality control mgr. of Phillips Control Co. **Carl David Todd** and **Richard S. Simpson** elevated to head of engineering and supervisor of production engineering, respectively, of the packaged assemblies dept. of the electronic products div. of Hughes Aircraft Co. **Ronald L. Bentley** advances to administrative mgr. of the Instrumentation div. of Microdot Inc. **H. T. Deverell**, previously with The Thomas & Betts Co., named executive engineer responsible for all product engineering for its subsidiary, Kent Mfg. Corp. **Murray Hoffman**, ex-Philco Corp., joins Airtron as engineering mgr. for ferrite devices. **Edwin J. Bradley**, from Sperry Rand to Diodes, Inc., as mgr. of marketing. **Helmut J. Schwarz** transfers from the Hamilton Standard div. to the Research Laboratories of United Aircraft Corp. as a senior research scientist.

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DOUGLAS AIRCRAFT CO. Missile and Space Systems Division Santa Monica, California	37	4
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MOLONEY ELECTRIC CO. St. Louis 20, Mo.	110	10
PHILCO WESTERN DEVELOPMENT LABS. Sub. of Ford Motor Co. Palo Alto, California	107	11
REPUBLIC AVIATION CORPORATION Farmingdale, Long Island, New York	109	12
SPACE TECHNOLOGY LABORATORIES, INC. Sub. of Thompson Ramo Wooldridge Inc. Redondo Beach, California	15	13
U. S. NAVAL CIVIL ENGINEERING LABORATORY Port Hueneme, California	108	14

* This advertisement appeared in the 8/31/62 issue.

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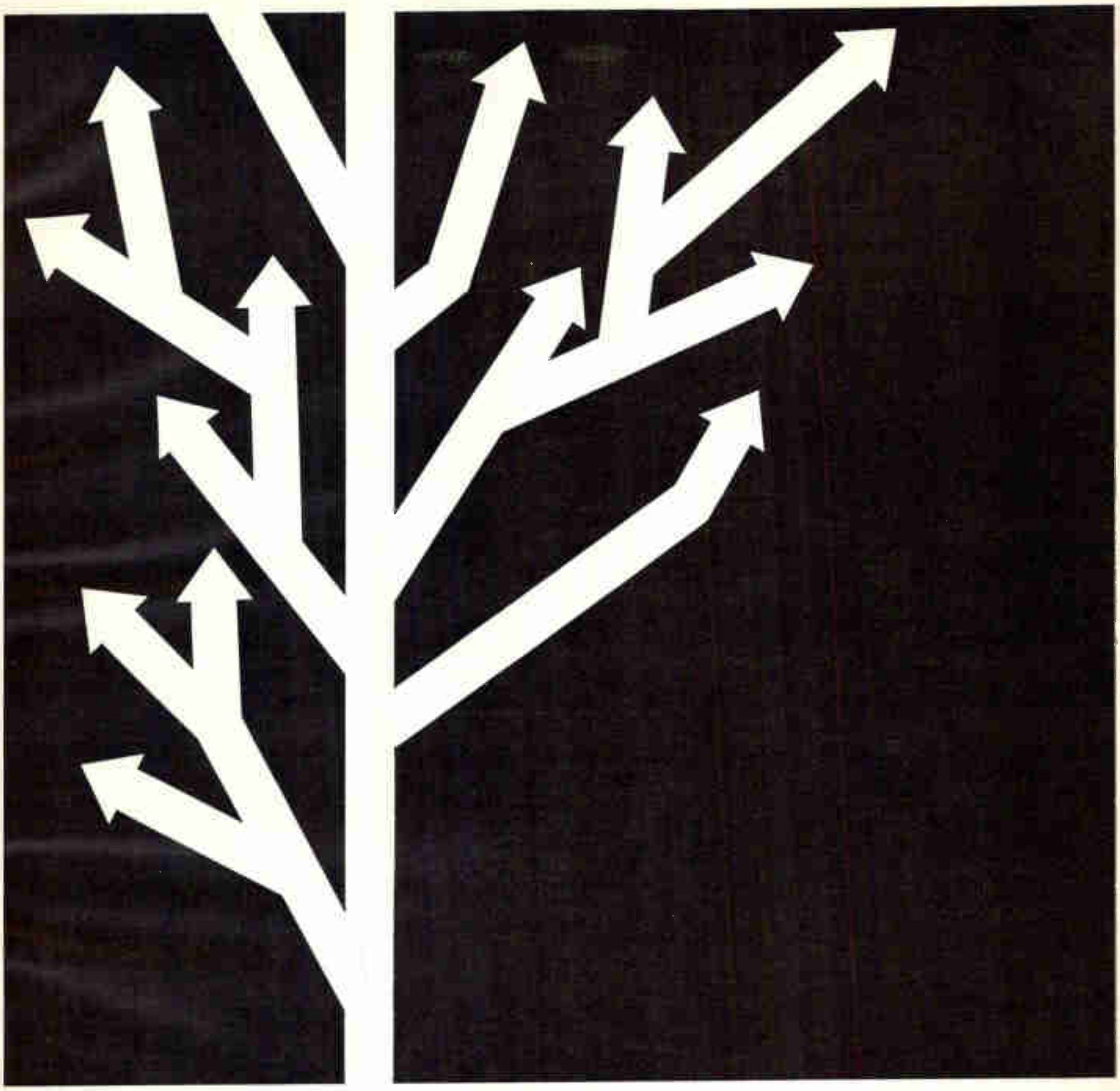

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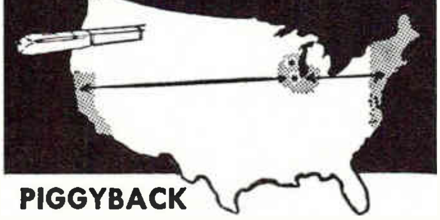

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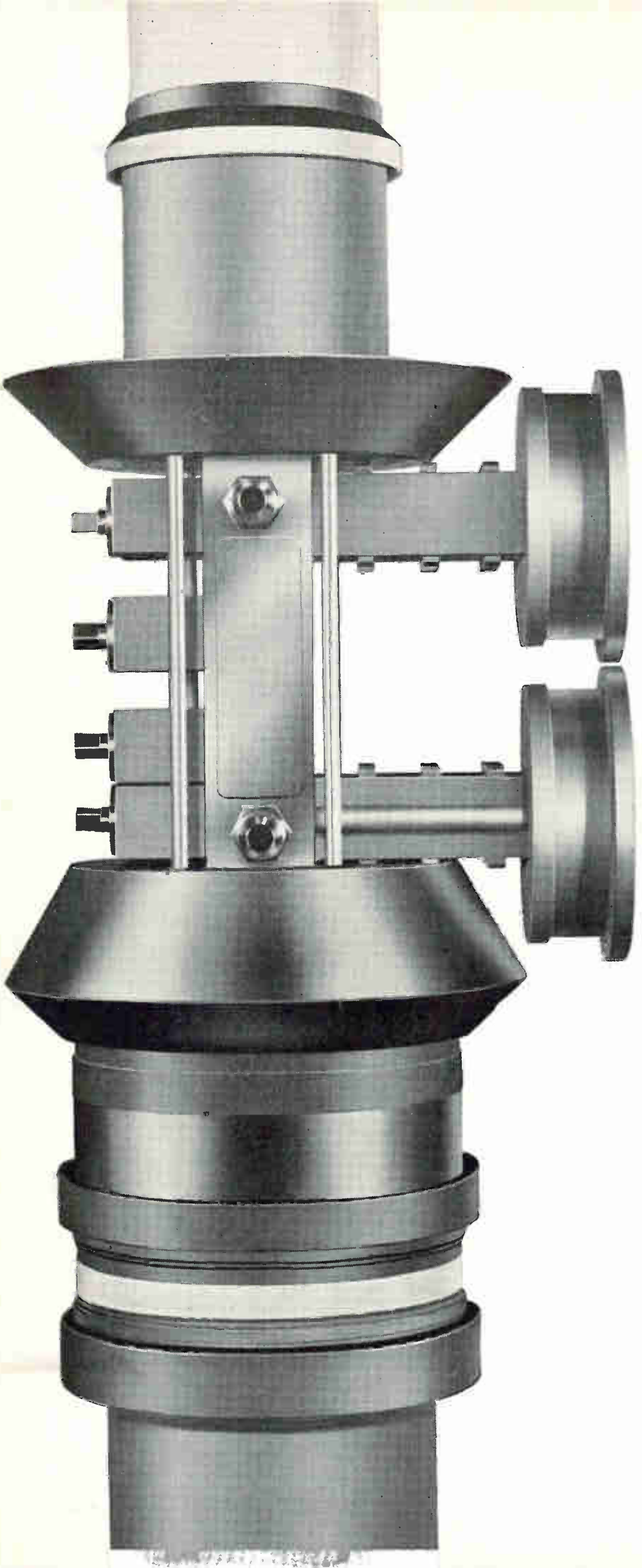
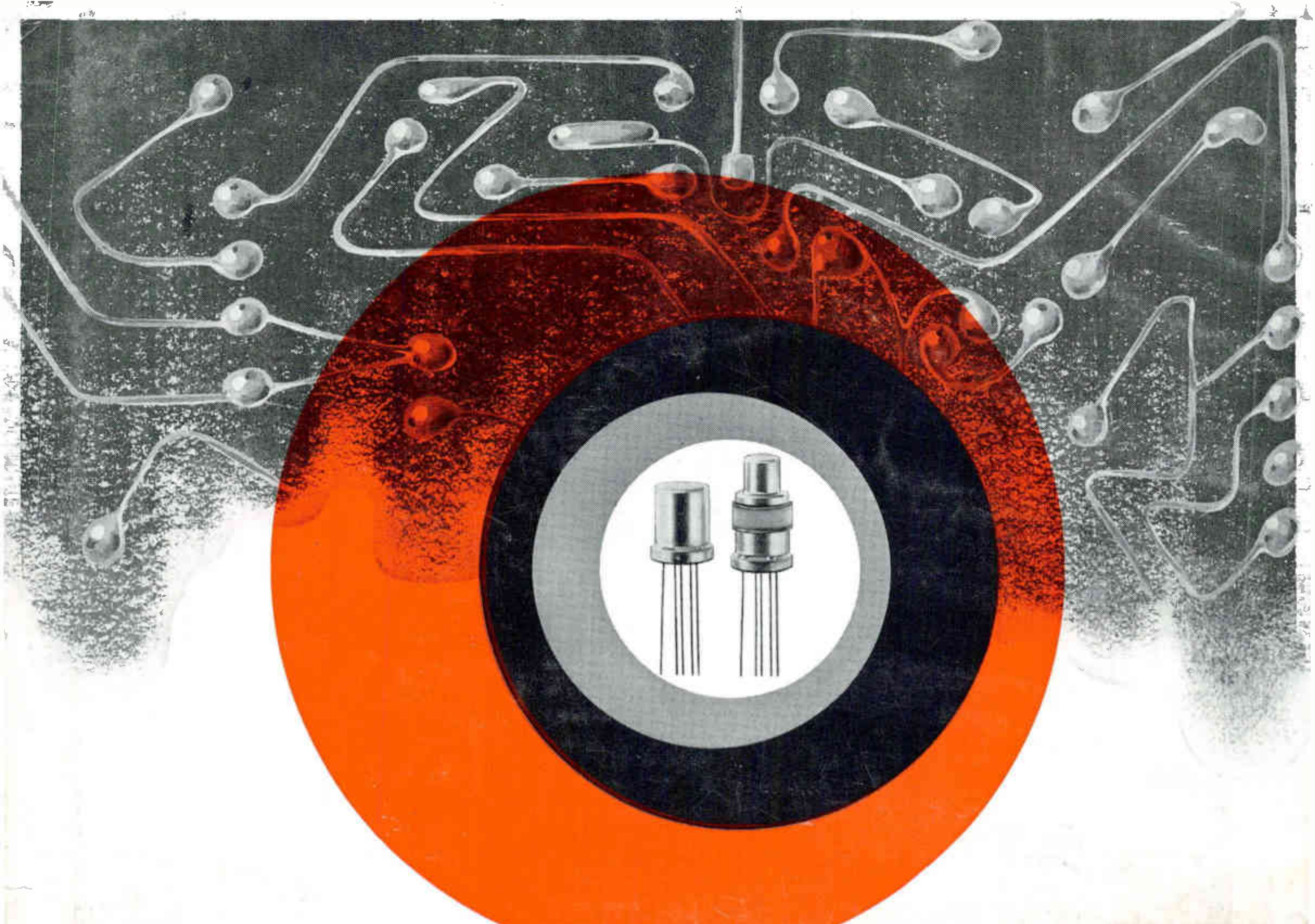


10 TO 50

120-DAY



New from RCA...
Developmental **LONG-LEAD NUVISTORS**
for applications requiring solder-in components

RCA is now developing a series of long-lead nuvistor types designed to be soldered directly into printed circuit boards ... without sockets. This simplification can:

- cut assembly cost and time
- save space
- eliminate the undesirable loading effects sometimes encountered with sockets in high-frequency applications.

Nuvistors are a perfect choice for high-frequency solder-in applications because of their high reliability and long life. (Recent tests proved the reliability factor of RCA-7586 nuvistors to be only 0.36% or less failures per thousand hours with a 95% confidence level.)

The table at right indicates the long-lead nuvistor types now in development.

Developmental Number	Commercial Prototype	Developmental Long-Lead Nuvistors Description
A-15212	RCA-7586	General-purpose industrial medium-mu triode
A-2702	RCA-7587	General-purpose industrial sharp-cutoff tetrode
A-15321	RCA-7895	Industrial high-mu triode
A-15319	RCA-8056	Medium-mu triode for low B+ and HYBRID equipment applications
A-15320	RCA-8058	Double-ended high-mu rf power amplifier triode for UHF applications
A-15317		Triode for low-level Class C service
A-15318		Double-ended triode for low-level Class C service
Following types offer EXTRA low failure rates in early life periods, for applications where the primary objective is high and reliable performance for periods up to 100 hours: e.g., sonobuoys, minibuoys, rocketsondes, weathersondes.		
A-2707		Tetrode for oscillator-multiplier applications through 100 Mc
A-15307		Triode for oscillator-multiplier, and amplifier applications through 200 Mc
A-15309		Triode for low B+ and HYBRID equipment applications

Still other nuvistor types are in early stages of development— including a nuvistor with a 13.5-volt heater for low B+ and HYBRID equipment applications in mobile communications. These long-lead nuvistor types constitute another dramatic step forward in the rapidly expanding field of nuvistor receiving tube design. For details about specific types, talk with your RCA Field Representative.

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RCA ELECTRON TUBE DIVISION FIELD OFFICES... EAST: 744 Broad Street, Newark 2, New Jersey, HUmboldt 5-3900 • **MIDWEST:** Suite 1154, Merchandise Mart Plaza, Chicago 54, Illinois, WHitehall 4-2900 • **WEST:** 6801 East Washington Boulevard, Los Angeles 22, California, RAymond 3-8361; 1838 El Camino Real, Burlingame, California, OXford 7-1620.

August 26, 1960

electronics

Miniature grid-controlled electron injectors make possible a 39-trace cathode ray tube of reasonable size described on p 51

New circuit extends transistor frequency performance. See p 56

A McGraw-Hill Publication 75 Cents

Creative Microwave Technology

Published by MICROWAVE AND POWER TUBE DIVISION, RAYTHEON COMPANY, WALTHAM 54, MASS., Vol. 2, No. 3

RAYTHEON 1,000,000-WATT MAGNETRON LOGS OVER 13,000 HOURS IN MOBILE RADAR

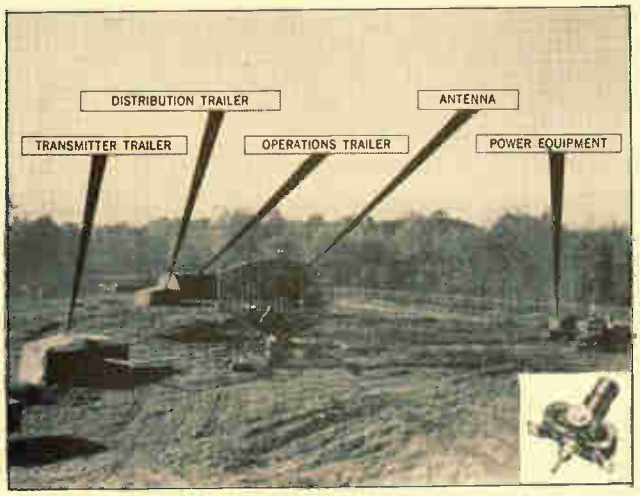
This is the first reported history of a Raytheon QK-358 magnetron substantiated with an exhibit. Still, there are numerous other cases in which these exceptional Raytheon tubes have been clocked in excess of 10,000 hours, radiating at peak power.

The case in point concerns the application of a QK-358 magnetron in an AN/FPS-8 radar, for which the General Electric Company is the prime contractor. When the tube was replaced after 13,000 hours of service for "preventative maintenance" reasons, it was returned to Raytheon where the tube was found to be operating within specifications. Findings showed it to be highly stable and still capable of radiating more than one megawatt of power.

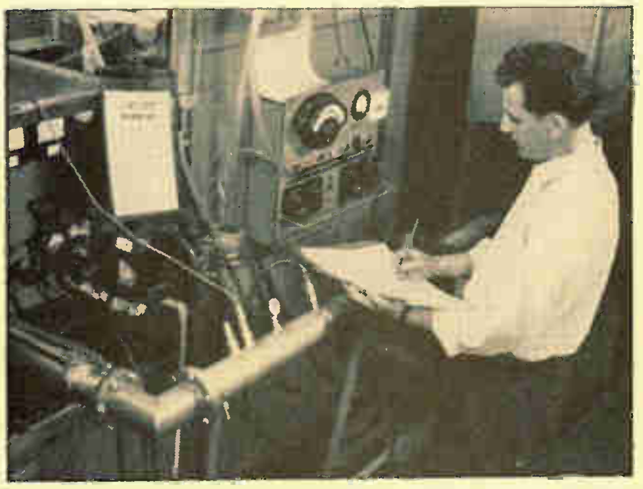
A large measure of the reliable operation and outstanding life of the QK-358 was achieved through special attention given to its unique characteristics in the overall design of the radar transmitter.

For your information, the QK-358 is a mechanically tunable pulsed-type oscillator with an integral magnet and is designed for coupling to a standard 3" x 6" waveguide. Typical operating characteristics include:

Frequency Range ...."L" Band
Peak Power Output..................... 1.3 Mw
Average Power Output .... 1,630 W



AN/FPS-8 high-power search system by General Electric, used primarily in aircraft control and early-warning operation. The complete mobile version (AN/MPS-11A) shown here, can be airlifted or carried on nine trucks and two trailers.



Life testing of Raytheon tubes, such as the QK-358 magnetron, for six weeks or more serves as a quality check of their performance characteristics as recorded and plotted against time.

August 26, 1960

electronics

A McGraw-Hill Publication *75 Cents*

W. W. MacDONALD, Editor

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DEPARTMENTS

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PRICE $495.00

VOLT-AMP METER MODEL VA-100A

A compact potentiometric voltmeter designed to measure DC voltages to accuracy of better than ±.05% absolute and currents to an accuracy of better than ±.1%. This instrument has a 5 digit readout with the last 3 digits readout on a precision 10 turn potentiometer. Weight and size 9 lbs., 8"w, 7"h, 6"d.

PRICE $625.00

REGULATION MONITOR MODEL RM-2A

This regulation monitor is a compact electronic instrument designed specifically to measure the stability of any DC voltage from 2.0 volts to 500 volts. The drift is less than .005% for an 8 hour day and its short term drift is less than .002%. At maximum sensitivity the meter gives full scale of deflection for a deviation of ±0.1%. Weight and size 7 lbs., 8"w, 7"h, 6"d.

PRICE $325.00

Calibration Standards Corporation

a subsidiary of ROYAL INDUSTRIES, INC.

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LA 50-03AM	(with meters)	0-34 VDC, 0-5A	$425.
LA 100-03AM	(with meters)	0-34 VDC, 0-10A	540.
LA 50-03A	(without meters)	0-34 VDC, 0-5A	395.
LA 100-03A	(without meters)	0-34 VDC, 0-10A	510.

MODEL	VOLTAGE STEPS
LA 50-03A, LA 50-03AM	2, 4, 8, 16 and 0-4 volt vernier
LA100-03A, LA100-03AM	2, 4, 8, 16 and 0-4 volt vernier

Regulation: *Line* Better than 0.15 per cent or 20 millivolts (whichever is greater). For input variations from 100-130 VAC. *Load* Better than 0.15 per cent or 20 millivolts (whichever is greater). For load variations from 0 to full load.

AC Input: 100-130 VAC, 60 ± 0.3 cycle. This frequency band amply covers standard commercial power lines in the United States and Canada.

Ripple and Noise: Less than 1 millivolt rms.

Ambient Temperature: 50°C—continuous duty.

Remote DC Vernier: Provision for remote operation of DC Vernier.

Remote Sensing: Provision is made for remote sensing to minimize effect of power output leads on DC regulation, output impedance and transient response.

Size:

LA 50-03A 3½″ H x 19″ W x 14⅜″ D
LA 100-03A 7″ H x 19″ W x 14⅜″ D

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1 and 2 AMP • 0-32 VDC

Compact 3½″ Panel Height

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LT 1095M	(with meters)	0-32 VDC, 0-1 AMP	$315.
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LT 1095	(without meters)	0-32 VDC, 0-1 AMP	285.
LT 2095	(without meters)	0-32 VDC, 0-2 AMP	365.

MODEL	VOLTAGE BANDS
LT 1095, LT-1095M	0-8, 8-16, 16-24, 24-32
LT 2095, LT-2095M	0-8, 8-16, 16-24, 24-32

Regulation: *Line* Better than 0.15 per cent or 20 millivolts (whichever is greater). For input variations from 105-125 VAC. *Load* Better than 0.15 per cent or 20 millivolts (whichever is greater). For load variations from 0 to full load.

AC Input: 105-125 VAC, 50-400 CPS.

Ripple and Noise: Less than 1 millivolt rms.

Ambient Temperature: 50°C—continuous duty.

Remote DC Vernier: Provision for remote operation of DC Vernier.

Remote Sensing: Provision is made for remote sensing to minimize effect of power output leads on DC regulation, output impedance and transient response.

Size:

LT 1095 3½″ H x 19″ W x 14⅜″ D
LT 2095 3½″ H x 19″ W x 14⅜″ D

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CIRCLE 3 ON READER SERVICE CARD

LA110

CROSSTALK

electronics

August 26, 1960 Volume 33 Number 35

Published weekly, with Electronics Buyers' Guide and Reference annually, by McGraw-Hill Publishing Company, Inc. Founder: James H. McGraw (1860-1948).

Executive, editorial, circulation and advertising offices McGraw-Hill Building, 330 West 42nd Street, New York 36, N. Y. Telephone Longacre 4-3000. Teletype TWX N.Y. 1-1636. Cable McGrawhill, N.Y. Printed in Albany, N. Y.; second class postage paid.

Subscription price U. S. and possessions $6 per year; single copies 75¢, Buyers' Guide $3. Other countries, and longer periods, on request. Subscriptions solicited only from those actively engaged in the field of the publication and in a manner served by its contents; position and company should be indicated.

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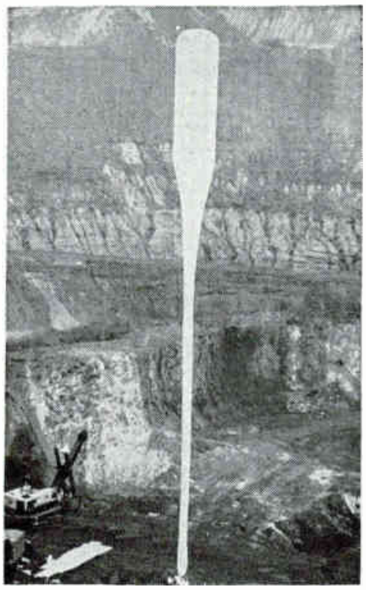


HIGH-ALTITUDE RESEARCH. Object at left is not a king-size oar. It is a 200-ft research balloon being launched from a mine at Crosby, Minn. The radio command set for this unmanned balloon is described in this issue by R. W. Frykman of the Schjeldahl Co., in Northfield, Minn. Equipment consists of a ground-based transmitter and the balloon-borne receiver and associated decoder. Frykman's article begins on p 54.

SALES REPS. Manufacturers' representatives play a vital role in our industry. It's not a 'bit part' by any means. This year alone the reps will sell about $2½-billion-worth of the products made by the electronics industry. This figure accounts for 25 percent of total factory-sales volume of approximately $10 billion anticipated by the industry for 1960. A year ago, rep sales totaled $2.2 billion.

This information comes from ELECTRONICS' exclusive 1960 Survey of Electronics Manufacturers' Representatives. We surveyed 1,450 representatives, including 1,150 from the United States. (That's nearly 80 percent of the 1,500 reps who serve the industry in this country.) Replies were received from 685 firms, of which 656 were from the U. S. and 29 from foreign sources, mostly Canada and Mexico. Our article (p 32) gives you complete details. Also, there's a map showing where U. S. reps are situated and what percentage of the total rep business they handle.

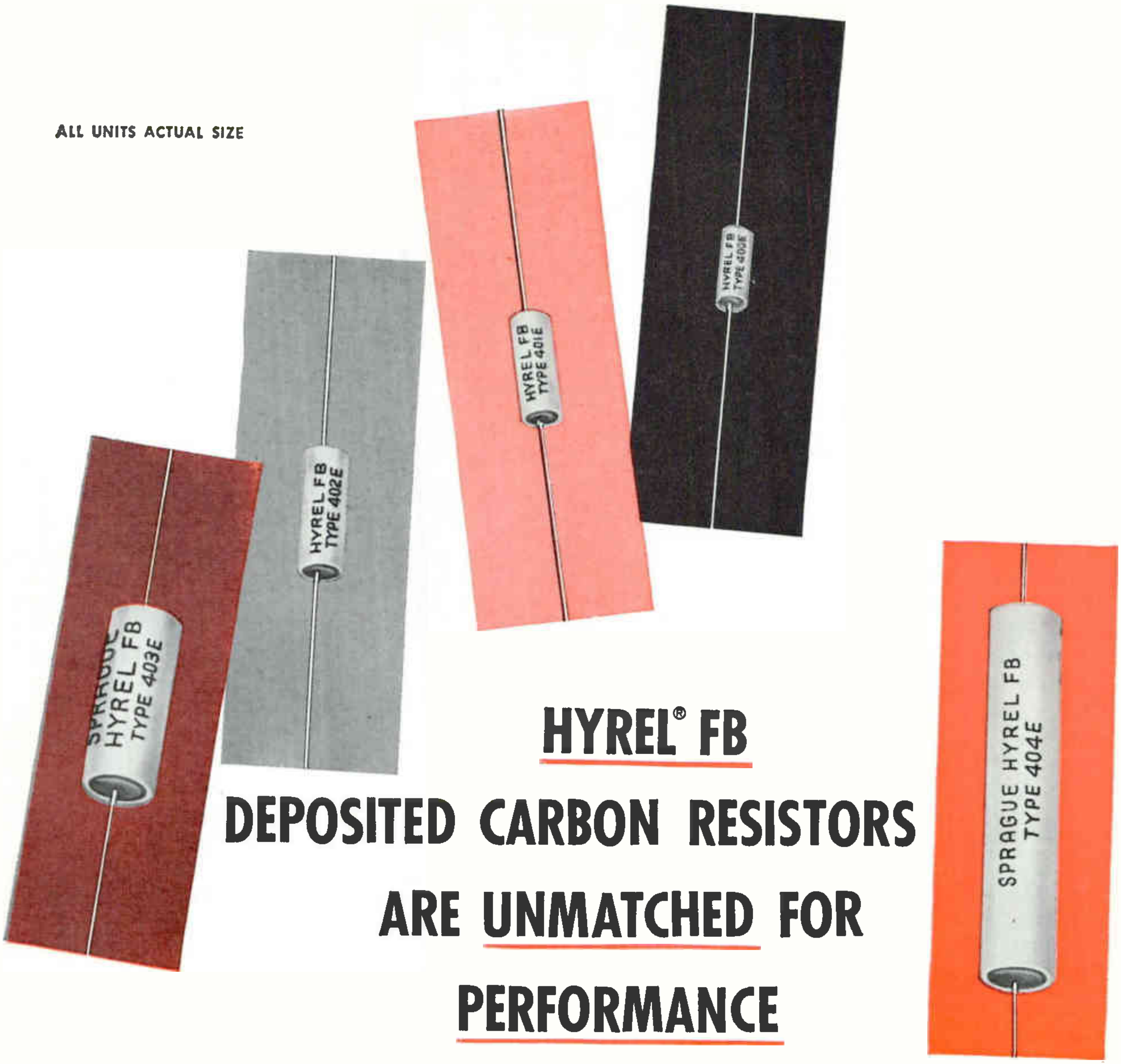
Coming In Our September 2 Issue

PATTERN RECOGNIZER. The ideal pattern recognition machine would be one that is capable of recognizing characters regardless of size, rotation, position, style and noise. For example, a reading machine that could recognize the symbol 5 whether it was continuous or in parts, and whether it had been printed by a machine or scrawled by a child, would be really useful.

In our next issue, L. D. Harmon of Bell Telephone Labs describes a line-drawing pattern recognizer which recognizes certain geometric line drawings independent of their rotation and distinguishes up to six objects with limited independence of size, shape and object position. The technique, which utilizes a circular scanning principle, is applicable to automatic detection of letters and numbers over a wide variety of styles, according to Harmon.

IONOSPHERIC RESEARCH. One technique for ionospheric research is the radar study of artificial or natural clouds of ionization in the ionosphere. Next week, S. R. Hennies and J. V. N. Granger of Granger Associates in Palo Alto, Calif., describe a broadband frequency-scanning radar system used in these studies. System has a novel method of detecting doppler shifts caused by target motion. Granger and Hennies are president and chief engineer, respectively, of Granger Associates.

ALL UNITS ACTUAL SIZE



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CIRCLE 5 ON READER SERVICE CARD

COMMENT

Accuracy and Precision

I frequently encounter the problem of defining the terms *accuracy* and *precision* as related to electronic equipment. If you have a standard definition or one that is most commonly used, I would appreciate knowing it . . .

E. M. THOMASON

MONSANTO CHEMICAL CO.
TEXAS CITY, TEXAS

"Accuracy" is defined as "exact or careful conformity to truth or to some standard, free from . . . error." It signifies the result of careful attention to detail. "Precision," derived from the Latin verb meaning "to cut off," is defined as "having determinate limitations, exactly or sharply defined or stated, not vague or equivocal." It signifies the result of exacting attention to minute detail; its third definition is "minutely exact."

In standard industry usage, the word "accuracy" properly is used to mean freedom from error, especially as a result of care. Precision, on the other hand, relates to the degree of fineness with which an operation is performed or a reading taken. In instruments, accuracy depends on calibration against an accepted standard; precision depends on such instrument characteristics as the number of divisions on a scale or the number of places in a digital presentation.

A former professor of ours used to point out that a three-place log table containing no errors is accurate; a five-place log table is more precise but, if it contains errors, less accurate.

Nanosecond

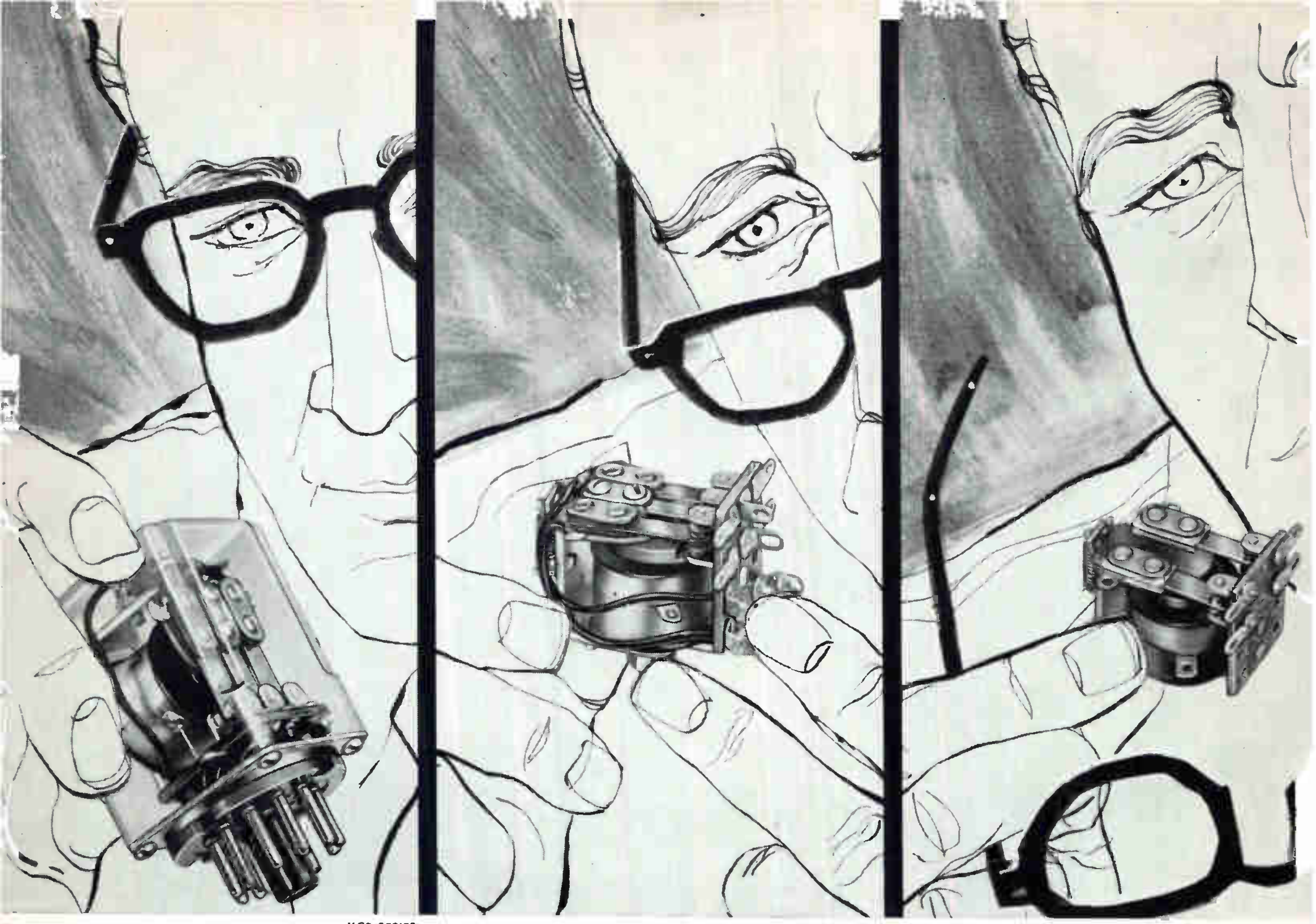
The other day I read in your magazine the word *nanosecond*, probably standing for one thousandth of one millionth of a second, or one billionth of a second.

Can you tell me the definition of this word, and its derivation? I am interested in the word from which *nano* came.

EDMUND C. BERKELEY

NEWTONVILLE, MASS.

Eclectic colleague Berkeley apparently missed our March 4 issue,



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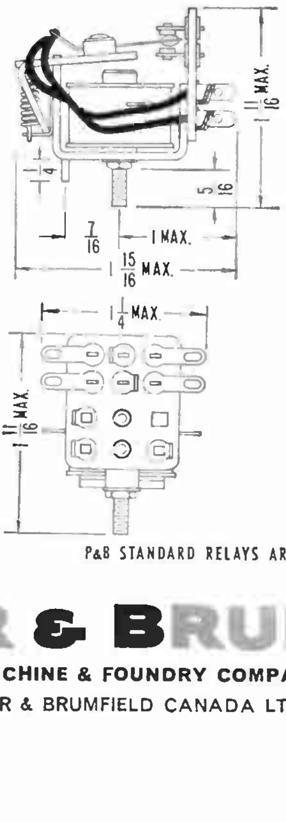
Here are only three of a large family of "K Series" relays by P&B. Blood brothers all, they are distinguished by fine craftsmanship and design maturity. Together they will handle a multitude of switching requirements.

Many design engineers find it saves time, saves money to integrate their circuits with *related* P&B relays. Makes sense, doesn't it?

KR—A small, lightweight relay used widely in communications and automation. Engineered for long life and dependability. 3PDT max. AC or DC. (See engineering data.)

KT—Designed for antenna switching. Capacitance: 0.5 mmfds between contacts. Terminal board is glass melamine and stack insulation is glass silicone for minimum RF losses to switch 300 ohm antenna line. 3 PDT max. AC or DC.

KC—Low cost plate circuit relay with sensitivity of 125 mw per pole. Factory adjusted to pull-in on specific current values. Available open, hermetically sealed or in clear plastic dust cover with standard octal-type plug. 3 PDT max. DC.



KR ENGINEERING DATA

GENERAL:
Breakdown Voltage: 500 volts rms minimum between all elements.

Temperature Range:
DC Coils—45°C to 85°C.
AC Coils—45°C to 70°C.

Terminals:
Pierced solder lugs standard. Octal 8 and 11 pin plug-in headers available.

Enclosures: Type K—Hermetically sealed.
Type P clear cellulose acetate dust cover.

CONTACTS:
Arrangements: 3 Form C (3PDT) max.
Material: 1/8" dia. fine silver (gold plated).
Other materials available to increase contact capacity.
Load: 5 amperes 115V 60 cycle resistive.

COILS:
Resistance: 16,500 ohms max. AC or DC.
Power: 1.1 watts minimum to 4 watts maximum for DC at 25°C ambient.
Duty: Continuous.
Insulation: Centrifically impregnated with insulating varnish.

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CIRCLE 7 ON READER SERVICE CARD

where—in Crosstalk—we discussed the four new prefixes that the National Bureau of Standards had adopted (pico-, nano-, tera- and giga-), and also hasn't seen the various discussions on their meaning, derivation and pronunciation that have taken place in Comment (on April 1 and June 3, for instance).

A nanosecond is indeed a thousandth of a microsecond; the prefix derives from the Greek "nanos," meaning a dwarf.

Exports: Up or Down?

Are exports going up or down? It depends on which McGraw-Hill paper you are reading. No sooner had I finished reading your article in the July 29 issue "Can We Stop the Export Decline?" (p 43) than I read on p 19 of the July 30 issue of *Business Week* that "Exports show a bigger improvement than had been expected."

The *BW* statement also seems to be confirmed by a graph on page 5 of the August issue of *Dun's Review*, titled "Exports keep strong lead over imports."

MAX WIESENDANGER
LANDIS & GYR
NEW YORK

We're glad reader Wiesendanger asked about this; several other readers have too. Our sister publication notes exports are improving, and they are—if you consider all U. S. business, which is Business Week's business. We called attention to a 3-percent decline in exports— in the electronics industry, which is our business. It's not so much a matter of which magazine you read, but from what point of view you look at the picture.

Electronics in country after country runs up against tariff and other import restrictions erected by governments anxious to shelter and protect their electronics industries. And in the meanwhile, the production costs in components and consumer goods are usually lower in other countries, so that the ability of U. S. industry to compete in these areas is lessened, and with the added result that imports of these classes of goods are rising. But this is only one small part of the generally strong export picture for U. S. industry overall.

What's up...and where?

Philco airborne radar for ALRI extends the vision of SAGE

ALRI, the Airborne Long Range Input system of the U. S. Air Force, is the seaward extension of SAGE, the vast electronic network that warns of aircraft approaching the North American continent. Philco will develop, produce and modify the airborne height-finding radar as an ALRI team member under the system manager, Burroughs Corporation. Philco was selected for this vital work because of its long and extensive experience in the development and production of military airborne radar and its major contributions to radar technology. Here is further evidence of Philco's leadership in advanced electronics . . . for reconnaissance, communications, weapon systems, space exploration and data processing.

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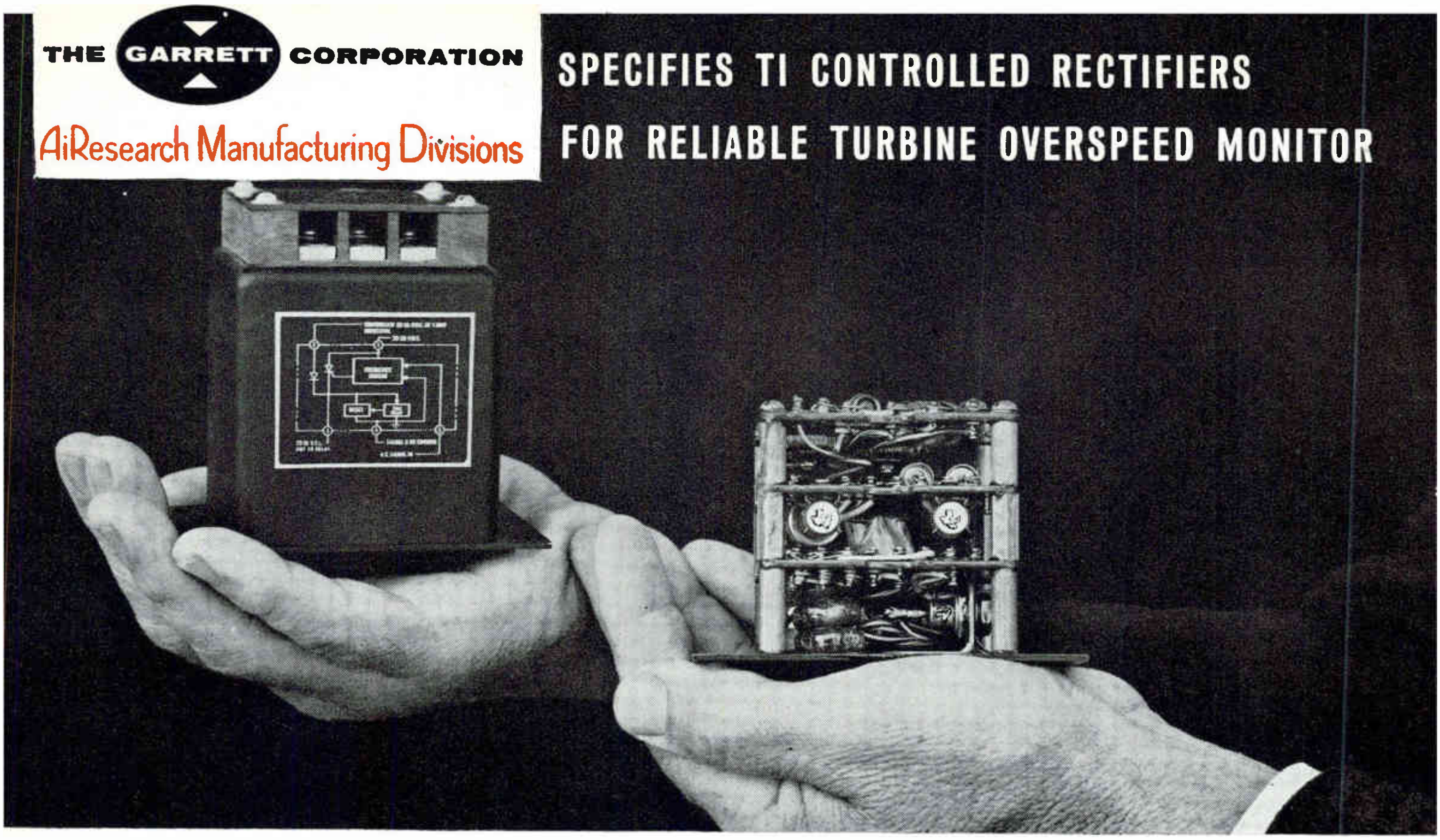

All-diffused TI 2N1595 in TO-5 case provides superior static control

Engineers at the Los Angeles AiResearch Manufacturing Division of the Garrett Corporation designed the Turbine Overspeed Monitor for use in missiles and aircraft. This 12-ounce unit utilizes electromagnetic sensing at 5000 cps for firing TI silicon controlled rectifiers to provide 1 amp of corrective current at 24 volts dc.

