A McGRAW-HILL PUBLICATION • PRICE ONE DOLLAR

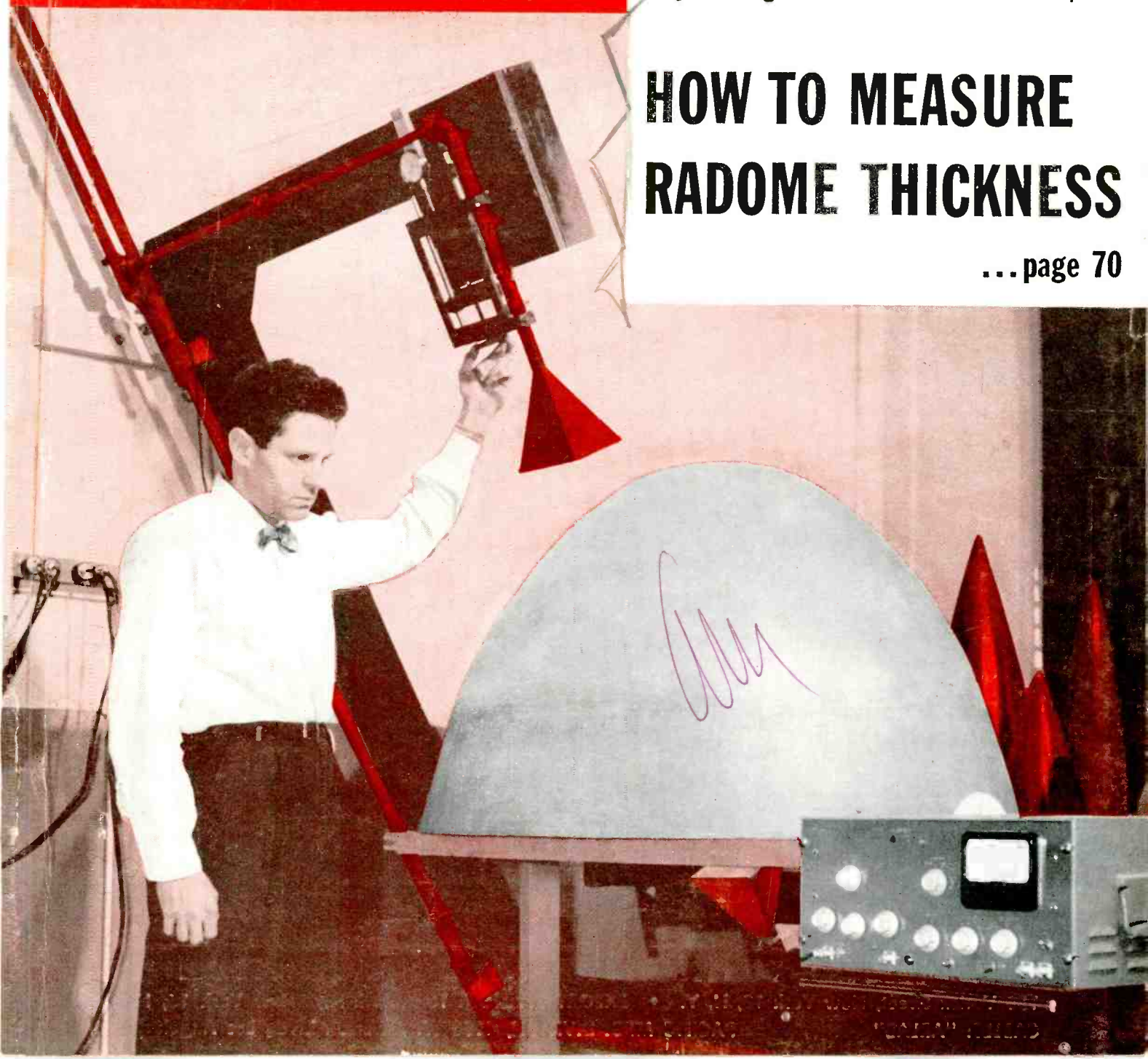
JUNE 20, 1958

electronics

engineering edition

HOW TO MEASURE RADOME THICKNESS

...page 70



For Your Special Applications

The bulk of UTC production is or special units designed to specific customers' needs. Illustrated below are some typical units and some unusual units as manufactured for special applications. We would be p eased to advise and quote to your special requirements.

FILTERS

All types for frequencies from .1 cycle to 400 MC.

400 ⁓ telemetering, 3 db at ± 7.5%, 40 db at 230 and 700 ⁓, ⅝ x 1⅛ x 2".

15 ⁓ BP filter, 20 db at 30 ⁓, 45 db at 100 ⁓, phase angle at CF less than 3° from —40 to + 100° C.

LP filter within 1 db to 49 KC, stable to .1 db from 0 to 85° C., 45 db at 55 KC.

LP filter less than .1 db 0 to 2.5 KC, 50 db beyond 3 KC.

HIGH Q COILS

Toroid, laminated, and cup structures from .1 cycle to 400 MC.

Tuned DO-T servo amplifier transformer, 400 ⁓ .5% distortion.

Toroid for printed circuit, Q of 90 at 15 KC.

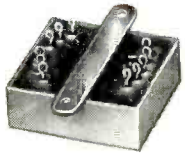
Dual toroid, Q of 75 at 10 KC, and Q of 120 at 5 KC.

HVC tapped variable inductor for 3 KC oscillator.

SPECIALTIES

Saturable reactors, reference transformers, magnetic amplifiers, combined units.

RF saturable inductor for sweep from 17 MC to 21 MC.



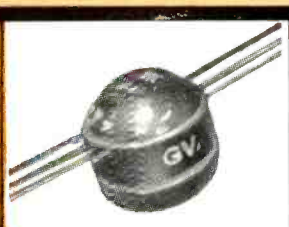
Voltage reference transformer .05% accuracy.

Multi-control magnetic amplifier for airborne servo.

Input, output, two tuned interstages, peaking network, and BP filter, all in one case.

PULSE TRANSFORMERS

From miniature blocking oscillator to 10 megawatt.



Wound core unit .01 microsecond rise time.

Pulse current tansformer 100 Amp.

Pulse output to magnatron, bifilar filament.

Precise wave shape pulse output, 2500 V. 3 Amps.

POWER COMPONENTS

Standard and high temperature . . . hermetic, molded, and encapsulated.

Multi-winding 140 VA, 6 KC power transformer 1¼ x 1¼ x 1"

200° C. power transformer, 400 ⁓, 150 VA.

400 ⁓ scope transformer, 20 KV output.

60 ⁓ current limiting filament transformer, Sec. 25 Mmfd., 30 KV hipot.

UNITED TRANSFORMER CORPORATION

150 Varick Street, New York 13, N. Y. • EXPORT DIVISION: 13 E. 40th St., New York 16, N. Y.,
CABLES: "ARLAB" PACIFIC MFG. DIVISION, 4008 W. Jefferson Blvd., Los Angeles, Cal.

electronics engineering edition

A McGRAW-HILL PUBLICATION • VOL. 31, NO. 25 • JUNE 20, 1958

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By Har…

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By G. Dome and H. d'Hoop

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electronics

June 20, 1958 Vol. 31, No. 25

Published weekly, with alternating engineering and business editions, and with a BUYERS' GUIDE issue in mid-June, by McGraw-Hill Publishing Company, Inc., James H. McGraw (1860-1948) Founder.

Executive, Editorial, Circulation and Advertising Offices: McGraw-Hill Building, 330 W. 42 St., New York 36, N. Y. Longacre 4-3000.

Publication Office 99-129 North Broadway, Albany 1, N. Y. See panel below for directions regarding subscription or change of address. Donald C. McGraw, President; Joseph A. Gerardi, Executive Vice President; L. Keith Goodrich, Vice President and Treasurer; John J. Cooke, Secretary; Nelson Bond, Executive Vice President, Publications Division; Ralph B. Smith, Vice President and Editorial Director; Joseph H. Allen, Vice President and Director of Advertising Sales; A. R. Venezian, Vice President and Circulation Coordinator.