To obtain top missile reliability, AiResearch specified TI 2N1595 silicon controlled rectifiers. These all-diffused highly reliable devices provide unique device characteristics, size and weight savings . . . in the more economically priced TO-5 case. TI provided AiResearch with controlled rectifiers featuring guaranteed specifications, tighter leakage tolerances, and consistent stability.

In addition to controlled rectifiers, AiResearch engineers have designed other TI components into such equipment as temperature controls, frequency converters, and frequency monitors . . . applications where maximum reliability is of paramount importance.

Contact your nearest TI sales office for price, delivery, and technical information concerning all reliable TI components.

Remember . . . you can *rely* on TI!

SILICON CONTROLLEO RECTIFIERS

Type	At 80°C Case Temp		Non-Recurrent Surge Current 1 Cycle at 60 cps Amps	Min Fwd Off Voltage* v	PIV	Min Breakdown Voltage v	Max Case Temp °C	Max Fwd Gate Current ma	Gate to Cathode PIV v	max Fwd Voltage Drop @ Avg Rect Fwd Current @ 25°C Stud Temp v @ a	Gate Current Req to Fire ma	
	Av Rect Fwd Current Amps	Recurrent Peak Current Amps									Typ	Max
2N1600	3	10	25	50	50	60	150	100	5	2 @ 3 amps	1	10
2N1601	3	10	25	100	100	120	150	100	5	2 @ 3 amps	1	10
2N1602	3	10	25	200	200	240	150	100	5	2 @ 3 amps	1	10
2N1603	3	10	25	300	300	360	150	100	5	2 @ 3 amps	1	10
2N1604	3	10	25	400	400	480	150	100	5	2 @ 3 amps	1	10
2N1595	1	3	15	50	50	60	150	100	5	2 @ 1 amp	1	10
2N1596	1	3	15	100	100	120	150	100	5	2 @ 1 amp	1	10
2N1597	1	3	15	200	200	240	150	100	5	2 @ 1 amp	1	10
2N1598	1	3	15	300	300	360	150	100	5	2 @ 1 amp	1	10
2N1599	1	3	15	400	400	480	150	100	5	2 @ 1 amp	1	10
TI-010	1	3	15	50	50	60	150	100	5	See data sheet for switching information		
TI-025	1	3	15	50	50	60	150	100	5			
TI-050	1	3	15	50	50	60	150	100	5			

*Measured with 1K ohm resistor gate to cathode

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ELECTRONICS NEWSLETTER

Wescon Opinion Reflects Sober Second Thoughts

WESCON this week is reflecting Sober Sixties retrenchment from the rampant enthusiasm that was so noticeable throughout the industry earlier this year. Reasons mentioned to ELECTRONICS in off-the-cuff preconvention conversations include cautious buying habits induced by high prices, increasing competition (domestic and foreign).

Wescon executive committee chairman H. P. Moore flew out to Honolulu for a meeting of the Chicago Parts Show board, got back in time to report that sales figures are running four or five percent under last winter's forecasts. Moore feels that the industry may have been moving too fast and has had to slow down to catch its breath. He says a greater percentage of businessmen than usual will attend Wescon this year to pick up ideas, drum up sales.

David Packard, president of Hewlett-Packard, will receive Western Electronics Manufacturers Association's Medal of Achievement, becoming the second West Coast industrialist to be thus honored. Les Hoffman won it last year.

Echo I (see p 38, this issue) got into the act; a signal from Bell Labs' Holmdel, N. J., transmitter was bounced off the satellite, received at Goldstone, Calif., relayed by landline to Los Angeles, triggered the opening ceremonies.

Europeans Note Increase In Japanese competition

IN SEPARATE MOVES, Germany, Sweden and Italy took note recently of substantial increase in Japanese competition.

West German imports of goods competitive with Telefunken's products have risen from an annual rate of 200 million Deutschmarks to 680 million ($50 million to $170 million), according to the managing director of the German electronics giant. Competition, he said, is especially keen in semiconductors and personal radio receivers from Japan, and tv picture tubes from the U. S. Shipments to the European Free Trade Area (the so-called Outer Seven) are higher, he indicated, than to the six Common Market countries.

Italy earlier excluded Japanese goods from some of her current trade-liberalization moves, as did Sweden. While neither country is raising new trade barriers, both are progressively eliminating import quotas, but maintaining these quotas for goods of Japanese or Soviet manufacture. In Geneva, officials of GATT (General Agreement on Tariffs and Trade) said that this action gave Japan the right to file a complaint through GATT machinery to demand negotiations aimed at ending the discrimination.

Meanwhile, manufacturer inventories of tv sets and radios in Japan reached 226,874 and 1,021,185 respectively at the end of June as the hoped-for boom in color and portable tv sets failed to get off the ground.

Olympics Spark Tv In West Germany

GERMAN RADIO & TV ASSOCIATION expects television receiver production to go over 2 million sets this year, of which some 400,000 sets will be exported. Output last year was 1.85 million sets.

The association also reports a considerable increase in demand caused by the Olympic Games, being held in Rome next month. Seasonal production slump ended in July this year; normally sales don't pick up until August.

Soviets Develop Acoustic Thermometer

RADIOPHYSICAL LABORATORY of the Soviet Academy's Institute of Atmospheric Physics is using acoustic techniques to measure air temperature in the stratosphere.

A sound source and two microphones of special design are used in the device; a controlled pulse of acoustic energy is emitted by the sound source, and the propagation time is measured by a circuit associated with the two microphones.

Apparatus has been successfully tested in a balloon flight to more than 20-mile altitudes, where nonthermal radiation and inefficient instrument-to-air heat exchange interfere with conventional thermometric readings. Further, the device can record rapid changes in thermal gradients induced by turbulence or layering, according to an article in the Soviet *Economic Gazette.*

Price-Cutting Hits Silicon Producers

STORM OF PRICE-CUTTING in electronic-grade silicon has been raging in the chemical industry since mid-August. McGraw-Hill publication *Chemical Week* reports that the first sign was a 6-to-28-percent cut by Merck which met industry price levels in some cases, undercut them in others. Then Du Pont set up different resistivity classifications for its products, in effect meeting some of the Merck prices and establishing some at lower levels.

Last week Dow Corning unexpectedly slashed prices on polycrystalline silicon rods 45 percent. These rods can reach 1,000 ohm-cm by float zoning, now cost $300 a pound for 1-in. rods in quantities of over 100 lb. Price had been $550.

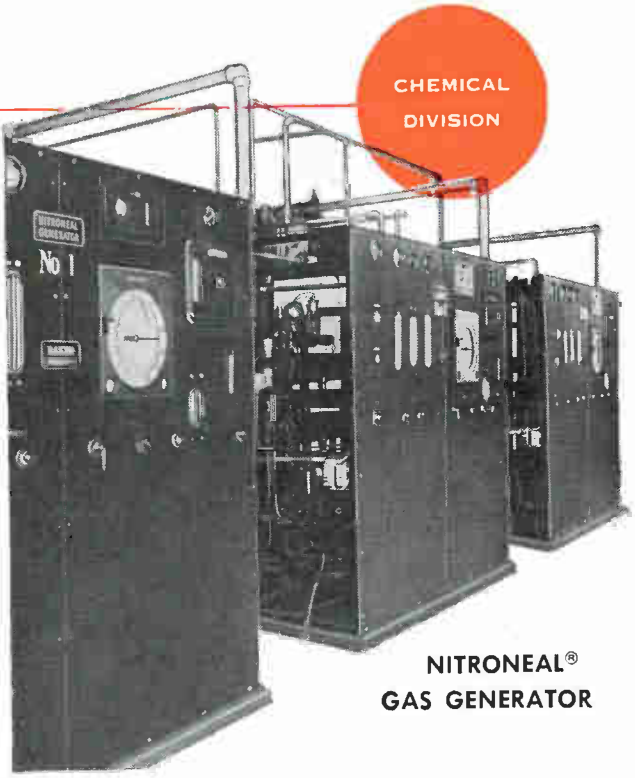
Industry-wide price on polycrystalline billet rods established by Texas Instruments in June and met by Merck's price cut is $.44 a gram, down from $.61. Prices for float-zone single-crystal silicon range from $1.59 a gram for *n*- and *p*-type 0.01-0.09 ohm-cm to $2.96 a gram for *n*-type over 500 ohm-cm and *p*-type over 1,000 ohm-cm.

Echo I Carries Tiny Transmitter

ELECTRONIC DEVICES aboard the 100-ft satelloon Echo I are two radio beacons, each about the size and shape of a dinner plate and equipped with a half-ounce transmitter about the size of a cigarette lighter.

The beacons were developed by RCA, are providing the signals that zero in the Holmdel and Goldstone tracking antennas.

for the most efficient and economical production of forming gas mixtures



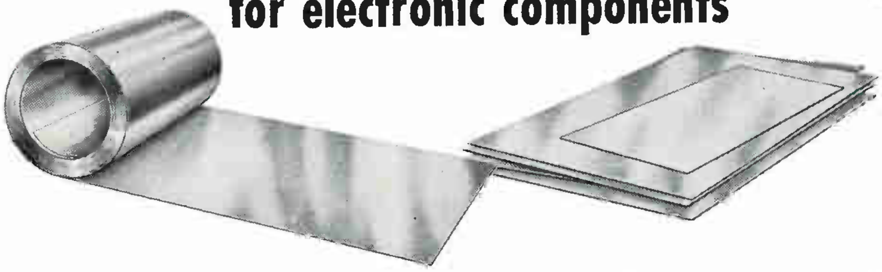
NITRONEAL® GAS GENERATOR

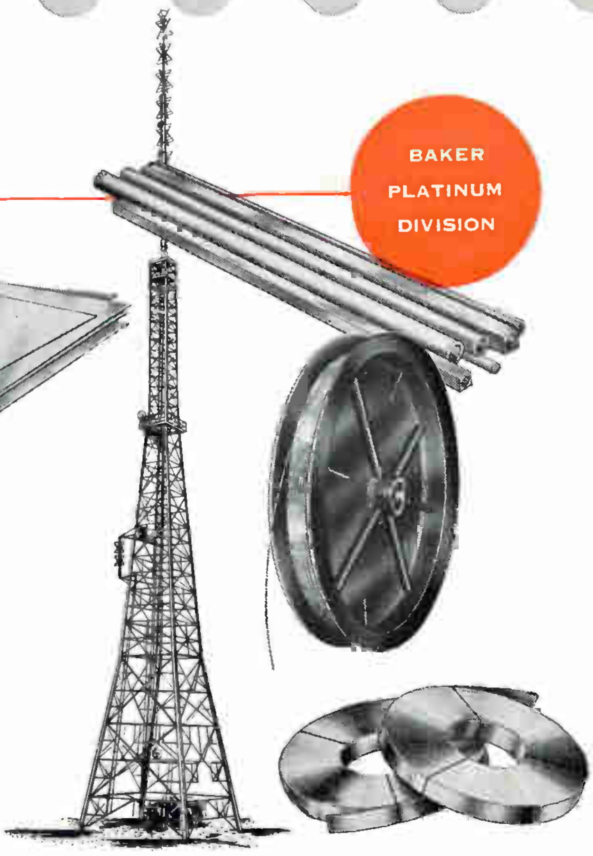
...provides by far the most economical and efficient method for the production of pure nitrogen — *completely free of oxygen* — and with hydrogen content precisely controlled at any desired percentage between 0.5% and 25%. Nitrogen is supplied at a fraction of cylinder supply cost.

The Nitroneal Generator is automatic except for startup, with no need for operating personnel. The unit performs instantly, efficiently anywhere in the range of from 25% to 100% of rated capacity. Installation requires only a 110 volt line, water, air, ammonia lines and drain facilities. Units can be supplied in capacities of 100 cfh to 10,000 cfh. . . . The catalyst lasts indefinitely — maintenance costs are practically nil. Write for complete catalog material and data.

CHEMICAL DIVISION • 113 ASTOR STREET
NEWARK, N. J.

platinum clad wire, sheet and tubing for electronic components





Platinum clad wire, sheet and tubing make it possible to incorporate all the important desirable characteristics of the noble metals in equipment, at minimum cost. Platinum clad is pure platinum or an alloy of platinum so securely bonded to a base metal body that the composite metal can be fabricated. The gauge of the platinum metal can be specified to requirements. The process guarantees continuous pore-free platinum cladding with a work function metal such as platinum or platinum alloy to perform at elevated temperatures. Write for literature.

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PROMPT PRECIOUS METAL SCRAP RECOVERY SERVICE • ENGELHARD PROCEDURES RECOVER

WASHINGTON OUTLOOK

ORBITING SATELLITES are about to become an integral part of U. S. military and civilian communications. Successful launches by the space administration, Air Force, Navy and Army keep expanding the number and variety of communications facilities orbiting the earth. Of a dozen or so now flying, half are effective communications instruments.

The Army is getting into space with Project Courier—one of the most advanced satellites so far. Of the satellite's 500-lb weight, the electronic equipment built by Philco accounts for about 300-lb. Courier has four voice channels and 20 teleprinter channels that operate on ultra-high frequencies. Some 19,200 solar cells power the satellite's communication system.

Courier can simultaneously transmit, receive and store some 68,000 words a minute. In a five-minute pass over a ground receiving station, the satellite can send and receive some 340,000 words.

Special 28-foot dish-shaped tracking antennas at Fort Monmouth, N. J., and Ponce, Puerto Rico, are designed to monitor the satellite. The operating life of Courier I is expected to be around three months.

Other satellites that are still actively transmitting are: Vanguard I and III, Tiros I, Midas II, Transit 2-A, and the Naval Research Laboratory satellite that was launched pickaback style from Transit 2-A. The National Aeronautics and Space Administration satellite Echo I, the 100-foot diameter inflated balloon, is used for passive communication experiments.

The satellites in orbit are only early versions of satellite systems to be perfected. Several other experimental satellites are scheduled to be launched in the next year or so. Over the next 10 years, the space administration plans to launch some 240 satellites to explore space and planets. These are in addition to the military's satellite systems in communication, navigation, and missile detection and surveillance that are in the works.

AN ELECTRONIC WAVE MEASUREMENT SYSTEM has been developed for Navy's Polaris missile-firing submarines. Wave action is reported to be a critical element in firing the 1,200-mile Polaris missiles. The missiles cannot be fired through the crest or the trough of waves if precise accuracy is to be obtained.

Navy won't comment officially, but it's Hydrographic Office reportedly has developed an electronic sounding system that measures wave heights. The machine reproduces wave contour on a monitoring screen in the submarine. Firing is then timed accordingly.

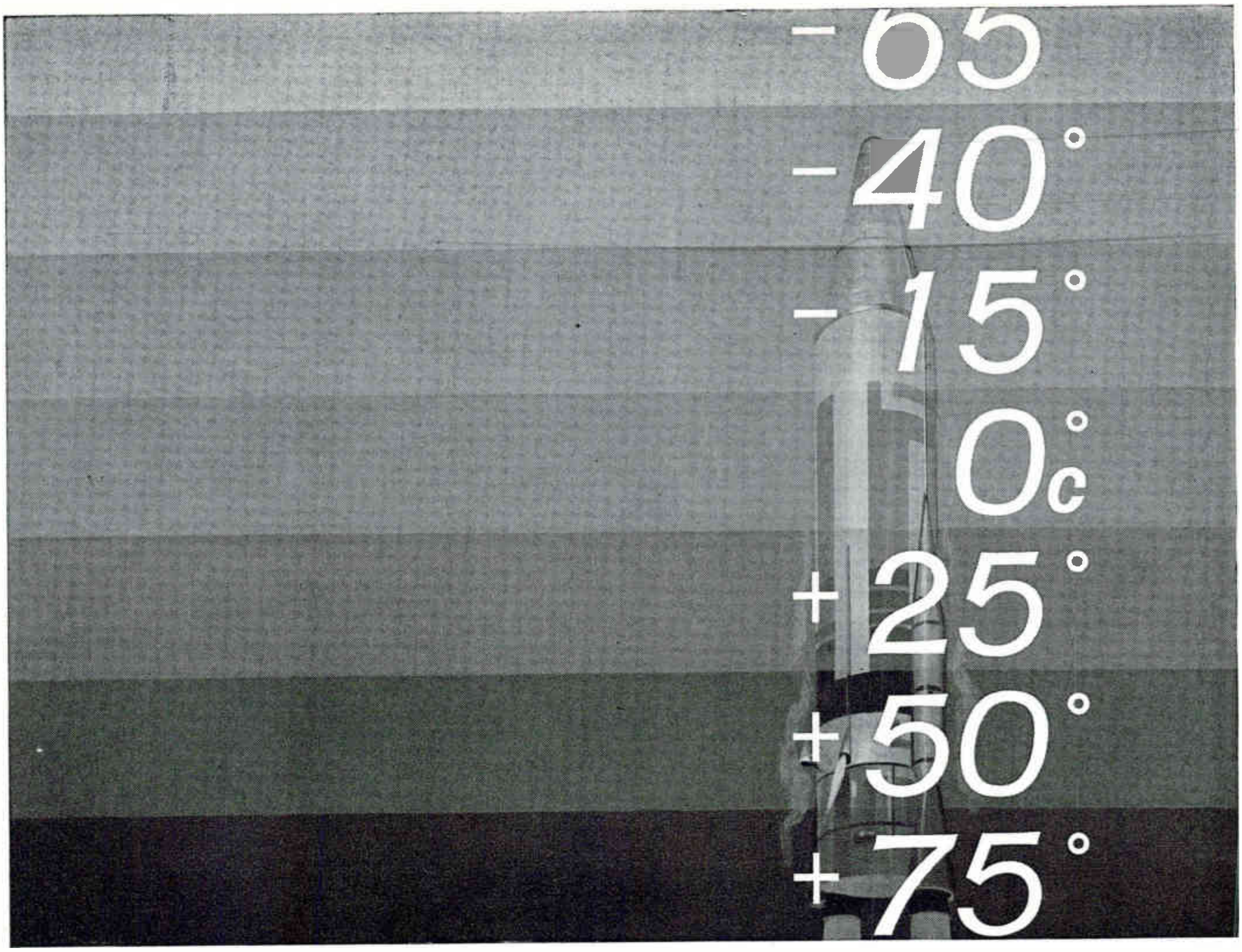
ELECTRONIC EQUIPMENT takes an important billing in the $476.3-million worth of additional military contracting just approved by President Eisenhower. The increase was made under sharp political pressures and provides still another push for the growing volume of new defense orders this year.

Lockheed's Samos reconnaissance satellite project will be boosted about 25 percent. The extra funds will go to buy components—radars, infrared and communications for back-up use in satellite tests.

The Air Force will be allowed to step up procurement of instruments and other B-52 bomber spare parts for stockpiling to prepare for a continuous airborne bomber alert.

The Air Force will also be allowed to spend half the $200 million extra appropriated by Congress for B-70 development. But as plans stand now, the additional money will be used for faster delivery of two stripped-down prototype models for flight testing.

The Navy gets the largest chunk of the additional funds—$163.9 million—to build two more Polaris submarines and to buy the Lockheed-built missiles which go with the vessels.



stability and reliability

OVER A WIDE TEMPERATURE RANGE: −65°C TO +175°C

Hughes Voltage Regulator Diodes give your circuits greater stability and truer voltage control than ever before feasible over an extremely wide temperature range. The diodes' flat zener dynamic resistance keeps noise to an absolute minimum and makes possible excellent electrical and mechanical reliability.

Compare these features of Hughes® VR diodes:

1. Voltage regulation to close tolerances. 2. Voltage regulation over a wide temperature range (—65° C to +175° C). 3. Voltage regulation with low noise.

The Hughes voltage regulator diodes are alloyed junction devices, which inherently demonstrate a sharp zener knee. They are ideal for voltage regulation, surge protection, AC-DC amplifiers (coupling devices, biasing element), wave generators, and clippers. See your authorized Hughes distributor, or write Hughes Semiconductor Division, Marketing Department, Newport Beach, California.

VOLTAGE REGULATOR DIODES (EIA-TYPES)

Type	Typical Voltage	Test Current mA	Package
1N702-1N707	2-8	5	A
1N708-1N712	5-9	25	A
1N713-1N720	9-20	12	A
1N721-1N725	20-30	4	A
1N1313-1N1319	7-32	0.2	B
1N1929-1N1932	5-11	5	A
1N1933-1N1937	11-30	1	A
1N761-1N769	4-27	0.2	A
1N465-1N470	2-8	5	B

A = Standard Hughes Glass package
B = Single Ended Epoxy case

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HUGHES

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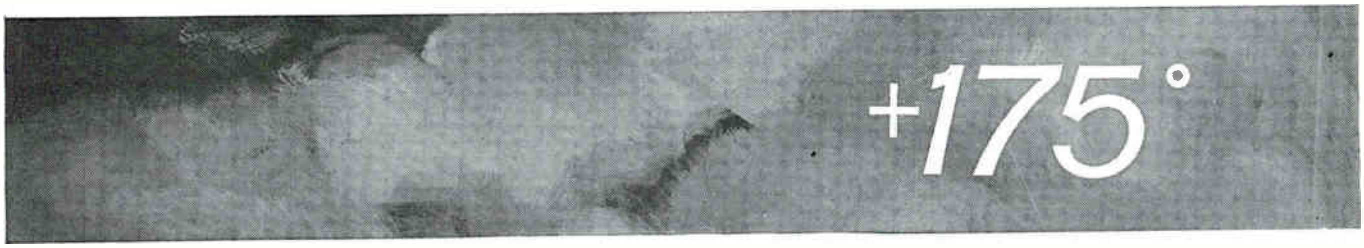
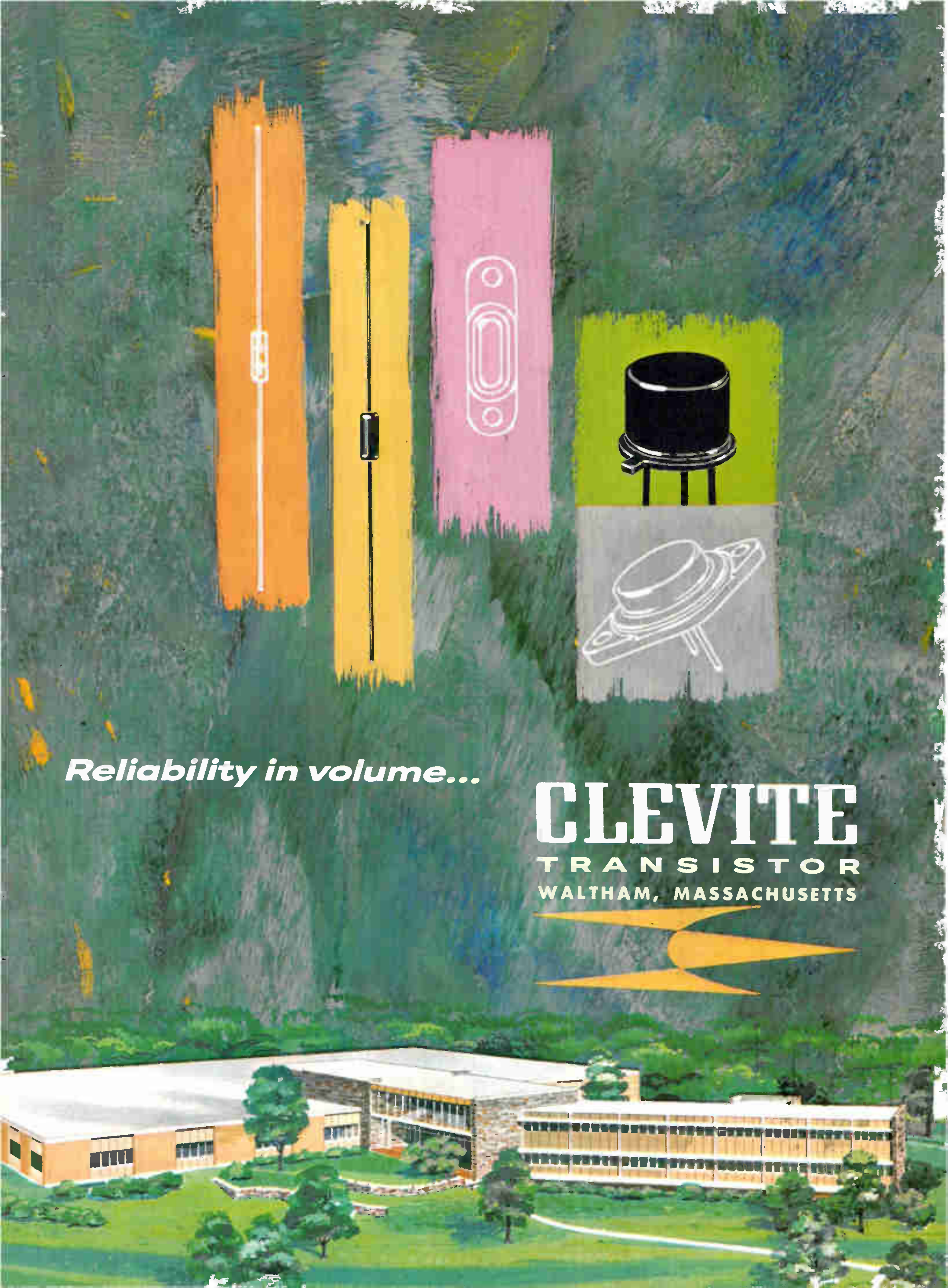
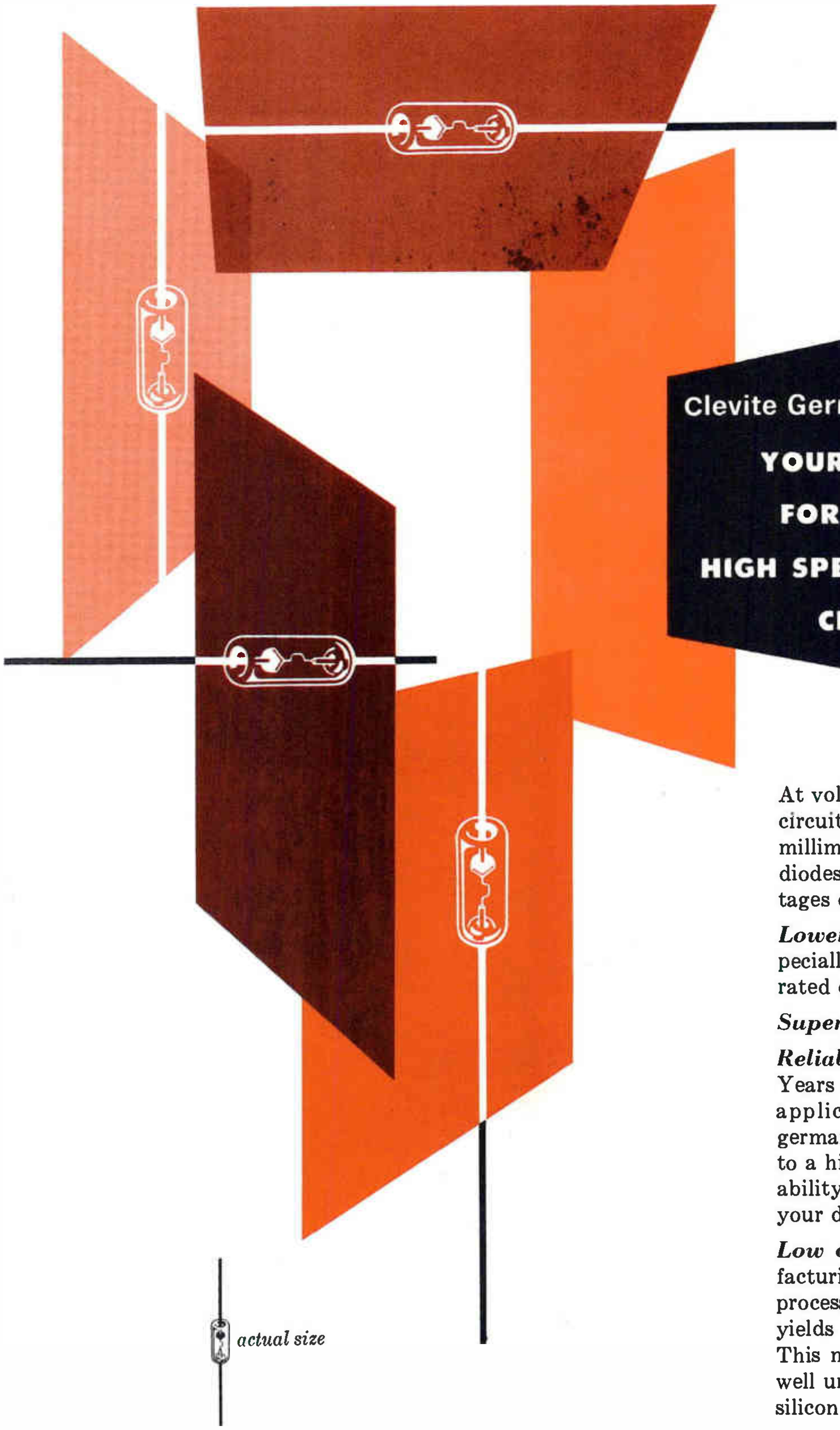



Reliability in volume...
CLEVITE
TRANSISTOR
WALTHAM, MASSACHUSETTS



Clevite Germanium Diodes . . .

YOUR BEST BUY FOR TODAY'S HIGH SPEED SWITCHING CIRCUITS

At voltages typical of solid state switching circuitry . . . and recovery times in the millimicrosecond range Clevite *germanium* diodes offer several outstanding advantages over costly silicon types:

Lower forward voltage drop. An especially valuable characteristic for saturated circuitry applications.

Superior forward transient response.

Reliability, availability, uniformity. Years of experience in the production and application of hundreds of millions of germanium diodes have brought these types to a high state of perfection and predictability. They take the gamble factor out of your design and production problems.

Low cost. Thoroughly developed manufacturing techniques utilizing automated processes and close controls result in high yields and high production efficiencies. This means top quality product at prices well under the present cost of comparable silicon types.

Take a close look at germanium . . . for fast switching at low voltages, it may well be your best buy!

Send for bulletin B-213-2

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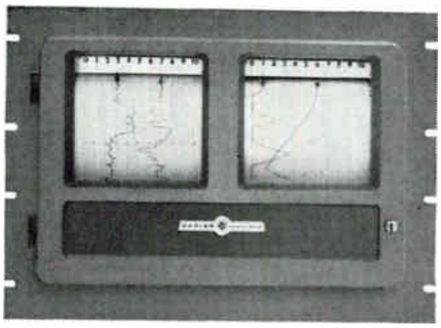
A new addition to VARIAN'S G-22 Dual Channel Potentiometer Recorder

ADJUSTABLE SPAN

0-10 MV To 0-500 VOLTS

More versatile than ever, the Varian G-22 will now record from sources of almost any likely signal voltage. A newly available plug-in input chassis, the B-22 attenuator type, is easily set as needed from spans as little as 10 millivolts full scale to as high as 500 volts. Front-panel adjustment is continuous in between for optimizing use of the chart's full width in any recording situation.

The G-22 can be your best all-purpose recorder in other ways too. Two channels in themselves also mean versatility—they make the recorder a correlator of simultaneous variables (any two you choose). Two plug-in input chassis mean that each channel's recording characteristics can be quickly changed. And zero can be reset anywhere across the chart from left to right—each channel separately. Last but not least don't underestimate the value of the handle on top. This recorder goes wherever there is recording to be done.*



*Varian offers rack mounted versions too—either singles or twins. The latter is pictured, showing how four channels of recording can be fitted within the 19-inch width of a standard rack.

SPECIFICATIONS, OPTIONS, AND ACCESSORIES

One second full-scale balancing time • Accuracy 1% of full scale • Sensitivity 0.25% of full scale • Two chart speeds standard, four speeds optional • Wide selection of chart speeds from ⅛" per hour to 16" per minute • Weight 33 pounds • Available accessories include retransmitting slide wires, alarm contacts, event markers, etc.

For full specifications, write the Instrument Division.

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FOR DEPENDABLE INSULATION...

SPECIFY VINYL SLEEVING BY ®Resinite

If you require high performance insulation in one or any combination of the areas shown, you'll find Resinite vinyl sleeving provides the outstanding dependability you need. Resinite vinyl insulation more than fills most applicable commercial and military specification requirements.

To save time and material at assembly, Resinite's SOFT-WOUND SPOOLING prevents flattening of thin wall sleeving at the tube core. What's more, every lot of Resinite Specification Sleeving is rigidly tested for conformance. And each spool carries this test number for easy, positive reference to the permanent test record.

Your Resinite Distributor has complete information on Resinite's many vinyl tubings, tapes, and lacing cords. For samples and performance data write:

RESINITE DEPARTMENT
THE BORDEN CHEMICAL COMPANY
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	EP-93C	EP-93	EP-69C	HI-HEAT 105 & 105C	SUPER-HEAT 125	EP-2	EP-14	VINYL GLASS
TEMPERATURE RANGE	200°F −95°F	185°F −90°F	205°F −75°F	221°F −5°F	257°F −40°F	185°F −40°F	165°F −50°F	395°F −50°F
DIELECTRIC STRENGTH	400 volts/ mil av.	390 volts/ mil av.	900 volts/ mil min.	1,000 volts/ mil	1,000 volts/ mil	900 volts/ mil av.	800 volts/ mil av.	8,000 4,000 2,500 volts
CUT-THROUGH RESISTANCE	Good	Good	Good	Excellent	Outstanding	Good	Good	Outstanding
OIL RESISTANCE	Slight Swelling	Slight Swelling	Slight Swelling	Excellent	Excellent	Slight Swelling	Slight Swelling	Excellent
RESISTANCE TO FLAME (SELF-EXTINGUISHING)	5 sec. max.	5 sec. max.	6 sec. max.	10 sec.	1 sec.	5 sec. max.	5 sec. max.	45 sec/ inch
FUNGUS RESISTANCE	Yes Clear Fungicide	Yes Amber Fungicide	Yes Clear Fungicide	Available (105C only) Clear Fungicide				
CORROSION RESISTANCE	Good	Good	Good	Good	Good	Good	Good	Good
SPECIFICATION CONFORMANCE	MIL-I-7444B Types I & III	MIL-I-7444B Type II	MIL-I-631C Type F Form U Grades a and b Cl. I & II Cat. 1	MIL-I-631C Type F Form U. Gr C Class I (105C only) Class II Cat. 1 Also U.L. 105°C	U.L. 105°C	MIL-I-631C Type F Form U Grade a Cl. II Cat. 1	AMS 3630	ASTM D372-53T NEMA-VSI-1950 MIL-I-3190(4)

Also a complete range of vinyl tapes and lacing cords

United Industrial Corp. Sales Up 40%

United Industrial Corp., New York and Los Angeles, reports sales 40 percent higher during the second quarter of this year than during the first three months. Total for the three months ended June 30 were $10,710,000, compared with $7,651,042 in the first quarter of 1960. Second quarter earnings were $102,496, compared with a deficit of $168,453 in the first quarter. Net income after taxes for the six months ended June 30, 1960, amounted to $529,121 or 14 cents a share on common stock, after provision for preferred shares. B. F. Gira, UIC president, accounts for the upturn in sales volume by citing the operational results of two new divisions, **Southern Pacific Milling** and **Perry Rubber,** both acquired earlier this year.

Hathaway Instruments, Denver, Colo., reports purchase of **Dale Electronics, Inc.,** Columbus, Neb., for $6 million. Transaction was carried out through exchange of stock. George Risk of Dale will become president and general manager of all Hathaway enterprises. D. J. Jones will remain as chairman of the board. Sales forecast for Hathaway in 1960 is $7.2 million. A joint statement by Risk and Jones reports annual combined sales will be more than $20 million. Hathaway also has two wholly-owned subsidiaries, **Sterling Electric Motors** in Los Angeles and **Clemco Aero Products** in Gardena, Calif.

Erie Resistor Co., Erie, Pa., announces an increase of 18 percent in consolidated shipments for the 24 weeks ended June 12, 1960, as compared with those of the equivalent period in 1959. Consolidated earnings after taxes and allowance for preferred shares were equal to 19 cents a share. Net sales for the period were $12,499,159. A year ago they were $10,579,110.

Crosby-Teletronics Corp., Westbury, L. I., reported last week that gross sales for the period from Nov., 1959, to April, 1960, rose 384 percent to a record $765,000. The equivalent period a year ago saw a total of $199,000. M. G. Crosby, president, says the rise is due to heavy orders for test equipment, facsimile devices and long-range communications devices.

Siegler Corp., Los Angeles, reports record net income of $3,201,023—an increase of 45 percent—for the fiscal year ended June 30, 1960. This is equal to $1.71 a share on 1,871,595 shares. Equivalent figures a year ago were net earning of $2,203,022, and $1.36 a share on 1,624,815 shares. The 15-percent rise in common shares was due to conversion of remaining outstanding debentures, issuance of a 4-percent stock dividend, shares issued for the purchase of **Magnetic Amplifiers, Inc.,** and executive stock options. Sales for the recently completed fiscal year were $84,095,002, a nine-percent increase over the last fiscal year.

25 MOST ACTIVE STOCKS

WEEK ENDING AUGUST 12, 1960

	SHARES (IN 100's)	HIGH	LOW	CLOSE
Avco	3,367	16⅞	15⅝	15⅝
Bulova Watch	1,601	22⅞	18⅝	21⅞
Fairchild Engine	935	9	8	8¾
Ampex	824	32⅛	30⅞	31⅜
Gen Tel & Elec	757	29	28⅛	28¼
Gen Electric	687	84¼	80	84
RCA	649	64	61⅛	63½
Westinghouse	541	55½	53⅛	55⅛
Gen Dynamics	504	48½	44⅜	45⅝
Sperry Rand	474	22½	21½	22¼
Univ Controls	445	16	14⅝	15⅝
Polarad	420	32½	28½	32⅛
Int'l Tel & Tel	413	41⅝	39¾	41⅝
Loral	412	102¼	92¼	96⅛
Cubic Corp	375	65½	56	63¾
Beckman Inst	362	92¼	87	92¼
Lear Inc	352	20½	19⅜	19¾
National Video A	349	19½	17⅝	18⅝
Collins Radio	339	62⅜	59⅛	61⅛
Zenith	312	118¾	110	112¼
Fairchild Camera	300	192¾	173¾	192¾
Litton Ind	296	88⅜	82⅞	82⅞
Raytheon	289	40⅝	38½	38⅞
Admiral	276	16⅛	14⅞	15⅛
Waltham Precis	272	2⅜	2⅛	2⅜

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.

AIR EXPRESS . . . FIRST ON, FIRST OFF . . . FIRST CHOICE NATIONWIDE!

AIR EXPRESS goes where the jets go. It has ever since the first commercial jetliner roared skyward. But 600 mph speed is just one more reason progressive businesses hail AIR EXPRESS as America's modern way of doing business; there are others:

Like the sure knowledge that AIR EXPRESS gets first priority treatment on all 35 of the nation's scheduled airlines. It's always first on, first off—with new loading systems tailored to the jet age, and kid-glove handling every mile of the way.

Other reasons? Dependable overnight delivery to more than 20,000 communities. Prompt pickup and delivery service by the AIR EXPRESS fleet of trucks — many radio-dispatched for maximum speed. Immediate confirmation of delivery, too, via the giant AIR EXPRESS-operated teletype network. And, in some areas, helicopter service links small airfields with major terminals.

That's why, more than ever, it pays to think fast, think AIR EXPRESS first. One phone call is all it takes to enlist the skills of thousands of AIR EXPRESS specialists — and speed your product FIRST TO MARKET... FIRST TO SELL!

AIR EXPRESS

CALL AIR EXPRESS DIVISION OF RAILWAY EXPRESS AGENCY • GETS THERE FIRST VIA U. S. SCHEDULED AIRLINES

CIRCLE 23 ON READER SERVICE CARD

Antisubmarine Warfare Market Winning Strong New Support

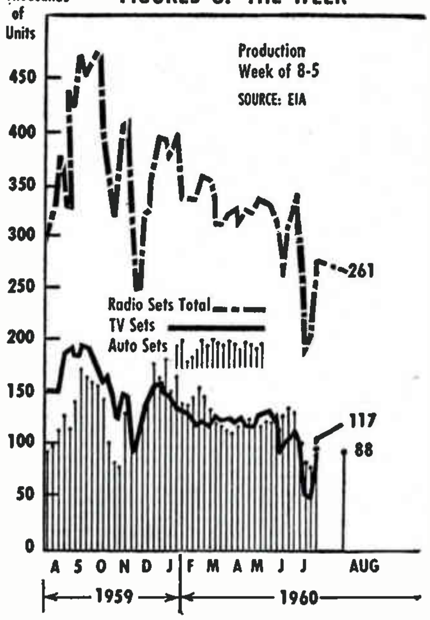
THREAT POSED by USSR submarines should spark about $500 million worth of antisubmarine warfare contracts for electronic equipment in fiscal 1961 and result in contract awards at similar high levels for several years to come.

Defense officials consider enemy submarines a powerful threat and have given ASW programs top priority.

"One of the gravest threats we face is the powerful Soviet submarine force," says Adm. Burke, chief of naval operations. "ASW carries a priority second only to Polaris," says Navy Secretary Franke. "This (ASW) is a place where we really ought to splurge," says Representative Mahon, chairman of the House Subcommittee on Appropriations.

Latest Navy budget for fiscal 1961 contains $1.8 billion for ASW. This figure includes $1.364 billion originally requested for the new year, $343 million for ASW ship construction left from last year and $100 million of additional research and development money tacked on to the budget by Congress.

FIGURES OF THE WEEK



ASW portion of Navy budget last year was $1.3 billion. In fiscal 1959 it was $1.6 billion. Known Navy ASW needs for which no money has yet been appropriated amount to over a billion dollars.

ASW programs this year stress oceanography, ocean surveillance systems, detection and classification and weapons development.

The estimated $500 million available for electronics procurement includes: For special ASW electronic procurement, $25.5 million; 40 percent of the $280.5 million available for research, development, test and evaluation; 15 to 20 percent of all planned ASW aircraft commitments, which amount to $340.1 million; 10 percent of ship construction funds which total $1 billion; an unidentified part of $56 million scheduled for ASW ordnance and ammunition.

Some of the electronic equipment Navy is now buying: SQS-23 sonars and variable depth sonars, data converters and radio control equipment for the DASH weapons system, and a new accurate range rate recorder for shipboard sonars.

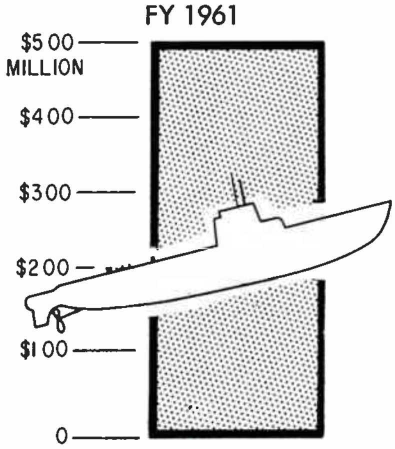
For submarines there are communications buoys, acoustic data-gathering equipment, sonar IFF equipment, and a secure communication system. For aircraft: new improved sonobuoys, Julie Jezebel readout equipment and new high-powered dipping sonars for helicopters.

However, the important part of the antisubmarine effort is really research, aimed at better identification, detection and communication, and all aspects of commanding, controlling and operating the systems for detecting, identifying and destroying the enemy.

Major portion of research effort is to increase acoustic detection range. Of the more than 100 antisubmarine warfare research projects, about one-half are concerned with acoustics and oceanography.

Of the $280.5 million scheduled

ASW Money for Electronics FY 1961



Source: Estimated by ELECTRONICS

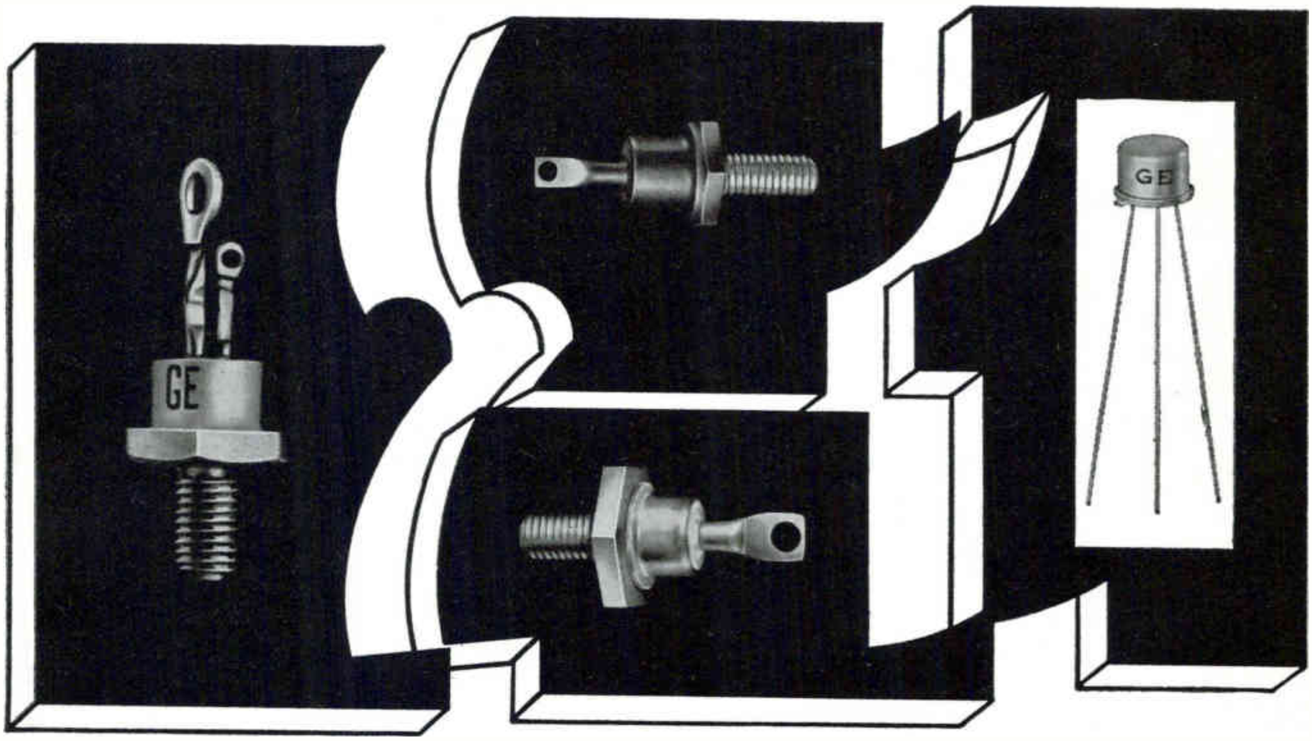
for research, development, test and evaluation in FY 1961, about half is ear-marked for classification, detection and localization studies; one-fourth for weapons, ordnance and fire control; 15 percent for vehicles and propulsion equipment, 10 percent for collateral support investigations.

U. S. exports of electronic equipment in the first quarter of this year show a gain of nearly 6 percent over the same period last year. Total value of exports was $99.1 million in the first three months of 1959 and $104.7 million in the first quarter of 1960, according to monthly reports issued by the U. S. Department of Commerce.

Despite overall increase, however, analysis of individual commodity groups shows a decrease in dollar value of 23 of the 43 groups. Batteries were down 40 percent, radio-phono combinations down 41 percent and radios down 20 percent. Decreases showed, too, for tv camera tubes (66 percent), picture tubes (37 percent), inductors (26 percent) and phonographs and parts—other than coin operated—down 18 percent.

Gains ranging from 39 to 71 percent were made by all instruments, and special-purpose tubes were up 68 to 81 percent. Semiconductors gained 60 percent, capacitors and resistors 25 and 34 percent respectively. Detection and navigation apparatus increased by 69 percent, computers and parts by 20 percent and nuclear devices by 49 percent.

How to fit proved



components into your SCR circuits

Hundreds of circuits have successfully proved out the General Electric semiconductors listed here as companions to the silicon controlled rectifier. In fact, General Electric used these very same components in developing and perfecting the revolutionary SCR. You capitalize on G.E.'s three years of unequalled SCR experience when you choose compatible G-E components. Together they form a seasoned, smooth-running team that will enhance the performance and reliability of your designs.

And remember, *only* G-E medium current rectifiers give you freedom from thermal fatigue (only hard solders are used); *transient* PRV ratings that save you money; reverse polarity for common heat sink mounting; and very low reverse leakage current for operation in series with SCR's.

For detailed information on SCR theory, ratings and applications, send $1.00 for General Electric's new *Controlled Rectifier Manual.* Also at many G-E Distributors.

CIRCUIT COMPATIBILITY CHART

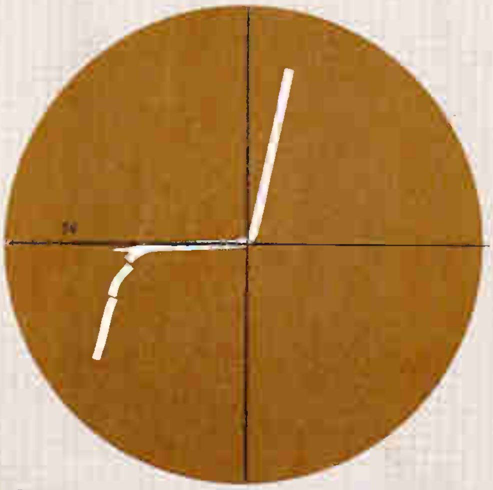
If using G-E SCR Type	Use G-E Rectifier Type	Max. Cont. Current @ Stud Temp.	Peak 1 Cycle Surge	Max. Trans. PRV	Stud Hex. Size
C10	1N1341A-1N1348A	7A @ 140C	150A	800V	7/16"
C11	1N1341A-1N1348A	7A @ 140C	150A	800V	7/16"
C35	1N1199A-1N1206A* 1N2154-1N2160*	12A @ 150C 25A @ 145C	240A 300A	800V 800V	7/16" 11/16"
C36	1N1341A-1N1348A 1N1199A-1N1206A*	7A @ 140C 12A @ 150C	150A 240A	800V 800V	7/16" 7/16"
C40	1N1199A-1N1348A 1N2154-1N2160*	12A @ 150C	240A	800V	7/16"
C50	4JA60*	50A @ 160C	900A	500V	1-19/32" Dia. Housing
ZJ50L	4JA62*	50A @ 110C	900A	500V	1-19/32" Dia. Housing
Compatible Unijunction Firing Transistor: 2N1671A					

*Stack Assemblies Available

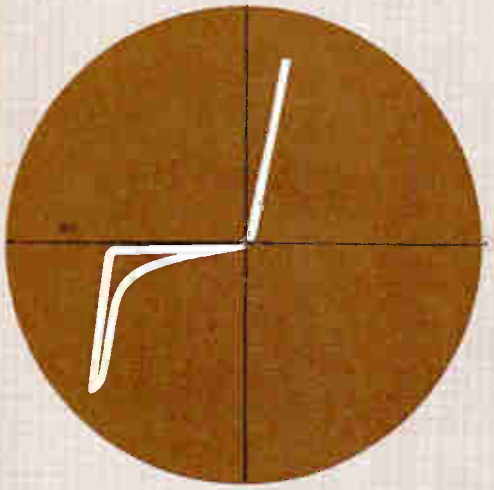
GENERAL ELECTRIC

Semiconductor Products Dept., Electronics Park, Syracuse, N. Y.

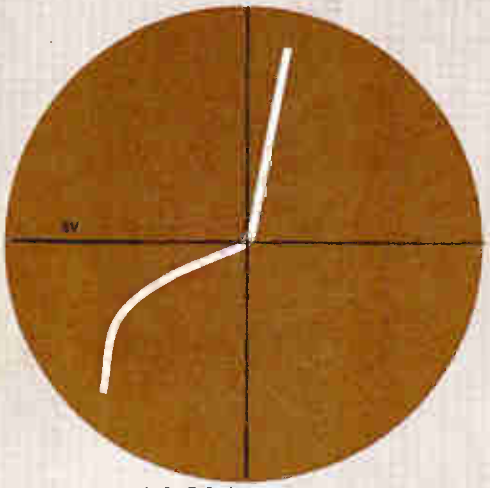
ALL PSI ZENER DIODES ARE 100% SCOPE-CHECKED



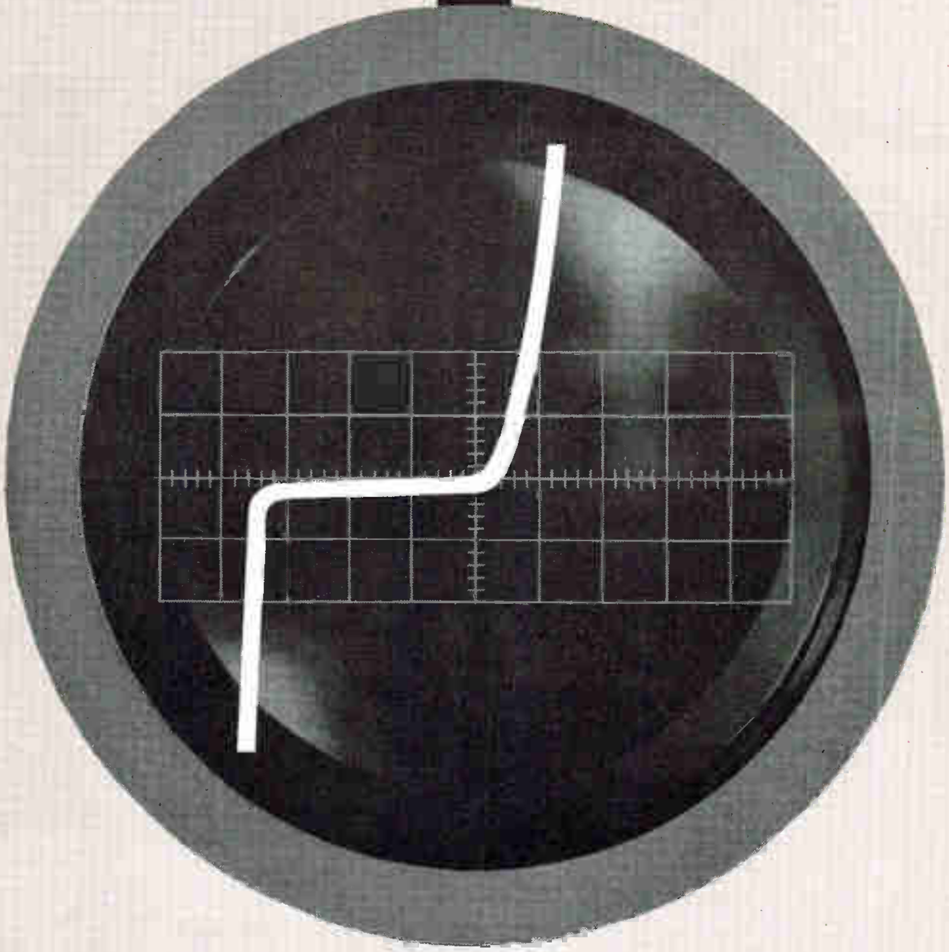
NO MULTIPLE BREAKS OR DISCONTINUITIES



NO HYSTERESIS



NO ROUND KNEES



MICRO SWITCH Precision Switches

New MICRO SWITCH Synchronized One-Shot switch circuit assemblies save engineering time and equipment rack space

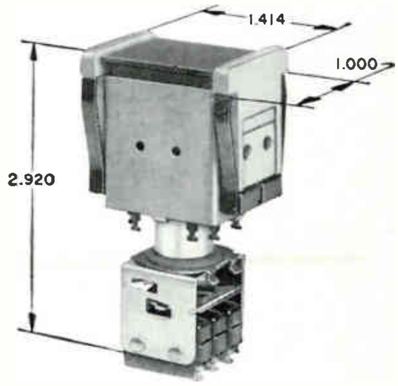
New Synchronized One-Shot push-button switch circuit assemblies for use in pulse and digital systems save design time required to develop flip-flop and gating networks.

The new MICRO SWITCH "1PB700" series assemblies have a special electronic circuit that generates a single square wave output pulse in synchronism with an external clock pulse with each operation of the push button. They can be used with clock pulse frequencies from 4 kc to 500 kc.

The electronic circuit is an integral part of the push-button switch, resulting in a saving of equipment rack space. All circuit components are sealed in resilient potting material to insure protection from physical damage.

Three assemblie: in the new series are patterned to fit a wide variety of d-c supply voltages and clock pulse rise times, voltages and frequencies. They can be applied to manual loading of magnetic drums, setting and resetting flip-flops, and checking ring counters. Ask for Data Sheet 172.

MICRO SWITCH modular lighted push-button switches can be customized for complete design flexibility



Give your control panel the finest in styling with the customizing that will precisely fit your control and display functions.

MICRO SWITCH "Series 2" lighted push-button switch modules simply snap together to match your styling requirements, then snap into slots in the mounting panel—all without tools. They perform both control and indicator jobs to save panel space.

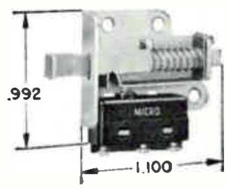
Select from 48 different units and 16 mounting barriers. Forty color display screens include lateral and longitudinal divisions. Available as operator-indicator switch units or indicator units only. Ask for Catalog 67.

MICRO SWITCH precision toggle switches offer you the exact control arrangements you need

MICRO SWITCH manufactures hundreds of different toggle switches and toggle switch assemblies. They are available with 2 or 3 operating positions, 1 or 3-hole mounting and a variety of circuitry and electrical ratings. All have enclosed type contacts. Ask for Catalog 73.

A new "400" Series Toggle Switch is now available with a paddle-shaped tab which can be numbered or color-coded as an indicator.

MICRO SWITCH door interlock switches assure maximum safety during maintenance



MICRO SWITCH door interlock switches are installed on high voltage cabinets to automatically cut the power circuit when the cabinet door is opened for repairs or testing.

Safety position adds protection against "tying down" or wiring around a conventional switch which might be forgotten after service is completed. By manually pulling the plunger out to the maintained-contact position, you close circuit for checking. When door is closed, plunger automatically returns to normal operating position. Ask for Catalog 63.

MICRO SWITCH . . . FREEPORT, ILLINOIS
A division of Honeywell
In Canada: Honeywell Controls Limited, Toronto 17, Ontario

Honeywell
MICRO SWITCH Precision Switches

CIRCLE 29 ON READER SERVICE CARD

New Developments in Computers

First six months of 1960 saw more than a dozen new systems enter the market, plus data-communications devices, peripheral equipment

By FRANK LEARY
Associate Editor

WITH THE YEAR half over, the computer industry is exhibiting a mixed appearance. There have been many new installations in the last six months, and more to go in every week; but the rate is slowing. Countering this are new capabilities and flexibilities, and many new systems, which are attracting new buyers.

Pace of new installations during the first half of the year is about half that of 1959. Middle-sized computers have fared better than either small or large ones in percentage of increase; of the more than 800 medium-sized systems currently installed, about 200 went in this year.

About 100 large systems have gone in, bringing total installations to more than 600. The population of small-scale general-purpose systems now approaches 3,000 installed, of which more than 400 went in this year.

This pace—good as it is—is slower than the installation rate last year when the computer population at least doubled. Informed industry opinion figures that delayed reaction from the 1958 recession is one cause. Another is undoubtedly caution inspired by fear of obsolescence.

With almost all computermakers praising their newest —and yet untried—systems to the implicit disparagement of older products, many businessmen are marking time, waiting for the transistorized systems to prove out in use.

Several factors are influencing the market for the better. Besides new and improved data-processing systems, data transmission over commercial lines or by microwave is attracting much attention. Several systems for carrying computer data rapidly from one place to another have recently been announced. Improvements in peripheral gear also are helping attract buyers.

New computer systems entering the market in the last six months include, in the large-scale category, IBM's 7074 and 7080, RCA's 601, the Univac III, Control Data Corp.'s CDC1604 and the Bendix G20.

New medium-sized systems include General Electric's GE225, the Honeywell 400 and Royal McBee's RPC9000. Among small systems, the CDC160 of Control Data, the Monrobot XI, RCA's 301, Royal McBee's RPC4000 and Packard Bell's PB250 are new.

Deliveries of these systems so far are limited to three CDC1604s, one RPC9000, one CDC160 and four Monrobot XIs, according to a recent census. The same count also reveals that, among previously announced systems, no IBM7080s or Honeywell 800s have as yet been installed.

Installations of National Cash Register's NCR304 system (with central computer and some other electronics made to order by GE) have started this year, as have installations of the Philco 2000 and IBM7070.

Of the new systems just entering the market, none marks a radical departure from previously announced technology. IBM's 7074 is an outgrowth of the 7070, made by replacing three modules of the older computer with two faster modules. The company says the 7074 is twice as fast as the 7070 for business processing, up to 20 times as fast for scientific work.

Remington Rand says its Univac III has a processing speed nine times faster than the Univac II. It is an all solid-state system, using both transistors and high-speed magnetic amplifier circuitry. Fast tape units permit a data-transfer rate on input and output of 133,000 alphanumeric or 200,000 numeric characters a second.

Systems for bank bookkeeping are catching on fast. Burroughs says some 60 of its visible-record computers are on order; an undisclosed number of IBM's bank systems has also been ordered. General Electric has installed two of its GE210 bank systems, one for California's giant Bank of America, the other for the First National Bank of Arizona.

There are several developments in data-communications. IBM's 1009 data-transmission unit permits the company's small 1401 computers—of which some 3,000 are reported on order—to enter into direct memory-to-memory communication with each other over telephone lines. Data flows at 150 characters a second from the core storage of the 1401 through a 1009 unit into a modulating subset provided by the utility company.

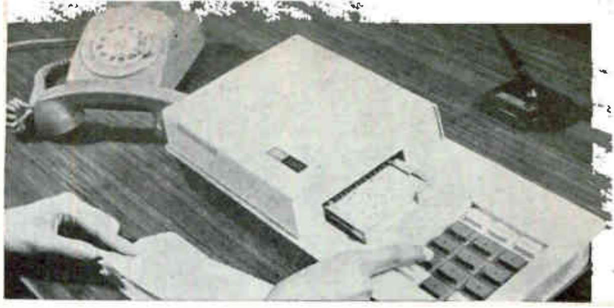
After passing over telephone or telegraph lines, the information goes through a demodulating subset, through another 1009 and to the core storage of the receiving 1401. Operators using telephone facilities merely dial the number of the receiving office, switch on the subset, and hang up when the data transfer is concluded.

Collins Radio has built two data-transmission systems. One, a magnetic-tape system, connects Army's Signal Supply Agency in Philadelphia to a signal depot in Lexington, Ky., 650 miles away. The other links a Douglas Aircraft engineering department in Charlotte, N. C., to the Douglas computing center 2,200 miles distant in Santa Monica, Calif. Each can transmit data at 300 characters a second over commercial telephone lines. The Douglas link uses punch-card data; the Signal Corps hookup transmits directly between IBM magnetic-tape units.

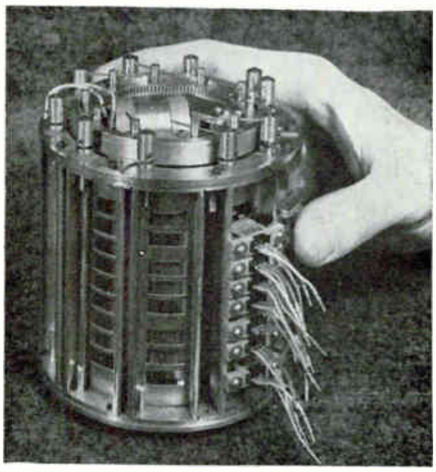
Telautograph Corp. has installed an interrogation system using standard teletypewriter lines and Olivetti interrogating sets to permit 20 remote locations to get information from an IBM Ramac computer installed at Lockheed's big West Coast plant.

IBM's data-transmission system (see photo) permits transfer of card-punched data over telephone

Among new computers is this medium-scale data-processing system from General Electric, designated the GE225



IBM 1001 data-transmission system connects card reader and keypunch to remote card-punching unit by commercial telephone lines



Miniaturization of electromechanical components is demonstrated by this new drum, capable of holding 100,000 bits

lines, also can be used to enter new data from a keypunch through the same remote unit. Receiving station is a card punch modified with a data translator. Modulating and demodulating subsets are provided by the telephone company; the telephones can also be used for normal voice communications. Transmission speed for punched cards is about 12 columns a second.

Motorola has developed a data-transmission multiplex system capable of sending 62,000 characters a second by microwave relay. System works from magnetic-tape input, converts data recorded in parallel to serial form, inserts timing pulses to separate alphanumeric characters. A single wideband subcarrier is used for the data. A parallel-transfer system using several subcarriers has also been developed; systems in use can transmit data at 15,000 characters a second.

New types of auxiliary equipment have increased the flexibility and speed of data-processing. IBM is producing a device to convert data punched on paper tape directly onto magnetic tape for computer use. Machine reads standard 5-level or IBM 8-level code at 150 characters a second, writes 7-track magnetic tape of the type used in IBM data-processing equipment.

Univac III came onto the market able to work with magnetic tape or a 700-card-a-minute card reader, can also convert card-punched or paper-tape data onto magnetic tape. Printers working with currently marketed big systems are commonly in the 500-, 700-, or 1,000-line-a-minute class.

New device recently released by IBM, called the 870, permits a user to type a document in two copies, simultaneously record the same information on two punch cards and one paper tape.

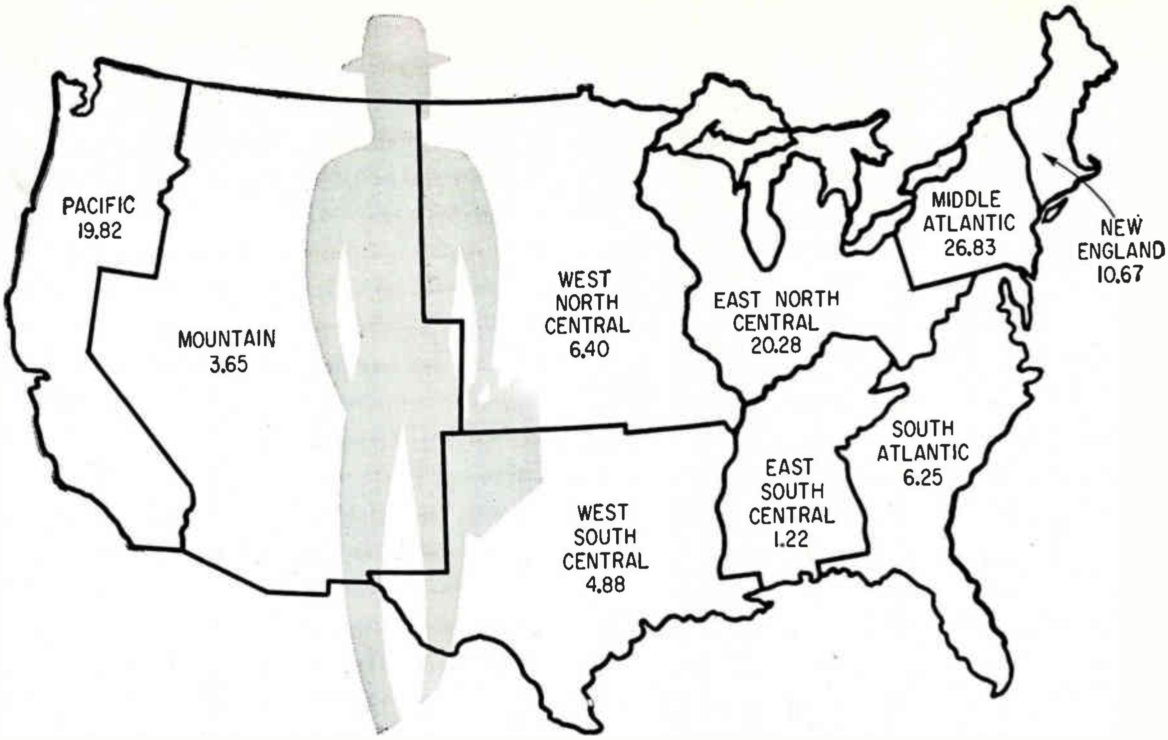
Other recent work is stressing the reduction in size of electromechanical components, to match the reductions afforded in electronic gear by transistorization.

IBM recently announced, for example, the development of a 6-oz drum 3 in. long and 3 in. in diameter (see photo) that can hold 100,000 bits of information. The drum spins at 6,000 rpm; heads are embedded in slider bearings that float on the airstream 0.0001 in. away from the drum surface.

Many computers produced heretofore are memory limited; the high-speed processing capabilities are held up by requirements of memory lookup, latency, readout and regeneration, and so forth. Increased high-speed core storage has helped minimize this problem. In its new 1401 system, IBM offers a basic 4,000-character storage; to increase the small system's flexibility, the company added a 1406 storage unit which can expand the memory to 16,000 characters. Univac III has 16,384 words of core storage which can be expanded to double that capacity.

Automatic program-interrupt features which permit the programmer to interlace several problems and program the priority of the procedure have been added to most large systems. The Philco 2000, CDC1604, Univac III and most of the other large systems entering the market contain this capability.

Programming in general is now being recognized as an essential part of computer manufacture. Compiling routines are designed as part of new systems prior to their being offered for sale. GE's 225, for instance, is sold with a general compiler as part of the system.



Distribution of electronics reps. Figures represent percentage of U.S. total in each region

Manufacturers' Reps to Sell $2½ Billion

By EDWARD DEJONGH
Market Research Editor

MANUFACTURERS' REPRESENTATIVES will sell about $2½-billion-worth of the products manufactured by the U.S. electronics industry this year. The figure represents 25 percent of total factory-sales volume of approximately $10 billion anticipated by the industry for 1960. Last year, rep sales totaled $2.2 billion.

Information comes from ELECTRONICS' 1960 Survey of Electronics Manufacturers' Representatives, and provides the first estimate of rep sales ever made from a broad sample of actual sales by rep firms.

ELECTRONICS surveyed 1,450 representatives, including 1,150 from the U.S., nearly 80 percent of the 1,500 reps who serve the industry in this country. Replies were received from 685 firms, of which 656 were from the U.S. and 29 from foreign sources, mostly from Canada and Mexico.

Typical rep among the 483 who supplied information on expected sales volume for 1960 looks for a 25-percent sales increase over 1959, indicating total rep sales of $2.8 billion for the year. But in evaluating the sampling, allowance was made for possibly decreased sales expectations among those who did not reply. Also, many estimates were made in the first quarter of the year, when Soaring-Sixties thinking was stronger than it is today.

Survey conclusions check with informed opinions in electronics representative circles. Bill Weber, executive secretary of Electronic Representatives Association, says "Total sales of the reps in this country had previously been roughly estimated at between $2½ and $3 billion."

Many firms are thinking of 1960 sales increases far in excess of the 25-percent average. A sixth of the respondents expect at least a 50-percent increase, and 3 percent of them look for sales to double.

Related sales information uncovered by the survey shows the 1,500 firms in industry employ 6,055 salesmen, an average complement of four salesmen per firm.

Sales of the average-sized firm in 1959 amounted to $1,464,000, with the average salesman turning in business worth $367,000 during the year.

Geographical distribution of rep organization headquarters has changed little in the past year. Returns from the current survey show that 67 percent of all rep activity is centered in three main regions. The Middle Atlantic region has 27 percent of all U.S. reps, the East North Central region 21 percent, and the Pacific region 20 percent (see map).

Comparison with last year's survey shows the three leaders, as a group, have dropped three percent. Each of four other regions—New England, South Atlantic, East South Central and Mountain—made gains of up to one percent of the U.S. total, while the West South Central region was off slightly.

Reps are continuing to maintain the technical level of their personnel. As in last year's survey, 90 percent of the respondents said they have engineering or technical talent with special knowledge of electronic equipment.

Previously growing interest in taking on additional services and functions is apparently leveling off. One out of four say they are equipped to service electronic equipment, about the same ratio as last year. Seventeen percent report they are willing to handle contracts to service industrial electronic equipment in their territories; in 1959, 21 percent expressed the same willingness.

There was a small decline in the number who expressed interest in soliciting business from jobbers. Percentage was down from 69 percent in 1959 to 67 percent in 1960. It has been previously thought that rep activity in soliciting jobber business would increase this year because of increased activity of jobbers or distributors in selling components to original equipment manufacturers.

However, there was some increase in the percentage of jobber reps, those reps who spend 50 percent or more of their sales efforts on jobbers. Respondents who say they distribute their effort this way numbered 21 percent, up a percentage point from 1959.

Number of reps with storage or warehouse facilities is slightly more than half, hardly changed from last year.

Five hundred representatives, or three out of four respondents, mention interest in acquiring new manufacturers' lines. Components (not specified by type) are most wanted items, with 371 mentions, followed by instruments with 79. Most popular specific components sought are relays, transistors and semiconductors, capacitors, connectors and microwave components. Test and measuring equipment (not specified) are top items in the instrument group, followed by meters and oscilloscopes.

Hi-fi is one product much sought after in the end-equipment field. Computers or data-processing equipment and microwave equipment trailed.

Among replies which did not fit a specific product group were 43 who said they want jobber lines and nine who would like to add systems.

ERA has just completed a related survey of rep operating expenses among its member firms, which shows that average representative's net profit before taxes in 1959 was 10.6 percent of total commission income. Largest single item of expense in the 89.4-percent overhead total was salaries, which account for 49.1 percent of total commission income.

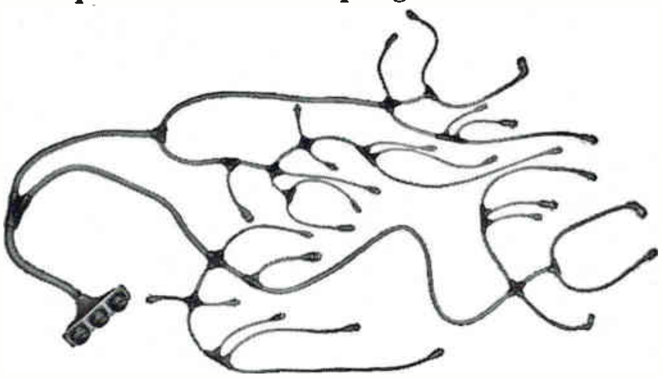
General Electric RTV* liquid silicone rubber

*Room Temperature Vulcanizing

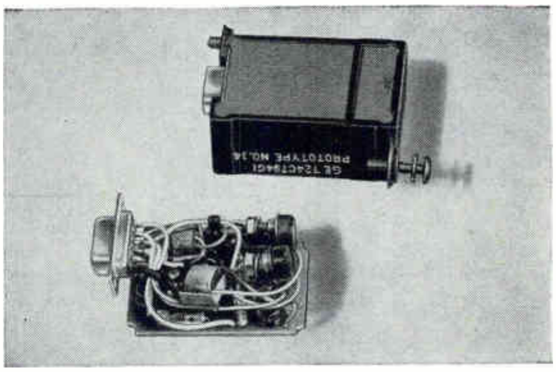
The latest addition to General Electric's RTV family offers lower viscosity than any other available silicone rubber compound — a typical viscosity of 120 poises. Easily pourable, it flows freely in and around intricate contours, making it ideal for protecting electrical and electronic components.

With RTV's new low viscosity, the range of G-E RTV compounds now extends from 120 to 12,000 poises. You can now meet your specific requirements by selecting from several G-E RTV compounds, all of which offer room temperature cure, heat and ozone resistance, and good electrical properties. Write for a free test sample, briefly describing your application.

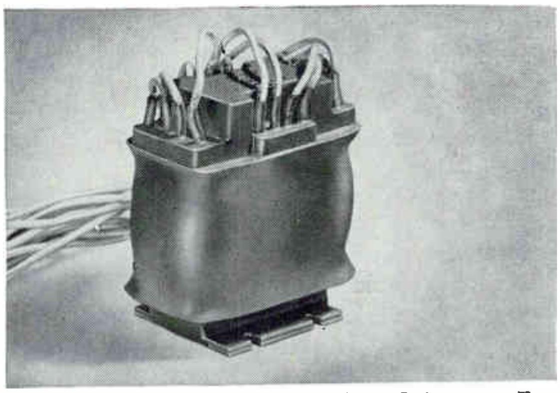
New low viscosity for easier encapsulation and impregnation



General Electric silicone rubber used extensively by Aerojet-General Corp. for the Titan ICBM's propulsion-system wiring harness. Breakouts and junctions molded from G-E RTV, wiring is silicone insulated, jacketing is high-strength G-E silicone rubber — all chosen for their stable insulating properties, resistance to temperature extremes and weathering, and stability in storage for many years.



Sight amplifier module potted with RTV by the Armament and Control Section of G.E.'s Light Military Electronics Department. Used on the Lockheed CF-104 and F-104G jet aircraft, RTV provides mechanical support and vibration damping, protects unit against moisture and ozone. (Bottom photo shows module before potting.)



High-voltage, high-altitude transformers from Laboratory For Electronics, Inc. are encapsulated with General Electric RTV to meet MIL-T-27A specs. This prevents flashover at maximum ratings of 2200 volts rms and 80,000 feet. General Electric RTV was selected for its good heat transfer, low viscosity and mechanical strength.

GENERAL ELECTRIC

Silicone Products Department, Waterford, New York

CIRCLE 35 ON READER SERVICE CARD →

SARKES TARZIAN
SILICON ZENER VOLTAGE REGULATORS

Tarzian silicon voltage regulators, commonly called zener diodes, are constant voltage devices used to control output voltage of power sources and as voltage reference elements capable of operating over a wide temperature range. Hermetic sealing and mechanical ruggedness provide long term reliability even under the most adverse conditions.

Three power classifications cover a wide range of applications.

¼ Watt Zener Regulators

Specifications 25°C.

Tarzian Type	Zener Volt. (V)	Test Cur. (Ma)	Dyn. Imp. (Ohms)	Jedec Type
.25T5.6	5.6	25	3.6	1N708
.25T6.2	6.2	25	4.1	1N709
.25T6.8	6.8	25	4.7	1N710
.25T7.5	7.5	25	5.3	1N711
.25T8.2	8.2	25	6.0	1N712
.25T9.1	9.1	12	7.0	1N713
.25T10	10	12	8.0	1N714
.25T11	11	12	9.0	1N715
.25T12	12	12	10	1N716
.25T13	13	12	11	1N717
.25T15	15	12	13	1N718
.25T16	16	12	15	1N719
.25T18	18	12	17	1N720
.25T20	20	4	20	1N721
.25T22	22	4	24	1N722
.25T24	24	4	28	1N723
.25T27	27	4	35	1N724
.25T30	30	4	42	1N725
.25T33	33	4	50	1N726
.25T36	36	4	60	1N727
.25T39	39	4	70	1N728
.25T43	43	4	84	1N729
.25T47	47	4	98	1N730
.25T51	51	4	115	1N731
.25T56	56	4	140	1N732
.25T62	62	2	170	1N733
.25T68	68	2	200	1N734
.25T75	75	2	240	1N735
.25T82	82	2	280	1N736
.25T91	91	1	340	1N737
.25T100	100	1	400	1N738

1 Watt Zener Regulators

Specifications 25°C.

Tarzian Type	Zener Volt. (V)	Test Cur. (Ma)	Dyn. Imp. (Ohms)
1T5.6	5.6	100	1.2
1T6.2	6.2	100	1.5
1T6.8	6.8	100	1.7
1T7.5	7.5	100	2.1
1T8.2	8.2	100	2.4
1T9.1	9.1	50	3.0
1T10	10	50	3.5
1T11	11	50	4.2
1T12	12	50	5.0
1T13	13	50	5.8
1T15	15	50	7.6
1T16	16	50	8.6
1T18	18	50	11
1T20	20	15	13
1T22	22	15	16
1T24	24	15	18
1T27	27	15	23
1T30	30	15	28
1T33	33	15	33
1T36	36	15	39
1T39	39	15	45
1T43	43	15	54
1T47	47	15	64
1T51	51	15	74
1T56	56	15	88
1T62	62	5	105
1T68	68	5	125
1T75	75	5	150
1T82	82	5	175
1T91	91	5	220
1T100	100	5	260

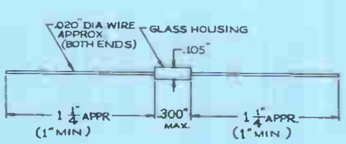
10 Watt Zener Regulators

Specifications 25°C.

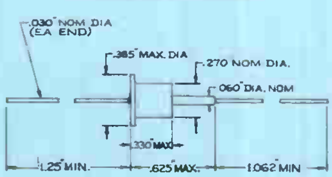
Tarzian Type	Zener Volt. (V)	Test Cur. (Ma)	Dyn. Imp. (Ohms)	Jedec Type
10T5.6	5.6	1000	1	1N1803
10T6.2	6.2	1000	1	1N1804
10T6.8	6.8	1000	1	1N1805
10T7.5	7.5	1000	1	1N1806
10T8.2	8.2	1000	1	1N1807
10T9.1	9.1	500	1	1N1808
10T10	10	500	2	1N1351
10T11	11	500	2	1N1352
10T12	12	500	2	1N1353
10T13	13	500	2	1N1354
10T15	15	500	2	1N1355
10T16	16	500	3	1N1356
10T18	18	150	3	1N1357
10T20	20	150	3	1N1358
10T22	22	150	3	1N1359
10T24	24	150	3	1N1360
10T27	27	150	3	1N1361
10T30	30	150	4	1N1362
10T33	33	150	4	1N1363
10T36	36	150	5	1N1364
10T39	39	150	5	1N1365
10T43	43	150	6	1N1366
10T47	47	150	7	1N1367
10T51	51	150	8	1N1368
10T56	56	150	9	1N1369
10T62	62	50	12	1N1370
10T68	68	50	14	1N1371
10T75	75	50	20	1N1372
10T82	82	50	22	1N1373
10T91	91	50	35	1N1374
10T100	100	50	40	1N1375

NOTES: Standard tolerance is ± 10% however, closer or wider tolerances are available on request.
Also available on request:
(a) Special voltage ratings.
(b) Symmetrical double anode types (for clippers).

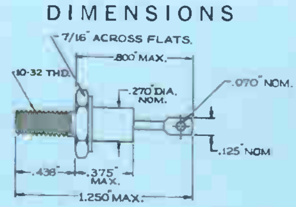
DIMENSIONS



DIMENSIONS



DIMENSIONS

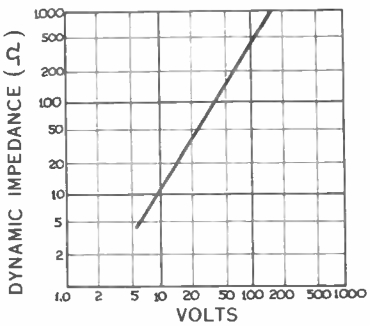


SARKES TARZIAN SILICON VOLTAGE REGULATOR ZENER DIODES
Characteristics and Application

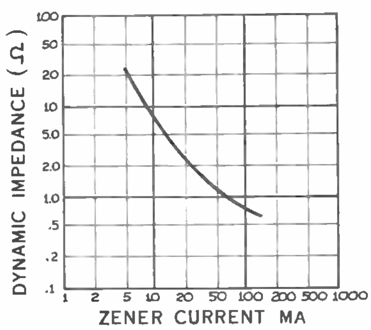
Dynamic Impedance

Dynamic impedance is a measure of voltage change effects on operating current and provides a practical measure of regulating performance. Dynamic impedance is measured by superimposing a small AC current upon the DC test current and measuring the resultant voltage across the diode.

The following curves show the effects of voltage and current on dynamic impedance.

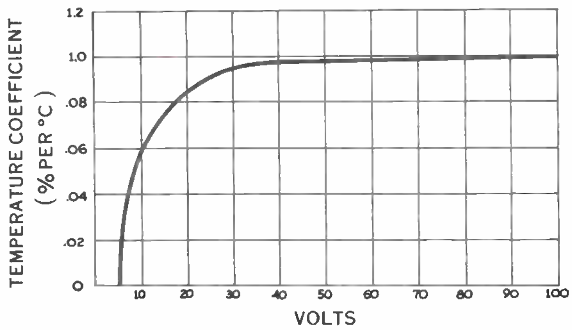


TYPICAL CURVE FOR 1T7.5



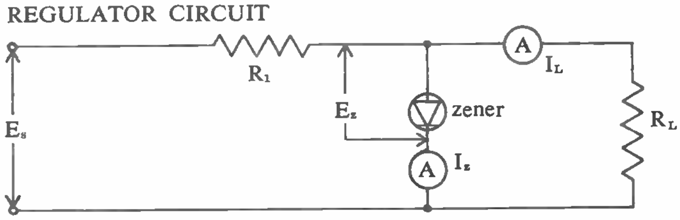
Temperature Coefficient

The operating voltage of a silicon regulator changes with operating temperature. This characteristic must be considered in design. The following curve shows temperature—voltage relationships typical in silicon zener diodes.



Typical Application

REGULATOR CIRCUIT



As the input voltage increases the inverse bias across the zener diode will increase and cause a large current to flow. This increase will cause more current to flow through R_1 and increase the drop thereby adjusting the load voltage. Load variations have a similar effect. The result is a substantially constant output voltage.

Determination of R_1 is as follows:

$$R_1 = \frac{E_s - E_z}{I_z + I_L}$$

$$I_z = \left(\frac{E_s - E_z}{R_1}\right) - I_L$$

$$P_z = \left(\frac{E_s - E_z}{R_1} - I_L\right) E_z$$

Where:

R_1 is the series resistor
E_s is the source voltage
E_z is the zener diode voltage
I_z is the zener diode current
I_L is the load current
P_z is the zener diode power dissipation

Where the load current and input voltage are variable:

$$R_1 = \frac{E_s\,(\text{min.}) - E_z}{I\,(\text{max.}) + .1 I_L\,(\text{max.})}$$

$$P_z\,(\text{max.}) = \left(\frac{E_s\,(\text{max.}) - E_z}{R_1} - I_L\,(\text{min.})\right) E_z$$

For constant load current but variable input voltage:

$$R_1 = \frac{E_s\,(\text{min.}) - E_z}{I_L + .1 I_L}$$

$$P_z\,(\text{max.}) = \left(\frac{E_s\,(\text{max.}) - E_z}{R_1} - I_L\right) E_z$$

For constant input voltage but variable load current:

$$R_1 = \frac{E_s - E_z}{I_L\,(\text{max.}) + .1\, I_L\,(\text{max.})}$$

$$P_z\,(\text{max.}) = \left(\frac{E_s - E_z}{R_1} - I_L\right) E_z$$

NOTES: The above equations allow a tolerance of 10% to compensate for load regulation.
If dynamic impedance is a significant percentage of the value of R_1, this must be taken into consideration.
A high impedance source presents additional problems and must be considered if it is significant compared to R_1.

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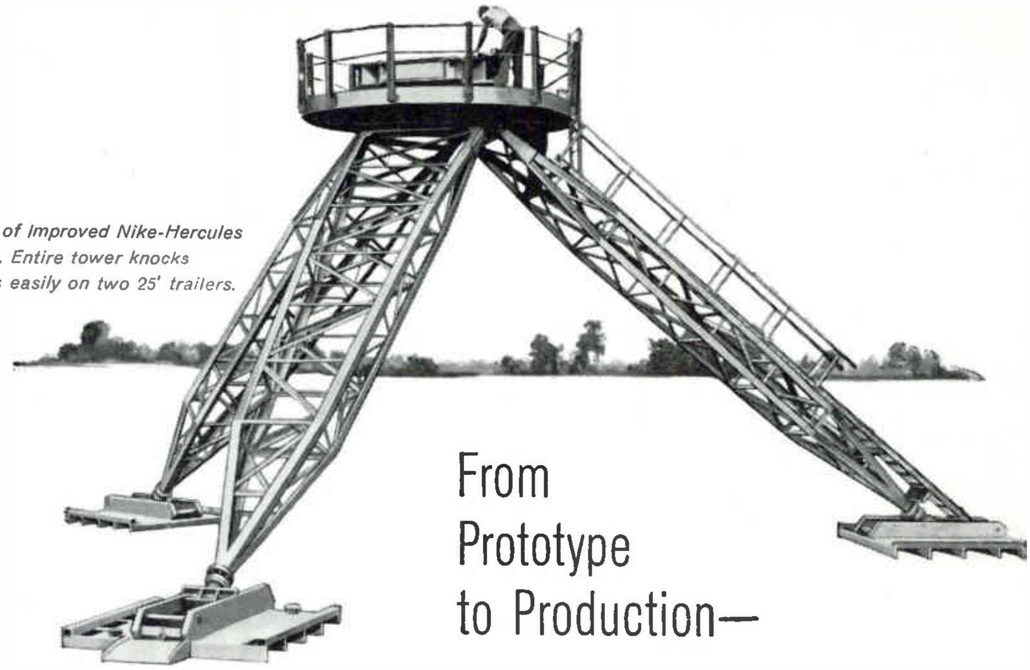

Field Army Version of Improved Nike-Hercules Radar Tower. Entire tower knocks down and packs easily on two 25' trailers.