Single copies $1.00 for Engineering Edition and 50¢ for Business Edition in United States and possessions, and Canada; $2.00 and $1.00 for all other foreign countries. Buyers' Guide $3.00. Subscription rates—United States and possessions, $6.00 a year; $9.00 for two years; $12.00 for three years. Canada, $10.00 a year; $16 for two years; $20.00 for three years. All other countries $20.00 a year; $30.00 for two years; $40.00 for three years. Second class mail privileges authorized at Albany, N. Y. Printed in U.S.A.

BRANCH OFFICES: 520 North Michigan Avenue, Chicago 11; 68 Post Street, San Francisco 4; McGraw-Hill House, London E. C. 4; A.M. Leonhards 12, Frankfurt Main; National Press Bldg., Washington 4, D. C.; Six Penn Center Plaza, Philadelphia 3; 1111 Henry W. Oliver Bldg., Pittsburgh 22; 1510 Hanna Bldg., Cleveland 15; 856 Penobscot Bldg., Detroit 26; 3615 Olive St., St. Louis 8; 350 Park Square Bldg., Boston 16; 1321 Rhodes Haverty Bldg., Atlanta 3; 1125 West Sixth St., Los Angeles 17; 1740 Broadway, Denver 2. ELECTRONICS is indexed regularly in The Engineering Index.

Subscriptions: Address correspondence to: Fulfillment Manager, Electronics, 330 W. 42nd St., New York 36, N. Y. Allow one month for changes of address, stating old as well as new address. Subscriptions are solicited only from persons engaged in theory, research, design, production, management, maintenance and use of electronics and industrial control components, parts and products. Position and company connection must be indicated on subscription orders.

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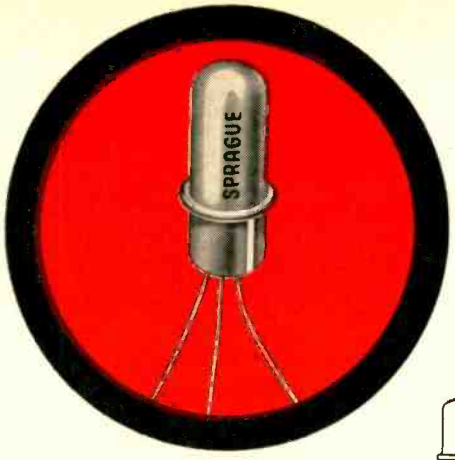
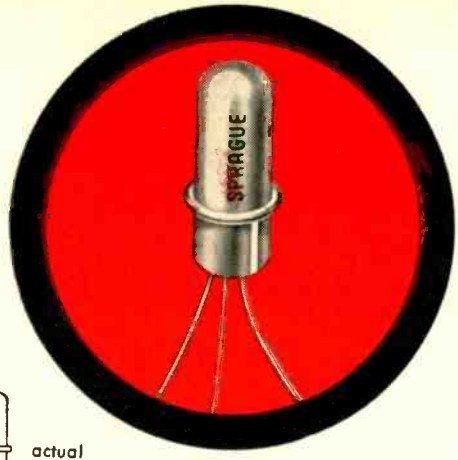
Member ABP and ABC

surface barrier transistors from SPRAGUE

2N344/SB101
for Medium Gain Amplifiers

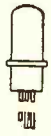
	Min.	Typ.	Max.
h_{fe}	11	23	83
f_{max}	30	45	—





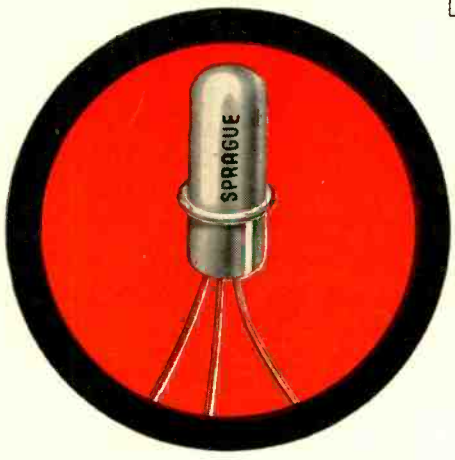
2N345/SB102
for High Gain Amplifiers

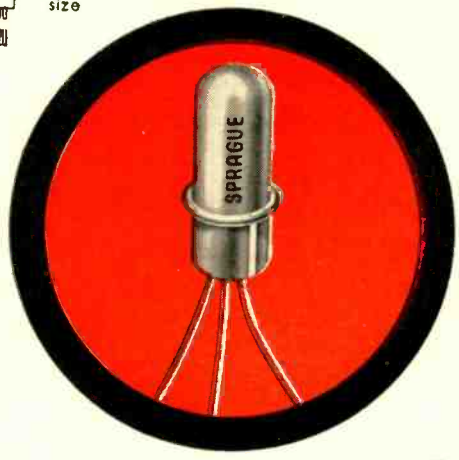
	Min.	Typ.	Max.
h_{fe}	25	40	110
f_{max}	30	45	—


actual size

2N346/SB103
for High Frequency Oscillators

	Min.	Typ.	Max.
h_{fe}	10	—	—
f_{max}	60	90	—





2N240/SB5122
for Computer Switching

	Min.	Max.
h_{fe}	16	—
f_{max}	30	—
T_s	—	80

IN VOLUME PRODUCTION *Now!*

For general high frequency applications, and for high speed computer switching circuits, design around Sprague surface barrier transistors. They are available now in production quantities from a completely new, scrupulously clean plant, built from the ground up especially to make high quality semi-conductor products.

The four transistor types shown are the most popular. Orders for these units are shipped promptly. What's more, surface barrier transistors are reasonably priced. High quality and excellent electrical characteristics make them an economical solution to many difficult circuit requirements.

Sprague surface barrier transistors are fully licensed under Philco patents. All Sprague and Philco transistors having the same type number are manufactured to the same specifications and are fully interchangeable. You have *two* sources of supply when you use surface barrier transistors!

WRITE FOR COMPLETE ENGINEERING DATA SHEETS ON THE TYPES IN WHICH YOU ARE INTERESTED. ADDRESS REQUEST TO THE TECHNICAL LITERATURE SECTION, SPRAGUE ELECTRIC CO., 35 MARSHALL ST., NORTH ADAMS, MASS.

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CAPACITORS • INTERFERENCE FILTERS • PULSE NETWORKS
HIGH TEMPERATURE MAGNET WIRE • PRINTED CIRCUITS

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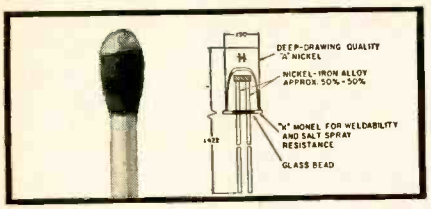
the trademark of reliability

Nickelonic News

VOL. 1 DEVELOPMENTS IN NICKEL AND NICKEL ALLOYS AND THEIR APPLICATIONS NO. 3



Four of six parts in miniature rectifier used in missile circuitry depend on Nickel (Hoffman Electronics Corp., Semiconductor Div.)

Matchhead-sized diode performs reliably at 400°F.

EVANSTON, ILLINOIS: Designers of circuit components for missile guidance find metals containing Nickel stand up under tremendous heat and vibration. Take above diode. Its easily-formed "A" Nickel cap resists oxidation at 400°F temperature. A corrosion-resistant "K" Monel* age-hardenable nickel-copper alloy header provides a high compression seal to glass bead. 50-50 Nickel-iron leads support diode in housing. Alloy works well with the glass, aids hermetic sealing. Tests show reliable operation for thousands of hours. **Pertinent Literature:** "Inco Technical Bulletin 'T-9'".

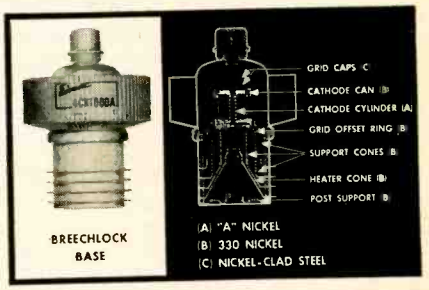
Nickel guards against shock in new high power ceramic tetrode

Assembling parts of Eimac, high-gain, amplifier tube. Nickel provides rugged structural support, helps assure electrical stability.