From Prototype to Production—

Dresser-Ideco offers a complete antenna tower service

Fixed-Site Version of Improved Nike-Hercules Radar Tower incorporates the field army tower mounted on a 25' height-extension and fitted with a radome.

These antenna support structures for the U.S. Army's Improved Nike-Hercules Missile System illustrate the kind of complete structural service rendered by Dresser-Ideco Company.

In designing and building both the field army and fixed site versions of this tower for Bell Telephone Laboratories, Inc. and Western Electric Company, Dresser-Ideco performed the following services:

- **Conducted design and feasibility studies**
- **Made structural design analyses**
- **Prepared manufacturing shop drawings**
- **Wrote erection and maintenance manuals**
- **Manufactured the two prototype towers**
- **Erected and tested prototype of the field army tower**
- **Test-erected complete fixed-site tower**
- **Shipped and erected complete structure at White Sands Missile Range**

Far more than "steel burners," Dresser-Ideco personnel are highly specialized structural engineers and technicians. The company is fully staffed to provide complete structural steel services ranging from research and development to field erection and testing of prototypes and large-scale manufacture and installation of production units.

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Communications centers like this Kansas City installation are proving the value of electronics to police. Dictaphone recording gear (far wall) keeps audio record of all verbal exchanges

Police Gear Sales Springing Back

SALES OF ELECTRONIC gear to police departments are climbing back to levels they held prior to the 1958 recession, according to manufacturers interviewed this week.

From 1953 to 1957 the police market hovered slightly under $8-million annually. Estimates vary regarding the sales decline experienced during 1958 and 1959, but a frequently mentioned figure is 30 percent.

It's estimated that this year sales of electronic equipment to police users will top the $7-million mark, and pass the $8-million level by the end of 1961.

In commenting on the upturn, the more optimistic industry spokesmen say sales might surpass the figures they presently anticipate. In support of this, they mention the many areas where, in addition to communications, electronics are proving their value in police work.

Traffic-control systems, visual data transmission systems, certain computer applications, as well as accounting and general recordkeeping, all form part of this expanding market.

Although these and other areas are growing in importance, communications gear continues to account for the major portion of all sales. One manufacturer estimates that 10 percent of all mobile radio gear sold goes to police users. One New Jersey company says about 30 percent of its total volume is in police radio systems.

It is significant to note that at the Associated Police Communication Officers Conference held earlier this month in Philadelphia, 26 electronics manufacturers participated. In addition to technical papers presented by company engineers and administrators, there were exhibits of new systems and devices aimed at police use.

A spokesman for Allen B. DuMont Laboratories says the police market is a very competitive one, and points out that equipment must be built to take a quasimilitary usage and still maintain reliability.

A General Electric man points out the extremely cost-conscious nature of the police market, in which voters can examine the proposed budgets of their communities and approve or protest new facilities.

"At the same time," he told ELECTRONICS, "the police are an important influence in design of radio equipment and often lead the way on standards."

One sales manager calls the police field "our toughest market, but one of our most valued." From a sales point of view, the manufacturer must meet competitive open bidding in almost all cases.

The days when a contract to furnish communications gear and other equipment depended on contacts in the municipality, rather than on equipment reliability, have long passed. The open-bid situation, according to salesmen, drives down the price but proves rewarding in terms of volume.

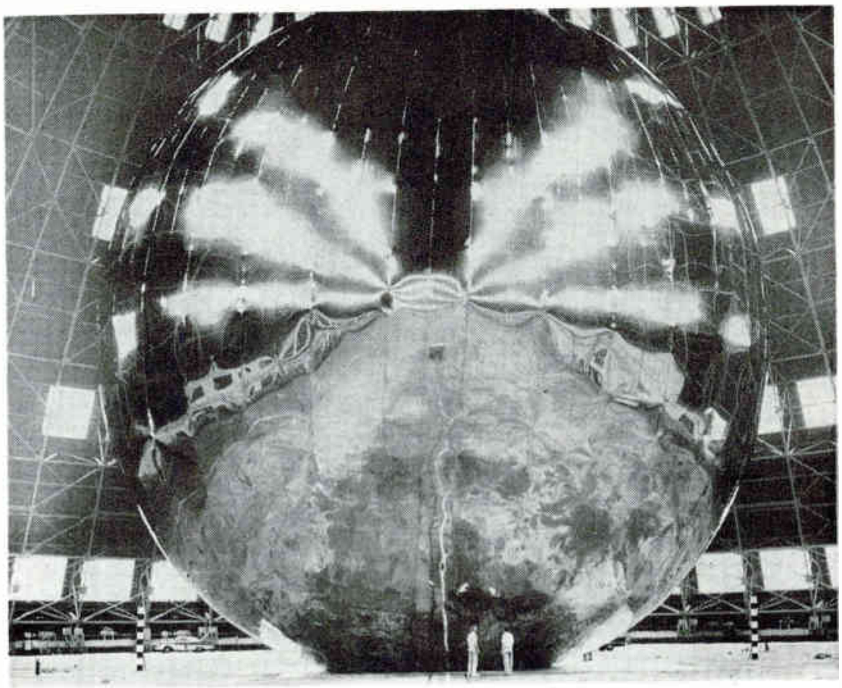
Manufacturers speak with respect for police customers because of the level of their technical knowledge. Most departments, according to a number of manufacturers, are very knowledgeable technically and consider communications their right hand. Many police communications officers are old-line radio men who, in many cases, began their careers in ham radio.

Although manufacturers provide service facilities on a regional basis, many police departments have members with enough engineering background to service their own equipment.

One benefit electronics has brought to police groups, in addition to rapid communications and data transmission, is the facility to record all conversations.

Among equipment available for this purpose is Dictaphone Corp.'s line of police recording equipment. Departments use the gear to keep an audio record of all incoming calls. Police are able to check indistinct alarm calls, record false reports and inaccurate descriptions, receive moment-by-moment details of speeder chases and maintain an automatic radio log.

How Echo I Opens New Space Era



Two men (center) are dwarfed by 100-ft-dia communications satellite

LARGEST SATELLITE ever orbited was lofted recently by National Aeronautics & Space Administration in an experiment designed to test the feasibility of global communications by passive satellite reflections.

Dubbed Echo I by NASA director Keith Glennan after is was successfully in orbit, the satellite went up after a launching-pad failure on May 13 and two postponements on Aug. 9 and 10.

Communications were established on the second orbit between Bell Telephone Laboratories' station at Holmdel, N. J., and the big dish at Goldstone, Calif., operated by CalTech's Jet Propulsion Laboratory for NASA.

First message, a statement by President Eisenhower, stressed that "peaceful purposes for the benefit of all mankind" inspired the experiment.

Glennan described the launching as " well nigh perfect." The satellite—or satelloon, as some were calling it—was programmed to orbit 1,000 miles up at nearly 16,000 mph. Its two-hour circular orbit started at a southeasterly angle inclined 47 deg to the equator.

Echo is a 100-ft sphere of aluminized 0.0005-in. Mylar, weighs about 125 lb. It rode aloft deflated and packed in a 26½-in. cannister in the nose cone of a Thor-Delta rocket.

Upon ejection from the launcher, the two hemispheres of the cannister separated and the plastic sphere spilled free. Previously injected crystals of subliming solid inflated the sphere; the sublimation process will continue for a month or so to compensate for micrometeorite punctures.

A special horn-reflector antenna recently completed at Holmdel is the eastern terminus of the satellite link. Goldstone is using its 85-ft dish at the western terminus. Transmission frequency is 960 Mc westbound, about 2.39 Gc eastbound. F-m is used with a deviation of ± 150 Kc at the highest modulation frequency of 3 Kc.

Computermakers got into the act in a big way. The Echo satelloon's successful orbit was established by Bell Telephone Laboratories' command-guidance system, which uses the Athena computer to derive course-correction data. The computer was designed for the Titan ICBM by Remington Rand Univac, was used for the same purpose when NASA threw Tiros I into orbit on April Fools Day.

After launch, an IBM709 at NASA's Goddard Space Flight Center, Greenbelt, Md., was immediately put to work aiming the radio antennas on the East and West Coasts so they could find the sphere to bounce their signals off it.

Two other IBM709s were involved in the project. One, at Cape Canaveral, calculated velocity, trajectory and impact point of the rocket for the range safety officer. The other, at IBM's Space Computing Center in downtown Washington, is keeping precise tabs on Echo's orbit, also produces timetables for observers throughout the world.

Echo I is the first of 12 missions included in the Delta space-vehicle program. Other Delta launchings scheduled for 1960 include Tiros II, Echo II and a lunar probe.

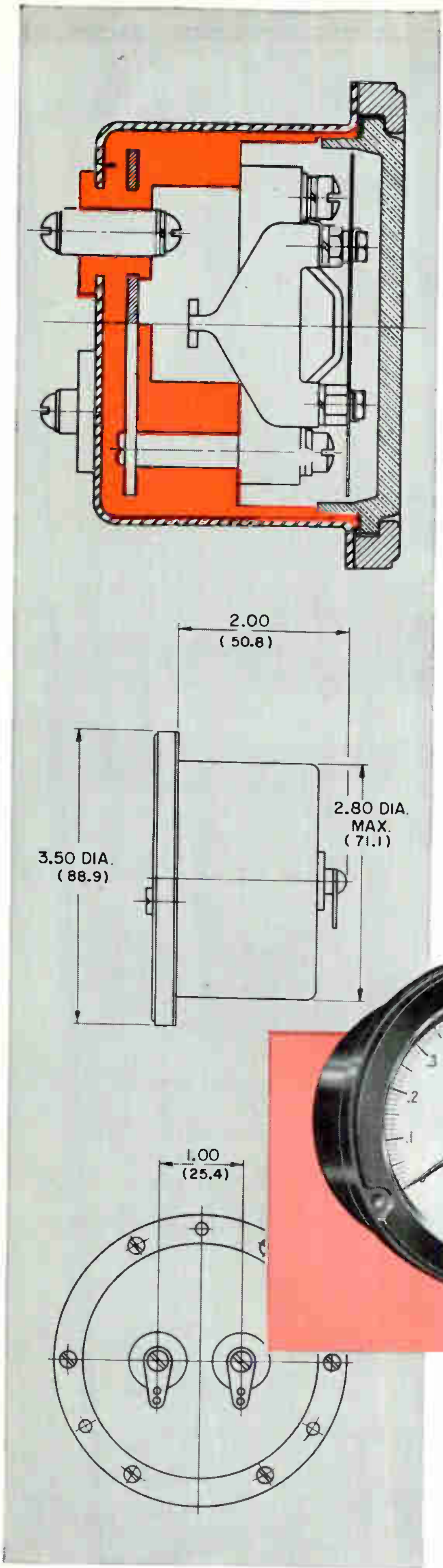
On the same day as the Echo I launch, a Navy helicopter finally was able to recover a capsule which had been ejected from a Discoverer satellite.

The 300-lb capsule was tossed out of Discoverer XIII over Alaska, retrieved in the planned recovery zone north of Hawaii. Air Force has been trying to recover a Discoverer capsule since February 1959; of twelve previous tries, seven went into orbit, six payloads were successfully ejected, four tries were made at recovery. One capsule is believed to have landed on Spitzbergen, may have been recovered by Soviet scientists.

The successes of Aug. 12 have followed a couple of disheartening failures. Besides the two Echo postponements, an attempt to rocket an unmanned Project Mercury capsule on July 29 was wrecked when the Atlas booster exploded shortly after takeoff and was lost in the Atlantic.

In other recent space developments:

McDonnell Aircraft has awarded a 5-month study contract to Collins Radio to investigate radio communications problem incident to soft-landing an unmanned spacecraft on the moon. Raytheon won a study contract to investigate active doppler velocity sensors for soft moon landings; aim is to find a system that will work 120 miles up over water, 360 over land.



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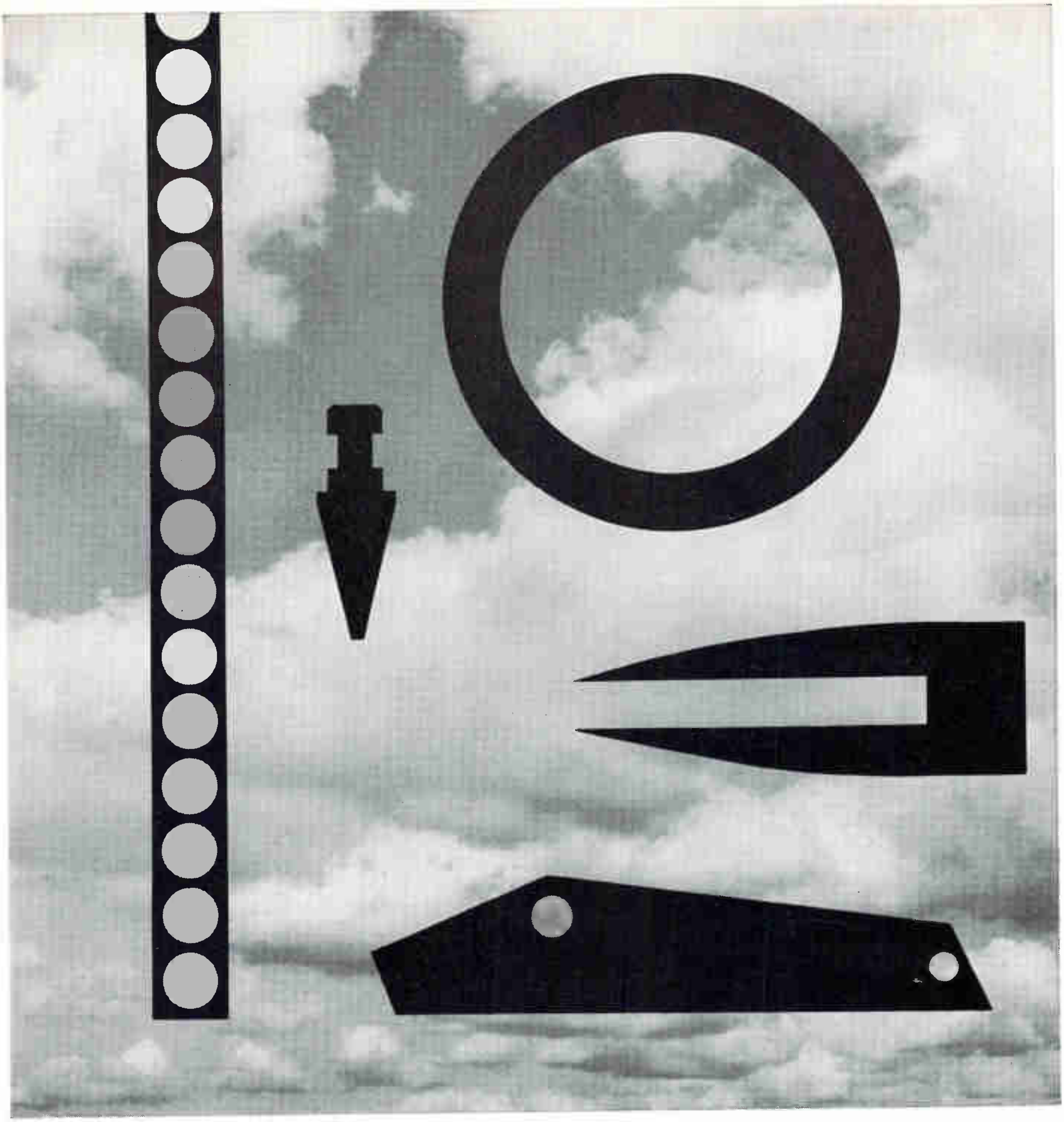

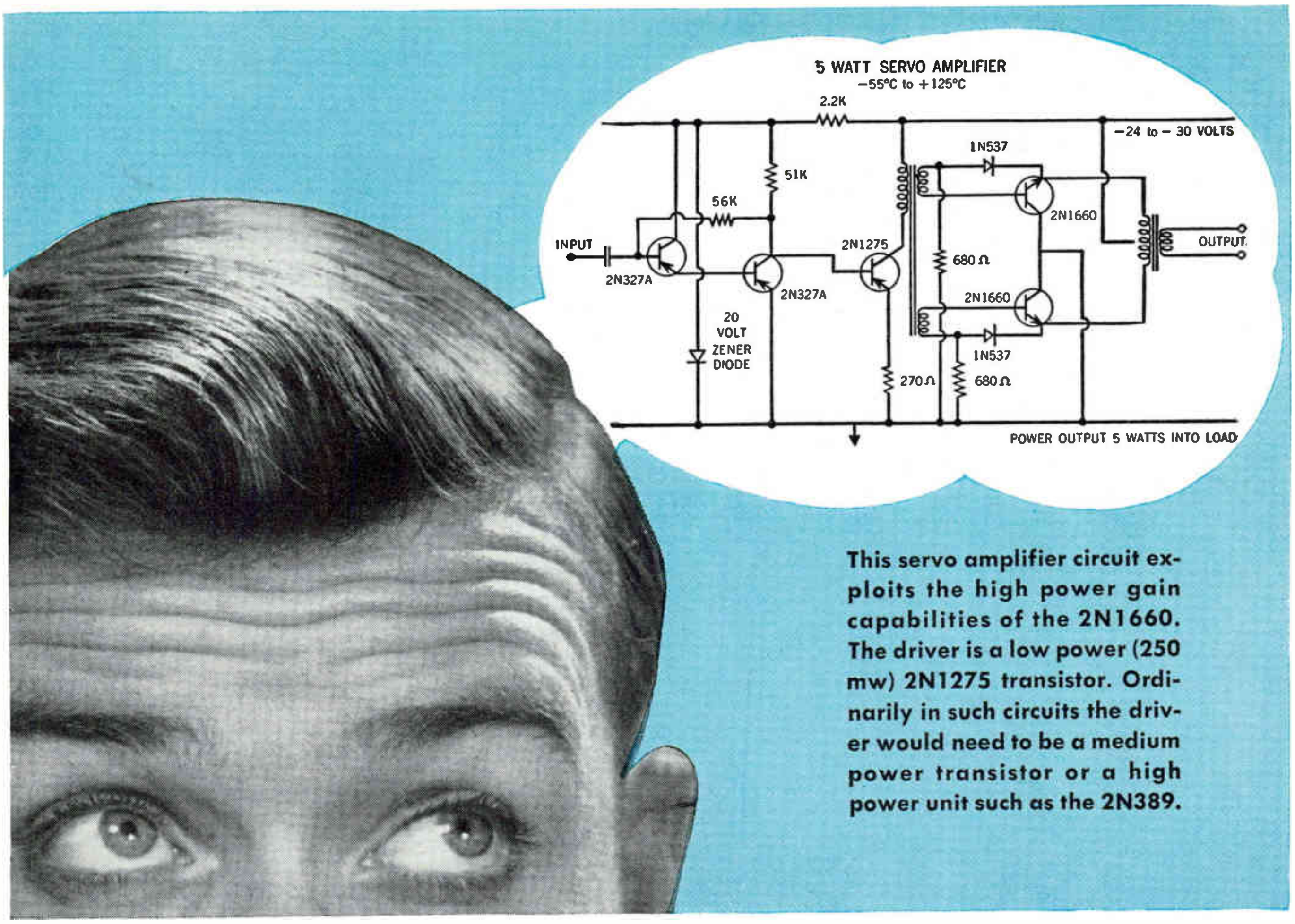

This servo amplifier circuit exploits the high power gain capabilities of the 2N1660. The driver is a low power (250 mw) 2N1275 transistor. Ordinarily in such circuits the driver would need to be a medium power transistor or a high power unit such as the 2N389.

New High Voltage, High Gain Transistors

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Type	BV_{CER} Min. Volts	BV_{EBO} Min. Volts	Vsat Max. Volts	H_{FE} Min.	V_{BE} Max. Volts	Ft. Min. Mc
Conditions:	R1=33 ohms		1c=1A 1B=0.2A	Vc=15V 1c=1A	Vc=15V 1c=1A	Vc=30V 1c=100MA
2N1660	60	10	4.0	45	3.0	25
2N1661	80	10	4.0	45	3.0	25
2N1662	100	10	4.0	45	3.0	25
2N1657	60*	3	3.0	15‡		
2N1470	60*	3	3.0	15‡		
2N389	60	10	5.0	12	8.0	
2N424	80	10	10.0	12	8.0	

*BV_{CES} ‡Vc=5.0 V; 1c=1.0 A

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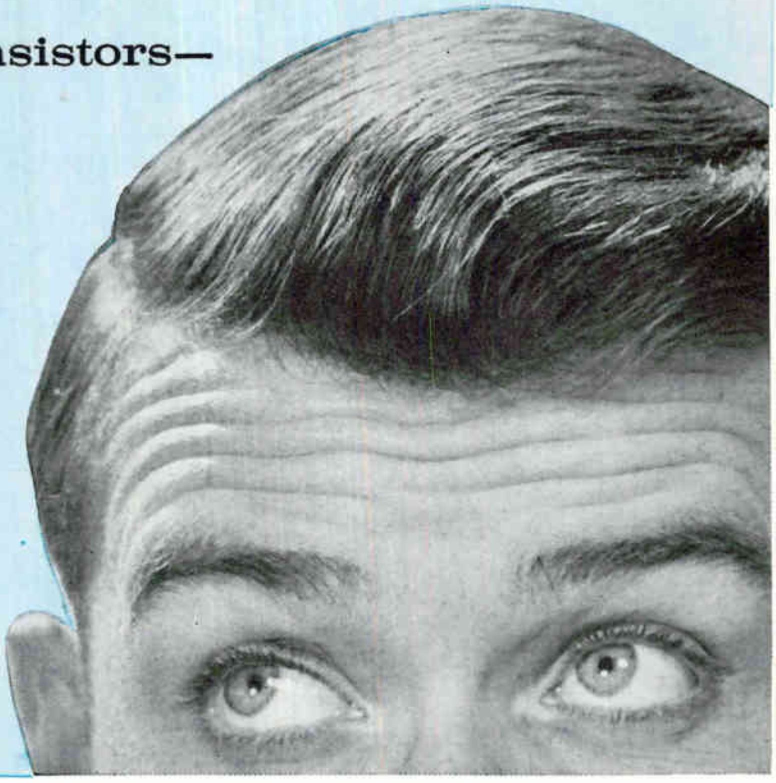

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Britain Steps Up Controls Research

Industrial instruments stressed as government gives funds to record total of 50 associations

LONDON—THE FIELD of industrial automatic controls is getting new attention in Britain, McGraw-Hill World News reports this week.

The British Scientific Instrument Research Association, after concentrating in its early years on laboratory-type instruments, is now embarking on a program of industrial instrument research.

Overall, Britain's pattern of co-operative industry research by government-aided associations is growing.

These are among highlights from a report just published by the Department of Scientific and Industrial Research (DSIR).

The report, "Research For Industry," reveals that in 1959 the number of government-aided research associations reached a new high of 50. Their income from both industry and government contributions totalled over $20 million, a hike of $1.1 million over 1958.

Of this total income, industry provided the bulk. DSIR contributed $4.7 million, a figure up by $840,000 over the 1958 contribution. This increased spending on research, says the report, is in line with the overall trend in Britain.

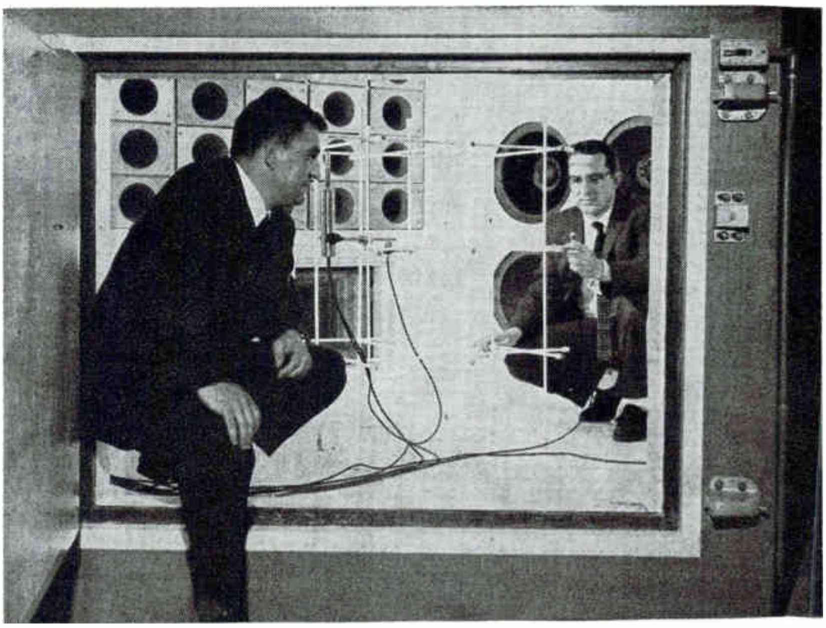
In 1958, manufacturers invested 4.2 percent of turnover in research and development, compared with 3.1 percent in 1955.

While each of the 50 research associations is an example of co-operative research within a section of industry, the report highlights three areas—creep, metal fatigue and shipbuilding—where combined research programs among several associations are in progress.

These are areas, reports the DSIR, where "we have aided the pooling of resources in all ways at our disposal."

On creep research the National Engineering Laboratory, cooperating with the National Physical Laboratory and the Electrical Research Association, has set up a creep information center to disseminate data on conventional British high temperature materials. A new laboratory slated to open in 1961 at a cost of around $450,000, will investigate creep phenomena in

Giant Noise for Testing Parts



Two 17 db Avco noise generators at Sud Aviation, France, simulate roar of rockets and jets to test parts under acoustic vibrations steam plant and turbine applications.

Fatigue research under a committee comprising the National Physical Laboratory and the British Welding Research Association is making its prime work investigations of fatigue failures of low-alloy high tensile steels in welded constructions. Aircraft and reinforced concrete structures are omitted from the committee's terms of reference. A report is due later this year.

The British Scientific Instrument Research Association is busy detecting elements and building up a card index on the 200 parameters that are measurable in industrial processes.

When complete, this bureau for detecting elements will provide industry with complete information of currently available techniques and their limitations. Other work includes development of position sensitive photo-conductive diodes capable of detecting a one angstrom unit movement in two directions at right angles. Also under development is a new gas flowmeter.

Japan to Export Tunnel Diodes

JAPAN'S electronics industry continues to proliferate new consumer goods and components.

Hayakawa Electric of Osaka has come out with a transistor radio that operates off a silicon solar cell. Dubbed the sunshine radio, the set can operate from ordinary chemical batteries as well, is expected to retail at about $15 more than ordinary transistor radios. It will be produced on a trial basis until Hayakawa figures out if anyone wants to pay the premium for a radio that operates only when the sun is out.

In other news, Sony Corp. announces that its tunnel diodes will go on sale on the domestic market this month at prices ranging from $2.80 to $10. Monthly production levels are currently about 30,000, are expected to pass a million by November when Sony opens a plant at Atsugi, near Yokohama. After that, the fast switching components will be offered for export, and the manufacturing techniques will be offered for license.

Small Business Group to Meet

Problems, complaints to be studied Sept. 13 at Indiana conference. EIA playing key role

SMALL BUSINESS PROBLEMS are slated for more discussion and study by Electronic Industries Association members on Sept. 13 at French Lick, Ind.

The agenda for EIA's Small Business Committee meeting includes:

1) How small business can team up with large corporations and fill in gaps.

2) Review House of Representatives Bill No. HR 11207 defining small business.

3) Review protection of small business being considered by government regulation.

4) Review technical manpower being expended in military procurement for preparation of many elaborate but unsuccessful technical proposals.

5) Develop an up-to-date list of companies that can be classified as small business.

6) Consider establishing territories along the lines of Small Business Administration for regional decentralization of the activities under committee jurisdiction.

At a recently held regional conference, some small business firms took the opportunity to air some complaints. Speakers said:

"The small businessman suffers from the lack of progress payments during the development and prototype stage of a contract. He is also hampered by the need to make payments for tools and advanced production costs prior to the delivery of merchandise.

"He is handicapped by lack of knowledge of planned expansion by the Department of Defense."

The Small Business Committee is planning further organization on a regional basis so frequent meetings will be possible.

The aim of these meetings, according to Ray Zender of Lenz Electric, Chicago, will be educational.

"We need to call attention to government groups like the Small Business Administration," he told ELECTRONICS. "The small business executive has been missing out on the channels of operation where federal help is available. He should learn as much as he can about these for the good of his company."

Arrangements have also been made to have larger electronics firms demonstrate and explain what programs they administer in support of small business, Zender said.

Mercury Data Display

Console, by Stromberg-Carlson, displays Project Mercury capsule flight data and astronaut's reactions

Mideast Banks Use Tv, Computers

ELECTRONIC OFFICE EQUIPMENT, a few computers and some closed-circuit television are bringing "office automation" to the Near East.

Banks in Lebanon, Iraq and Jordan are already using multiple electronic bookkeeping systems provided by National Cash Register at $20,000 each.

Big computers are in use, too; Arabian American Oil uses an IBM705 and two electronic calculators; Bahrein Petroleum uses an IBM1401; Kuwait Oil and the Iranian Consortium use Hollerith 500-series systems.

Intra Bank of Lebanon, with 15 branches in various Arab countries, uses a closed-circuit tv from Siemens & Halske in it main Beirut office. The system is used to inspect and validate counter transactions.

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Sept. 7-8: Value Engineering, EIA, Disneyland Hotel, Anaheim, Calif.

Sept. 7-8: Automatic Control, Joint Conf., ASME, IRE, AIEE, ISA, MIT, Cambridge, Mass.

Sept. 8-9: Conference on Technical Communications, Society of Technical Writers and Editors, Univ. of Dayton, Dayton, O.

Sept. 9-10: Communications: Tomorrow's Techniques—A Survey, IRE, Roosevelt Hotel, Cedar Rapids, Ia.

Sept. 11-16: American Chemical Society, Annual, Statler Hilton, New York City.

Sept. 13-14: Bionics Symposium, Applying Biological Principles to Engr. Design, ARDC, Wright Air Devel. Div., Dayton Biltmore Hotel, Dayton, O.

Sept. 14-15: Industrial Electronic Test Equipment Symposium, Armour Research Foundation, Chicago.

Sept. 15-16: Engineering Management Conf., IRE, Morrison Hotel, Chicago.

Sept. 15-17: Upper Midwest Electronic Conf., Twin Cities Elec. Wholesalers, Civic Auditorium, Minneapolis.

Sept. 19-21: Data Transmission, International Smp., PGCS of IRE and Sectie Voor Tele. of Koninklijk Ins. van Ingonieurs, Delft, Neth., Contact B. B. Barrow, Benelux Section, IRE, Postbus 174, Den Haag, Nederland.

Sept. 19-22: Space Electronics and Telemetry, Nat. Symposium, Shoreham Hotel, Washington, D. C.

Sept. 21-22: Industrial Electronics, Annual, PGIE of IRE, AIEE, Sheraton-Cleveland Hotel, Cleveland.

Sept. 23-24: Broadcasting Symposium, PGB of IRE, Willard Hotel, Washington, D. C.

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

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a continuing series on technical topics relating to electronic applications

Folio 11 REFERENCE DATA FILE

Considerations In Selecting Mica Capacitors

Mica Capacitors may have identical capacitance and voltage rating on their name plates, yet one may be up to a hundred times larger than another—why? It is the purpose of this article to discuss how the dc voltage rating, rf voltage rating, rf current rating, corona starting voltage, and pulse application affects size and physical configuration of mica capacitors. Examples will be given showing typical Sangamo types that are used to account for these electrical environmental variations.

DC Voltage Rating — Many electronic applications require that a mica capacitor be used in a circuit of moderate to high-voltage dc with a slight ac voltage superimposed on it. Because mica exhibits a very low dissipation factor, very little heat is generated due to the small amount of ac. Of primary concern is the dc voltage stress. Mica has a very high dielectric-strength capability. Hence, required capacity can be contained in a package that is significantly small such as Sangamo's Types D, DR, KR, CR, H and A. (Figure 1)

Fig. 1

Type-DR Type-H Type-A

RF Voltage and Current Rating — Like the small mica capacitors described above, capacitors of a larger size are frequently required to operate with a comparable dc voltage across their terminals. However, in transmitting rf oscillator tank circuits, radio frequency is predominant and the primary requirement is the ability to handle a large magnitude of rf current. It is therefore necessary to use a capacitor that can dissipate the heat generated

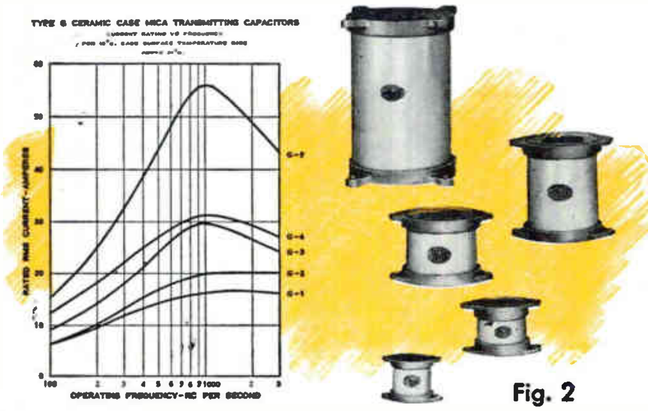


Fig. 2

hy the rf field. Because these factors are so important, smitting capacitors are rated in rms current and peak volts. They are usually potted in a material that h thermal conductivity and packaged to have a ace area. Sangamo's Types E, F, and G are examples of high rf current application capacitors Figure 2 shows, for example, the relative size and current-carrying ability of Types G1, G2, G3, G4 and G5.

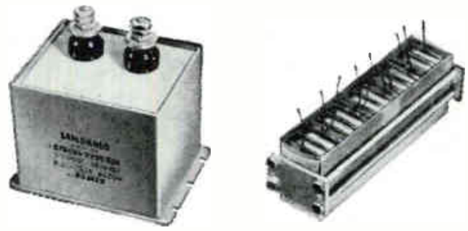
Corona Starting Voltage — Corona can occur in any capacitor where the conditions are right. Capacitor manufacturers are aware of this and design accordingly. Where amplitude and frequency of ac voltage across the capacitor are relatively low, a wax impregnant can be used. However, when voltage is low and frequency is high, a liquid impregnant is used. The difference is due to the physical nature of the impregnant. The wax, when cooling, leaves holes and promotes corona, while a liquid impregnant is homogeneous. A typical example of a liquid impregnated capacitor that is used for miniaturization, low distributed inductance, and high frequency applications is the Sangamo Button® Capacitor. (Figure 3)

Fig. 3

Type M-23 Type M-63 Type M-72

Pulse Application — Unfortunately there are no industry standards on capacitor ratings for pulse applications. Design and testing of these capacitors follow individual specifications at the present time. Applications involving high-frequency pulse operation should be reviewed carefully with regard to corona and peak stresses. These two factors are very closely related to life expectancy of the capacitor. With the growth of pulse circuitry, users and manufacturers must begin to develop meaningful specifications, standards, and test procedures for pulse capacitors. Figure 4 shows typical examples of Sangamo Capacitors designed for pulse applications. The Type N-87 is a multiple-section Sangamo mica capacitor designed for packaging with other components in a hermetically sealed, oil-filled enclosure.

Fig. 4



Type N-38 Type N-87

Your inquiry for more complete information on special applications of Sangamo mica capacitors is invited.

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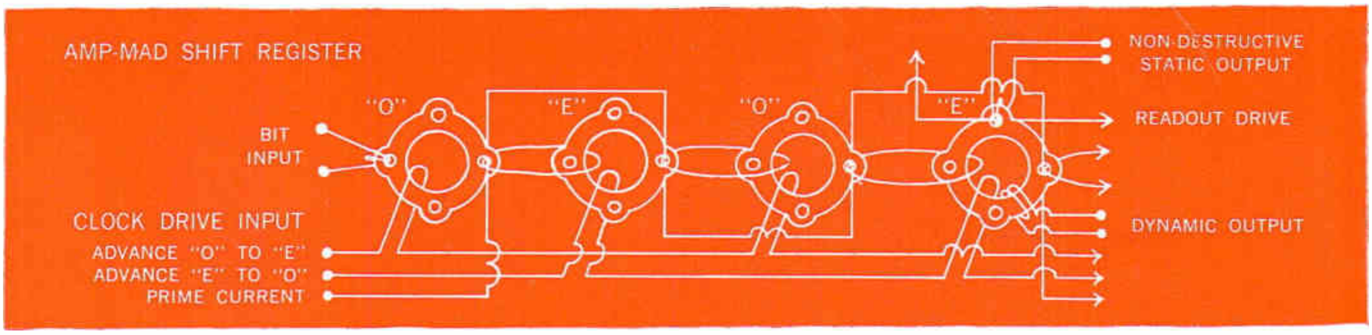

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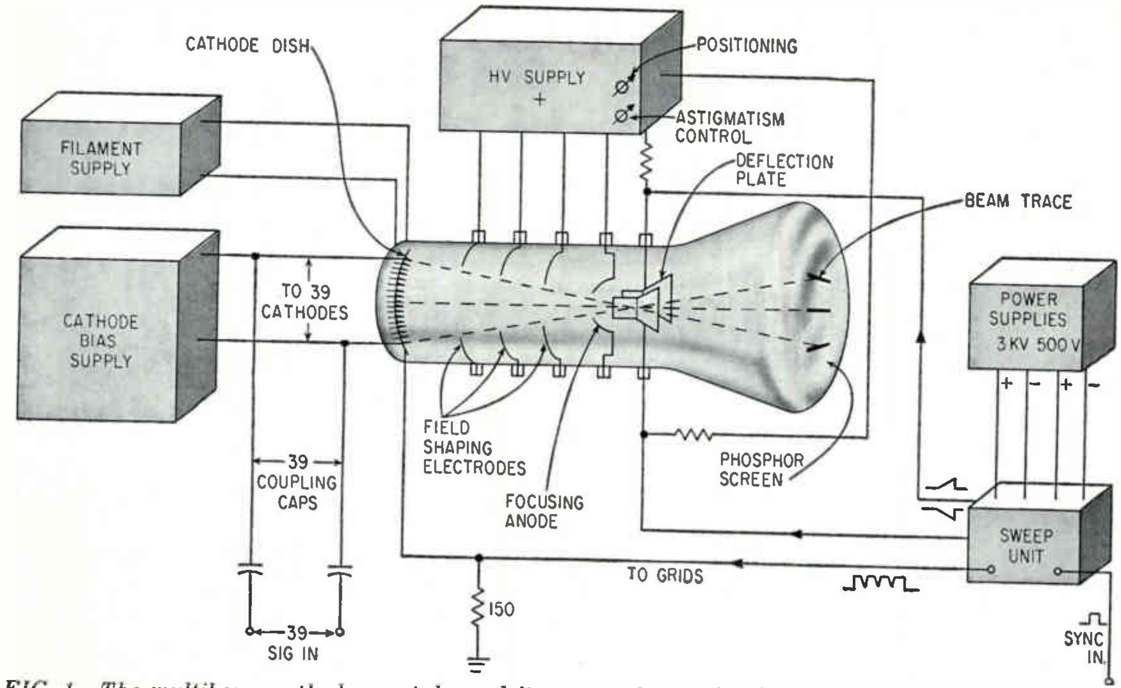

FIG. 1—The multibeam cathode-ray tube and its external test circuit

Multibeam Cathode-Ray Tube Aids Shock-Wave Studies

This cathode-ray tube, which displays a raster of thirty-nine traces originating from separate electron injectors, is useful in research where amplitudes can be presented as time durations

By LLOYD MANCEBO,
Lawrence Radiation Laboratory,
University of California,
Livermore, California

ALTHOUGH CATHODE ray tubes with dual guns are in common use and some special purpose ten-gun tubes are commercially available, for shock-wave studies in which a hundred signals are compared a crt with many more guns is needed. However, when forty or fifty of the standard commercial guns, each with its own focusing and deflection systems, are stacked side by side working ... of formidable dimensions has a hi... To scale down a standard large ... diminutive size is impractical because the electron beam intensity would be reduced and mechanical tolerances could not be easily maintained. Moreover, all that is required for shock-wave studies is a bar-graph display with an on-off, time-dependent trace.

Out of such considerations there evolved a common, spherical lens system that focuses the beams from multiple injectors and affords a common crossover point permitting a single pair of deflection plates to sweep all of the beams. A tube of reasonable size was possible only after techniques were developed that allowed the fabrication of a miniature, grid-controlled electron injector. The tube, which displays a raster of thirty-nine traces and has a time resolution of one part in a thousand, excels in one-shot, fast-transient, diagnostic work.

A single lens with low aberrations and little bulk has been described.[1] The lens is essentially two concentric spheres, but since the image produced is virtual, a small hole is provided in the smaller sphere (anode). In this lens, as adapted, an electron emitted at the cathode dish arrives at the anode and passes through the hole. As it passes through, it experiences the divergent lens effect of the aperture and crosses through a point slightly

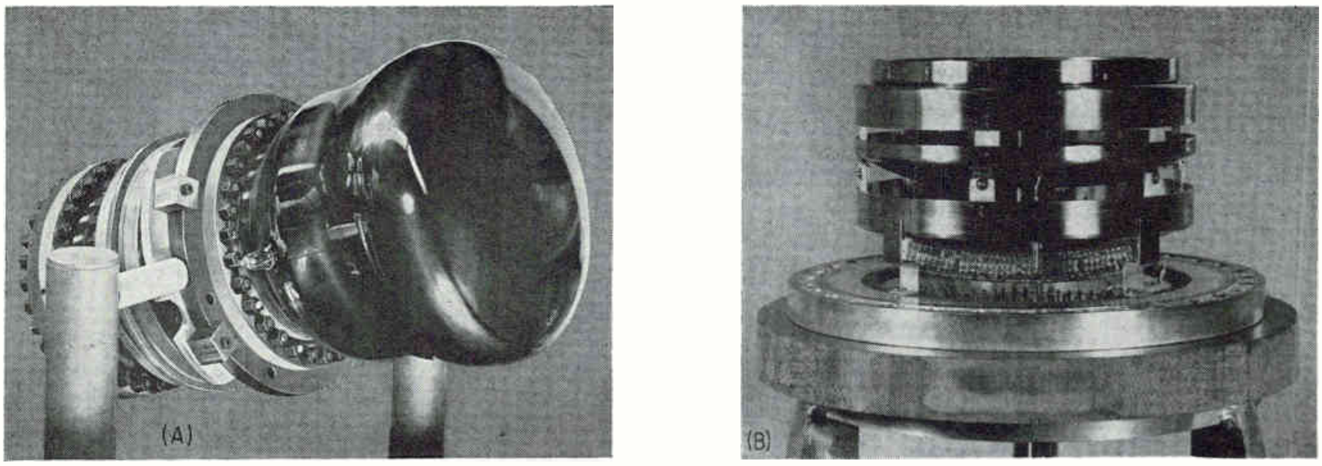

FIG. 2—Assembled tube on its test stand (A), and a closeup of the lens and mounted electron injectors (B)

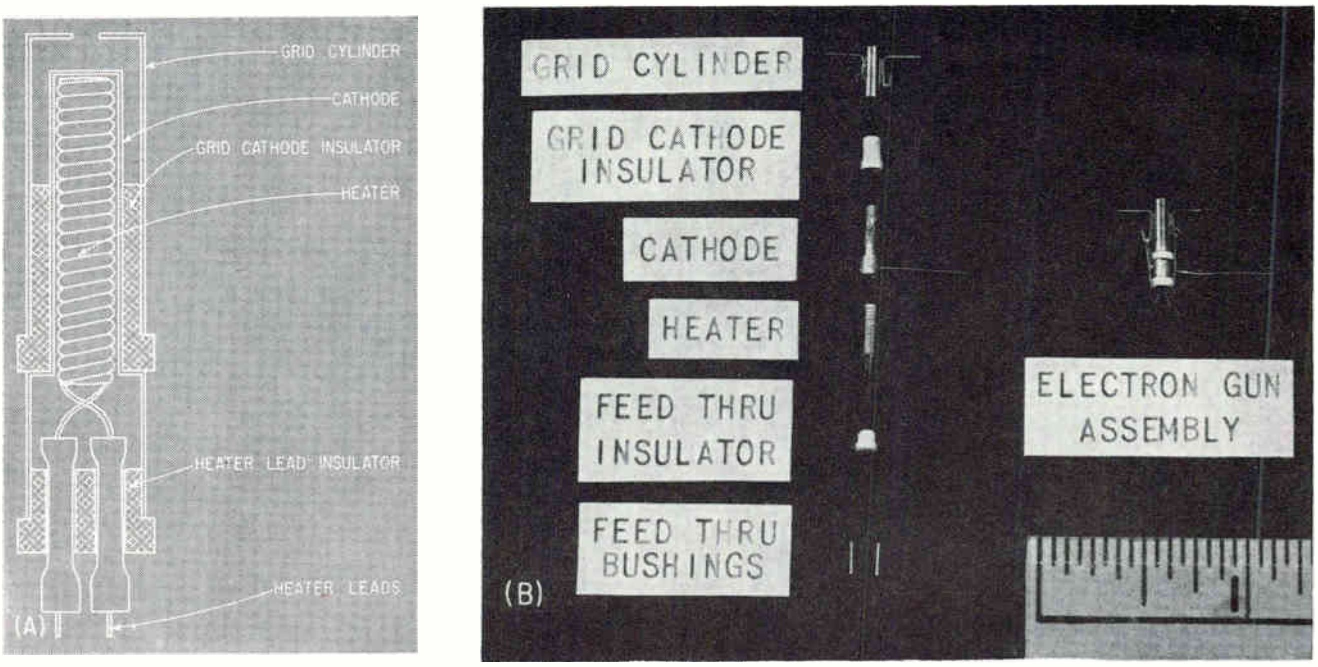

FIG. 3—Single electron gun assembly (A), and exploded view in (B) showing actual components

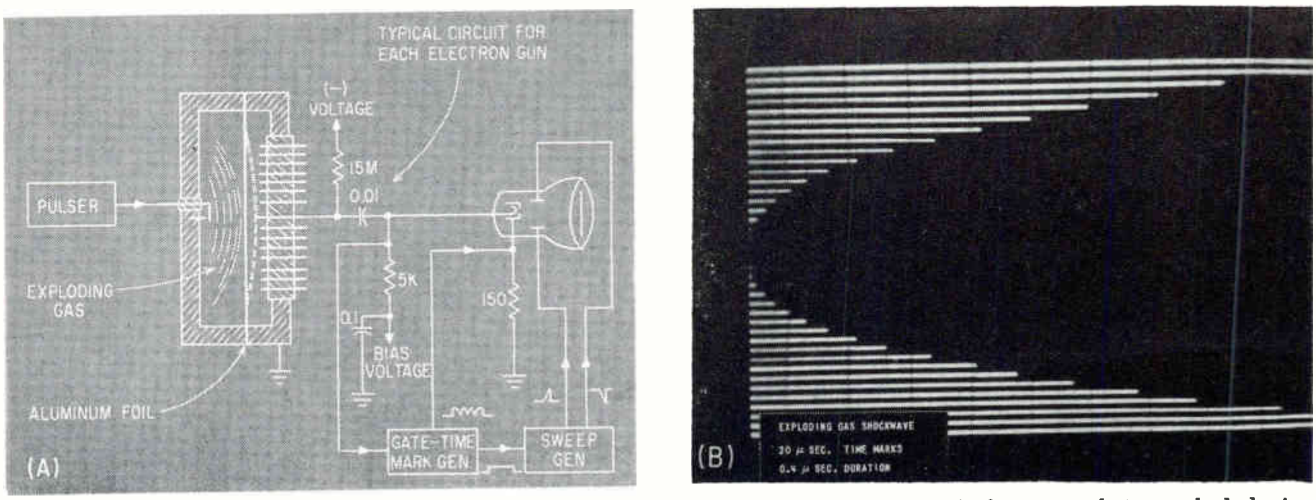

FIG. 4—Exploding gas in chamber is used to test the multibeam tube (A), and a typical raster photographed during such a test (B)

beyond the geometrical center. All the beams from the electron injectors, which are along a segment of the cathode dish, pass through this crossover point, so it is here that the deflection plates have been located.

Only that portion of the cathode dish radially opposite the anode hole is useful, but removing the unused portion distorts the spherical field. However, the field can be restored with a cascade of field-shaping electrodes between the cathode dish and the anode. The electrode voltages can be closely determined in a tank with a wedge-shaped electrolyte. This electrode configuration is shown in Fig. 1.

An injector in this tube is an indirectly heated electron emitter spaced behind an aperture in the grid cylinder. The injector is mounted on the outside of the cathode dish by spot welding the grid cylinder to the dish. This technique permits the grids to be electrically grounded through a low common impedance, thereby shielding the individual cathodes and decreasing the crosstalk. The cathode-to-grid spacing is large (0.020 inch rather than the more usual 0.005 inch) to insure a good mechanical tolerance in such a small assembly and to provide a good cutoff characteristic. The aperture in the grid cylinder focuses the electron beam approximately 1/10 inch inside the cathode-dish radius. It is this crossover that the lens focuses on the screen. Because the electrons at the cathode dish have such small components of velocity tangential to the cathode dish, the circle of confusion on the screen is small despite high electron energy.

The tube (Fig. 1) consists of a vacuum envelope, 39 electron injectors, field-forming electrodes within a spherical lens, a pair of horizontal deflection plates and phosphorescent screen. The tube is 24 inches overall and has a maximum diameter, that of the screen, of nine inches. Total weight is about 100 pounds. Figure 2A is a picture of the tube on a test stand.

The vacuum envelope is glass and Kovar with demountable steel flanges and copper gaskets to permit disassembly without rebuilding.

A settled P-11 phosphor (zinc sulfide with a silver activator) forms the screen. The first screen employed was an evaporated P-5 (calcium tungstate) phosphor that had better resolution and less halation than the P-11. The settled phosphor, however, has a greater luminescent efficiency. An aluminum film, approximately 1,000 A thick, was evaporated over the phosphor to prevent electron sticking and to complete the shielding for the field-free region between focusing anode and screen.

A photograph of the lens and electron injectors before enveloping appears in Fig. 2B. The anode and the cathode dish radii are one and eight inches respectively. The hole in the anode is approximately $\frac{3}{4}$ inch in diameter and is 10.6 inches from the screen. The injectors are mounted radially on approximately 1/10-inch centers along a four-inch segment of the cathode dish.

These electron injectors are only $\frac{1}{2}$ inch in length and 0.110 inch in diameter. The assembly is sketched in Fig. 3A and the components are shown beside the injector in Fig. 3B. The emitting surface is a barium-strontium-calcium oxide. It is indirectly heated with a bifilar winding of three-mil tungsten wire spray coated with two mils of RCA Alundum for insulation. The alumina insulators are cast in carbon molds and the nickel cathode and grid are electroformed. The focal length of the aperture is approximately 0.100 inch, neglecting space-charge effects. In future tubes the cathode emission surface will be made concave to increase the beam current and to prefocus the electrons in the gun. The beam current in the present model is approximately 5 microamperes.

In operation, the start of an event to be measured triggers the sweep generator and turns on the beams. (Figure 1 shows the external test circuit.) Some time later a positive pulse applied to the cathode of the individual injector shuts off the trace. The length of the trace is proportional to the duration of the event and is measured with time marks superimposed on the trace. The tube can be used in one-shot, on-off applications or it can be electrically or mechanically cycled over short durations.

The cathode heaters are operated in parallel at five volts and draw a total current of 15 amperes. The cathode bias, approximately one volt, is adjusted for each gun so that each trace is equally bright on the screen. A sweep length of eight inches requires that a push-pull sawtooth of two Kv be applied to the deflection plates. The deflection sensitivity is approximately 500 volts per inch. The anode voltage is 10 Kv. An astigmatism correction is applied in the direct-current positioning circuit.

The lens system yields a trace with extremely good depth of focus with minor aberrations, a small pin cushion distortion being the most prominent. When a square pulse is applied to one of the guns, the raster shows a time resolution of one part in a thousand or 0.1 percent. Spot size is 0.015 inch.

The tube and circuits were tested with an exploding gas contained in a cylindrical chamber. A cross-section of the chamber and the circuit for the middle pin is shown schematically in Fig. 4A. Each of the other pins was similarly tied to an injector but not to the gate-time mark generator. A spark ignited a mixture of oxygen and propane and a compression wave was generated. The expanding wave front pressed an aluminum foil against the row of projecting pins, grounding them. The center pin, slightly longer than the rest, acted as the sweep and time mark generator trigger. As successive pins were grounded, the corresponding guns were turned off. A raster photographed in this experiment is shown in Fig. 4B.

This tube, although designed for shock-wave diagnostic work, will find application in any field where amplitudes can be presented as time durations.

ACKNOWLEDGMENTS

The author acknowledges the help of the technicians who constructed and tested the tube: D. Stewart, W. Tindall and A. Maddux. He thanks H. M. Owren for ideas and encouragement, and E. Sikorsky, for design of the test circuit. This report was prepared by G. A. Leavitt.

Work on this project was done under the auspices of the U. S. Atomic Energy Commission.

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(1) P. Schagen, H. Bruining and J. C. Francken, A Simple Electrostatic Electron-Optical System With Only One Voltage, *Philips Res Repts*, 7, p 119, April 1952.

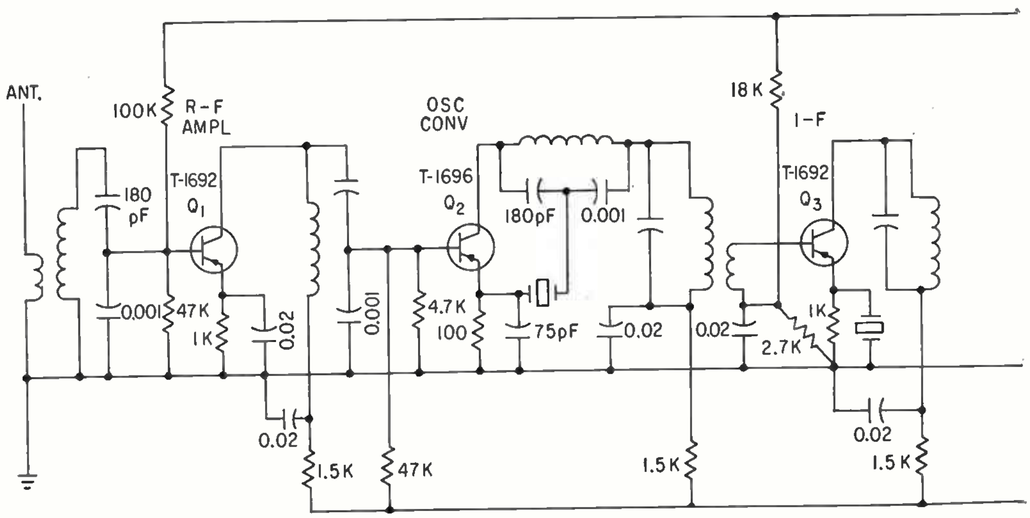
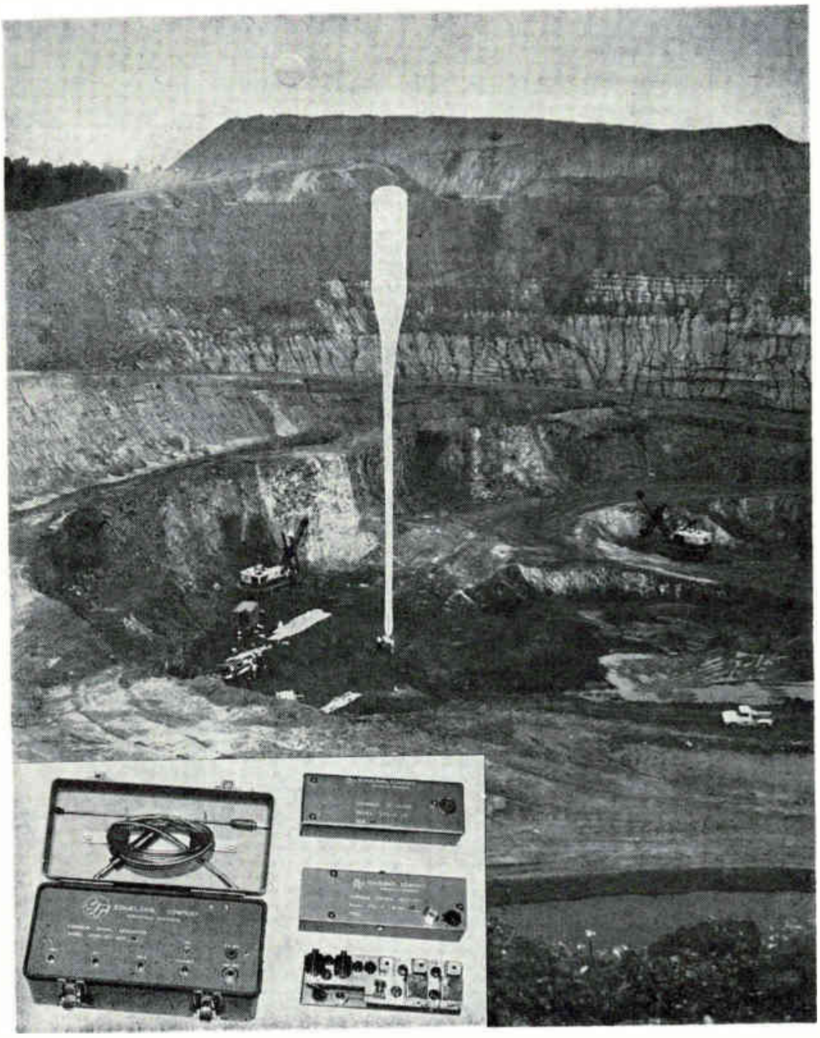


FIG. 1—Crystal-controlled balloon-borne receiver uses crystal filters as i-f emitter bypass elements to produce desired selectivity curve. Tone signals activate resonant-reed relay K_1 which in turn drives four-layer diode D_1 to turn output relay K_2 on or off. Relay K_2 energizes balloon-borne equipment

Radio Command Set for

Lightweight command receiver uses tone signals to activate balloon-borne gear. Combination of resonant-reed relay and four-layer diode permits positive reception on crowded military radio channel



200 ft high-altitude balloon being launched at Crosby, Minnesota. Inset shows ground transmitter and balloon-borne components of command set

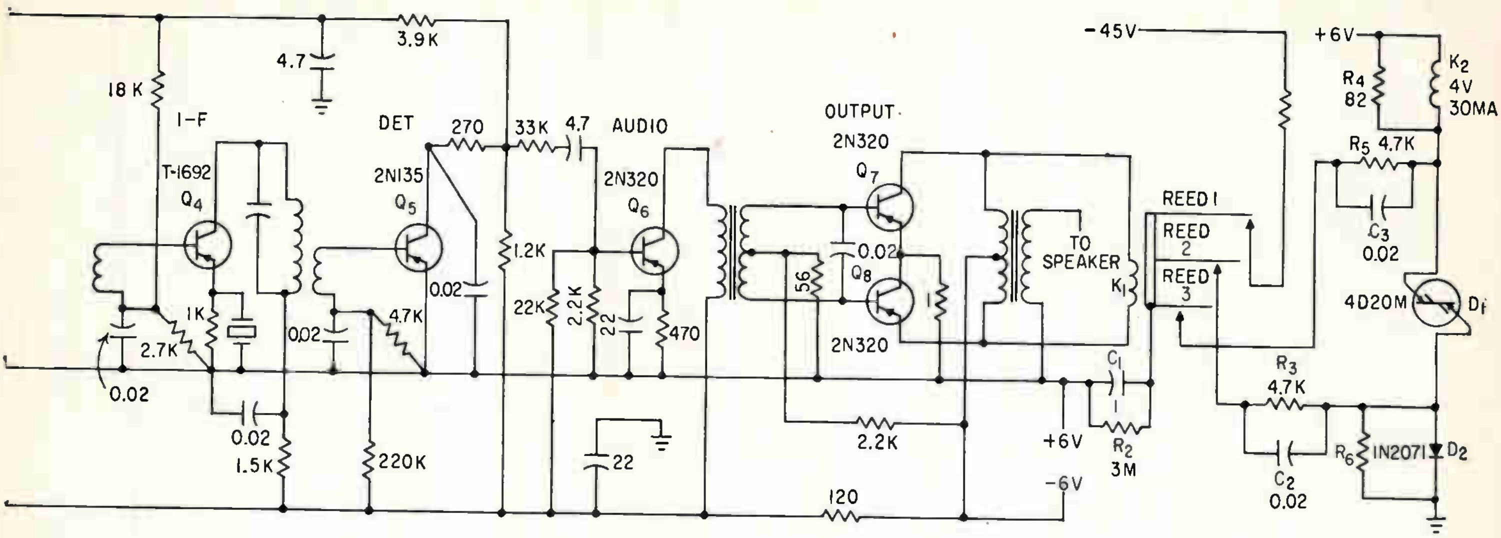
UNMANNED HIGH ALTITUDE balloon flights require light-weight and reliable radio command equipment.

The frequencies normally used to communicate with the high-flying balloons are the high-frequency bands between 3 and 18 Mc, so the command system must not operate on voice modulation or the usual clutter of skip signals and heterodynes usually found within this portion of the frequency spectrum.

Other requirements are high sensitivity for operation over long skip paths and a broad overall selectivity to allow for the small variations in carrier frequency found in military field communication transmitters.

The device consists of three parts: the ground transmitter, balloon-borne receiver and its associated decoder.

The airborne receiver, shown in Fig. 1, is a crystal-controlled superheterodyne using MADT germanium transistors in r-f stage Q_1, autodyne converter Q_2 and i-f stages Q_3 and Q_4. The selectivity of the i-f stages is greatly improved by the use of crystal filters in the emitter



High-Altitude Balloons

By R. W. FRYKMAN,
Schjeldahl Co.,
Northfield, Minnesota

bypass circuits. This results in a symmetrical selectivity curve 5 Kc wide at the 3-db points.

Triode second detector Q_5 is used because it provides stronger agc signals than the usual diode detector. An input signal range of 55 db from 5 μv results in an audio-signal level change of 3 db. The signal-to-noise ratio is 20 db below 1 μv.

Audio signals from the receiver are applied to 3-reed resonant relay K_1 as shown in Fig. 1. When excited by its particular audio frequency, each reed makes intermittent closure with its associated contact.

The command transmitter, shown in Fig. 2, consists of three stable audio oscillators and a low-powered crystal-controlled transmitter. The three audio signals are generated by Q_1, Q_2 and Q_3 at frequencies between 200 and 500 cps determined by the feedback network of each oscillator.

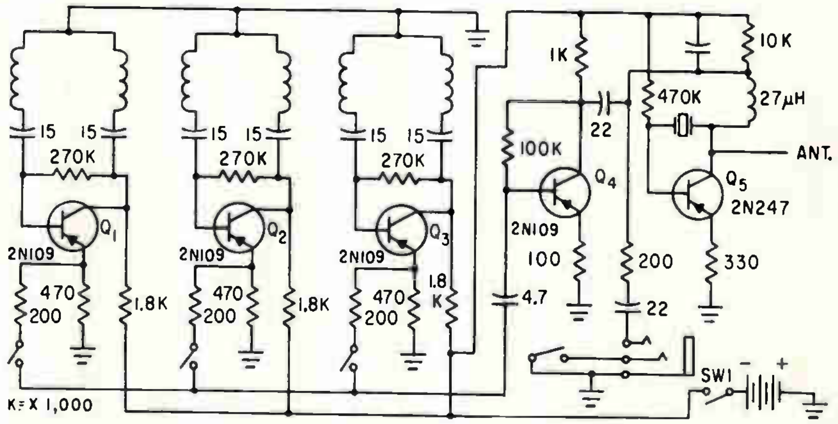


FIG. 2—Ground-based transmitter can be tone-modulated by either of three tones, each corresponding to a particular reed of receiving relay K_1

Audio amplifier Q_4 acts as the modulator for the low-power crystal-controlled carrier generator as well as an impedance matching network for the microphone input.

When the arming pushbutton of the ground transmitter is depressed, the received audio signal causes reed-1 of relay K_1 to make intermittent contact to charge capacitor C_1 through resistor R_1. The duration of the charge on C_1 is determined by resistor R_2. This time constant is 3 seconds.

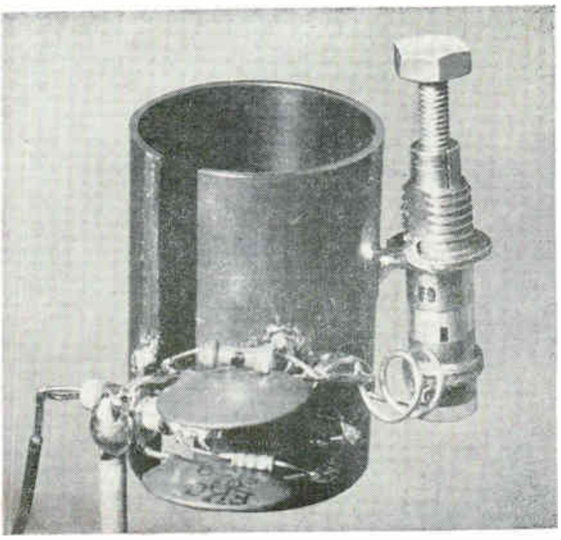
When the operating pushbutton on the ground transmitter is depressed (within 3 seconds of applying the arming signal), the audio tone causes resonant reed 2 to operate thus applying the negative potential from C_1 through coupling network C_2 and R_3 to the junction of four-layer diode D_1 and silicon diode D_2.

This momentary negative pulse is in excess of the four-layer diode striking potential causing it to conduct heavily through the parallel combination of R_4 and the coil of output relay K_2. Operation of relay K_2 turns on the desired balloon-borne equipment.

The load current, thus relay K_2, can be turned off by operating the arming signal for 3 seconds and then operating resonant reed 3. This reed is connected to the junction of the load and the four-layer diode through R_5 and C_3. The resulting momentary negative pulse depresses the four-layer diode current below its minimum holding value causing it, and relay K_2 to turn off.

Resistor R_6 dissipates any charge built up on C_2 by random excitation of the resonant-reed relay by noise or voice signals.

TRANSISTOR OPERATION

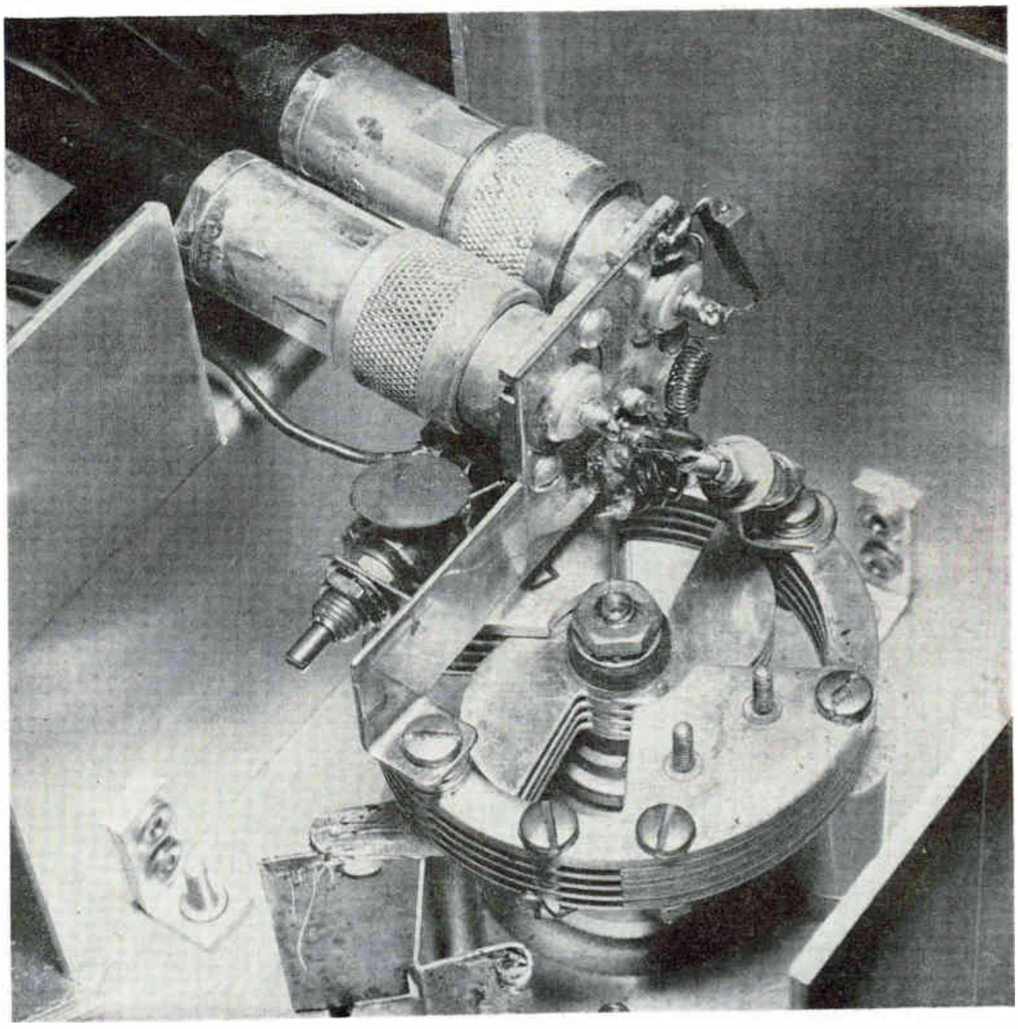


By V. W. VODICKA,
Lenkurt Electric Co., Inc., San Carlos, Calif.

R. ZULEEG,
Hughes Semiconductor Laboratory,
Newport Beach, Calif.

Low-power microwave transmitter uses 1.56-Gc modulated oscillator circuit

Experimental setup uses butterfly resonator in 450-Mc converter circuit



BEYOND CUTOFF FREQUENCY

Special converter circuit allows useful amplification considerably beyond the normal frequency. The technique is useful mainly with high-frequency transistors

THE HIGH FREQUENCY performance of a transistor can be defined without ambiguity as the frequency at which the gain drops to unity.[1] In a straightforward application of transistors to previously known circuits, useful gain with existing transistor types is limited to about 700 Mc. By impurity gradients in the base of a transistor,[2] that cause drift rather than the slow diffusion of minority carriers, the frequency performance is extended. However, even with the development of the mesa transistor,[3] frequency response is limited by the geometry of the structure. By shrinking the size, better performance can be obtained but power handling capabilities are sacrificed. Diffusion-type transistors with graded base widths have a theoretical frequency response in the gigacycle range but the limitations on high frequency performance are the capacitances of the *p-n* junctions. These capacitances are proportional to the junction area, so that reduction in size helps; on the other hand, smaller size generally decreases power rating.

Practical limits in commercially available transistors are a maximum frequency of oscillation around 1 Gc and 30 to 50 mw power dissipation (2N700, 2N502), although experimental values of 3 Gc at 50 mw have been reported.[4]

A new mode of operation makes it possible to extend the useful frequency range of certain types of transistors. The technique uses a converter or mixer circuit.

Taking advantage of oscillatory conditions of a transistor and the complex phase relation of the currents in existing loops, a stable mode of operation is established whereby the undesirable capacitances apparently are removed by incorporating them into tuned elements. Thus the transistor operates under conditions that show a true frequency performance that is limited only by the transit time of minority carriers across the effective base width.

Transistors with f_{max} equal to 600 Mc produced gains at 1.4 Gc; others with 1 Gc f_{max} had gains in the 2.3 Gc region, well beyond their normal cutoff limits. Relatively no sacrifice in power dissipation was made and a better frequency performance was obtained even at the same power dissipation.

The circuits are given in Fig. 1A and 1B. The basic circuit is an oscillator. Oscillation requires that input and output be 180 degrees out of phase and that the loop gain be unity or greater. Feedback is applied through capacitance C_F, Fig. 1A. The feedback loop reflects the input impedance into the output and the tuned circuit sees a negative impedance in the region of oscillation. The input impedance Z_{in} is negative, equivalent to a capacitive reactance. For the converter circuit, the input blocking resistance R has been replaced by inductance L_s (Fig. 1C) and a second resonance circuit L_D, C_D added

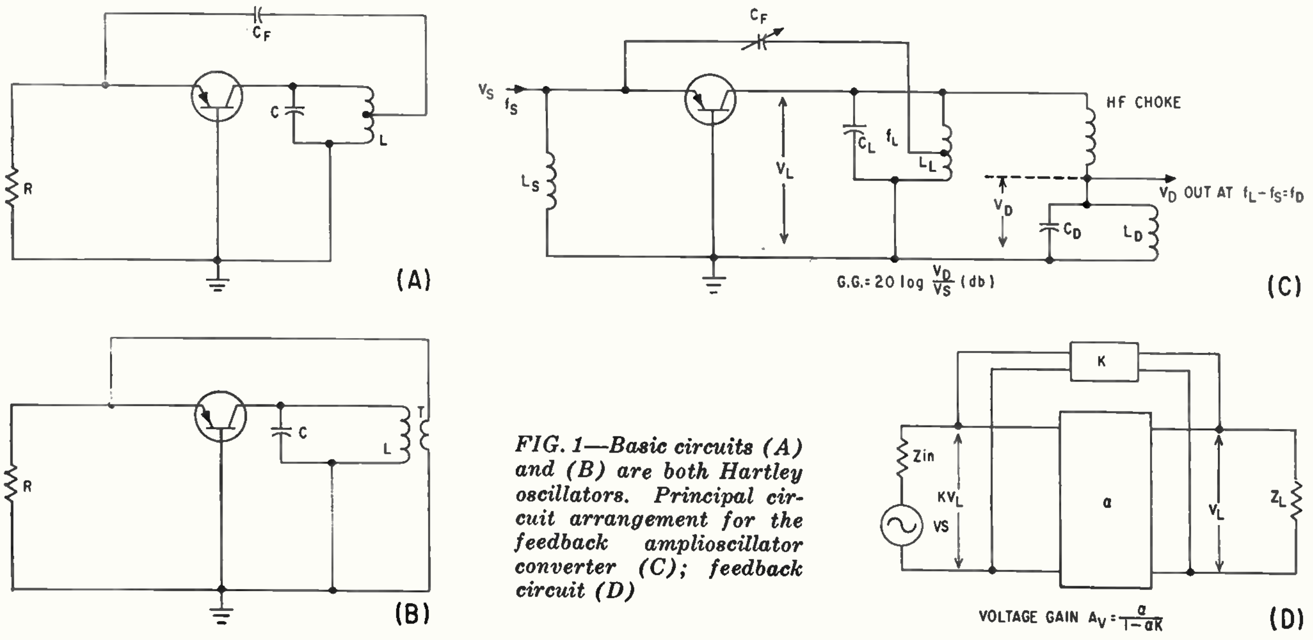


FIG. 1—Basic circuits (A) and (B) are both Hartley oscillators. Principal circuit arrangement for the feedback amplioscillator converter (C); feedback circuit (D)

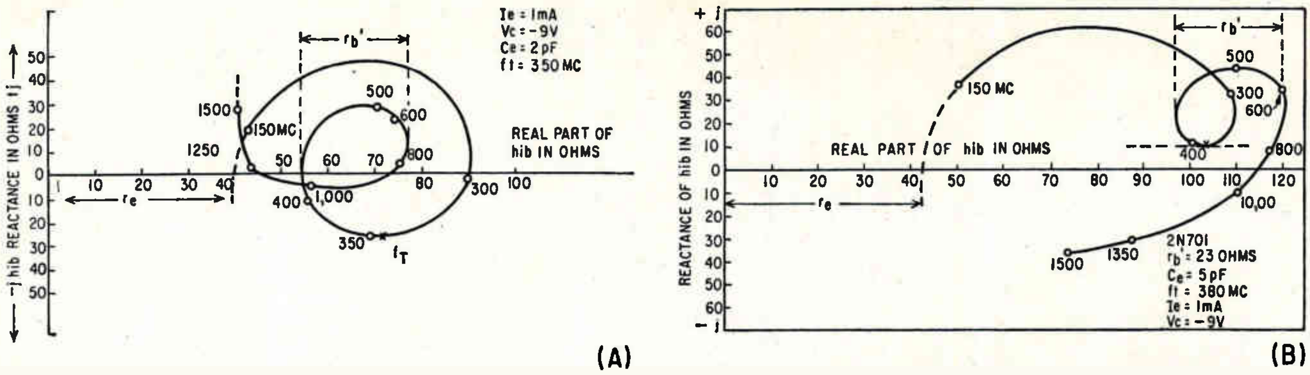


FIG. 2—Complex input impedance for Hughes GXG4 npn transistor (A); input impedance for pnp mesa transistor (B)

in the collector. The transistor is oscillating at frequency f_L (smaller than the f_{max}); with f_L determined by tank circuit L_L and C_L.

The input of the transistor is then current tuned to give maximum conversion gain for signal frequency f_s. Capacitor C_F controls the amount of feedback and therefore the conversion gain. The requirements on the transistor are that during current-tuning of the input, oscillation must be maintained. These conditions are met by only a few high-frequency types. However, conversion is merely a function of the external circuit elements. The circuit can be made extremely stable at high gains if matching conditions are satisfied. Figure 1C shows the circuit.

For frequency conversion, assume that only oscillation frequency f_L and signal frequency f_s are of appreciable amplitude. Applying the square law and superposition:

$$[\sin(2\pi f_L t) + \sin(2\pi f_s t)]^2 = \sin^2(2\pi f_L t) + 2\sin(2\pi f_L t)\sin(2\pi f_s t) + \sin^2(2\pi f_s t) \quad (1A)$$

Only the cross-product between the frequencies is interesting and can be written

$$2\sin(2\pi f_L t)\sin(2\pi f_s t) = \cos[2\pi(f_L - f_s)t] + \cos[2\pi(f_L + f_s)t] \quad (1B)$$

Frequency f_L modulates a nonlinear network—the input impedance of the transistor—so that the network transfer function at f_s, the signal frequency, includes a major term proportional to sin $(2\pi\ f_L\ t)$. The parameter to describe such a function quantity is the conversion gain, defined as the ratio of an output voltage V_D at the difference frequency ($f_D = f_L - f_s$) to an input voltage V_s at f_s. The output represents therefore a high impedance, which depends upon the Q of the $L_L\ C_L$ circuit and other shunt impedances. The input impedance is low and close to the real part of the emitter input impedance for a particular current level $r_e \approx [KT/q][1/I_e]$). The voltage V_D across the L_D-C_D circuit can therefore appear only at a frequency $f_D = f_L - f_s$, if the output of the active network, the transistor, contains a component of the signal input voltage V_s at f_s. This is the case when a signal, V_s, is applied to the emitter input.

Referring to the theory of feedback amplifiers[5] and to Fig. 1D, tne overall voltage amplification factor A_V, is given by

$$A_V = \frac{\alpha}{1 - \alpha K} \quad (2)$$

where α is the amplification factor of the active network and K the feedback ratio of output to input voltage of the passive feedback network.

In general, α and K are complex. Assume that K can be adjusted and is therefore a constant. Amplification factor α is then a complex parameter and can be approximated by[6]

$$\alpha = \alpha_0 \frac{\exp[-jm(f/f_c)]}{1 + j(f/f_c)} \quad (3)$$

where

α_0 = low frequency α of the transistor,
f = amplifier frequency of operation,
f_c = angular cutoff frequency of transistor, and
m = phase factor (0.21 for diffusion transistors, greater than 0.21 for drift transistors).

Inserting Eq. 3 into Eq. 2 and rearranging,

$$A_V = \alpha_0 \exp[-jm(f/f_c)] / \left\{[1 - \alpha_0 K \exp[-jm(f/f_c)]]\,[1 + j(f/f_c)\right. \frac{1}{(1 - \alpha_0 K \exp[-jm(f/f_c)])}\Bigg]\Bigg\} \quad (4)$$

Equation 4 reveals that by adjustment of K, to compensate for the term of the phasor $\exp[-jm(f/f_c)]$ at a particular frequency, resemblance to Eq. 2 can be restored. On the other hand an apparent increase in frequency response has been obtained of $1/\{1 - \alpha_0 K \exp[-jm(f/f_c)]\}$ when comparing with Eq. 3. Likewise,[7] noise of such an amplifier is reduced by the same fraction. Both increase of frequency response and reduction of noise are confirmed by experimental data.

When applying the feedback principle to the circuit of Fig. 1C, signal V_s can be amplified arbitrarily by changing the feedback that contains the term 1/2 cos $[2\pi(f_L - f_s)t]$ and converting it into a signal V_D at $f_D = f_L - f_s$. A calculation of V_D in terms of intrinsic transistor parameters and external circuit elements will not be attempted here. However, when comparing the new mode of operation with conventional circuits,[8] the local oscillator, which is the transistor itself, can be operated with much higher power and is not restricted to the condition $V_S\ q/KT \leqq 1$ to to avoid substantial distortion. Conversion gain is then merely a function of the feedback amplifier and is almost independent of transistor parameters up to frequencies beyond normal cutoff, if the conditions of oscillation and input current tuning are met for the frequency of operation.

The upper limit of frequency,

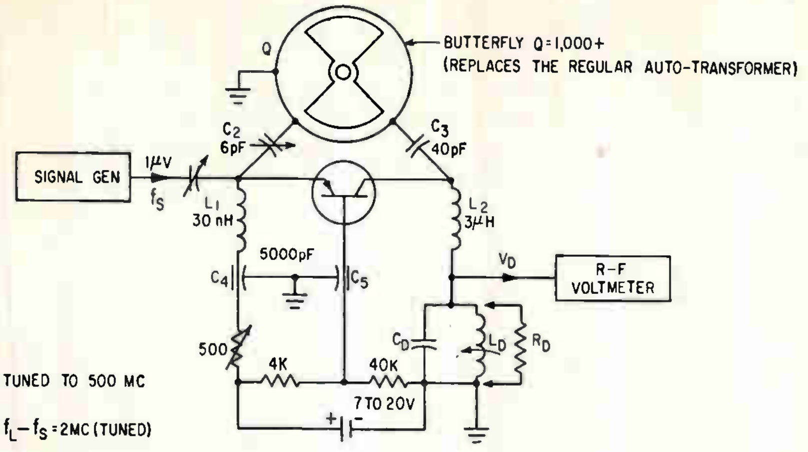


FIG. 3—Circuit for measuring conversion gain

TABLE—Best Results (With Approximately 2 Mc)

f_s	Bandwidth	Conv Gain	Input dbm	Z	μV	s/n	Noise Fig
450 Mc	20 Kc	70 db	−106	40	1	21 db	5 db
	150 Kc	60 db	−107	50	1	10 db	6 db
	750 Kc	49 db	−107	50	1	3 db	6 db
Average results							
450 Mc	150 Kc	56 db	−107	50	1	7 db	8.5 db

f_{max}, at which oscillations may be maintained is usually expressed by[9]

$$f_{\max} = \sqrt{\frac{\alpha_0 f_{c\alpha}}{8\pi\, r_b'\, C_C}} \quad (5)$$

Where

α_0 = low frequency current amplification factor,
$r_b' C_C$ = extrinsic base resistance collector layer capacitance product, and
$f_{c\alpha}$ = alpha cutoff frequency of transistor.

For maximum gain in the converter circuit, it is necessary to tune the input impedance with a d-c current. This is not possible for most high-frequency transistors. For maximum output gain, the input circuit has to produce matching whereby minimum input impedance is established. This effect was demonstrated experimentally. The complex behavior of the input impedance, h_{ib}, has been studied and correlation with circuit performance indicates that best stability and maximum gain is obtained for transistors with $|h_{ib}|$ minimized. Measurements of a Hughes experimental *pnp* mesa transistor showed excellent stability and performance (see Fig. 2A); *pnp* mesa transistors exhibited instabilities in the

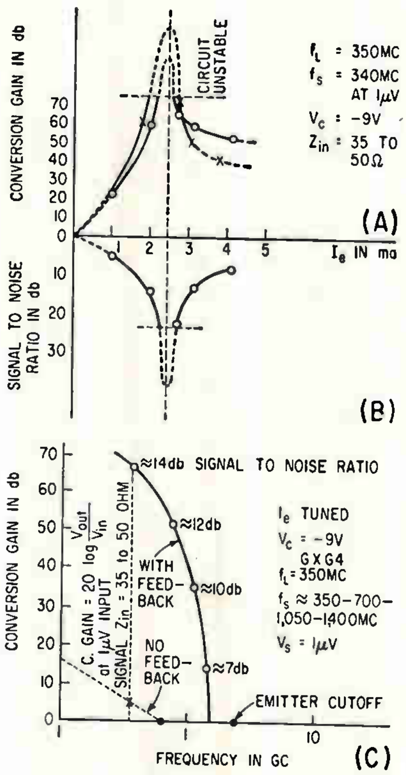


FIG. 4—Conversion gain (A) for two transistors (both type GXG4) in the circuit of Fig. 3. Signal-to-noise ratios for one of the transistors is shown in (B). Conversion gain with and without feedback (C) for same type transistor

circuit and require critical bias adjustment (see Fig. 2B). Besides the two transistor types mentioned, good results were obtained with the Philco madt 2N502, a transistor partly limited by the maximum allowable dissipation. The input impedance measurement offers a simpler way than transfer function measurement to study the frequency cutoff properties of the device, since the alpha-circuit generator is implicitly in the base lead resistance, yielding

$$h_{ib} = r_e(f) + r_b'(1 - \alpha) \quad (6)$$

Where

α = the complex form of Eq. 3 and
$r_e(f)$ = emitter differential resistance, shunted by depletion layer and diffusion capacitance.

Thus the emitter capacitance is important to assure good amplification at harmonics of the fundamental frequency.

Measurements have been made with a Hughes GXG4 transistor with input impedance characteristics as plotted in Fig. 2A. The test circuit for conversion gain data is shown in Fig. 3.

Figure 4A is a plot of conversion gain of the Hughes GXG4 units at a local-oscillator frequency of 350 Mc with a 1-μv input signal at 348 Mc. The emitter current was used as a variable to demonstrate the current tuning effect at a fixed collector voltage of −9 volts.

Figure 4B gives the corresponding signal-to-noise ratio of one transistor and confirms optimum noise performance at maximum conversion gain. From a circuit performance with no feedback mechanisms, a gain of approximately 5 db can be predicted for f_{max} = 600 Mc and a 6-db per octave slope. Figure 4C shows a plot of gain against frequency with and without feedback and reveals the gain bandwidth.

Figure 5A shows the results for another transistor with an f_{max} of approximately 1,000 Mc. The tank had a high Q at the third and fourth harmonics but the input was untuned. When the input was tuned to resonate at almost the input signal frequency, the gain increased 12 db. The oscillator was at 450 Mc, the input signal at 1,350 Mc.

Figure 5B shows that best results are obtained when f_s is close to f_{osc}. When the mixer is used as a synchronous detector, the gain was approximately 6 db above the curve for the 2 Mc i-f. The gain-bandwidth products shown are not the best obtainable, as the extension of the bandwidth was achieved by loading the $L_D C_D$ resonance circuit by a noninductive resistor R_D.

When using the mixer circuit (Fig. 3), the transistor has a tendency to oscillate at unwanted frequencies, sometimes determined by the $C_D L_D$ resonant circuit and sometimes at frequencies where L_1 and L_2 play a role. Proper matching to the resonant circuit Q (butterfly, split cavity or other resonator) is essential. The resonant circuit should preferably have a higher Q at the second, third or higher harmonics than at the fundamental. Sufficient neutralization must be provided for the demodulated frequency; this can best be accomplished by determining the correct constants of C_2, C_3 and C_4.