SAN BRUNO, CALIFORNIA: A high degree of immunity to damage by mechanical or thermal shock is claimed for a new, air-cooled, 1-kw ceramic tetrode produced by Eitel-McCullough, Inc. The tube (4CX1000A) is a low-voltage, high-current, class AB_1, RF, or AF linear amplifier designed for heavy-duty single side band operation with zero grid drive.

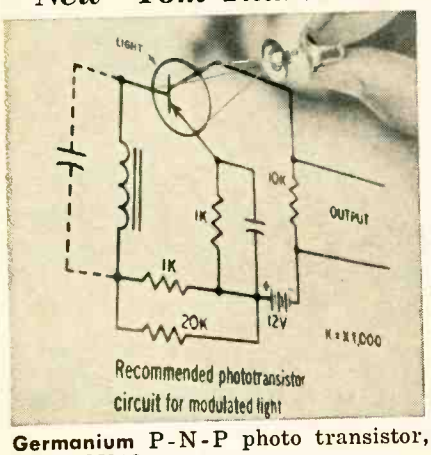
As the illustrations show, the designers have made liberal use of Nickel to give the tube maximum shock resistance. Most current-carrying supports are Inco Nickel "330"*. Non-current-carrying structurals are Nickel-clad steel. The inner cathode cylinder (oxide-coated) is Inco Electronic Nickel.

At the high temperatures met in processing and operating the tube, these Nickel parts retain exceptional strength, dimensional stability and oxidation resistance. Nickel is also easy to form and join and provides the good vacuum properties so essential in producing a clean, high-performance, long-life tube. **Pertinent Literature:** Write for "Inco Nickel Alloys For Electronic Uses".



Where Inco Nickel is used in the Eimac stacked-ceramic tetrode.

New "Tom Thumb" cell miniaturizes photo circuits



Germanium P-N-P photo transistor, Type 2N318.

"A" Nickel makes it rugged and reliable

JAMAICA, NEW YORK: General Transistor Corporation turns out this tiny transistor-type photocell. Its sensitivity (0.16 volts per foot-candle) is ample to assure positive relay operation by miniaturized circuits. It's tough enough, too, for portable instruments, industrial machines, other rugged service. Electronic Grade "A" Nickel base tab and leads provide high strength without contamination. Kovar®, a Nickel-containing alloy in base and header, insures a tight metal-to-glass seal. **Pertinent Literature:** Write for "Inco Technical Bulletin 'T-15'".

®Trademark Westinghouse Electric Corp.

"R" Monel provides advantages of Monel plus extra machinability of its own

"R" Monel* free-machining nickel-copper alloy is essentially Monel* nickel-copper alloy modified slightly to improve its machinability. As such, it provides all the desired properties of Monel alloy—corrosion resistance, strength, ductility, weldability — with a plus. Table shows the machining advantage gained by using "R" Monel alloy. **Pertinent Literature:** Write for "Inco Technical Bulletin 'T-5'".

*Registered trademark

Machining speeds for "R" Monel on automatic screw machines with high speed steel tools[1]

Operation	Surface speed (ft per min)	Feed (in per rev)
Turn	140-160	0.003 -0.005
Form	140-160	0.0004-0.001
Drill	60-80	0.001 -0.005
Ream	30-45	0.003 -0.012
Tap	30-40	
Thread	30-40	
Cutoff	140-160	0.0005-0.001

[1]For cemented-carbide tools, speeds may be increased 25-30%.

INCO TRADE MARK **THE INTERNATIONAL NICKEL COMPANY, INC. • 67 Wall Street • New York 5, N. Y.** INCO TRADE MARK

For HIGH VOLTAGE DC Supplies—
Call *BETA*...*High Voltage* HEADQUARTERS

voltage ratings to 150 KV and continuous currents up to 1000 MA

Whatever your need in High Voltage—whether it's a rugged, portable unit, or an elaborately instrumented supply for wide-range operations . . . Beta is your *best* source.

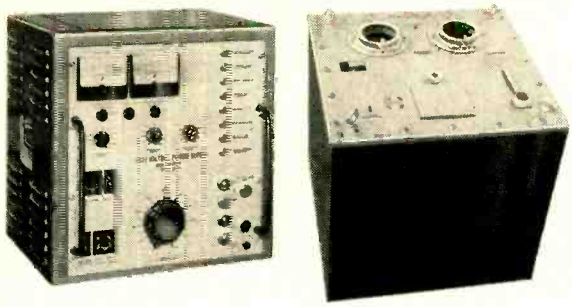
Beta's many years of specialization in the design, production, and application of AC and DC high voltage equipment—in all kinds of applications, ranging from electrostatic smoking of meats to nuclear particle acceleration—assure a level of quality and performance in apparatus and instruments that is exceptional. Equally outstanding is the famed line of Beta overpotential testers capable of testing transcontinental cables to individual AC and DC circuits.

All the advantages of this distinctive leadership in the growing field of electrostatics and other high voltage operations are immediately available to you through your Beta representative.

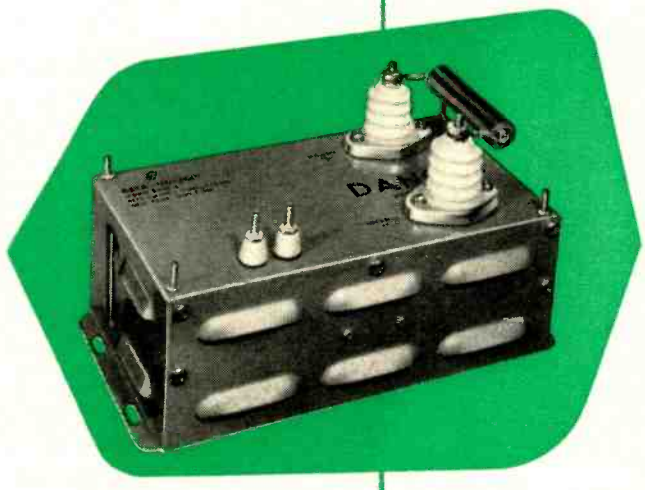
Or you are cordially invited to call or write directly to Beta headquarters for full information—on the MOST COMPLETE LINE of DC high voltage equipment, some of which are illustrated.

200 Series, Portable
Light-weight, easily carried, air-insulated. Output from 0 to 30 KV continuously variable, 2 to 5 ma, with reversible polarity. Ripple, 1% per ma at 30 KV.

1000 Series, Rack-Mounted DC Supplies
0-1 to 0-60 KV, 2-500 ma. Rugged construction, conservative design, with full self-protection. Selenium rectifiers in models below 10 ma rating. Ripple; below 2.5% rms for max. current at max. voltage. Polarity reversible, with center-tap provision if desired.



2000 Series
0-1 and 0-250 KV; 5 to 3000 ma. Two-unit design, for remote operation and maximum safety for personnel and equipment. Conservative rating, simple operation. Polarity reversible.

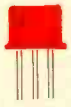


9000 Series, "HI-SEL" DC Power Packs
Five models, from 0-5 KV and 5 ma up to 0-30 KV and 5 ma. Low ripple at all ratings. Selenium rectifiers and air-insulated design. Can be mounted in any position.