Matching and selection of transistor parameters produced the results shown in the Table. The results are for $f_L \approx 2$ Mc and are the best that were obtained. Experiments were also conducted with f_s of 1.56 and 1.9 Gc. With the device used as a harmonic power generator at the same frequencies, efficiency exceeded 5 percent.

Useful gain can be produced well beyond normal cutoff at frequencies that are multiples of the local oscillator frequency. The conclusions are supported by the theory of harmonic power generation in nonlinear networks and can be seen from Eq. 1, which contains the terms of πf_L. Extrapolations of the measurements to predict ultimate performances in the mode are subject to speculation. However, matching in the test circuits has not been fully perfected and transistor designs have not been fully explored, so the extension of the useful frequency range of available transistors into the 5 to 10 Gc region is a possibility.

Some of the applications of the circuit include use as a front-end mixer oscillator for uhf and microwaves, local oscillator, pump power, synchronous detector (phase lock), particularly with pulse modulation techniques and as a harmonic generator.

Considerable gain with the mode is obtained beyond the normal cutoff region, both for the fundamental frequency of oscillation and for harmonics of that frequency. All the advantages of a feedback amplifier, even under oscillatory conditions, are preserved, including increase in gain-bandwidth, noise reduction, and reduction in the influence of transistor parameter variations on gain.

Although feedback amplification and current input impedance tuning do agree qualitatively with the experimental data, a quantitative analysis that includes the mathematical model of the transistor is desirable. This evaluation is now under way but is not yet completed. The prevailing conditions of oscillation establish a state of extreme changes in the nonlinear elements of the transistor and it is the nonlinear variations that are mainly responsible for the conversion properties. Specifically, the displacement currents in transistor input and output capacitances require attention. This attention is directed toward the intrinsic transport factor (alpha current generator) and the feedback factor

$$\mu = \frac{KT}{q} \times \frac{1}{W} \times \frac{dW}{d\,Vc}$$

The analysis is concerned in application of this up-conversion gain to harmonic power generation. The simultaneous presence of sweeping fields across the base widths, W, offer possibilities that have to be confirmed by theory and experiment.

The authors are grateful to R. A. Gudmundsen and G. M. Lebedeff for valuable discussions and support in technical matter.

[Ed. Note: In Mr. Vodicka's letter accompanying galleys, he comments: "(Since submitting the manuscript to you,) we have conducted further experiments which produced still better performance and better results at higher frequencies; useful gain at 3.2 Gc with commercial transistors, without coaxial cases."]

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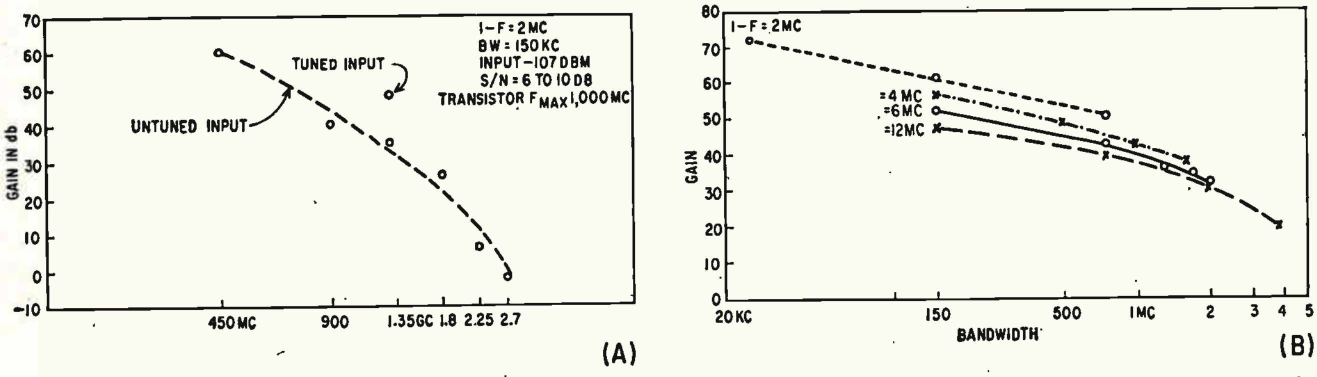
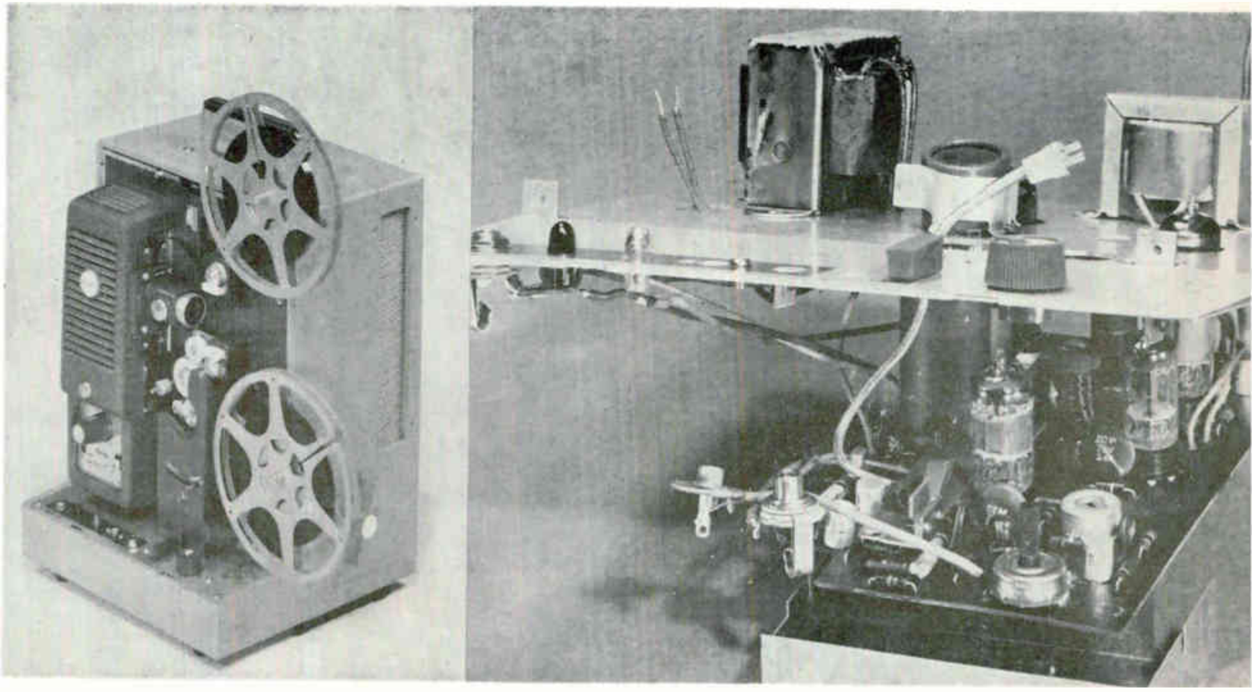


FIG. 5—*Conversion gain with feedback, for input signal at harmonics of the oscillator frequency (A). Conversion gain decreases as the i-f band increases (B)*



Complete projector (left) uses amplifier assembly (right). Slide switches are mechanically interlocked to operate simultaneously

Magnetic Sound Track For 8-MM Home Movies

Basic incompatibility of film drive and tape transport requirements in a magnetic stripe-on-film system is overcome by care in head and film transport design. High-quality sound is achieved by equalization techniques

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HOME MOVIES of the 8-mm variety can be made more useful by adding a sound track. This article describes a system for providing a sound record on a magnetic stripe applied to conventional 8-mm movie film. The magnetic stripe is approximately 0.030 in. wide located about 0.002 in. from the edge of the sprocket-hole side of the film.

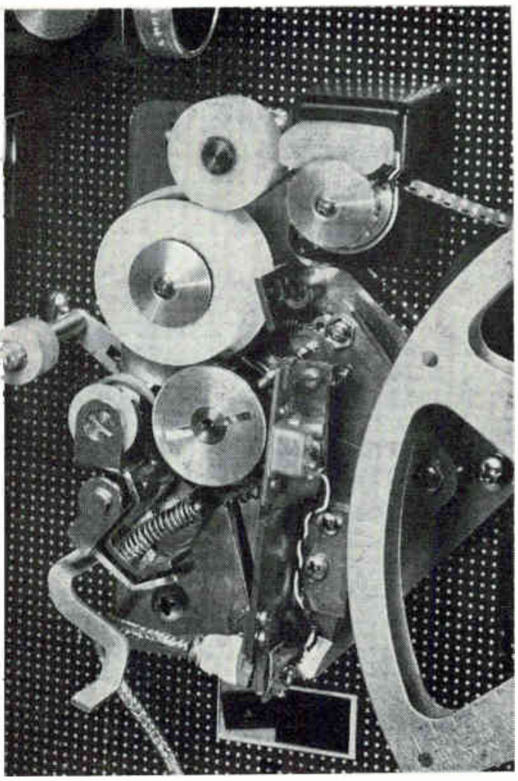
Film drive systems that meet the requirements of picture projection fall short of satisfying the needs of a magnetic audio tape transport. Furthermore, the location and dimensions of the magnetic stripe on the film require a record-playback head designed for this application. Added to these problems, is the need for determining satisfactory equalization.

The film transport system is shown schematically in Fig. 1A while Fig. 1B shows its electrical analogy. The system is a low-pass filter that attenuates the flutter and some of the wow generated in the film at the sprocket. Flutter is produced by engagement of the sprocket teeth with film perforations and by irregularities in the driving gear train. Wow is generated by gross irregularities in the sprocket drive system. In practice these can be tightly controlled, and therefore a minimum of wow is easily attained.

Mechanical filtering is done by using the film as a compliance member that drives sound drum *D* loosely coupled to flywheel *M* through a friction clutch. The clutch allows slippage of the sound drum relative to the flywheel during the starting transient.

The compliance of the film between the sprocket and support roller *H* is indicated by C_1. Unless damped, this compliance will act with the flywheel moment of inertia and cause the flywheel to oscillate at a frequency determined by the values of compliance and inertia.

The damping mechanism, the two closely-spaced, fixed support rollers *R* and *H*, prevents flexing in all part of the film path except that



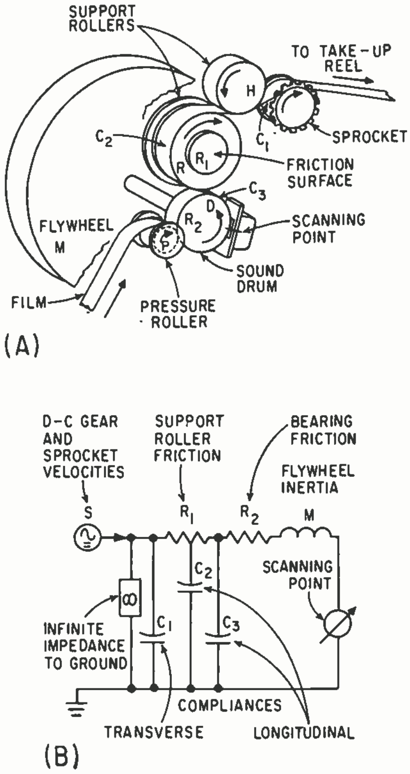


FIG. 1—Tight loop film transport system mechanical arrangement (A) and photograph, with its electrical analogy shown in (B)

immediately adjacent to the sprocket (C_1). The tendency of the film next to the sprocket to sustain oscillation is eliminated by supplying large support roller R with a spring-loaded friction surface that uniformly resists film motion between the sprocket and sound drum. This resistance-damped support roller serves another function if its resistance is adjusted to be greater than maximum take-up reel torque —it causes the sprocket to function as a drive sprocket, rather than a holdback sprocket. This reduces the need for carefully controlled bearing clearances in the rest of the system to provide sufficient film drag to assure the same drive sprocket operation.

The system reduces flutter produced at the sprocket to under 0.16-percent rms at the scanning point with 8 mm film traveling at linear speeds of 2.7 and 3.6 inches per second (corresponding to 18 and 24 frames per second, respectively).

This offers very rapid damping of the starting transient (within one second) and is very stable.

Oscillations that may be caused by splices or other inhomogeneities completely dampen out within one-quarter of a second.

The system is a low-pass filter, and can be represented by the equivalent circuit of Fig. 1B. High-frequency disturbances generated at S are substantially attenuated by C_1 and M, and to a lesser extent by C_2 and C_3. Oscillation between M and C_1 and C_2 is damped by resistance R_1, while oscillation between M and C_3 is dissipated by R_2.

One of the major difficulties in designing an 8-mm sound projector is the tremendous abrasion to which the necessarily small pole pieces of the record-playback head are subjected. This problem was overcome through the selection of an aluminum-iron magnetic alloy known as Alfenol, because of its desirable magnetic and wear-resistant properties. The material was formulated by the Naval Ordnance Laboratories. The gap is shimmed with 0.00025-in. beryllium copper. Molded nylon bobbins support and position the windings, which consist of 350 turns on each bobbin connected so as to cancel hum voltages due to any stray external field. No spacer is used at the back gap. The head is potted in a mumetal cup which serves both as a container and as a magnetic shield.

The record-playback amplifier is shown in Fig. 2. The record amplifier consists of a two-stage voltage amplifier V_1 which drives output tube V_2. To linearize frequency response and reduce distortion to an acceptable level, 10 db of negative feedback from the secondary of the output transformer is used. Oscillator V_3 supplies bias and erase current at 40 Kc. Transistor Q_1, connected as a common emitter amplifier, serves as a playback preamplifier to provide required playback equalization and gain.

Two input connectors are provided for recording. The microphone input is designed to accommodate ceramic and crystal microphones, or any high impedance program source requiring the gain available at this jack. The voltage gain from microphone input to the nominal loudspeaker load is 54 db, with a frequency response of 70 cps to 10 Kc at $\pm$ 2 db.

The phonograph input enables the recording of background music, sound effects, or other program material from sources not requiring the high gain at the microphone input. Voltage gain from the input to loudspeaker load is 14 db. The same socket can also be used as an output jack to drive an external power amplifier or sound system, since the playback signal is equalized ahead of this point.

In the record mode the signal to the internal loudspeaker is reduced by R_1 to a comfortable listening level permitting its use as a monitor loudspeaker. The jack for the external loudspeaker permits selecting either the internal or the external speaker, or both.

Two neon lamps provide a visual display for monitoring the recording process. Red neon lamp I_1 lights whenever the record-playback switch is in the record position. This warns the operator against accidental erasure. Clear neon lamp I_2 has a calibrated firing voltage which functions as a record level indicator. The lamp fires at peak signal levels exceeding the maximum distortion level.

Of all the parameters that contribute to high quality magnetic recording performance, good record and playback equalization is one of the most important. The medium must be used to its maximum capability to optimize performance with respect to distortion, signal-to-noise ratio and frequency response. Since these three characteristics are interdependent it is necessary to achieve the best overall compromise. Having determined an equalization it must then be defined so as to be reproducible and useful as a tool for measurement.

Equalization may be defined by specifying the response-frequency characteristic of the playback system. Alternately, the response versus frequency characteristic on the magnetic track can be defined. The choice of one of these dictates what the other must be to yield a smooth overall response.

The ideal contour of the recorded surface induction versus frequency curve should permit the same maximum distortion (usually 2 or 3 percent) for all frequencies within the passband. Stated differently, all frequencies recorded should ideally just saturate the tape to the 2 or 3 percent distortion level. This yields the best signal-to-noise ratio by recording at the maximum permissible level.

The peak audio energy for a wide variety of program material is greatest in the 300 to 600-cps region falling off below and above this. The peak audio energy determines the saturation level on the tape, therefore the peak energy distribution should influence equalization.

Best results are obtained when treble preemphasis is supplied during recording and bass boost is supplied as part of playback. Treble boost is supplied by the network of R_2, R_3 and C_1. Resistor R_2 is a high impedance current source for the record head, with the parallel network R_3 and C_1 providing the treble boost at high frequencies. The frequency at which treble boost begins is determined by the time constant of this network. Playback equalization is provided by losser network R_4 and C_2 at the output of preamplifier Q_1.

The curve of playback amplifier response is shown in Fig. 3. Note the agreement between this curve for 8-mm sound tracks at 24 frames per second (3.6 inches per second) and that used by many tape recorders at 3.75 inches per second.

Switching from record to playback requires transferring a number of circuits. Since these include low-level input circuit as well as the high-level output and the bias-erase oscillator, it is necessary to prevent coupling between circuits. This is done by separating the circuits to be switched, using three separate dpdt slide switches and locating them where they logically fit in the circuit. The sliders of all three switches are then linked with a common actuating bar. The part of the actuating bar that extends up through the support deck is step notched so that it locks the actuating bar in the playback position. To transfer the switch to the record position it is necessary to lift upward on the knob, lifting the notch up above the support deck, and then to pull back. This requires a conscious effort, and thus guards against accidental erasure.

The phenolic circuit board is mounted parallel to the steel support deck. The amplifier is completely assembled and wired prior to dip soldering. After soldering, the circuit board is cleaned of flux residue and the tubes inserted.

This approach requires that the circuit board be firmly mounted in its ultimate location before dip soldering. Warping or deformation due to thermal shock is thus constrained. Furthermore, no subsequent additional stress is imposed on the board by forcing it to conform to a plane different from that which it assumes as a result of the thermal strains of soldering. Even if it becomes necessary to separate the circuit board from the support plate for repair or servicing it can be safely reassembled since it is a prestressed circuit board naturally conforming to its mounting position. This technique yields a reliable circuit board, completely free of hair line cracks or delaminations.

The steel plate supports the transformers, and acts as a magnetic shield between them and the circuit board. Further shielding can be applied selectively.

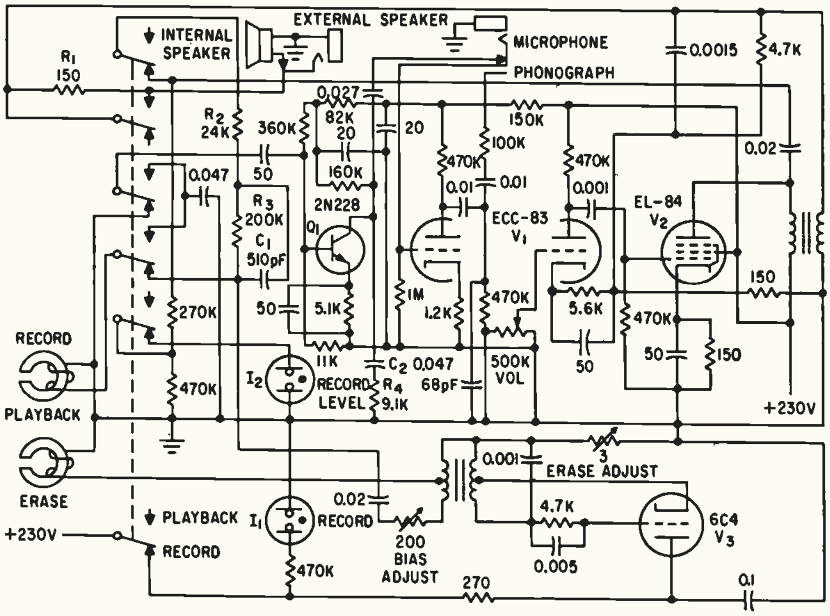


FIG. 2—*Vacuum-tube amplifier uses transistor preamplifier for playback only*

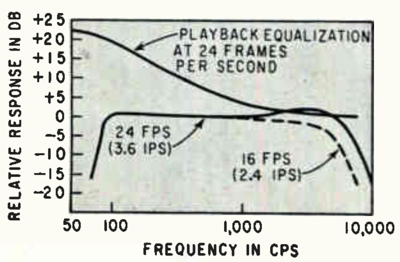


FIG. 3—*Frequency response and equalization curves for amplifier*

SEMICONDUCTOR CLAMP

Usual barrier potential difficulties associated with semiconductor components are overcome by a bridge configuration, permitting the circuit to sample signals down to a 10 millivolt level

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SEMICONDUCTOR CLAMP and detecting circuits of the conventional type are subject to inaccuracies when applied in the millivolt range, owing to their barrier potential nonlinearities. The purpose of the circuit described is to provide a method for clamping pulses in the millivolt range to any d-c level even though these pulses are below the barrier potentials. It is also useful for sampling pulse amplitudes in the millivolt range and to store the sampled amplitude in a memory capacitor.

Use of semiconductor devices in circuits involving sampling measurements of low voltages is complicated by a characteristic inherent to the semiconductor itself. At all temperatures above absolute zero a barrier potential exists due to the formation of the depletion layer at the *p-n* junction. This depletion layer in essence is a dielectric medium since it is a region depleted of both majority and minority carriers. The electrostatic potential which exists across the depletion layer is a function of the temperature

$$V_D = [kT/q]\ [\ln\ (NP/D_i^2)]$$

As the temperature increases the depletion layer becomes wider and the barrier potential increases.

In the circuit of Fig. 1, the barrier potential problem is cancelled by a bridge type balanced detector. Storage is obtained by using zener diodes in two arms of the bridge, since these zeners prevent discharge of the storage capacitor.

The clamp circuit consists of a four-diode bridge, the upper two diodes of which are conventional silicon diodes while the lower two are zeners. A signal whose amplitude is to be clamped, or sampled, is applied at input II; a second, gate signal, which occurs during the interval of the first signal, is applied at input I. An emitter follower is used to obtain a low driving impedance for the bridge.

When the blocking oscillator in Fig. 1 is fired by the input gate, a short-duration pulse is applied across the bridge by the oscillator tertiary winding. This pulse keys the bridge for the pulse duration of the blocking oscillator, the upper diodes then conduct in the forward direction, while the lower (zener) diodes are placed in the region of zener conduction.

During this keyed interval, if the bridge is balanced, points *A* and *D* will be virtually connected, and the output capacitor will be charged to the peak value of the signal at *A*.

The sampled signal at *A* may be small in amplitude but the output storage or memory capacitor will be charged to that amplitude since the barrier potentials of the diodes are cancelled.

Upon the termination of the blocking oscillator pulse, the output capacitor will remain charged and may discharge only through the reverse impedance of the diodes, which impedance is deliberately arranged to be high.

A detailed schematic of the circuit is shown in Fig. 2A. In this circuit a potentiometer is employed in the bridge to compensate for

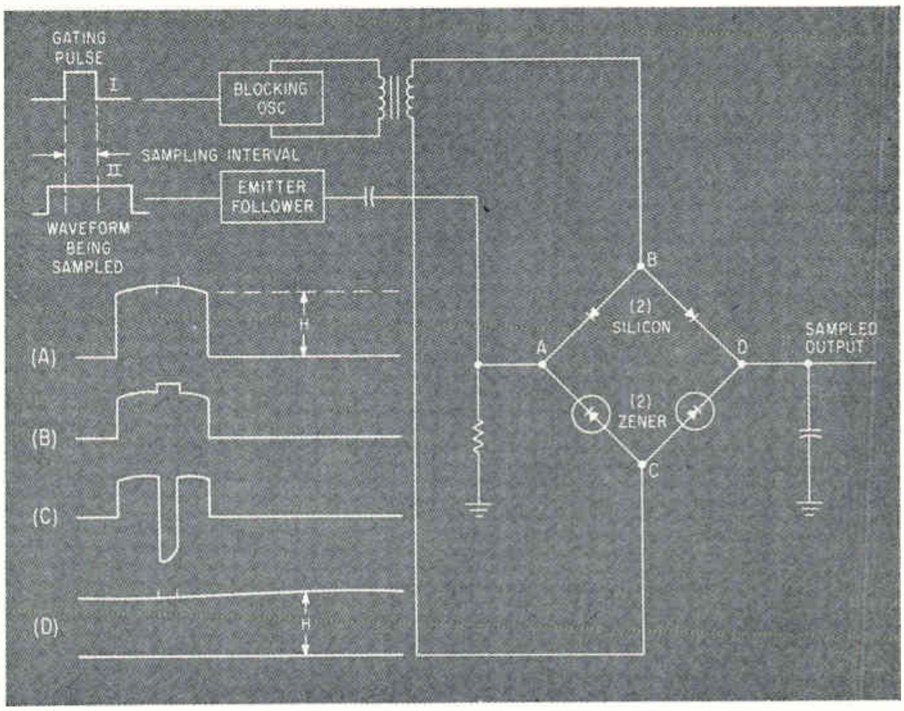


FIG. 1—Peak voltage of imput waveform is stored on the memory capacitor; waveforms appear at bridge points indicated

HANDLES MILLIVOLT SIGNALS

slight differences in the voltage drops across the diodes; in addition, resistors are included in series with the tertiary winding to limit the diode current during keying.

It is usually desirable in employing circuits of the sampling and storage type to have a memory of infinate time constant. With practical circuit elements this is not feasible. Careful circuit design and selection of components will, however, provide a leakage resistance suitable for most applications. In general, a readout circuit having a minimum of shunt loading of the memory is employed in this application. Ideally, the circuit would be applied to the grid of a vacuum tube. For storage times of longer than one second, special consideration of tube types would be required to insure a grid conduction of sufficiently small value.

Since the storage device of Fig. 2A has the advantage of permitting the use of semiconductor components, it would be desirable to employ a readout circuit of semiconductors, also. To do so the input impedance of the readout circuit should be at least ten megohms and preferably higher. Measurements made on the circuit of Fig. 2A have indicated the performance which may be expected at various signal levels. A graph of input gate amplitude versus d-c output, Fig. 2B, shows that good linearity ranging from 9 volts down to 10 millivolts was obtained from the breadboard model.

Data for the linearity curve shown was taken at room temperature. Since the barrier potential of the diodes will vary with temperature, it is indicated that compensation elements should be included in the legs of the bridge for satisfactory operation over a wide temperature range. These would be, typically, thermistors or Sensistors placed in series with the individual diodes. In employing this clamp circuit with gates having fast switching times, where the capacitance of the diodes is significant, the addition of small capacitors across each leg of the bridge would be helpful in balancing out high-frequency switching transients.

In addition to the advantages of analog storage at low-voltage levels, the capability of increased dynamic range is attractive. Assuming a minimum voltage of 19 millivolts, which is well above the minimum value observed during tests, and a maximum voltage level of 10 volts, a linear dynamic range of 60 db is easily obtainable. In circuits where the barrier potential is a limiting factor, a maximum output level of 1,000 volts would be required for a 60 db dynamic range.

The advantage of operation in the millivolt range, then, is clear when a wide dynamic range is required.

The disadvantage in using signals in the millivolt level, other than noise problems, are: the necessity to use devices for coupling elements similar to the clamp under consideration and the difficulty in handling the full dynamic range on an amplitude basis with a simple device other than digital.

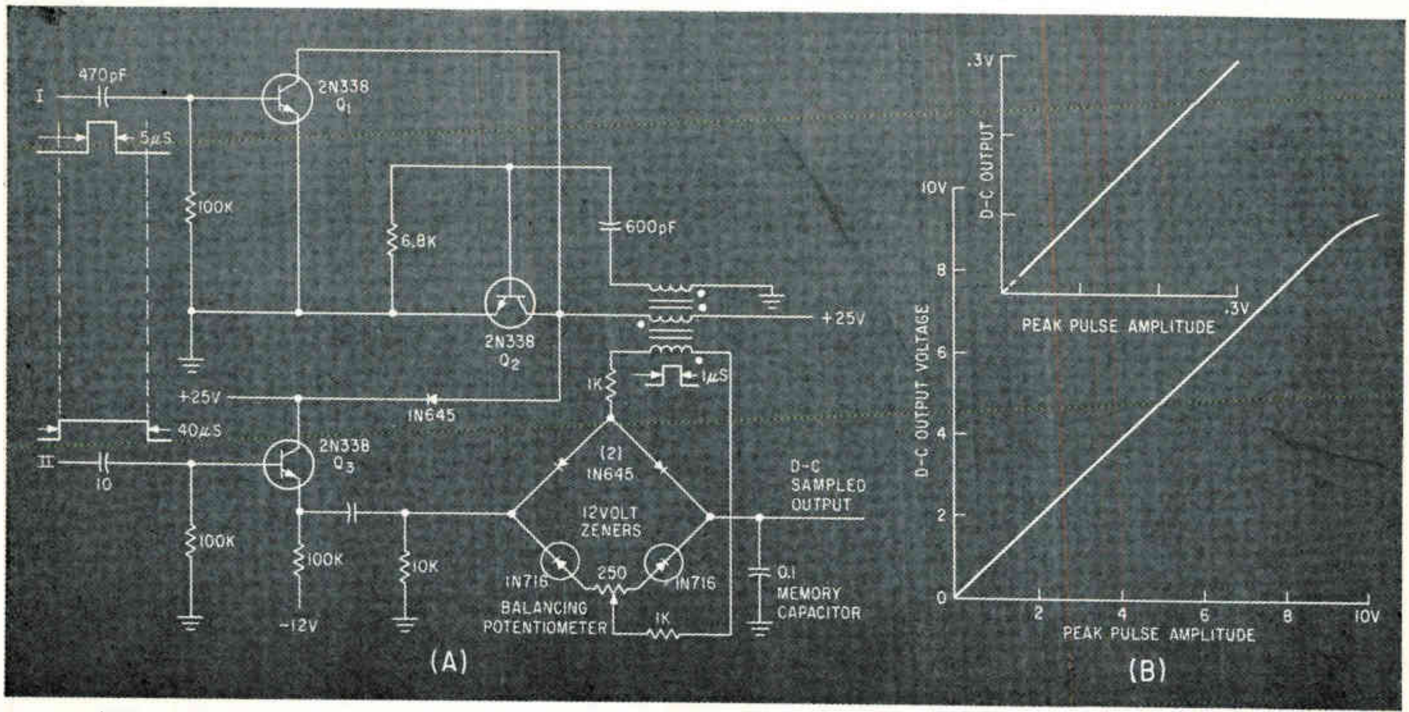


FIG. 2—Balancing potentiometer compensates for individual variations in characteristics of bridge components (A); linearity of circuit operation extends over 10-millivolt to 10-volt range (B)

Method for determining the acoustic characteristic of lecture halls and auditoriums requires an integrated reading of reflected sound patterns. Since sound energy is proportional to the square of the incident amplitude, the microphone output is squared before passing to the integrating circuits

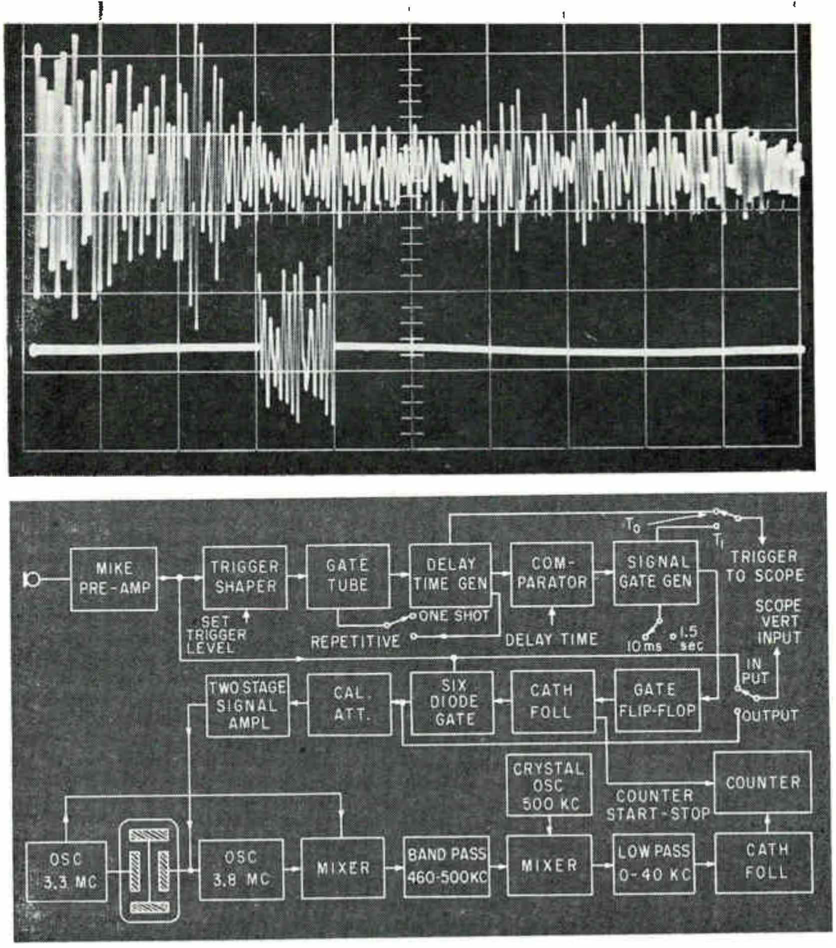


FIG. 1—Upper photograph shows oscillogram of reflected sound pattern and (same photo) portion of the waveform selected for integration; the lower illustration is overall block diagram showing squarer and integrator

Electrostatic Squarer for Acoustic

A CONVENTIONAL method of gaging the acoustic characteristics of lecture halls and other auditoriums consists of reading special words to observers within the hall, who then write down what they hear. Echos and other forms of distortion reduce the intelligibility of these words, so a measure of the hall's acoustic acceptibility is the percentage of words correctly understood. Unfortunately, this method is time consuming and subject to error.

Recently, research work on the mechanism of human hearing has given insight into the operation of the ear, and in particular, to its integration and masking characteristic.[1] Knowing more about the ear's operation, it is now possible to deduce from an analysis of sound patterns produced by each auditorium, just how acceptable that auditorium is to listeners[2].

Sound patterns from the auditoriums are analyzed by the present equipment, which integrates indirect sounds that arrive after the first sound from the source is received. Integration takes place over a predetermined interval, while a variable delay caters to reflections arriving up to 120 milliseconds after the initial signal.[3]

Integrator output which is a measure of sound energy over the period, is read out on a digital indicator, and permits the hall's acoustic characteristic to be mapped.

The design of this equipment is based on the fact that the force exerted on the plates of a capacitor is proportional to the square of the voltage applied between the plates. The squaring unit consists of a thin Duralumin diaphragm between two electrodes. The signal is applied between one electrode and the diaphragm causing a diaphragm deflection proportional to the square of the applied voltage (provided this deflection is small). Deflection causes a differential frequency deviation of two r-f oscillators that are controlled by the capacitances between the diaphragm and electrodes. The sum of the frequency deviations on either side of quiescent frequency is proportional to the deflection of the diaphragm, again provided that this deflection is small. Hence, over a range, the sum of the frequency deviations is proportional to the square of the applied voltages. The sum of the frequency deviations is measured by mixing circuits, gates, and an electronic counter, so that the energy within a certain period is given by

$$E = K \int_{t_1}^{t_2} F dt \qquad (1)$$

where K is a constant and F is the sum of the frequency deviations.

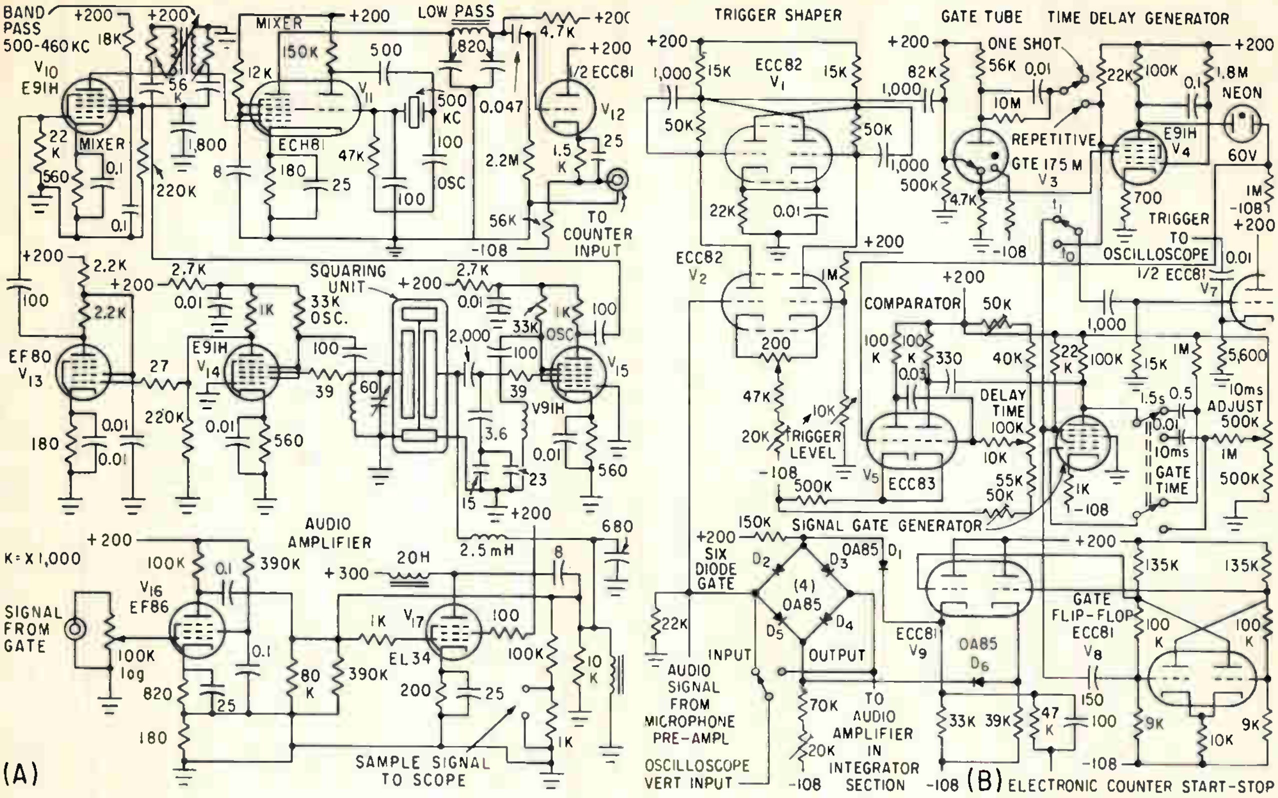


FIG. 2—Timing circuit can be set to accept any portion of the incoming sound signal; moreover, the time-period of the accepted signal is also variable (B). Chunks of the sound signal passed on by the timing circuits are first squared by the electrostatic squarer, they are then handed on to the digital counter for final integration (A)

Measurements

By J. P. A. LOCHNER and P. MEFFERT,
National Physical Research Laboratory, Pretoria, South Africa

A block diagram of the complete sound energy integrator circuit is given in Fig. 1. The circuit can be divided into two sections: the timing section including the signal gate, and the integrator section with its associated audio amplifier.

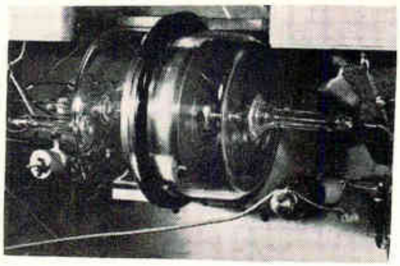
The incoming signal from the microphone preamplifier triggers the timing circuit which opens the six diode gate for a predetermined period at a preselected delay after arrival of the first signal. The incoming signal is supplied through the gate, calibrated attenuator, two-stage feedback amplifier, and r-f choke, to the one electrode of the electrostatic transducer. The two capacitors of the electrostatic squaring unit control the frequencies of two oscillators that are mixed in a double heterodyne system to give a zero beat when no audio signal is applied. With a signal applied, a frequency deviation between the two oscillators occurs in proportion to the square of the applied voltage. The number of cycles is counted over predetermined periods by an electronic counter switched by the square wave which actuates the gate.

An oscilloscope may be triggered at either the beginning of the timing cycle or at the moment the gate is opened. The audio signal can be checked at the input or output side of the gate or at the amplifier output.

The electrostatic squaring transducer is shown in photograph at the top of p 68. This device consists of a 0.025 mm thick Duralumin diaphragm stretched tightly between two electrodes 2.6 cm in diameter leaving gaps of 0.05 mm on either side between electrodes and diaphragm. The entire unit is sealed into a glass container evacuated to eliminate air damping of the diaphragm and to reduce the effect of temperature variations to a minimum.

A frequency response curve of the electrostatic unit connected as electrostatic actuator and capacitor transducer is given in Fig. 3A.

A circuit diagram of the integrator section is given in Fig. 2A. This section consists of the electrostatic squarer, which incorporates the frequency determining elements of two transitron negative resistance oscillators working at about 3.3 Mc and 3.8 Mc. The inductors and other components of the two oscillators are similar to keep their drift alike. After amplification the signals from the two oscillators are mixed to obtain a difference frequency of 500 Kc. This difference signal is passed through a 460 to 500-Kc band-pass filter and mixed with a 500-Kc signal from a crystal oscillator to give an output fre-



Electrostatic squarer in its evacuated envelope

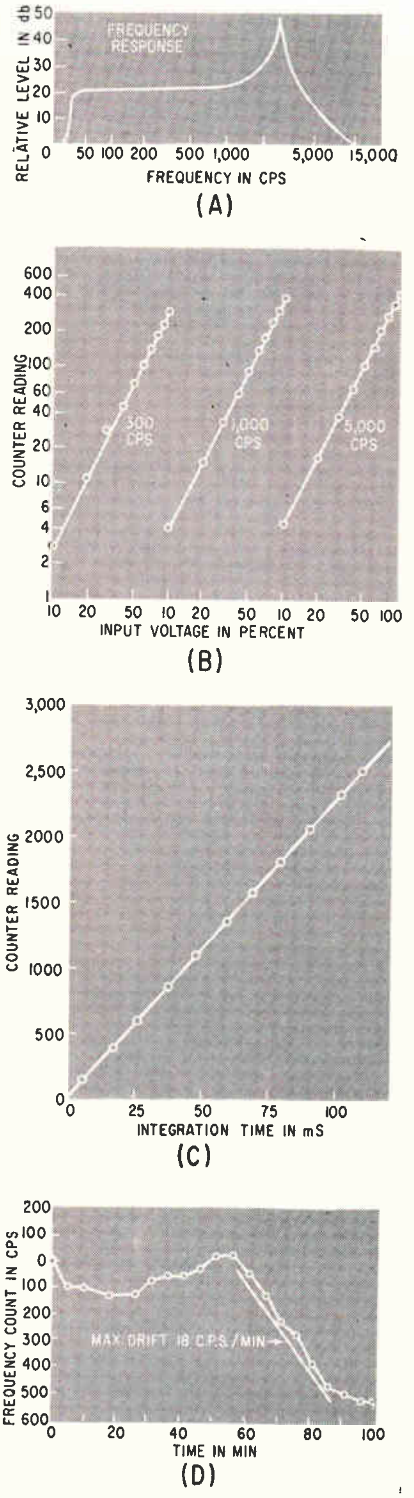


FIG. 3—Calibration curves of squarer and integrator are discussed in text

quency varying from zero to about 35 Kc for maximum deviation of the transducer diaphragm. This output signal is fed through a low-pass filter and cathode follower to the electronic counter input.

A circuit diagram of the timing section is given in Fig. 2B. This section passes the selected portion of signal from the microphone preamplifier through to the integrator section, and at any delay after the first pulse of incoming sound.

The incoming signal from the microphone preamplifier feeds the gate input and trigger shaper, this latter being a two-tube bistable circuit giving sharp pulses whenever the input signal exceeds the setting of the trigger level control. The gate tube is a cold-cathode type giving visible indication of being ON. The time base consists of a phantastron saw-tooth generator and a comparator, giving a delay time linearly variable from zero to 120 milliseconds. The comparator triggers the integration time phantastron, which can be accurately adjusted to the integration period. The integration period in the instrument is switched to either 10 millisec or 1.5 sec.

The signal gate consists of a bistable multivibrator triggered from the phantastron screen grid, plus two cathode followers and six crystal diodes. In the OFF position, diodes D_1 and D_6 are conducting, thereby biasing D_2, D_3, D_4 and D_5 to cutoff. In the ON position D_1 and D_6 are cut off while D_2, D_3, D_4 and D_5 are heavily conducting, allowing the audio signal to go through. Once it has been balanced, the gate passes audio signals with negligible switching transients.

To give an energy reading, the counter reading over any fixed period should be proportional to the square of the applied voltage. Figure 3B shows curves of counter reading against percentage of input voltage at 300, 1,000 and 5,000 cps. The points are experimental and the straight lines are theoretical square law lines.

Figure 3C is a curve of counter reading against integration time for a constant input voltage of 330 mv at 1,000 cps. Again, the points are the experimental values and the solid line the theoretical straight line. This curve shows that for constant voltage bursts the energy registered by the instrument is directly proportional to the integration time, even for times as short as 5 milliseconds.

The frequency response of the instrument is the frequency response of the feedback audio amplifier feeding the integrater section and is flat to within ±½-db from 50 to 15,000 cps.

The energy reading on the instrument should be independent of the wave shape of the applied signal. To test this, the reading obtained from a random noise signal having a bandwidth of 160 cps to 7,000 cps was compared with the reading obtained from a 1,000-cps sine-wave using a thermocouple meter as transfer standard. The agreement was within 0.1 db.

It was also found that the dynamic range of the instrument was reduced to 15 db by using white noise as a signal. This was because overloading of the audio amplifier occurred sooner because of the high peaks in the signal.

One of the limitations of any beat frequency instrument is frequency drift. To investigate to what extent drift could upset readings with this instrument, the zero frequency drift was measured for 100 minutes and the results presented in Fig. 3D. The maximum drift registered is only 18 cps a minute, which represents a negligible error due to drift.

Apart from its intended application the instrument should be useful for analysis of all sorts of signals within the audio range, especially because of its wide range of integration periods and low drift. Since it is a true rms device and can be made frequency-independent over a large range, the electrostatic squarer holds possibilities for use as a transfer standard.

The authors acknowledge the permission of the *Journal of the Acoustical Society of America* to publish this review article.

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(2) J. P. A. Lochner and J. F. Burger, The intelligibility of speech under reverberant conditions, Submitted for publication in *Acustica*.

(3) J. P. A. Lochner and P. Meffert, *J. Acoustical Soc. Am.* 32, p 267, 1960.

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Obtaining Equivalent Circuits Of Inductors Graphically

Simplified method for determining the dynamic characteristics of inductors or parallel circuits in wideband applications is useful in design of matching circuits

By W. P. CZERWINSKI, Antenna Research Engineer
U. S. Army Signal Research & Development Laboratory
Fort Monmouth, New Jersey

IN APPLICATIONS that involve narrow frequency ranges, it does not matter greatly how large the distributed capacitance of an inductor is, while furthermore, the effective inductance can be obtained easily by direct measurement. If wide frequency bands are involved, it is important to know the distributed capacitance. Presented is a convenient and accurate method of quantitative analysis of an inductor in respect to true inductance, self-capacitance, parallel resonance, plus dielectric and copper losses. While the method itself is not new,[1] it is presented here in a more comprehensive form.

The analysis is based on the equivalent circuit of Fig. 1. In this parallel resonant circuit, C_S represents the effective stray capacitance. From Fig. 1 it follows that

$$(\omega C = -1/\omega L + \omega C_s \quad (1)$$

$$\text{or } L = 1/[4\pi^2 f^2 (C_s - C)] \quad (2)$$

$$\text{Defining Slope} = (C_s - C)/(1/f^2) \quad (3)$$

$$\text{gives } L = 1/(4\pi^2 \text{ Slope}) \quad (4)$$

Figure 2 illustrates the parameters. A presentation such as Fig. 2 is made up by marking a linear scale of $1/f^2$ as a base line on graph paper. The values for the ordinate, which is a linear scale also, depend on the inductor. These values are obtained from admittance bridge readings for the frequency range. The ordinate is marked off to accommodate the range covered by the susceptance readings of the inductor. For greatest accuracy, frequencies should be chosen that yield susceptance readings on both sides of a zero susceptance line.

A straight line is drawn through the plotted points and extended to intersect the ordinate (point X). The value on the ordinate scale at X represents C_S, the self-capacitance of the inductor. The intersection of the curve with the zero susceptance line, when projected down to the base line, identifies f_o, the resonant frequency.

To calculate the true inductance, the slope values are taken from the graph in the following manner: A convenient point, Z, at the low end of the curve is selected. The corresponding values for C (point Y) and $1/f^2$ are determined; the slope is then the total capacitance from X to Y over the value of $1/f^2$ at Z. Point Z has been selected as shown to give higher accuracy. If a point higher up had been selected, the relative accuracy in reading $C_S - C$ and in reading $1/f^2$ would have been less.

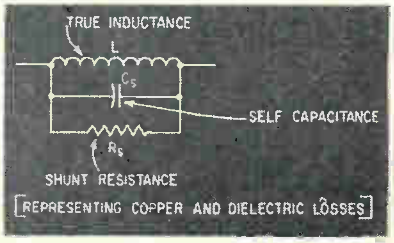

FIG. 1—Equivalent circuit of coil defines terms used in derivation

The conductance G is obtained directly off the admittance bridge in millimhos and converted to R_S in ohms by

$$R_s = 1{,}000/G \quad (5)$$

EXAMPLE—The numerical values shown in Fig. 2 are for a Q-2 ferrite-core inductor. Measurements of positive and negative capacitance values were obtained by making three or four admittance bridge readings of the sample inductor in the frequency range. From the plot $C_s = 12$ pf,

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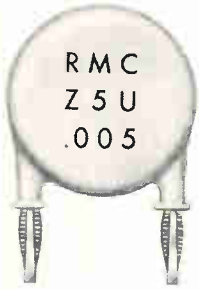

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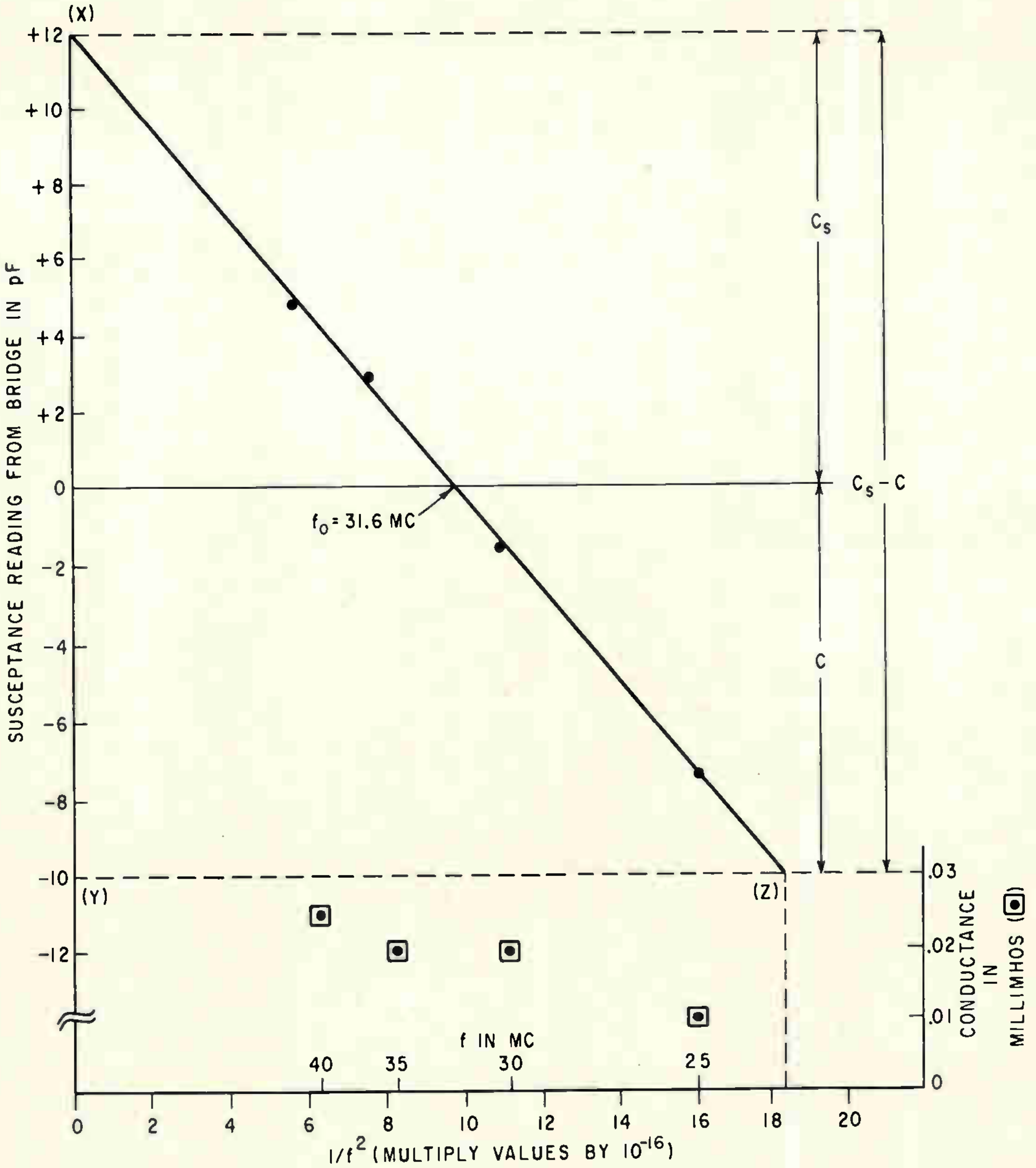

FIG. 2—Graph reduces need for laborious calculations and can pinpoint incorrect bridge readings

$C = -10$ pf, and G at 31.6 Mc $= 0.02$ millimhos.

Using Eq. 3

$$\text{Slope} = \frac{22 \times 10^{-12}}{18.3 \times 10^{-16}} = 1.20 \times 10^{4}$$

and with Eq. 4

$$L = \frac{1}{39.5 \times 1.20 \times 10^{4}} = 2.11 \times 10^{-6}$$

$$L = 2.11 \ \mu h$$

Using Equation 5 the shunt resistance is

$$R_s = 1{,}000/0.02 \text{ (millimhos)}$$
$$R_s = 50{,}000 \text{ ohms}$$

An important advantage of this kind of plot is that erroneous readings show up as deviations from a straight line. Inaccuracies can be averaged by drawing the straight line to minimize the sum of the square of the errors. If the readings lie on a curved line, then this indicates that the equivalent circuit concept of one lumped capacitor in parallel to the inductor does not apply to the inductor measured. Of course, this method can be applied to an actual parallel circuit.

In practice, the conductance is plotted as shown in Fig. 2. Thus, all pertinent data and calculations relating to the inductor under test can be recorded on a single sheet.

The suggestions of Helmut Brueckmann are gratefully acknowledged.

REFERENCE

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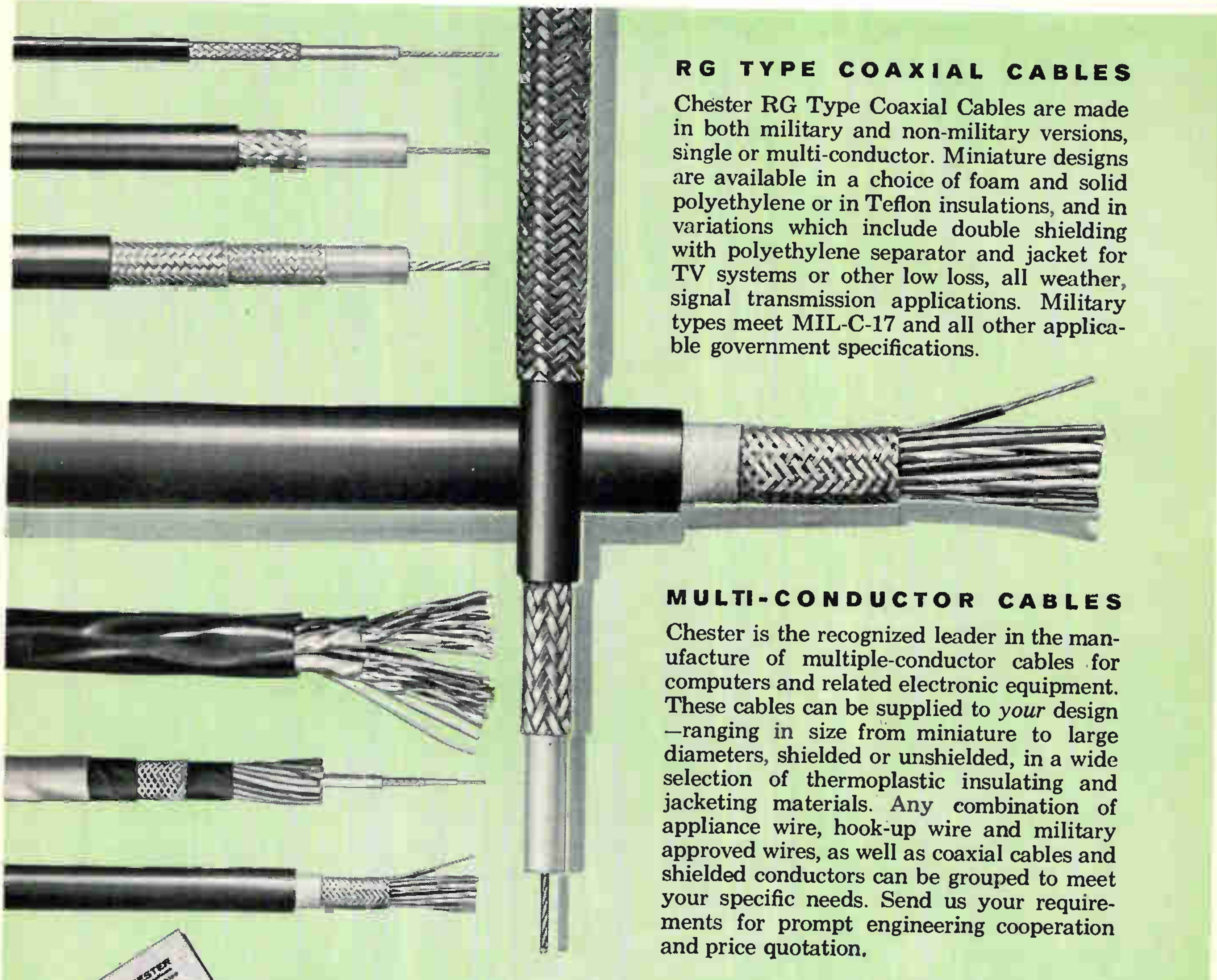

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Lack of Standards Hampers Development

RESEARCH and development of electronic equipment is being seriously hampered by lack of adequate standards. (See ELECTRONICS, p 90, Sept. 11, 1959.) This need was underscored at the 1960 Conference on Standards and Electronic Measurements at the Boulder Laboratories of the National Bureau of Standards. Specifically, Aerospace Industries Association with representatives from 15 different firms indicated to NBS a critical need for better standards for measuring microwave power and attenuation.

Needs of military and space programs are requiring unprecedented measurement accuracies. Standards for the higher frequencies now finding increasing use are also urgently needed.

Surveys conducted during the past year by AIA indicated accuracies currently required by industry in different areas of measurement. Based on these surveys, the series of AIA-NBS conferences have been initiated. Each field of measurement will be probed in depth to determine the most urgent needs and how they can best be met.

A primary purpose of the meeting was to suggest action that might be taken to correct specific situations described by industry. For example, the million-dollar development of radomes is proceeding more by trial and error rather than through measurement and analysis because precise phase and amplitude measurements do not exist in the required frequency range.

One firm must use its precision measurement laboratory facilities to test sections of coaxial cable from the production line because adequate production-line standards do not exist. This test requires 11 hours for a single section of cable.

Klystrons are being over-designed to ensure that they generate sufficient power because there is no way to measure precisely peak microwave power. Costs and equipment size are increased, production schedules slowed and expensive equipment is not being used at its optimum capacity or range.

A few years ago, radar performance was evaluated on the basis of two or three measurements. To measure performance of present-day radars requires testing many new complex devices. Often the radar is assumed to have failed when the fault is actually with test instruments.

Crash missile programs are being impeded because measurements of microwave power made on different days by the same instruments may vary by fifty percent. Some radars are operated at near maximum capacity. To avoid breakdown, power must be limited to a given level dependent on measurement accuracy. One speaker said that a five percent error in power measurement can make the difference between operating or not.

Discussion of these problems indicated that in a few cases NBS can provide interim standards with present facilities that will greatly help many users. Calibration can now be provided of microwave power-measuring instruments between 8,200 and 12,400 Mc. Using different techniques, calibration can be extended to lower frequencies soon. Although accuracy will be somewhat less, it will help meet many immediate needs.

However, many standards cannot be extended to new frequency ranges even though techniques are known because equipment and personnel are lacking. Industry urgently needs an extension of a current microwave attenuation standard to three higher frequency ranges. To evaluate this technique at even one new frequency in the millimeter wave region requires $11,000 worth of new equipment. This figure exceeds the present total annual equipment funds allotted to the project involved.

Another limitation is time. NBS representatives were asked to estimate time required at the present level of activity to develop minimum acceptable standards not now in existence for frequencies to 100 Gc and other most-needed quantities. However, accurate estimates are impossible until techniques have been developed.

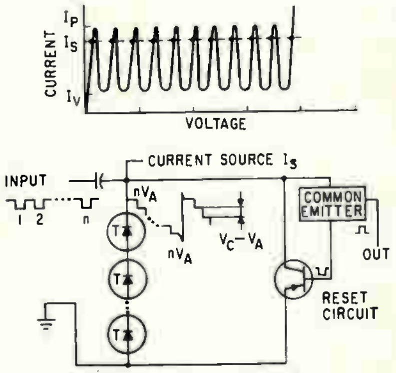
Estimates, varying with the measurements involved, ranged from five to ten years for most quantities. Even with substantial increases in funds, hiring capable personnel and their initial training take considerable time. These estimates also make no provision for new needs that will arise during the next few years.

To estimate the urgency of the needs, industry representatives indicated their reasons for requiring certain standards. NBS described and discussed for each field the present status of research, development and calibration. From the discussions, tentative recommendations evolved for action by all interested groups. These recommendations will be reviewed by AIA before official presentation.

Discussion revealed the difficulty of discovering whether expressed needs were realistic. Extreme accuracies were sometimes specified simply to play it safe.

High-Speed Scaler Uses Tunnel Diodes

GALLIUM ARSENIDE tunnel diodes are used in a newly developed high-speed scaler. Double pulse resolution for switching between intermediate states is said to be less than 14 nanoseconds. The device was developed by Philco's Re-



Voltage-current characteristic of tunnel diodes in series are used in high-speed scaler

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Emitter Voltage BV_{EBO}	60	60	40	40	30	30	20	20	Volts
Collector Current I_C	15	15	15	15	15	15	15	15	Amp
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search Division.

Operation of the scaler is based on a characteristic of tunnel diodes connected in series. Voltage is a multi-valued function of current, as shown in the voltage-current curve in the figure. Gallium arsenide tunnel diodes were chosen because of their wide voltage swings and because they have peak-to-valley current ratios (I_P:I_V) exceeding ten-to-one. In addition, switching time is less than one nanosecond.

When current I_B is initially applied to the stack of series-connected diodes in the figure, voltage across the stack is at minimum. Each input pulse of proper amplitude increases voltage across the stack by an amount $V_C - V_A$ to the next higher level. The transistor reset circuit is biased to operate when voltage across the stack reaches maximum ($nV_C - nV_A$). An output pulse is provided and voltage across the stack is returned to its original minimum level.

In addition to high switching and reset speeds, the tunnel diode scaler provides significant reductions in space, weight and power requirements compared with beam-switching tubes or cascaded transistor binary circuits used in similar applications.

Spectrometer to Study Neutrons and Protons

MILLION-WATT magnetic spectrometer may provide a better understanding of the structure of matter. The new instrument for studying nuclear particles is the result of three years of effort. It can handle billion-volt electrons from targets bombarded by a large linear accelerator.

The 150-ton spectrometer will be used at the High Energy Physics Laboratory of Stanford University by Professor R. Hofstadter and his associates in attempts to probe to the cores of protons and neutrons. The project is being supported by the Office of Naval Research, the Atomic Energy Commission and the Air Force.

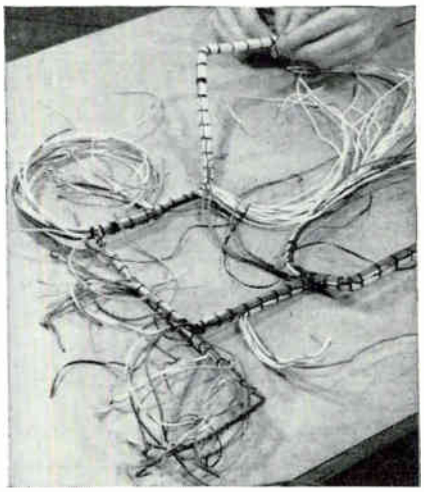
Three years ago this research team made precise measurements which demonstrated that protons and neutrons are of equal magnitude magnetically but that the size of their electrical charge is not equal. The spectrometer used in that investigation was only half the size and required only one-fifth the power of the present instrument.

It had been assumed that the neutron was a mirror image of the proton in its outer parts. This assumption was proved to be true magnetically but not electrically. The much smaller electrical charge of the neutron presents an anomaly in that magnetic phenomena seem to be explained perfectly. Some scientists believe that existing theories may not be valid for particles as fine as protons and neutrons.

The earlier measurements demonstrated that both type particles have a radius of 8 x 10^{-14} cm. Each particle seems to be composed of a cloud of mesons, believed to hold the nuclei together, that becomes denser toward the center. The former spectroscope could not probe to the cores of the neutrons and protons but could reach to within 3 x 10^{-14} cm of them. The new equipment may permit penetration to the cores of both type particles. Even if it does not solve the problem of magnetic versus electrical charge size, it is expected to provide much other valuable information.

The new spectrometer, primarily a large electromagnet, is mounted with the older spectrometer on a wheeled carriage that rides on a circular rail. By allowing full 360-degree rotation of the spectrometers, the magnets can pick up electrons scattered at all angles from the target. The magnets bring the electrons to the top of the apparatus. Behind heavy radiation shielding, Cerenkov counters and multiplier phototubes determine their numbers and energy.

Counters in the new equipment are set in parallel to permit simultaneous counting of five times as many electrons as before. Rotating coils inside vacuum chambers in the magnets allow easy variation of field strengths. Both refinements will increase considerably the speed of gathering information for study and computer analysis.



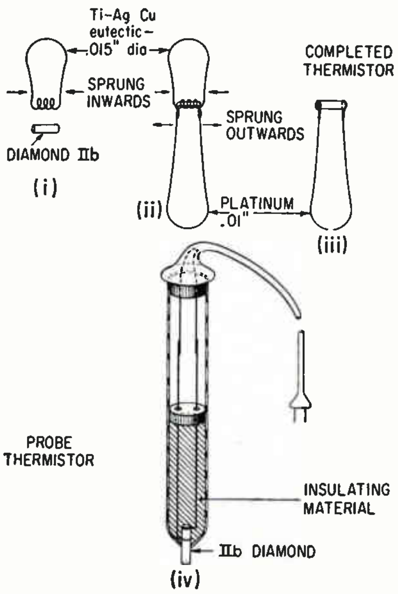
Blue Diamonds Make Rugged Thermistors

BLUE DIAMONDS (Type IIb) are extrinsic p-type semiconductors, and have a high negative temperature coefficient from below 200 K up to approximately 500 K. Past that point the temperature coefficient decreases, rapidly becoming zero, and then going positive in the region 600 K to 700 K.

G. B. Rodgers, Diamond Research Laboratories, Crown Mines, Johannesburg, S. Africa, reports that, when provided with suitable ohmic contacts, a blue diamond can be used as a thermistor over a wide temperature range. A diamond thermistor is in operation at DRL measuring coolant temperature in a diffusion pump.

Diamond has certain physical properties that make it an excellent thermistor material. These include low specific heat, high heat conductivity (greater than copper at room temperature), and high physical strength, as compared with conventional oxide thermistors. Diamonds are non-hygroscopic, and are highly resistant to corrosive fluids and high temperatures.

These attractive physical properties suggest that in many applications, the diamond thermistor can be placed in actual contact with the medium to be measured. In this manner, the heat dissipation constant can be increased, and the thermal time constant reduced.



Leads are attached to diamond with titanium wire weld technique (top). Diamond in probe type mount (bottom)

Thermal time constant, which determines the response time of a thermistor to rapid changes of temperature, is inversely proportional to the heat dissipation constant.

For a thermistor in air, the dissipation constant is determined mainly by the exposed surface area. Thin wafers, and thin cylinders, have the highest dissipation constants. Thermal conductivity is not an important factor, as most thermal impedance is as the surface, from thermistor to air, and internal impedance is negligible in comparison.

The high heat conductivity of diamond is important in a probe type thermistor, using a cylindrical diamond, as shown in sketch. Electrical connections to the diamond are remote from the heat source, and heat must diffuse through the cylinder from the point of contact.

True ohmic low resistance contacts between the diamond and leads must be made to insure accurate temperature readings. Additional resistance in series with the element can swamp the small change of resistance, lowering sensitivity. The extra ohmic heating will raise the ambient temperature, and produce a false reading.

Early research developed the process of coating diamonds with a mixture of titanium and silver, that is used to mount diamonds for various applications. As titanium is a group IV element (as is carbon), it seemed likely that a true ohmic contact might be obtained by welding or alloying titanium with the diamond.

Using a titanium weld, a successful method was developed at DRL for attaching platinum leads to small diamond cylinders. As shown in the diagram, a small bridle of silver-copper eutectic wire, .015 in. in diameter, having a titanium metal core, is fitted over the ends of the cylinder. A loop of .01 in. platinum wire is attached to the cylinder over the Ti-Ag-Cu wire.

The entire assembly is placed in a furnace and heated to 1,200 C for 2 minutes. During heating the assembly is bathed in a stream of argon to prevent oxidation of the diamond. At 1,200 C the Ti-Ag-Cu wire melts, and fuses the platinum wire, which doesn't melt, onto the ends of the diamond cylinder.

Quantity of Ti-Ag-Cu wire used in the process depends on the length of the diamond. Excess wire will melt, forming a thin film that shunts the thermistor action, ruining the device.

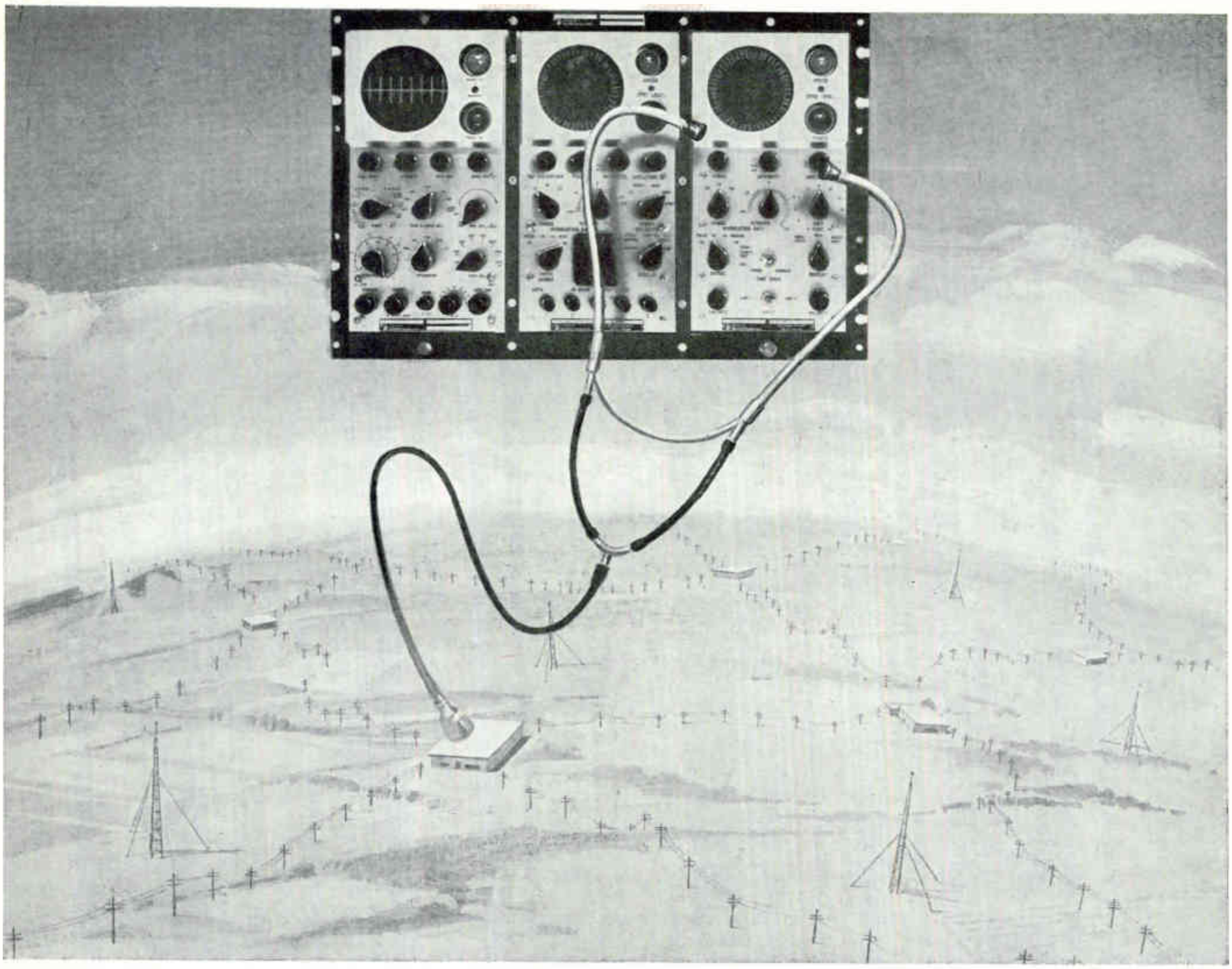
Prototype thermistors used diamond cylinders measuring 2.5 to 5 mm in length, and 1 to 1.5 mm in diameter. The diamonds were shaped by polishing and drilling. No crystal lattice orientation was required, as diamond is an electrically isotropic material.

Diamond thermistors are useful over a wide range of operating temperatures, and under severe operating conditions. They therefore may be more desirable in many applications than silicon, germanium or oxide units. Silicon and germanium thermistors operate in the intrinsic temperature ranges of greater than 200 C and −15 C respectively. Diamond units will operate from below −70 C to about 300 C, with a negative temperature coefficient. Although not useable above this maximum temperature, a diamond thermistor could survive environmental temperatures of up to 600 C, if oxidizing conditions are not present.

Cost of the devices would depend on the availability of IIb diamonds, and the wastage in preparing suitable thermistor shapes.

Metal-Composite Laminates For Automatic Post Office

METAL-COMPOSITE laminated plastics for applications requiring intermittent electrical contact have



been developed by Taylor Fibre Co., Norristown, Pa.

With the metal embedded in strong, durable insulation material, copper-clad laminates ordinarily used for etched printed circuits the need for metal-laminate combinations where the more intricate, close-tolerance printed circuits are not required.

Typical of possible applications for metal-composite laminates is their use as tray code readers in new automated equipment being installed by the United States Post Office. Attached to the sides of mail-bearing trays, the coded readers signal electrically-activated mechanisms went to shunt the tray to a branch conveyor for a given geographical area.

Among other end-uses for metal-composite laminates is a model seascape on which Navy and Marine officers can simulate the maneuvering of as many as 100 radio-controlled models of naval vessels. The giant 70 × 24 foot device is made up of 36 × 36 inch sections of copper strips embedded $\frac{1}{4}$ inch apart in $\frac{3}{64}$ inch thick phenolic-paper laminate. The flatness of each section is held to plus or minus $\frac{1}{64}$ inch over the entire area, and the spacing between the strips is also held to $\frac{1}{64}$ inch tolerance.

Taylor Fibre has supplied these laminates in three ways: with the metal inserted in windows which are cut in the top layers of the laminate; with the metal pressed flush into the laminate; and with a sandwich of metal foil between two layers of laminates which have been cut out at designated locations where electrical contact is desired.

Although initial work in this field has been done with copper, cold rolled steel, and stainless steel, virtually any metal can be used in making these laminates.

Due to the large number of possible product variations, all composite laminates are custom-engineered to fit a specific application.

Organic Gaskets for High Temperatures

A NEW FAMILY of gasketing and packing materials made of flurocarbon resins and inorganic fibers, has been announced by Armstrong

Cork Co., Industrial Div. The materials can be used at temperatures from −425 F to over 500 F with excellent torque retention.

The new sheet materials, called Flurocarbon Accopacs, are inert to most chemicals over a wide range of temperatures, and have a low coefficient of friction which makes them useful as seals and packings in contact with moving parts.

The material is reported to have good dielectric properties, and excellent thermal dimensional stability.

Components make of the material can be adhesively bonded to other surfaces with either thermoplastic or thermosetting cements.

The materials consist of combinations of flurocarbon resins and asbestos or other inorganic fibers in different proportions and densities. Flurocarbons are characterized by having good dielectric properties, extreme chemical inertness, high heat resistance, and toughness over a wide temperature range.

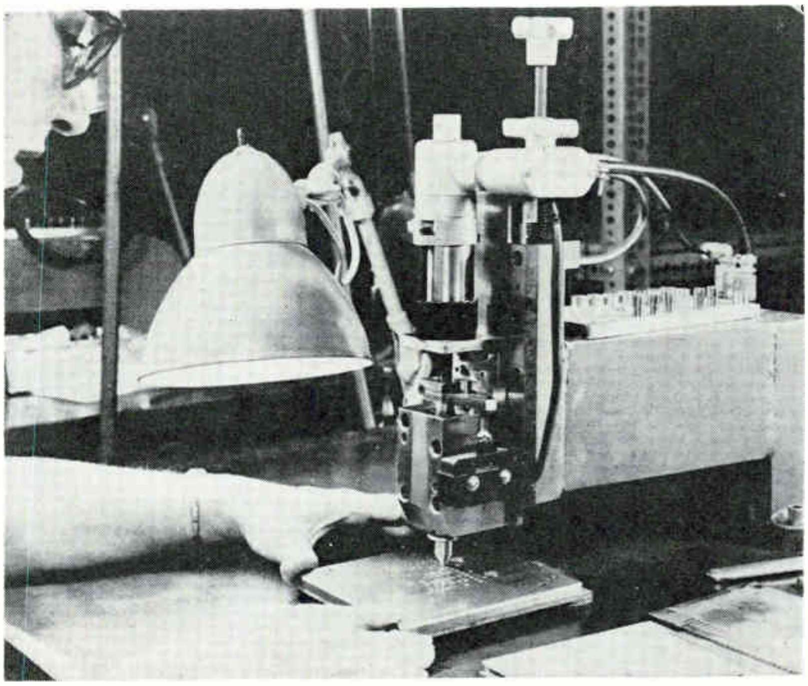
Despite these useful qualities, the flurocarbons have inherent disadvantages, the most pronounced of which are high coefficient of thermal expansion, and low resistance to deformation under load at high temperatures. Addition of fibers to the pure resins overcomes these disadvantages, and produces a useful material for a variety of gasketing and packing applications.

During Accopac process each fiber is given a thorough coating of resin, and the fibers are evenly distributed to form a uniform material.

These materials have potential applications in several industries. Uses in the aircraft and missile field include gaskets for fuel systerm, hydraulic systems, and baffles and fire walls in high temperature areas up to 500 C, and as components in cyrogenic materials handling systems.

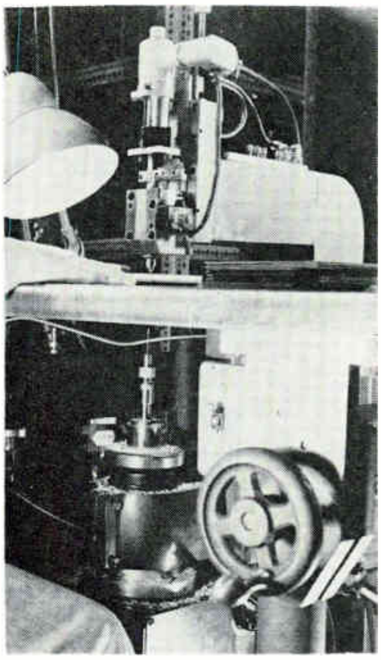
Applications in the electronics field include gaskets for high temperature ("H" type) equipment, including dry transformers, converters, circuit breakers, motors and switches, and as terminal bars and spacers in these devices. As in the aircraft industry, low temperature stability is useful for cryogenic applications.

Patterned Fixture Guides P-C Driller



Finger drops in indentation, locating hole position over drill. Etched pattern traces path from hole to hole

UNDER-THE-TABLE DRILL and a drilling fixture that provides positive positioning of the drill are combined in a semiautomatic machine in use at Librascope Division, General Precision, Inc., Glendale, Calif. Boards are drilled 5 at a time and hole locations are precise enough for automatic component insertion.



Drill rises when finger is centered and operator presses toe switch

Librascope, which designed the machine and had it built by subcontractors, reports that it has increased operator output while cutting rejects. The boards are aligned in the fixture with alignment holes drilled before etching. The same holes also serve in other production steps requiring alignment. Boards made are used in computers and other industrial-military equipment.

The operator stacks 5 circuit boards in the positioning fixture. This fixture is a rigid metal plate backed by reinforced plastic. The surface of the plate contains a drilling path or pattern etched into the metal, with positioning indentations corresponding to the holes to be drilled.

The loaded fixture is placed, metal plate up, on the drill table. A positioning finger located above the tabel is guided along the pattern. When the fixture is positioned so the finger drops into an indentation, the operator presses a toe switch. The carbide drill below the table automatically rises at a controlled rate, spinning at a preset speed. Safeguards prevent the drill from operating unless the finger is centered in an indentation. The drilling stroke ends in the fixture's plastic backing. On completion of the stroke, the drill returns to rest position and the operator locates the positioning finger in the next indentation.

Computer-Prepared Lists Serve as Wiring Diagrams

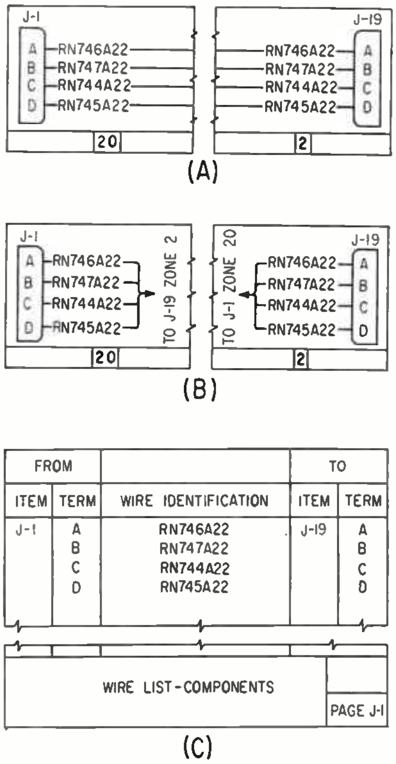
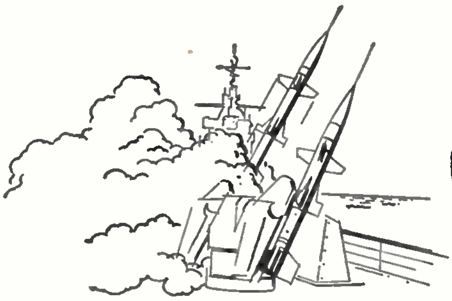


FIG. 1—Evolution of wiring list from wiring diagrams

WIRING DATA LISTS prepared on electronic data processing machines are being used instead of wiring diagrams for aircraft electrical-electronic wiring systems. North American Aviation, Inc., Los Angeles, Calif., says the lists permit the discard of conventional pictorial diagrams.

Because aircraft wiring systems



HANDY & HARMAN SILVER FLAKE

Coats Lighter, More Effective Plastic Lens For Long Range Missile Control System

An exciting new application in the missile control field is the development by the Surface Armament Division at Sperry Gyroscope Company of a silver-coated plastic lens for use with the Navy's Talos missile. As compared to earlier metal versions, the new lens weighs substantially less and provides twice the signal gain at the same production cost! The Talos delivers, with extreme accuracy, a high explosive or nuclear warhead to any altitude at which airplanes now fly, as well as far beyond the range of human visibility.

The silver coat imparts RF reflectivity and electrical conductivity to the lens and is applied in paint form. As the silver base for this paint, Sperry uses Handy & Harman's Silver Flake. An important quality of this flake is that its waferlike particles are asymmetrical and overlap on the surface of the lens, affording up to 35% of the conductivity of an equivalent weight and shape of fine silver.

Handy & Harman Silver Flake finds use throughout the electronic and electrical industries...it is ideal for pigments to make conductive coatings on such non-conductors as ceramics, glass, mica, plastic and paper, as in the manufacture of capacitors, thermistors, carbon resistors, printed circuity and electrostatic shields.

Handy & Harman has available every form of silver useful to manufacturers and fabricators—flake, powder, paint, paste, sheet, strip, wire bimetals, silver oxide, divalent oxide, etc. Our Research and Engineering Department is always available to assist you in the selection or use of any silver form for any application from brazing to conduction coating. **Below are listed six of our Technical Bulletins. Please indicate their numbers for prompt attention.**

Fine Silver	Bulletin A-1
Silver-Copper Alloys	Bulletin A-2
Silver-Magnesium-Nickel	Bulletin A-3
Silver Conductive Coatings	Bulletin A-4
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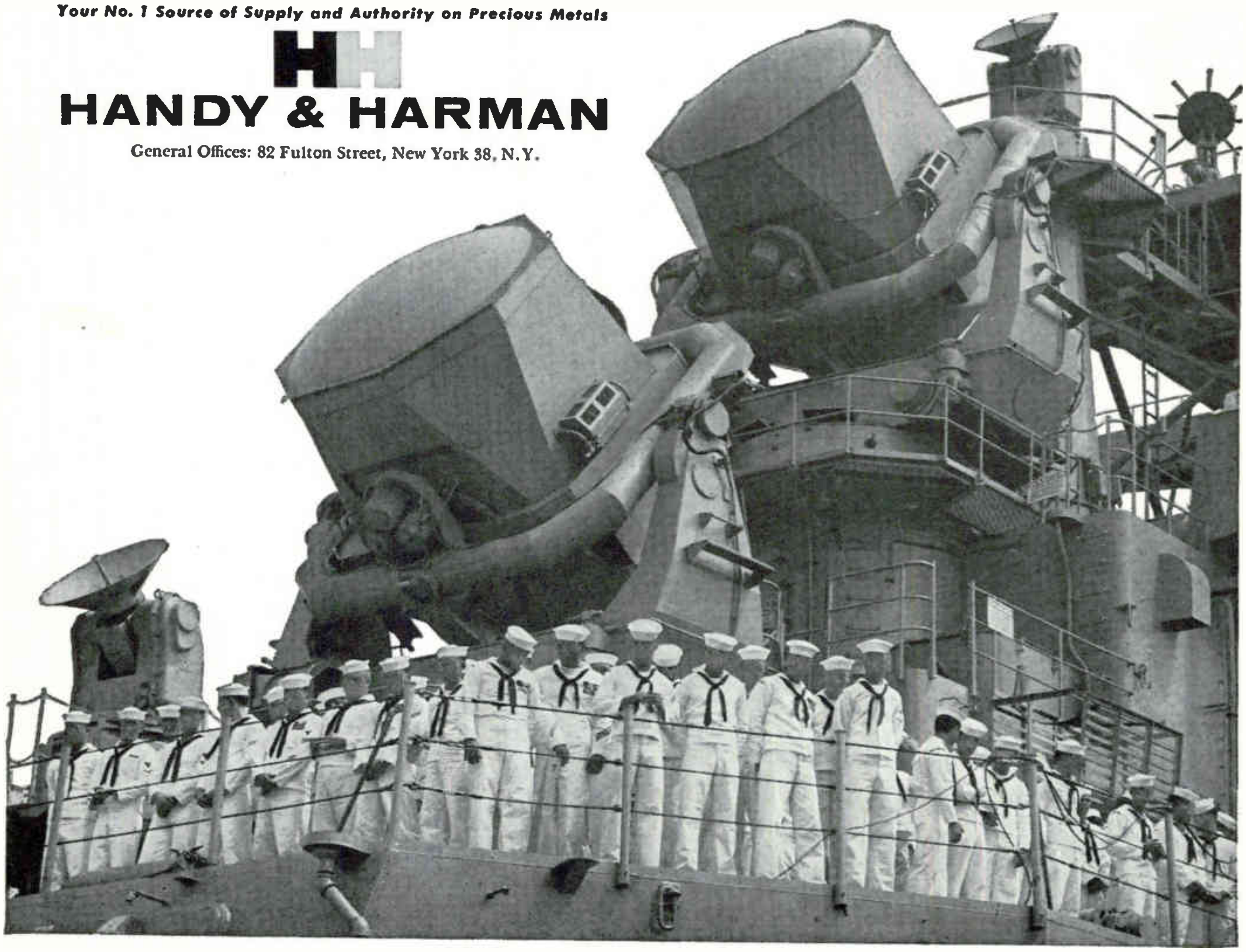


have become so large, NAA points out, massive collections of often huge diagrams became necessary. This became costly to prepare and difficult to follow, change and break down into wiring lists for various specialized purposes.