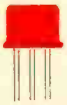
BETA ELECTRIC COMPANY
division of SORENSEN & CO., INC.
Richards Avenue South Norwalk, Conn.
TEmple 8-6571

NPN • PNP • NPN • PNP • NPN • PNP • NPN • PNP

SIX REASONS WHY YOU SHOULD BUY RAYTHEON SILICON TRANSISTORS



1. NPN as well as PNP — *only Raytheon offers both* — with characteristics so similar as to permit use in complementary circuits

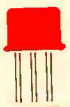


2. Higher, more constant beta

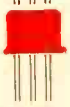
Actual Size

3. Lower saturation voltage

4. Characteristics more constant over the entire −65°C to +160°C range



5. Low noise type available in both PNP and NPN



6. Made by the reliable *fusion-alloy* process

PNP SILICON TRANSISTORS
Temperature Range
−65°C to +160°C

JETEC-30 Type	Reverse Current at −20V		V_{CE} Max. Volts	H_{FE} ave. at $I_B = -0.1$mA $V_{CE} = -0.5$V	Base Resistance ohms	Collector Resistance kilohms	Noise Figure db (max.)	Collector Capacity μμf	Alpha Freq. Cutoff KC
	Collector μA	Emitter μA							
2N327A	0.005	0.005	−40	15	1200	500	30	65	200
2N328A	0.005	0.005	−30	30	1400	500	30	65	300
2N329A	0.005	0.005	−20	60	1500	500	30	65	400
2N330A	0.005	0.005	−20	25	1300	500	15	65	250

NPN SILICON TRANSISTORS
Temperature Range
−65°C to +160°C

JETEC-30 Type	Reverse Current at 20V		V_{CE} Max. Volts	H_{FE} ave. at $I_B = 0.5$mA $V_{CE} = 1.5$V	Base Resistance ohms	Collector Resistance kilohms	Noise Figure db (max.)	Collector Capacity μμf	Alpha Freq. Cutoff KC
	Collector μA	Emitter μA							
2N619	0.005	0.005	40	15	2000	500	30	35	200
2N620	0.005	0.005	35	30	2500	500	30	35	350
2N621	0.005	0.005	30	60	2700	500	30	35	500
2N622	0.005	0.005	30	25	2400	500	15	35	300

All ratings are for 25°C All types measured at $V_C = 6V$ and $I_E = 1$ mA For all types: Dissipation Coefficient in air, 0.35°C/mW; infinite sink, 0.20°C/mW.

RAYTHEON SEMICONDUCTOR DIVISION
Silicon and Germanium Diodes and Transistors • Silicon Rectifiers

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Los Angeles: 5236 Santa Monica Blvd., NOrmandy 5-4221

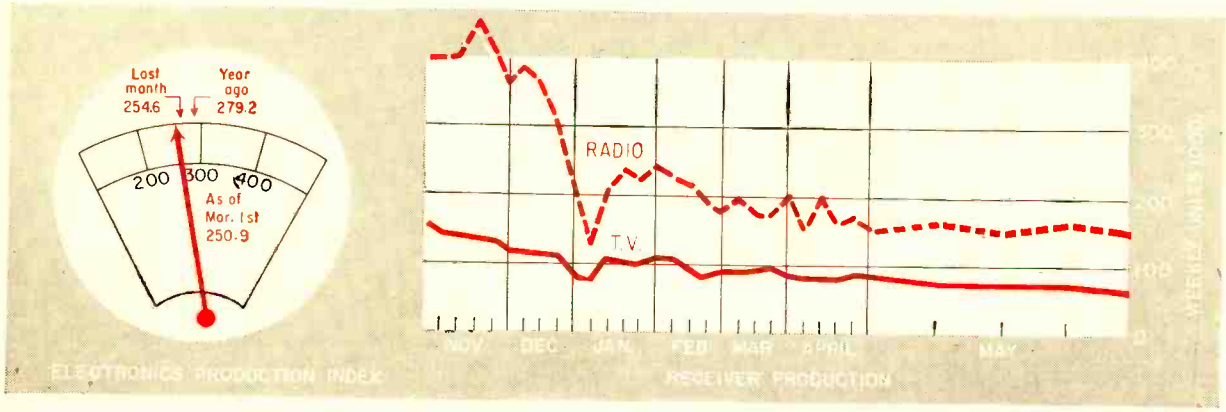
ELECTRONICS NEWSLETTER

NAVY TRANSMITTING STATION'S construction this week is being pushed along near Cutler, Me. An estimated $4-$5 million worth of electronic gear is being designed for the high-power, low-frequency station that will cost more than $40 million. Completion is slated for 1960-61. Station will permit the Navy to transmit orders and messages to anywhere in the world; it's the Atlantic coast counterpart of the Navy's Jim Creek Valley station in Washington State. But the Maine facility will have about double Jim Creek's 1-million watt transmitting power. Design contract for electronic gear has been awarded by BuShips to Continental Electronics Mfg. Co. of Dallas, Tex.

VARIABLE REACTANCE DIODE amplifier just announced may open up a new family of low-noise amplifiers for the uhf and microwave frequency ranges. Preliminary results indicate that the device, under development at Bell Telephone Laboratories, can improve microwave receiver performance in radar, radio astronomy, radio relay and uhf television. Variable reactance is provided by a new diffused silicon diode whose capacitance varies with applied voltage derived from a high-frequency pump signal. At 6,000-mc one experimental device has an 8-mc bandwidth with a noise figure of 5 to 6 db; gain was 18 db and pump signal 12,000-mc. Another device, a traveling-wave amplifier configuration using arrays of several diodes, shows promise of providing bandwidths of 25 percent or more in the uhf region, says firm. Such an arrangement has provided a 100-mc bandwidth at 400-mc signal frequency, with pump frequency of 900-mc and pump power of 10-milliwatts; amplifier has gain of 10 db and a noise figure of 3½ db. Bell says low-noise characteristics are realizable at room temperatures.

LOCAL GOVERNMENT RADIO SERVICE, recently established by FCC, will be open to applications from state and local governments at the end of this month. Initially, 47 split channels in the 152 to 162 mc band are available. Cost of conventional gear: about $1,200 for transmitters, under $600 for mobile receivers. Equipment makers see steady slow growth in business. One suggests that much of the gear may be leased, with part of the payment coming from the Federal Government if there's civil defense tie-in.

ASTROELECTRONICS this week is part of USAF's terminology and electronics R&D following reorganization of the Electronics Research Directorate at Cambridge Research Center, Bedford, Mass. ERD has in mind new applications of electron physics, including energy conversion and propulsion, space-environment adaptation of communications, navigation, surveillance, reconnaissance, guidance, control, countermeasures and counter-countermeasures. Projects will also include radio and radar astronomy, and techniques for orbit determination.



FIGURES OF THE WEEK

RECEIVER PRODUCTION

(Source: EIA)	May 30, '58	May 23, '58	May 31, '57
Television sets, total	64,957	73,468	72,770
Radio sets, total	147,506	161,882	167,781
Auto sets	43,099	52,119	59,041

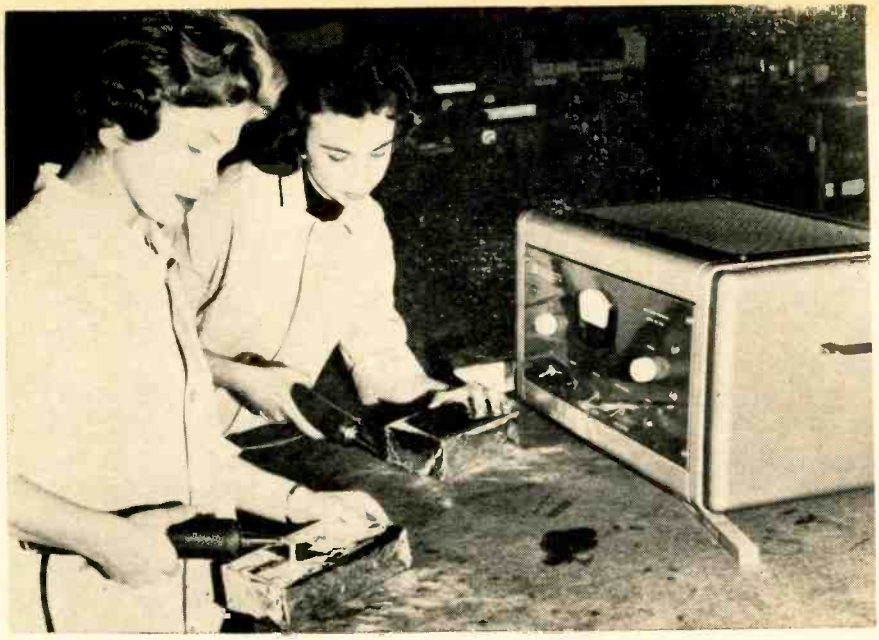
STOCK PRICE AVERAGES

(Source: Standard & Poor's)	June 4, '58	May 28, '58	June 5, '57
Radio-tv & electronics	47.79	47.79	51.06
Radio broadcasters	63.52	62.43	67.94

FIGURES OF THE YEAR

Totals for first three months

	1958	1957	Percent Change
Receiving tube sales	84,990,000	125,041,000	—32.0
Transistor production	9,038,798	5,125,000	+76.4
Cathode-ray tube sales	1,812,825	2,322,480	—21.9
Television set production	1,221,299	1,474,729	—17.2
Radio set production	2,834,759	3,959,367	—28.4
TV set sales	1,446,969	1,682,911	—14.0
Radio set sales (excl. auto)	1,493,668	1,818,976	—17.9



Ultrasonic hand welder seals aluminum foil without stickum or heat as . . .