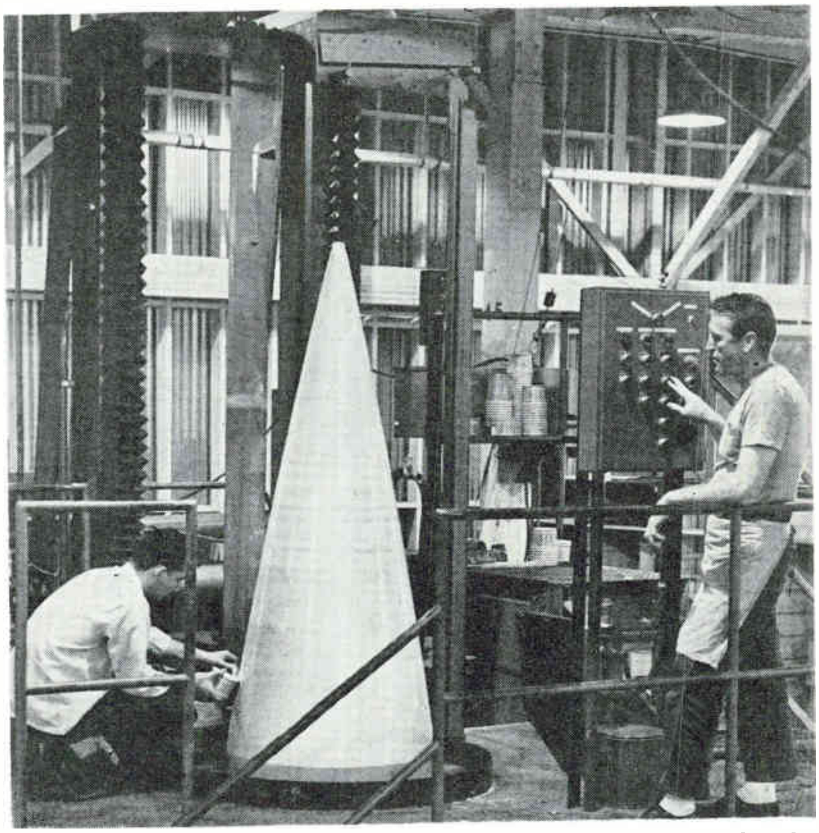
Under the system now used, the wiring data is taken off the designers' rough sketches by a wiring data group. The data is punched on cards and transferred to a magnetic tape memory. The data processing equipment (IBM 709) is programmed to prepare specialized lists for designers and production personnel.

Evolution of the system used by the firm is shown in Fig. 1. Fig. 1A shows the old method in which every circuit was shown continuously. Fig. 1B eliminates trunk lines by cross-referencing wire destinations.

The data list method of Fig. 1C eliminates the diagram. Each end of the wire is seen on the same line. The actual wiring lists contain much additional data. Included are component identifications, wiring function, lists of materials, military specifications, wire lengths, callout drawings, remarks, revision dates and so forth, depending on the requirements of the personnel using each list.

Among advantages are savings in engineering and drafting, speed in issuing wiring instructions and change orders, automatic rejection of erroneous orders and automatic preparation of wiring data for maintenance handbooks. The chief disadvantage is that the cost of preparing the memory tapes and programs is justified only when wiring diagrams would be voluminous and complicated.

Nose Cone Mandrel Winds Its Own



Lockheed's California Division uses a revolving mandrel to wind radar nose cones for the F-104. Spinning on a controlled-speed base, the tool pulls glass fiber strands through a resin bath. Some 18 layers of 15-mil glass strands are woven into the cone. After threading and curing, the inner and outer layers are ground to exact dimensions. Small deviations discovered during testing are corrected with glass fiber tape. Corrections can be incorporated in the tool by remachining it. Man at left in photo is scraping off excess resin

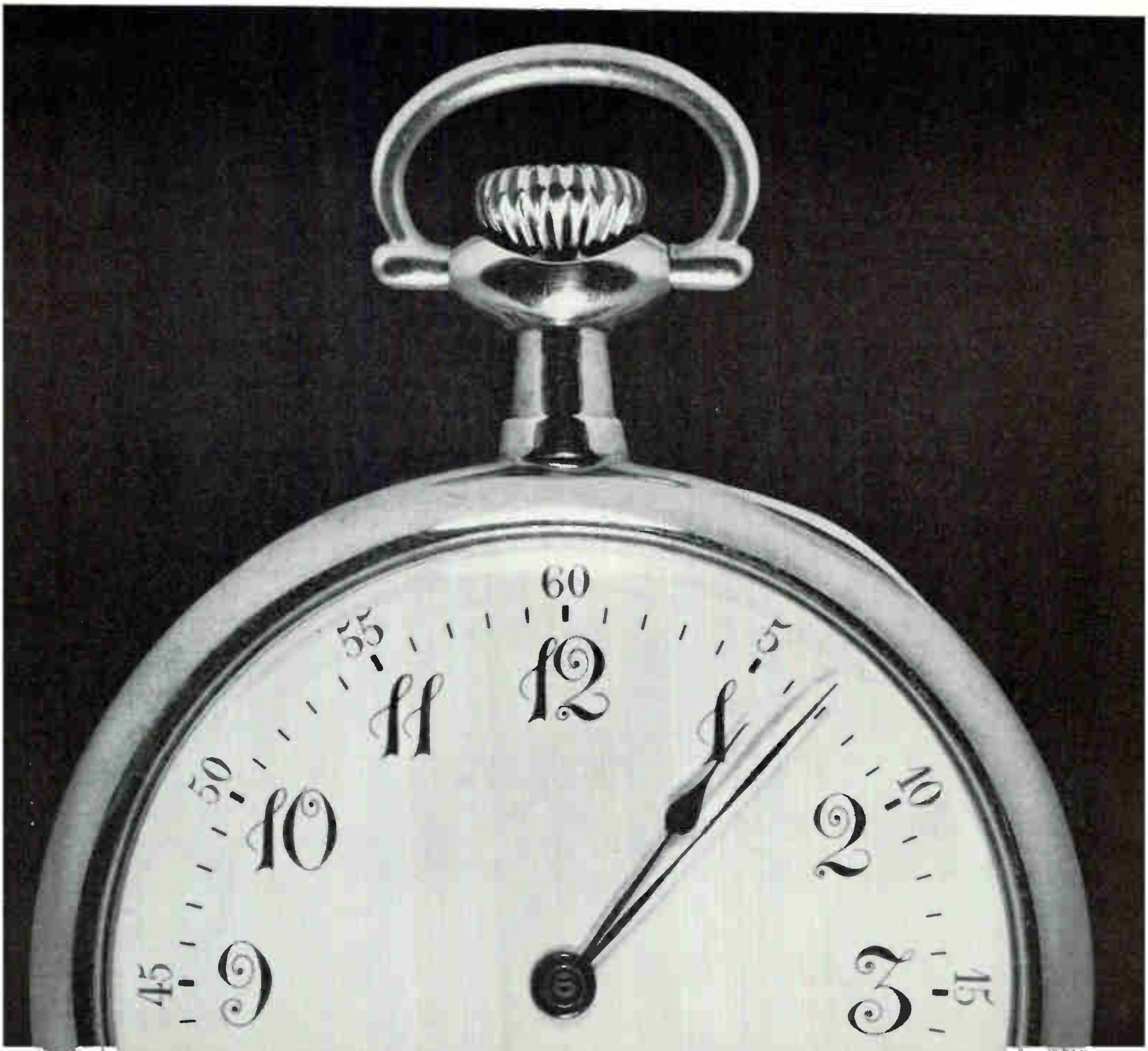
TIME means both money and reputation to system builders. To help customers save both, over 10,200 klystron and traveling wave tubes have been shipped ON TIME from Sperry's Gainesville, Florida plant. If prompt tube delivery is vital to your system, call Gainesville, FRanklin 2-0411 collect, for full information about Sperry capabilities.

SPERRY

ELECTRONIC TUBE DIVISION

Gainesville, Florida • A Division of Sperry Rand Corporation

SPERRY'S FAMILY OF TRAVELING WAVE TUBES covers P through X Bands with unusually high output and light weight. These characteristics, combined with the inherent ruggedness of metal-ceramic construction, conduction cooling and wide-range thermal compensation, make Sperry traveling wave tubes particularly suitable for airborne applications.



New On The Market

Machine Tool Controls

NUMERICAL TAPE AND AUTOMATIC TRACERS

A SERIES of advanced automatic control systems are being introduced by Minneapolis-Honeywell, Machine Controls Division, 2747 Fourth Avenue South, Minneapolis, Minnesota. Included are both numerical tape and automatic tracer control systems that are capable of automating many machining operations.

Three electrohydraulic control systems will be shown at the National Machine Tool Builders Show in Chicago (Sept. 6-16). The systems will be displayed by several manufacturers on a variety of machine tools. The control systems are highly versatile and require a minimum of setup time, thus are economically feasible for a small machine shop operator. Previously, only the large manufacturer with a highly skilled crew of programmers and large-volume production runs could afford sophisticated automatic machine control equipment.

An attractive console is used with each of the control systems. The consoles are completely transistorized and utilize modular construction techniques to simplify maintenance and keep machine down time at a minimum. Each of the systems can produce parts at accuracies of 0.001 inch.

The numerical control system will control any three-axis machine used in turning, milling, punching, drilling, slotting, or routing operations. Known as an absolute point-to-point numerical positioning and speed control system, it feeds taped information into the control system in the form of exact *X* and *Y* axis dimensions. The tool path between any two programmed points is governed by speed control of each axis. A typewriter is used to prepare the tape from blueprint information.

The multimode tracer system is capable of operating in full contouring control through 360 degrees and full die sinking with automatic pick and feed without requiring a change in machine setup, template or tracing head. The electrohydraulic control system makes it possible to automatically machine any contour on a lathe—including turning squares on a lathe—without changing cutting tools. It gives an engine lathe many of the capabilities previously available only with an automatic milling machine.

CIRCLE 301 ON READER SERVICE CARD

Portable Oscilloscopes

LIGHT-WEIGHT, TRANSISTORIZED

A NEW LINE of transistorized, portable oscilloscopes, measuring only $2\frac{3}{4}$ by $3\frac{1}{4}$ by $5\frac{1}{2}$ inches, and weighing as little as two pounds (for the 1-inch model 150), has been announced by the EI Labs Division of Electro Instruments, Inc., 1165 Morena Blvd., San Diego, Calif.

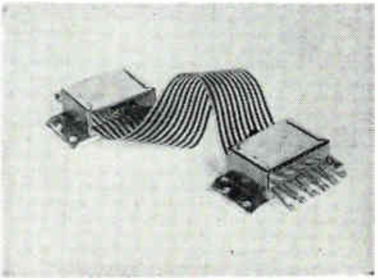
The oscilloscopes will operate on internal rechargeable batteries, a-c power line, or low voltage d-c, providing a precision, 1-, 2- or 3-inch display equivalent to a laboratory instrument. Performance and reliability, combined with portability, make these particularly useful to the service engineer.

Symmetrical vertical deflection amplifiers provide high-voltage and high-frequency deflection potentials. The sweep is generated by a gated, constant-current generator

with a variable charging capacitor. Cost of the model 150 oscilloscope is less than \$500. Delivery can be made within 90 days.

Specifications of the model 150 include sensitivity from d-c to 1.5 Mc, with input impedance of 1 megohm.

CIRCLE 302 ON READER SERVICE CARD



Flex-Tape Connector

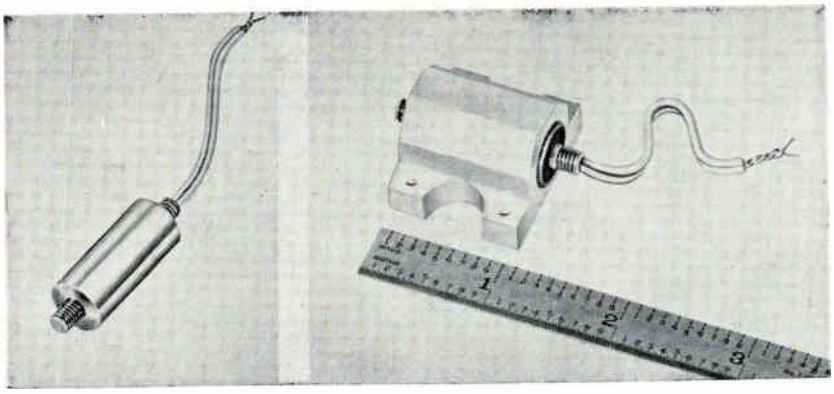
BARBED CONTACTS

NEW FLEX-TAPE CONNECTORS provide a simple means of terminating, splicing or tapping unterminated non-prepared flexible conductive tape. Electrical continuity, positive gripping, and strain relief are all

obtained with a single cam adjustment.

Multiple barbed contacts are forced through the conductive metal, as well as the insulation on both sides of the conductive strips, and firmly implanted into a holding block. The connector may be used repeatedly without damage. The device is being manufactured by Digital Sensors, Inc., 6443 N. Figueroa Street, Los Angeles, California.

CIRCLE 303 ON READER SERVICE CARD



Explosive Switch

NO MOVING PARTS

AN ADAPTABLE miniature explosive switch manufactured by the Mimx Corporation of 1505 Gardena Avenue, Glendale, California, has no moving parts, has a reliability factor of 99.997 percent, will withstand unlimited g-force, shock and vibration, both before and after contact is completed, and is suitable for environmental temperatures ranging from —100 F to 400 F. In operation an explosive charge establishes a large-area permanent contact, providing virtually failure-proof completion of the circuit.

The switch provides a contact capacity of 20 amps, and the firing current may be adjusted to specific needs by modifying the explosive element or bridge wire. Redundant bridge wires are optional.

External contacts also may be modified to use solder pots or any other type of junction. A delay factor, adjustable to ten seconds, is available if the switch is to be used as a timer.

The explosive switch has a fully self-contained reaction and does not contaminate its environment. A spst switch, it may be modified to accommodate multiple circuits. Configuration and size of the switch also may be modified to satisfy particular requirements.

CIRCLE 304 ON READER SERVICE CARD

Brushless D-C Motor

SMALLER SIZE

A SIMPLIFIED d-c motor in which brushes, brush racks, springs, slip-rings, commutators, and other mechanical components have been eliminated, has been developed and is undergoing advanced testing by Yuba-Dalmotor Division, Santa Clara, California. In this motor, d-c current is commuted by transistors, which form the heart of an oscillating system. In earlier transistor-commutated d-c motors the motor has constituted the load on the oscillator. Here the winding in the motor is an integral part of the circuit; there is no separate toroid. Operational life is limited only by the bearings.

This simplified design not only allows a drastic decrease in motor size, but also eliminates radio noise and environmental problems formerly encountered in operating direct-current motors in explosive gases, fuels or in outer space.

Motor speed can be varied through an infinite range, and only mechanical factors due to centrifugal force determine maximum limits. Small units can be operated up to 250,000 rpm, and by voltage change, speed can be varied linearly to provide analog-type stepless control.

Size of the motor is 3 inch outside diameter by 2½ inch long; power is about ¼ hp. The brushless d-c motor, therefore, could be important for the systems engineer who has thus far developed other components to minute fractions of their former size only to be stymied by a relatively large motor. Prototypes are now being tested by the missile and tape recording industries. Production is scheduled for the fourth quarter of 1960.

CIRCLE 305 ON READER SERVICE CARD

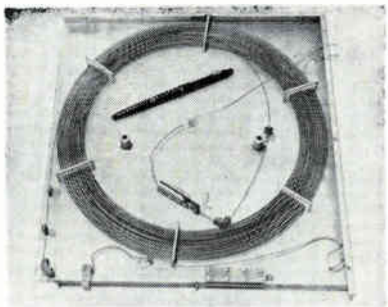
Sonic Delay Lines

GIVE DELAYS TO 20 MS

VERSATILE new wire sonic delay lines, with substantial improvements in insertion loss, bandwidth, temperature stability and package size, now are available to military electronics design engineers through the General Electric Company's Heavy Military Electronics Department, Court Street Plant, Syracuse, New York.

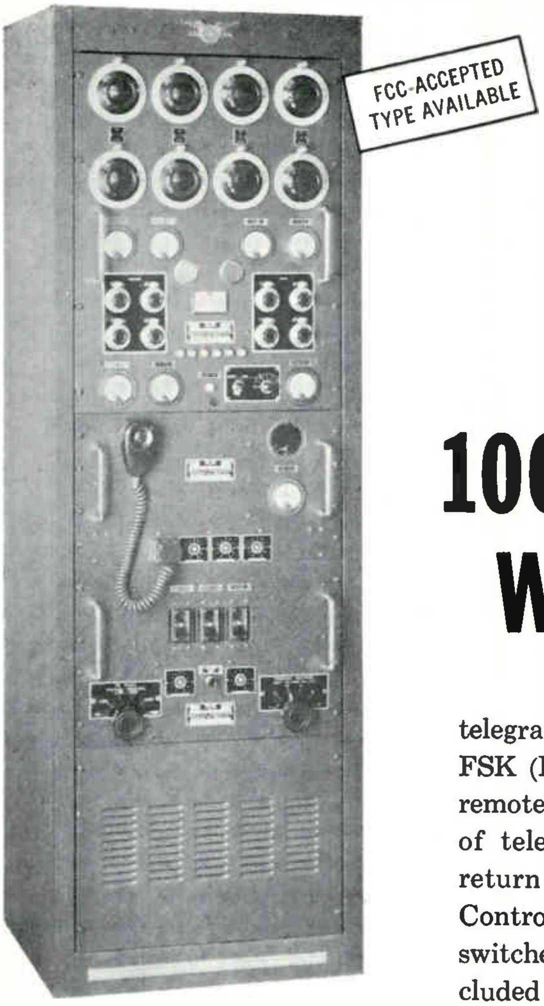
The sonic delay lines operate by the propagation of ultrasonic stress waves through a special alloy wire. They can provide delays from 2 microseconds to 20 milliseconds.

Relatively low insertion loss is made possible by the use of piezoelectric transducers, with typical



loss for a 1 millisecond fixed delay, at 1 megacycle, of 30 to 35 db. Where a relatively narrow bandwidth is specified, a tuned input/-output technique permits insertion losses of less than 15 db.

Maximum bandwidth presently available is 1.25 Mc; temperature coefficients of delay are now about 1 ppm per degree C. Typical military applications include computed data storage, radar target simulator, signal processing, video pulse, car-



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

CIRCLE 89 ON READER SERVICE CARD

rier, or modulated carrier, integrating circuits, correlation circuits, pulse-timing and signal-to-noise improvement.

Designed for stable operation over wide temperature ranges and built to withstand extreme shock and vibration conditions, the wire sonic delay lines, operating at 1 megacycle, have been packaged in units weighing 3 ounces and measuring 4 by 4 by ¼ inch thick for 1,000 microseconds delay. The delay lines are available in both sample and production quantities, at 4 to 6 weeks delivery.

CIRCLE 306 ON READER SERVICE CARD

Two NPN Transistors

HIGH-VOLTAGE TYPE

TWO NEW high-voltage, high-gain transistors have been added to the Raytheon line of *npn* diffused, silicon power transistors. The 2N1661 and 2N1662 supplement the 2N1660 which was introduced in May and form a family of devices especially designed for reliable high-frequency power handling.

Collector-to-emitter voltages have been increased from 60 to 80 and 100 volts, respectively, in the 2N1661 and 2N1662. The new transistors have a maximum collector current of 2 amps, a minimum beta frequency of 25 Mc, and a power output of 85 watts.

The transistors are particularly well suited for regulated power supplies, power switching, power amplifiers, power oscillators, core drivers, and servo amplifiers.

Full specifications are available from Semiconductor Division, Raytheon Company, 215 First Avenue, Needham, Massachusetts.

CIRCLE 307 ON READER SERVICE CARD

Solid State Relay

LAYER-CAKE DESIGN

A modular construction solid state relay, with a life of millions of cycles, has been announced by the Controls Division of Leach Corporation, 5915 Avalon Blvd., Los Angeles, California. The new relay, SR-101-1A, is designed for high reliability in space and air vehicles or for computers, factory automation, materials handling systems, data processing or other analog or proportional control systems.

Layer-cake construction allows quick adjustments for special purpose designs. The relay has fast response, no contact bounce, isolated contacts, snap action and high shock and vibration resistance. Some specifications are: max. operating voltage of 30 v d-c, spst normally open contact, approximately 10 microsecond operate time and 50 microsecond release time. The relay will operate to 1,500 times per second; ambient range is from −55 to 71 C.

CIRCLE 308 ON READER SERVICE CARD

Multiplier Phototubes

TWO MODELS

CBS LABORATORIES, High Ridge Road, Stamford, Conn., announces two new 10-stage multiplier phototubes sensitive to the visible portion of the spectrum and designed to withstand shock and vibration. The CL-1002 and CL-1003, 2 in. and 3 in. diameter respectively, are end-on 10-stage multipliers with special linear dynode structures. The faceplate is plano-concave with S-11 photocathode (visible response) deposited on a curved surface to insure excellent uniformity of response across the face of the tube. Result is an extremely short transit time spread and very high photoelectron collection efficiency. Special Inconel spring support and rugged construction assure increased resistance to shock and vibration. The tubes are designed for use in scintillation counting, spectroscopy, photometry and flying spot scanner applications.

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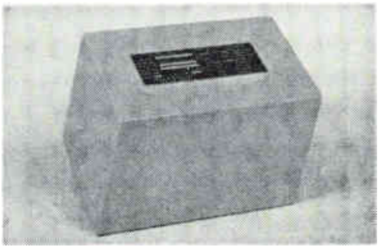

Static Converter

60 CPS TO 28 V D-C

VARO MFG. CO., INC., 2201 Walnut St., Garland, Texas. Model 3078 static d-c power supply is used in applications requiring conversion of 60 cps 115 v a-c power to 28 v d-c power. Unit is designed for continuous maintenance free operation in missile checkout systems, fire control systems, computers, and for general instrumentation. It is ruggedized and conforms to exacting environmental specifications.

CIRCLE 316 ON READER SERVICE CARD

Beam Power Tube

PERFORMS TO 175 MC

WESTINGHOUSE ELECTRIC CORP., P. O. Box 284, Elmira, N. Y. The WL-7371 r-f beam power pentode is designed for communication transmitters and adaptable for ssb linear amplifier service. Input power ratings of 300 w and plate dissipation of 75 w are applicable for continuous commercial service. A maximum signal power dissipation of 125 w applies for ssb service. Per-

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Print clearly, circle numbers carefully.

Employment Section

377	380	383	386	389	392	395	398
378	381	384	387	390	393	396	399
379	382	385	388	391	394	397	400

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461	464	467	470	473	476	479
462	465	468	471	474	477	480

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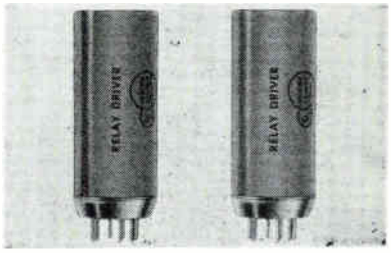
formance of the new tube extends to 175 Mc. Reliable service and high efficiency are obtained by the thoriated tungsten cathode. Also, good isolation between input and output circuit is provided by the tube's construction. A rugged screen grid gives ample dissipation for all types of communication service.

CIRCLE 317 ON READER SERVICE CARD

Preamplifier
TELEMETRY TYPE

LEL, INC., 380 Oak St., Copiague, L. I., N. Y. Using newly developed high gain- bandwidth ceramic triodes, the TP-5 telemetry preamplifier provides a gain of 26 db, a nominal noise figure of 3.5 db over the passband of 215-260 Mc telemetering band. The integral power supply provides regulated heater voltage. The entire assembly, contained in a weather-proof housing for antenna tower mounting, requires a mounting space of 6½ by 6½ by 6 in. and weighs 6 lb. The TP-5 is also available rack mounted.

CIRCLE 318 ON READER SERVICE CARD



Relay Drivers
DUAL UNITS

ENGINEERED ELECTRONICS CO., 1441 E. Chestnut Ave., Santa Ana, Calif., announces two new transistorized relay drivers that provide the power to operate moderately sensitive relays, indicator elements, or resistive loads. The T-134 and T-135 are dual units. Each will switch a resistive load at frequencies up to 50 Kc at currents up to 50 ma, maximum, and voltages up to 28 v maximum. The drivers will also operate with relays when diode clamping is provided to protect against back surges. The units are actually germanium switching transistors that may be operated directly from EECO T-Series germanium digital modules. The turn-on signal for the T-134 is −11 v nominal; turn-off is − 3v nominal. The T-135 operates on the opposite signal polarities—turn-on signal is − 3 v nominal and turn-off signal is − 11 v nominal. Both units have the same power requirements (± 12 v d-c), maximum load (− 35 v at 100 ma, each output), and operating temperature range (− 55 C to + 71 C).

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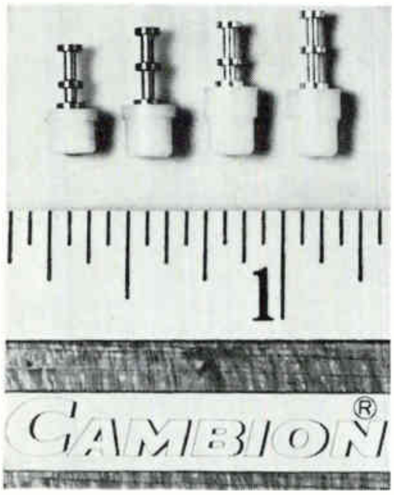

Standoff Terminals
DOUBLE-TURRETED

CAMBRIDGE THERMIONIC CORP., 445 Concord Ave., Cambridge 38, Mass., announces four new double-turreted Teflon insulated standoff terminals. They are available in the following heights when mounted: No. 4025, $\frac{1}{4}$ in.; No. 4026, approximately $\frac{9}{32}$ in.; No. 4027, approximately $\frac{5}{16}$ in.; and No. 4028, $\frac{11}{32}$ in. They are 0.148 in. in diameter and press fit into a 0.136 in. ± 0.002 in. hole, accommodating panel thicknesses from $\frac{1}{16}$

CIRCLE 97 ON READER SERVICE CARD

in. to ¼ in. Terminals are brass and finished in 0.0003 in. silver plate or 0.0003 in. electro-tin lead plate. They are available in natural Teflon or 8 different code colors.

CIRCLE 320 ON READER SERVICE CARD

Hydrogen Thyratron
CERAMIC-METAL

ITT COMPONENTS DIVISION, P. O. Box 412, Clifton, N. J. The Kuthe type Ku-74 ceramic-metal hydrogen thyratron has been specifically designed to meet the requirements of long pulse, high average power radars. Rated at 33 megawatts peak power this tube is capable of operation at an average anode current of 4.0 amperes at an rms value of 90 amperes. Design features include the use of internal heat sinks to maintain proper operating temperatures of the grid and reservoir. A unique anode design prevents local hot spotting of the anode. No artificial cooling of this tube is necessary under ordinary ambient condition during full power operation.

CIRCLE 321 ON READER SERVICE CARD

D-C/D-C Power Supply
FOR TELEMETRY USE

NETWORKS ELECTRONIC CORP., 14806 Oxnard, Van Nuys, Calif. A new d-c/d-c power supply which combines the features of close tolerance regulations, high temperature stability and galvanically isolated input and output terminals has been designed for bridge excitation and other telemetry applications. It has an output of 5 v d-c, adjustable ± 5 percent, and features regulation of $\pm \frac{1}{4}$ percent for combined line, load and temperature variations. Rated output on the unit is 100 ma, but the device will maintain regulation to 200 ma. Maximum ripple under rated load is less than 0.1 percent rms. Input voltage is also filtered to prevent switching-current pulses from feeding back into the line. Temperature ranges are available from -55 to $+100$ C. Overload and short-circuit protection are inherent in the design. Input is 28 v d-c ± 4 v with a maximum current drain, under any conditions, of 220 ma.

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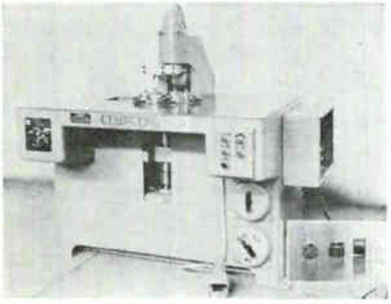


Transistor Welder
AUTOMATIC MACHINE

NATIONAL ELECTRIC WELDING MACHINES CO., 1846 Trumbull St., Bay City, Mich. This console type automatic transistor welder is essentially a basic unit which uses standard key components and which can be tooled for either dial feed or single point operation. A 3 ft by 4 ft table, 32 in. high, forms the top of the unit's base and is designed specifically to accommodate a standard dry box. An operator, seated at the console and hand-loading a six-station dial, can produce 2,000 transistors an hour. A major design feature is the location of the welding transformer in the base of the unit. This not only makes for greater compactness but permits a user who has a single point machine to convert to dial feed later with minimum change-over.

CIRCLE 323 ON READER SERVICE CARD

Literature of

THERMISTOR PROBES Fenwal Electronics, Inc., 51 Mellen St., Framingham, Mass., has released a new 8-page folder on its standard line of thermistor probes. It contains more than 50 outline drawings showing dimensions, and gives a description and primary use for each.
CIRCLE 350 ON READER SERVICE CARD

MODULAR POWER SUPPLIES Dressen-Barnes Corp., 250 North Vinedo Ave., Pasadena, Calif. A data sheet describing a series of 24 new modular power supplies shows photographs of the unique packaging method designed to dissipate transistor and transformer heat without use of auxiliary dissipators.
CIRCLE 351 ON READER SERVICE CARD

MICROWAVE OSCILLATORS Menlo Park Engineering, 711 Hamilton Ave., Menlo Park, Calif. Electronically swept microwave oscillators covering the frequency ranges from 1,000 to 12,400 Mc are described in a recent catalog sheet.
CIRCLE 352 ON READER SERVICE CARD

RECORDERS & REPRODUCERS Westrex Corp., 6601 Romaine St., Hollywood 38, Calif. The RA1500 series of magnetic film recorders and reproducers is described in a four-page illustrated brochure.
CIRCLE 353 ON READER SERVICE CARD

ENVIRONMENTAL TESTING Webber Mfg. Co., Inc., P. O. Box 217, Indianapolis 6, Ind. Latest data on environmental testing and other applications for controlled atmospheric conditions is the subject of new 32-page brochure No. 600.
CIRCLE 354 ON READER SERVICE CARD

IMMERSIBLE TRANSDUCERS National Ultrasonic Corp., 111 Montgomery Ave., Irvington, N. J. A catalog sheet now available describes the bulkhead type and end fitting type immersible transducers offered by the firm.
CIRCLE 355 ON READER SERVICE CARD

INSTRUMENT DRIVE Insco Co. Division of Barry Controls Inc., Hollis St., Groton, Mass. Application data sheet No. 5 describes the Auto-Scan, a drive system for the tuning condensers of a receiver used in a missile detection system. The instrument described is based on the versatility of the step-function speed reductor principle, also using various other linkages and mechanisms.

CIRCLE 356 ON READER SERVICE CARD

BASIC SWITCHES Micro Switch, Freeport, Ill. Data sheet No. 175 is a four-page folder covering three series of basic switches with gold contacts. It includes photographs, mounting dimension drawings, mechanical characteristics, electrical ratings and pricing as well as other helpful information.

CIRCLE 357 ON READER SERVICE CARD

PLANAR DIODES Fairchild Semiconductor Corp., 4300 Redwood Highway, San Rafael, Calif. Catalog No. SL-201/1 is an eight-page, two-color brochure containing essential data on more than 200 planar diodes.

CIRCLE 358 ON READER SERVICE CARD

POTENTIOMETERS Basic Electronic Controls Div., Wells Industries Corp., 6880 Troost Ave., North Hollywood, Calif. Four-page two-color brochure describes three basic lines of potentiometers in production—subminiature trimming, precision rotary and linear motion potentiometers.

CIRCLE 359 ON READER SERVICE CARD

CONSTANT-CURRENT CONVERSION Electronic Measurements Co., Inc., Eatontown, N. J. Technical Note 23 describes the simple external connection required to convert Regatran programmable power supplies from voltage-regulated to current-regulated output, and explains the method employed for control.

CIRCLE 360 ON READER SERVICE CARD

BIDIRECTIONAL TRANSISTORS Radio Corp. of America, Somerville, N. J. Bulletin ICE-213 covers the types 2N1169 and 2N1170 bidirectional germanium alloy-junction transistors for switching applications in military and industrial data-processing systems.

CIRCLE 361 ON READER SERVICE CARD

CIRCLE 101 ON READER SERVICE CARD

MIT to Widen Vistas in Solid State

EXTENSION of solid state research is under way at Massachusetts Institute of Technology as the institute shapes plans for a new Magnet Laboratory to be built on the campus with $9,502,000 provided by the Air Force.

The national research center will provide advanced experimenters with unprecedented facilities for use of one of the most significant modern research tools—very high magnetic fields (ELECTRONICS, p 43, Oct. 2, 1959). Scientific applications of the powerful instrument will range from sub-atomic particle research to cosmological studies.

Expected to be in full operation in 1964, the facility will house the world's most powerful magnet and is expected to become an international center of work on very high magnetic fields. "We view it as an Institute for Advanced Experimental Research, analogous to Brookhaven and the Institute for Advanced Study," says Benjamin Lax (shown at left), who will be director of the lab. Lax is now head of the solid state division at MIT Lincoln Laboratory.

Construction will start in mid-1961, a few months before the first International Conference on High Magnetic Fields is scheduled to convene at MIT in November of next year.

Design and construction of the laboratory will be directed by Prof. Francis Bitter (right), a pioneer in the development and application of high field magnets. Simultaneously, Bitter will begin new studies and research at MIT on the magnetization of the sun and its planets and on the role of magnetic forces in the evolution of the solar system. He will become professor of geophysics at MIT.

Two motor generators at the facility will be capable of producing 8 megawatts of continuous power, 32 megawatts of pulsed power, for creation of continuous magnetic fields up to 250,000 gauss. Twenty years ago, Prof. Bitter developed a 1-inch-caliber, 100,000 gauss magnet, and this has been duplicated in several laboratories.

Some 4,000 gallons of water per minute will be pumped from the Charles River nearby to cool the magnets in the new MIT lab. Eight stations will be built into the center, for simultaneous experiments by staff members and visiting scientists.

In solid state research, plans are being made for detailed experiments with tunnel diodes, including exploration of the basic phenomenon of tunneling. Prof. Bitter's old lab is being used as a testing ground for some of the solid state experiments.

The higher magnetic fields, in combination with microwave, millimeter and infrared radiation, are expected to yield significant data for electronic applications. They will provide a versatile instrument for research in plasmas, solid state and low temperature physics, high resolution spectrometry, cyclotron resonance in semiconductors, studies of the optical properties of solids, nuclear physics and magnetohydrodynamics.

Monitor Products Appoints Engineers

TWO recent appointments have been announced by Monitor Products, South Pasadena, Calif., manufacturers of oscillators, crystals and ovens for more than 25 years.

David Collins has been named chief oscillator engineer. He recently came from JPL, where he was attached to spacecraft control group. He was with Hughes Aircraft, as senior research engineer in the communication division.

A second appointment is Charles Ryan as production coordinator. Ryan, formerly with the New Haven plant of A. C. Gilbert Co., as product development and commercial control engineer, will handle the expediting of Monitor's products.

Shelton Heads Up New Eimac Division

EARL J. SHELTON has been appointed manager of a newly-formed high-power tube division at Eitel-McCullough, Inc., San Carlos, Calif.

His appointment to this position centralizes the management responsibility for Eimac's extensive engineering and production facilities for high-power klystrons, super-power tubes and accessory hardware. These facilities include the high-power microwave tube laboratory and manufacturing plant which were formerly functions of the development division and the manufacturing division.

Shelton, with 14 years of electron-tube development experience, joined Eimac in February of this year as the director of development and held that position until his re-

cent advancement. Before coming to Eimac, he was manager of the high-power tube laboratory of Raytheon's Spencer Laboratory in Waltham, Mass., where he was instrumental in the development of high-power, broad-band microwave amplifiers.

Forms International Consulting Service

TO HELP smaller electronics companies participate in the European markets without making substantial investments or diverting time and personnel from their domestic effort, Stephen V. Hart recently formed a consulting service, Electronic Engineers International, with headquarters in Wilton, Conn. Offices have been established in Germany, France and England.

All the team are scientists and professional electronics engineers with an average of twenty years' technical and managerial experience. The group is dedicated to certain specific aims: (1) Study and investigate the market conditions that affect a client's competitive standing. (2) Find parallel interests, interview foreign companies that complement the client's interests and establish an exchange of know-how and technical liaison that leads to licensing contracts. (3) Seek new products, related to the client's existing line, to be imported and marketed through already-established distribution channels.

The founder of EEI, Stephen V. Hart, was previously associated with the Perkin-Elmer Corp., Norwalk, Conn., as manager of development engineering, Electro-Optical division. Amongst his other duties was the evaluation of new products and inventions submitted by Perkin-Elmer's German subsidiary, Bodenseewark. Before that, as vice president of Electronic Control Corp., Detroit, he set up that company's field staff in Europe and the U. S.

USECO Promotes Richard Douglas

U. S. ENGINEERING CO., Van Nuys, Calif., a division of Litton Industries, recently named Richard Douglas chief engineer.

This is a newly-created post and Douglas will direct research and development programs as well as continuing supervision of engineering support activities.

Douglas joined USECO in 1958 as production manager for printed circuits and terminal boards. From 1950 until 1958, he was with the Bevil Co. of Los Angeles, as production manager and plant manager.

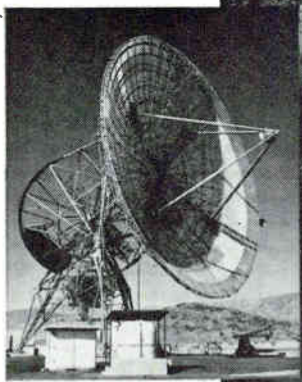
Amperex Completes New Wing

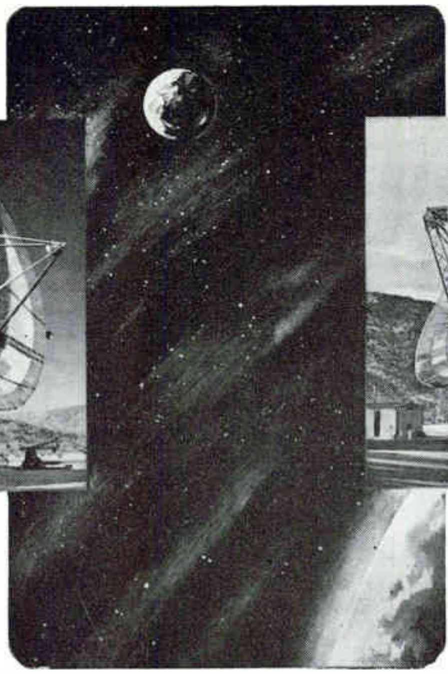
AMPEREX ELECTRONIC CORP., Hicksville, Long Island, N. Y., has announced the completion of a new wing to the present Amperex building.

This new wing adds 13,000 sq ft of production area to the 123,000 sq ft of the present building. Last year a 23,000 sq ft engineering wing was completed.

"The engineering wing completed last year enabled Amperex to enlarge its engineering staff. The added personnel have now made it feasible for us to enlarge our production facilities; therefore, the need for the new wing", according to Frank Randall, president. "We expect now to markedly increase production of our highly successful line of frame grid tubes, both PQ types for military and industrial applications as well as entertainment types," he said.

LUNAR and PLANETARY COMMUNICATION





RECEPTION
The 85 foot parabolic antenna at Goldstone, California built in 1958 and used in tracking and recording telemetry from U.S. spacecraft.

TRANSMISSION
This 85 foot antenna, seven miles from the reception facility, has recently been put in operation to transmit signals to U.S. spacecraft.

SENIOR RESEARCH SPECIALISTS

New opportunities involving advanced research and development projects are now open at JPL in the Laboratory's Telecommunications Division for engineers and scientists capable of assuming a high level of technical responsibility.

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Communication Specialists Execution of RF tracking and communication system projects.	**Radio Research Engineers** Design of advanced RF transmitter/receiver equipment.
Antenna Specialists Analysis, design and evaluation of giant Antenna Structures and Servo Systems.	**Research Scientists** Digital data and control system analysis and synthesis.

Mathematicians or Communication System Analysts
Analog and Digital system analysis. Noise, coding, information theory. Linear and non-linear filter theory.

Several openings also exist for supervisors of Research and Advanced Development Projects performed by industry for JPL.

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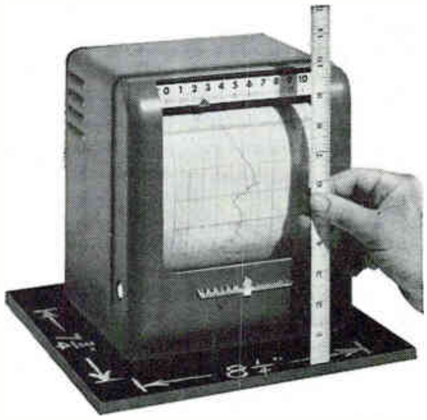

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SATIN (SAGE Air Traffic Control Integration) is the experimental electronic surveillance and control system which MITRE is engaged in designing and evaluating for the Federal Aviation Agency. The design incorporates advanced data processing techniques and equipment for enroute air traffic control.

The major elements of SATIN include a large scale digital computer, its specially prepared program, and associated radar, communications and display equipments. The goal is positive control of high speed jet aircraft at high altitudes under all weather conditions.

Projects such as SATIN are typical of the large scale system engineering tasks in which MITRE is engaged.

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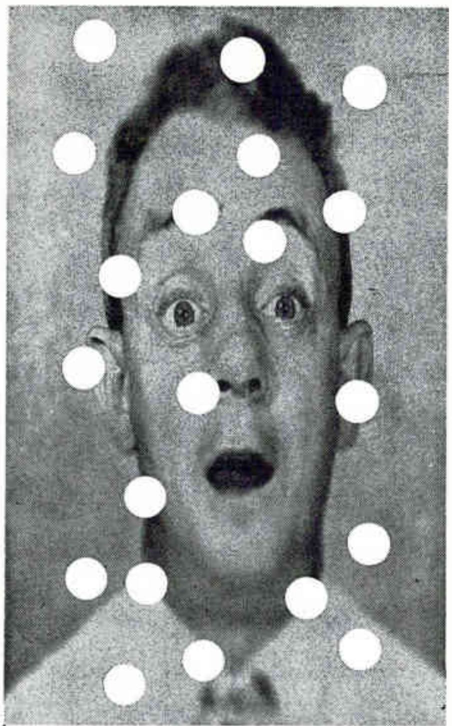

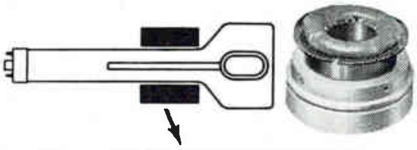

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