Packing Goes Electronic

Devices get new assignments as firms seek more speed and efficiency in production

SCALED DOWN version of a heavy production-line ultrasonic aluminum foil welder (ELECTRONICS, p 14, Feb. 14) was shown by Gulton Industries at the AMA's recent National Packaging Exposition in New York. This was only one of many ways the packaging industry is making increasing use of electronic controls to do a faster and more efficient packaging job.

Packagers are a prime target of the new welder. They have been using thermoplastics, crimping or waxing to get continuous seam closures in aluminum foil. Ultrasonics fuses the seam by molecular transference, caused by sound waves at 20,000 cycles.

Seen as potential applications: aluminum beer cans, food packages, elimination of cellophane over cigarette packs by making foil wrappings airtight.

The earlier model uses two 2 kw ultrasonic generators. The new model uses a 100 watt generator. Several welding heads can be operated from one generator, either for hand sealing or on automatic production lines.

Visitors who peered underneath other machines at the packaging exposition quickly discovered additional electron devices are now on the job.

For example, a blister or bubble packing machine with a dielectric heat sealing unit; foil crimper with electronic registration control of slitting; a blister forming machine with registration controls; batch counting units and a plastic bag machine with thermistor control of heat sealing equipment.

Also shown were an indicator controller for high speed cutoff of flowing materials, which has been used for loading missile fuel, and an antistatic cleaning gun.

Other electronic equipment seen around the show included registration controls; web tension controls; oxygen analyzer for testing air removal equipment; temperature recorders and controllers; counting and time recording units and weight controls.

Packaging machine exhibitors see an increasing trend toward use of electronic equipment, credit manufacturers with striving to give their customers something extra in speed or efficiency. The trend is being accelerated by receptive attitude of packaging machinery builders and users towards new quipment development, said exhibitors of electronic gear.

Armed Forces Disclose Needs

WASHINGTON—Needs of the armed services—and what manufacturers have up their sleeves—are more evident this week as government buying increases in the electronics industry.

The recent Armed Forces Communications and Electronics Association's 12th annual convention here provided both sides with a sounding board.

Requirements of a future global communications system were outlined by Col. George P. Sampson, chief of Army Communication.

The heart of such a system must be an automatic circuit exchange to handle high priority traffic. It will have also an automatic message exchange for deferred traffic and an automatic data service center for storing information. An essential part of this system will be a common language for the various communication modes.

Weather radar as a tool for combat was discussed by D. Swingle, U. S. Signal Research and Development labs. He believes weather radars can be used to detect the cloud from atomic warfare.

A panel discussed the future of ground-based and self-contained air navigation aids. The speakers said there is a future for both air and ground types of aids. Elements that could be combined for a highly reliable air navigation system were listed by James L. Anas, technical director, Airways Modernization Board.

Radio navigation; dead reckoning; inertial navigation; radar, on the airborne side, and on the ground; passive radar; and position finding devices such as d-f equipment.

The primary method of navigation for the Air Force for the next decade or more will be Tacan, said Lt. Col. Darral J. Freund, deputy chief, Navaids Branch, AF Directorate of Communications-Electronics.

(Continued on p 12)

1948—*Early "point contact" transistor.*

The remarkable transistor observes its 10th birthday

In 1948, Bell Telephone Laboratories announced the invention of the transistor. In 1958, the transistor provided the radio voice for the first United States satellite.

To advance the transistor to its high level of usefulness, Bell Labs had solved problems which, in themselves, approached the invention of the transistor itself in scientific achievement.

First, there had to be germanium of flawless structure and unprecedented purity. This was obtained by growing large single crystals—and creating the "zone refining" technique to purify them to one harmful part in *ten billion.*

The "junction" transistor, another radical advance, spurred transistor use. Easier to design, lower in noise, higher in gain and efficiency, it became the heart of the new electronics.

An ingenious technique for diffusing a microscopically thin layer on semiconductors was created. The resulting "diffused base" transistor, a versatile broadband amplifier, made possible the wide use of transistorized circuits in telephony, FM, TV, computers and missiles.

In telephony the transistor began its career in the Direct Distance Dialing system which sends called telephone numbers from one exchange to another.

For Bell System communications, the transistor has made possible advances which would have been impossible or impractical a brief decade ago.

1958—*Satellite transistor, incorporating 10 years of Bell Labs research and development.*

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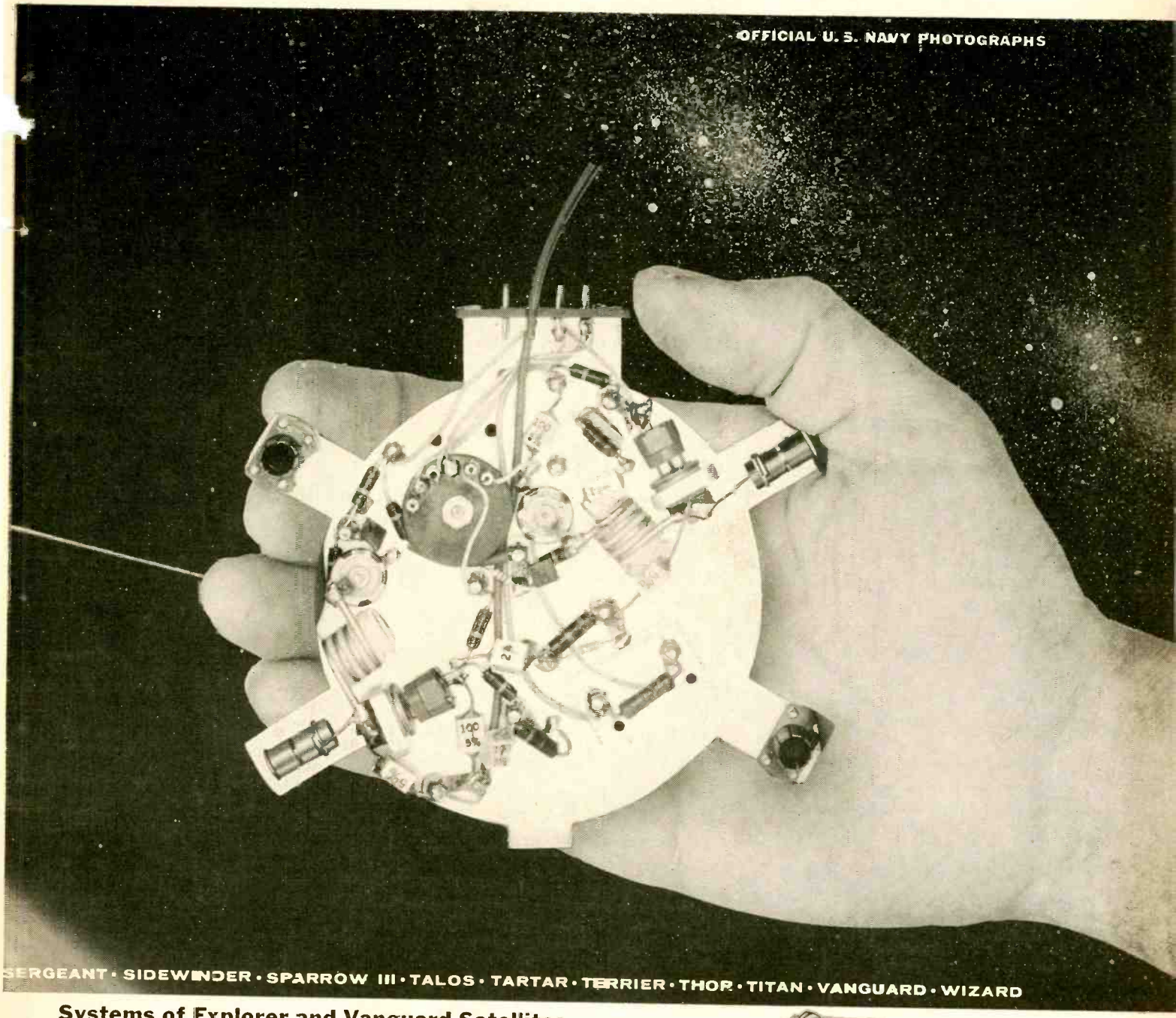
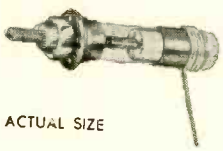


Systems of Explorer and Vanguard Satellites

Whether you are designing electronic equipment for a giant step into space or equally demanding applications, JFD Piston Capacitors belong. Their unique combination of physical and electrical characteristics speed circuit or system development—meet and beat exacting performance demands. Send for the new JFD 1958 Engineering File Folder covering 71 JFD Trimmer models. Or send us your special application requirements for recommendations by our engineering staff.

ACTUAL SIZE

model VC9G 0.8 to 8.5 mmf



ACTUAL SIZE

model VC5 0.6 to 6 mmf

model VC11 0.8 to 10 mmf

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He said someday USAF may be able to rely solely on self-contained aids. He said USAF has discontinued work in long-distance navigation research, which is being done by AMB. Doppler radar, he added, will be used for combat flying.

B. F. McLeod, systems communications engineer, Pan American Airways, reported his firm is testing new navigation systems.

Lt. Comdr. Robert T. Norris, chief, Electronics Section, U. S. Coast Guard, said that branch favors "Loran C" for its navigation work.

There were more than 100 exhibits showing communications gear with both military and commercial applications.

Visitors saw a facsimile transmitter into which copy can be flat-fed rather than wrapped around a cylinder. Copy size can vary in width from three in. to 10 in. and in length from five in. up. A total of 20 messages can be loaded and automatically transmitted.

There was a carrier system—four-channel, miniaturized, transistorized—for spiral four-cable or radio transmission. It is stackable to a 24-channel radio or cable system, making use of modular construction.

New antennas up to 120 ft in diameter were shown. They can establish a communications system far beyond the horizon, providing quality telephone circuits.

Workings of a variable increment computer were explained. Unit, representing a new concept in airborne digital computers, is designed for fire control and guidance applications.

Tv for Nurses

Monitor system in New Jersey hospital shows student nurses bedside patient care. Two-way audio circuit allows them to question instructor

WASHINGTON OUTLOOK

THE ARMY of the future is going to require electronic devices of radically new capabilities. Officials aren't sure yet what these will be, but the new Combat Development Experimental Center (CDEC), at Ft. Ord, Calif., is well into a long-term program to find out.

Picked Army officers staffing the Combat Development Experimental Center say, for example, that in the limited wars of the future they'll require portable radio transceivers with range and other characteristics that can't be met by equipment now available. Radar and infrared equipment will have to be specially designed. Equipment for coping with tactical atomic bombs—offensively and defensively—is badly needed.

Brig. Gen. Frederick W. Gibb, CDEC commander, is working on plans and projects for Army adoption so that the Army will get, with weapons and communications, equipment that will make use of the huge technological advances that have taken place since World War II. In fact, the Center has a contract with a team of outside scientists who sit in on all phases of CDEC paper work and experimentation with war games to get as much objectivity as possible into the research.

Electronics manufacturers and other companies are already sending representatives to Ft. Ord to find out what this new Army operation is up to. They aren't coming away with contracts (CDEC only makes recommendations to higher echelons) but they are learning that at CDEC the Army is trying to be scientific about discovering what its needs for new equipment will be in the decade ahead.

Basically, the Army has recognized that in the past it has prepared itself to fight better the last war in which it fought—not the war next coming up. Now, it is trying to figure out its needs for new equipment—and then let industry take on the job of devising the gear that will do the job. The emphasis is away from setting up detailed specs.

- Congress is putting top priority on fighting Russian submarines as it votes money for the military this session. The House of Representatives—and the Senate is expected to follow suit—voted every request made for antisubmarine warfare. And, in some cases increased funds over the Administration's requests. The House added $638 million to provide for six more of the Polaris-carrying nuclear-powered subs, for example. This brings the total to nine that Congress has approved so far.

  Although it is difficult to put an exact dollar figure on just what the Navy will spend on fighting hostile submarines, the bulk of its $10-billion-plus budget will be pointed in this direction. Of the $2 billion slated for ship construction, the Navy says virtually every ship in this program will have some antisubmarine warfare capability. It includes work on 13 submarines, and 14 guided missile surface ships. The legislators added $11 million to the budget to speed up work on three nuclear powered subs that will fire the 1,000-mile Regulus missile.

  Any day now, the Navy will let a $60-million contract spread over a three-year period to develop a submarine-fired rocket—Subroc. The weapon will be fired against enemy subs from underwater. It will first surface and travel through the air to the vicinity of the sub, then reenter the water for the kill.

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Here at last is a portable all-electronic digital voltmeter that measures DC voltages from .001 to 1000 volts with 0.1% accuracy. In less than 1/10 of a second the measured voltage is presented in clear numerical form on a digital in-line readout that even unskilled personnel can read quickly and accurately, with little possibility of error. *Direct* voltage measurement by successive approximation provides accuracy and sensitivity previously obtainable only in the delicate, complex and expensive instruments. Extremely stable operation – continuous calibration against an internal reference.

The low price of the Model 801 allows you to put one on every bench. Its accuracy and reliability are assured by KIN TEL's years of design and manufacturing experience . . . experience gained in the manufacture of more than 10,000 precision electronic instruments.

BRIEF SPECIFICATIONS (model 801)

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Accuracy . . . . . 0.1% of full scale
Readout . . . . . 4 digits plus decimal point
Input Impedance . . . . . 20,000 ohms per volt*
Conversion Rate . . . . . 10 per second
Conversion Time . . . . . approximately 70 milliseconds
Display Time . . . . . Adjustable from approximately .1 second to infinity (plus push-button *read once* control)
Dimensions . . . . . 11" high x 7½" wide x 20" deep
Power Requirements . . . 105 to 125 volts, 60 cycle AC, 180 watts

*The Model 802 provides 10 megohms input impedance. Price $1190. In other special models the binary coded decimal and decimal outputs are externally available to permit use as an analog to digital converter.

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KIN TEL
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Signalman operates new teleprinter which produces taped messages at rate of seven in. per sec

Army Teleprinter Hits 2,000 WPM

OPERATING SPEED of a transistorized teleprinter introduced last week is 750 words per minute. This speed can be increased to as high as 2,000 wpm. The development was announced jointly by Kleinschmidt Laboratories and the Army Signal Corps.

The printer, which also simultaneously perforates $\frac{7}{8}$-in. paper tape, receives either sequential or simultaneous signals in Baudot code.

Internal signal distribution is through transistorized circuits which also control the mechanical printing and punching operation.

Use of transistors has allowed reduction in size. The new unit is 13 in. high, 13 in. wide, 18 in. deep.

Character printing is done from a wheel continuously revolving at 3,750 rpm. Printing is accomplished by an impact hammer striking the type wheel in a time somewhat less than 20 microseconds with a force of 1/280 oz. The wheel is shifted axially to provide figure and letter alterations.

In addition to military uses, the new printer/perforator is considered of possible future value for telegraph, stock-market quotation and weather data transmission. It may also prove useful in integrated data processing.

MILITARY ELECTRONICS

• Eighty percent of USAF's Bomarc surface-to-air guided missile system is subcontracted by prime contractor Boeing.

• A 300-mi electronic "scoreboard" for testing antiaircraft missiles will be built on the gulf coast of Florida under a $5.6 million USAF contract awarded to International Telephone and Telegraph Corp.

Known as Eglin Gulf Test Range, the three stations will stretch southward into the Gulf of Mexico, parallel to major tracking sites, to provide missile control and safety.

The installation will include radar, telemetry, optical, drone tracking and control, data transmission, countdown and associated suport systems.

Three IT&T divisions will have key roles in the range:

Federal Telecommunication Labs is responsible for overall system management and design; Federal Electric is subcontractor in charge of installation, maintenance and operation of equipment; and Kellogg Switchboard and Supply will be responsible for specialized engineering for switching and communications systems.

• All SAC planes are being converted to single sideband high frequency communications system, according to a Defense Dept. announcement. Modifications will include B-52 and B-47 bombers and KC-135 and KC-97 tankers. Air Materiel Command has assigned its Dayton AF Depot responsibility for modifying the radio sets and its Rome (N. Y.) Depot responsibility for altering ground support facilities. About $3.5 million has been allocated for first 900 conversions.

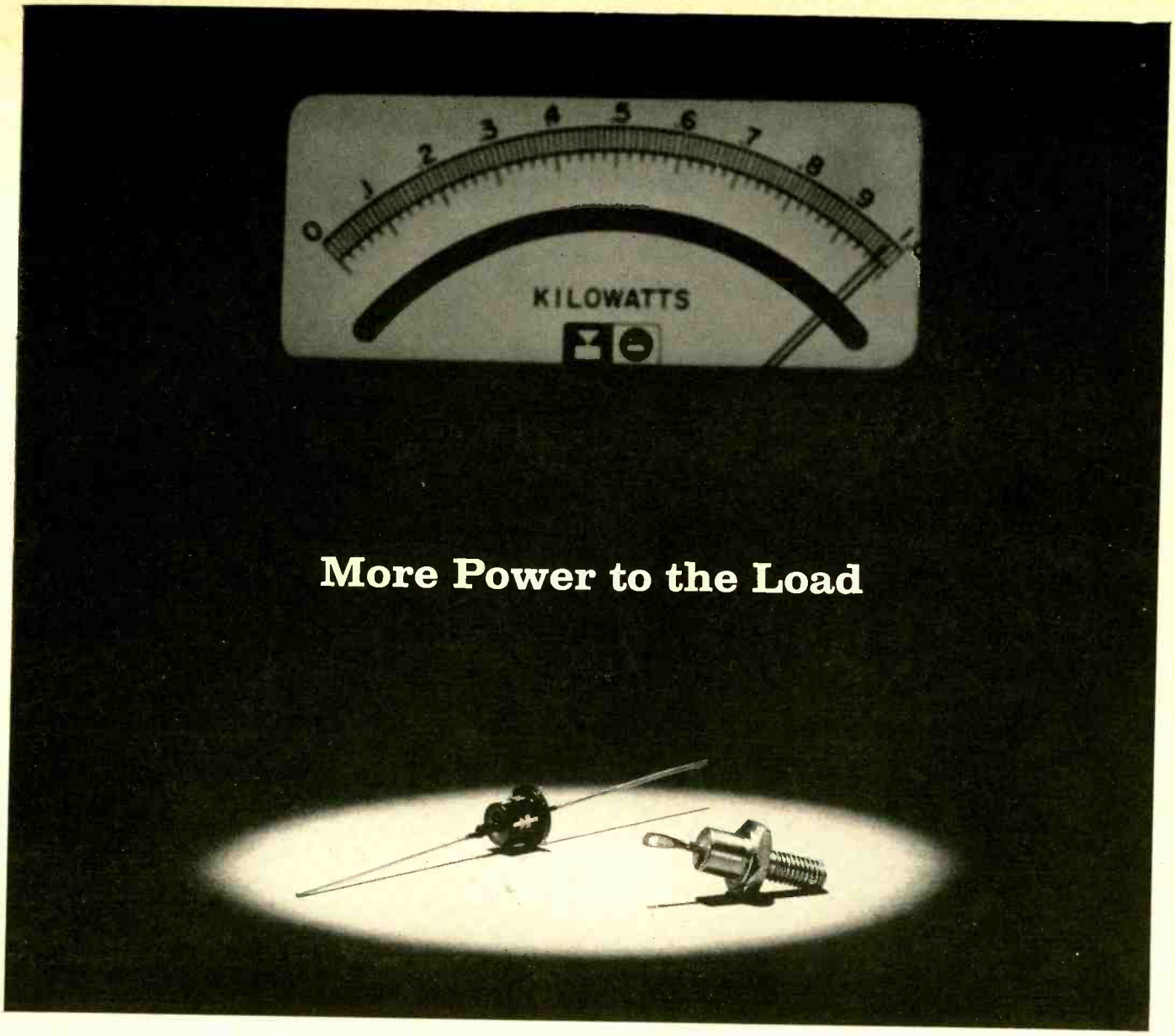
Engineer adds error-correction system to data-processing machine as . . .

Computer Corrects Itself

Adding columns and rows helps data-processing machine pinpoint errors and fix them

SELF-CORRECTING system for electronic data processors, introduced last week by Minneapolis-Honeywell's Datamatic Division, can fix 99 percent of tape errors caused by noise, dust and the like. It will not fix arithmetic errors introduced at the source, however.

Designed to work with the firm's model 1000 data processor, the self-correcting system costs $100,000 to install, will hike the $1.8-



Hughes medium power, silicon rectifiers

The exceptionally high efficiency of these rectifiers, obtained by advanced development and construction techniques, makes possible power supply design which was previously impossible. Efficiency like this means less power loss in the rectifier and, for a given size of rectifier, more power to the load. Cooler operation also results, thereby contributing increased life since there is less heat to dissipate.

In most instances, the voltage drop across the rectifier is so small—and it is constant throughout the life of the rectifier—that it may be neglected in power supply design. The low drop improves regulation of the power supply too.

So specify the types listed at right and capitalize fully upon the advantage of high rectifier efficiency. In addition to the types shown, Hughes has two groups of 1N-numbered units, one with a lead-mount configuration and the other in the standard JETEC 7/16″ hex package.

For literature or a visit from one of our sales engineers, please write: HUGHES PRODUCTS, Semiconductor Division, International Airport Station, Los Angeles 45, California

STUD-MOUNT TYPES

	Peak Inverse Voltage (Volts)	Average Rectified Current @ Specified Case Temperature (Amps max.)	(Degrees C)	Average Inverse Current (mA, max.)*
HR10671	100	3.0	150	0.5
HR10673	200	3.0	150	0.5
HR10675	300	3.0	150	0.5
HR10677	400	3.0	150	0.5
HR10679	500	2.0	135	0.5
HR10681	600	2.0	135	0.5

LEAD-MOUNT TYPES

	Peak Inverse Voltage (Volts)	Average Rectified Current @ Specified Ambient Temperature (mA max.)	(Degrees C)	Average Inverse Current (mA, max.)*
HR10422	100	350	100	0.1
HR10423	200	350	100	0.1
HR10424	300	350	100	0.1
HR10425	400	350	100	0.1

* Averaged over one cycle at full rated conditions of current, voltage, and temperature with a resistive load.

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HUGHES PRODUCTS

million price of a new machine eight to 10 percent.

Two model 1000 edp's with the self-correcting feature are now at work for Michigan Blue Cross-Blue Shield in Detroit and First National Bank in Boston. Production is underway at the firm's Boston plant but deliveries of new machines with error correction and of modification kits will not start until mid-1959.

Data-processor machine operators report they now spend 12 to 16 percent of operating time fixing tape errors. The new error-correcting system can correct a whole block of information in only 0.05 sec.

The error-correction system compares correction information recorded on the data tape with fresh correction information figured as the data tape is in the process of being run.

The system stops the tape when an error is discovered, then backs it up until the error is pinpointed and fixed.

FINANCIAL ROUNDUP

• **Paramount Pictures'** president, Barney Balaban, told stockholders at their recent annual meeting that subsidiary **International Telemeter** is completing arrangements to launch closed circuit pay tv in several U. S. communities and one in Canada. It is presently negotiating contracts with suppliers to manufacture hardware needed for the system. Firm expects to have pay tv systems in operation in test communities by end of the year.

Balaban also said that color tv sets, using the Lawrence color tube, rights for which are owned by **Paramount's Chromatic Division,** will be in production by **DuMont Labs** by end of the year. DuMont is a domestic licensee for the Lawrence tube. The DuMont color set is expected to be list priced at ¼ to ⅓ less than present sets. It will have only one more control knob than current black and white sets.

• **International Telephone & Telegraph** reports the best first quarter earnings record in its history. Consolidated earnings for the March 1958 quarter are estimated at a little over $6 million, approximately 84¢ per share. This compares with $5.9 million or 82¢ a share in the corresponding quarter of 1957.

• **Martin Co.** plans to offer $25 million of nonconvertible debentures early next month, paying about 5 percent interest. The new cash will be used to provide extra working capital required by changed Defense Dept. regulations calling for lower percentage of contract progress payments. Martin's net working capital declined to $15 million by Dec. 31, 1957 from $37.2 million the year previous. Smith, Barney & Co. of New York City is slated to head underwriters.

• **Jetronic Industries,** Philadelphia, Pa., plans to issue 130,000 shares of common stock at $3.75 a share. Some $165,000 of the proceeds will be spent on research and development for new commercial products and applications in sonar, underwater communications and automatic controls.

Inertial System To Guide X-15

GUIDANCE and control for North American's soon-to-be-tested X-15 manned rocket will be provided by Sperry Gyroscope. The inertial system is composed of a three-gyro stable platform which provides critical attitude, velocity, distance and altitude sensing, and a lightweight computer which digests and interprets the data.

Altitude data is provided inertially. Accelerometers record changes in velocity in any direction, including components of altitude.

Miniaturized to meet space and weight requirements of the X-15, firm's system may be adaptable to many forms of missile guidance and other space-age navigation or stabilization needs.

Proposed flexibility of the system allows for Doppler or pure inertial modes, or optical coupling with a startracker for celestial-inertial functions as well.

Ruggedness of the system permits accelerations in excess of 10g's, extremes of temperature, velocity and weightlessness.

Principal function of the system is to assist the pilot in controlling the X-15 to prevent it from burning up by reentering denser atmosphere too steeply, or bouncing back too high from too shallow a trajectory. The system also feeds electronic information into airborne recorders which permanently chart each flight.

First tests of the inertial system will be conducted in a McDonnell F-101 Voodoo, according to latest plans.

Army Sets Module Specs

NEW DIMENSIONAL specifications for electronic components will shortly be issued by the U. S. Army Signal Engineering Labs., Fort Monmouth, N. J.

Component dimensions are being arranged in a modular plan so components will fit together like building blocks. The objects are to boost automatic assembly through uniform components and to cut down wherever possible on the waste space in electronic equipment.

Tables of preferred dimensions for printed wiring board conductors, holes, leads, terminals and components will be sent out soon, according to W. Lane and G. W. Gerhold, of USASEL. They outlined requirements at the IRE-PGPT National Conference on

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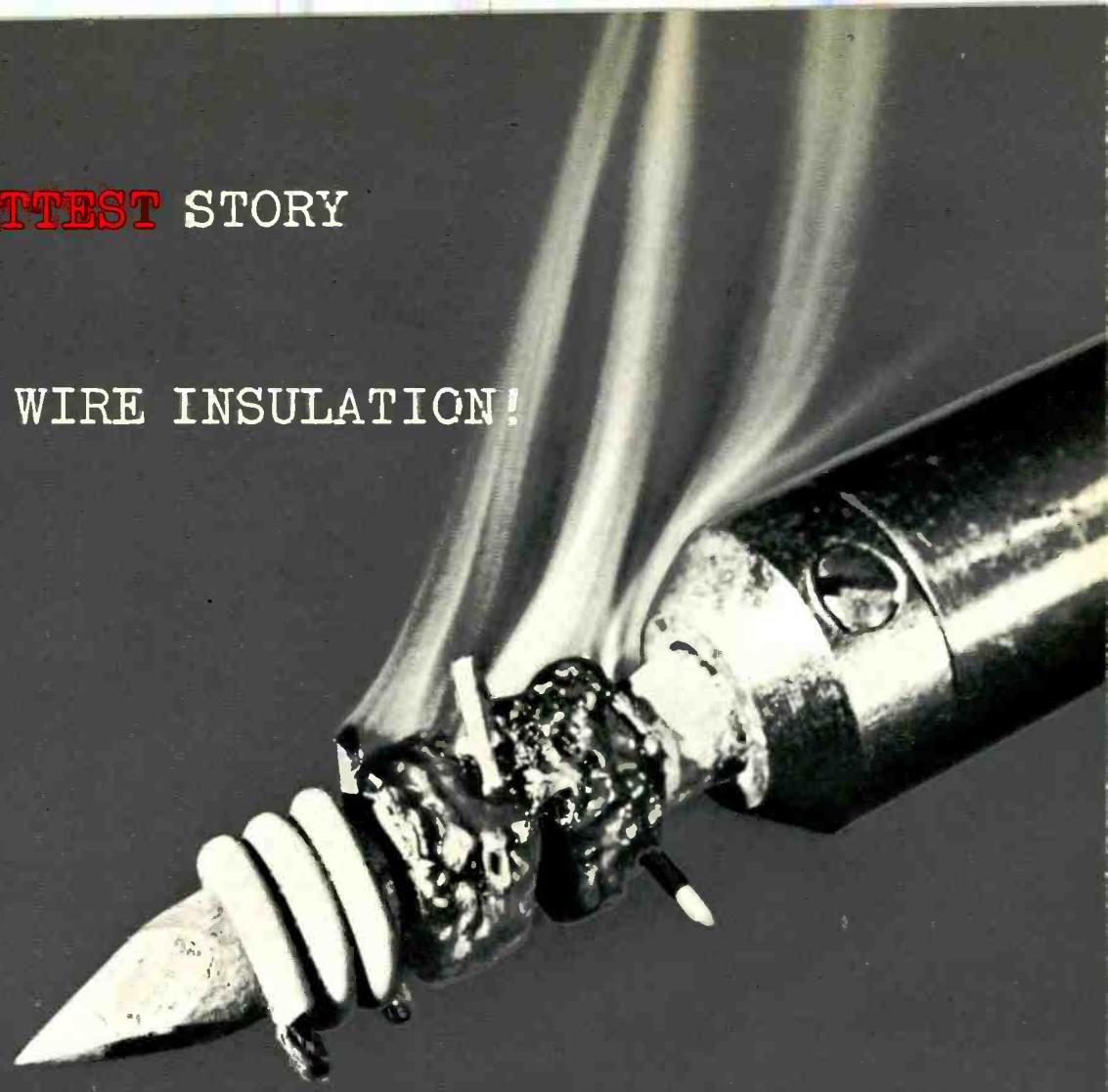

It's easy to tell which is the insulation of TFE resin as other insulations melt, smoke and char during this simple test.

No other organic insulating material can match the properties of DuPont TFE-fluorocarbon resins. They have virtually ideal electrical properties. Their temperature ratings are unsurpassed by any other flexible insulation. TFE resins are steadily becoming more attractive to electrical and electronics engineers for economic reasons.

The two inside pages of this folder show you some of the ways *you* can benefit from the stable characteristics and reliability of TFE-fluorocarbon resins. *On the back page* you will learn how TFE resins speed fabrication and aid miniaturization . . . at *cost savings* to you!

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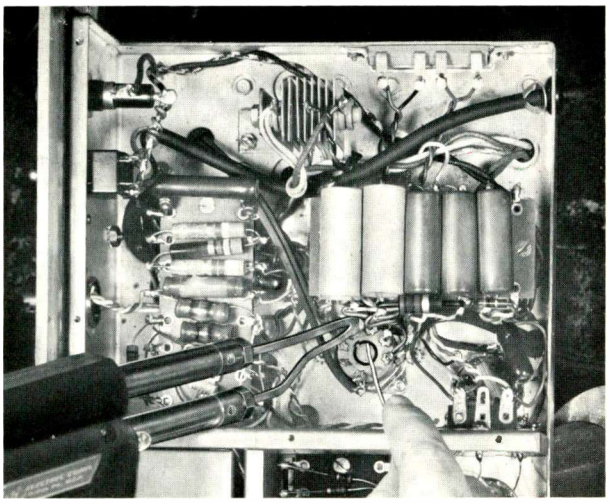
...THROUGH CHEMISTRY

Here's how Du Pont TFE resins provide easier assembly and space savings ... with cost reductions for you

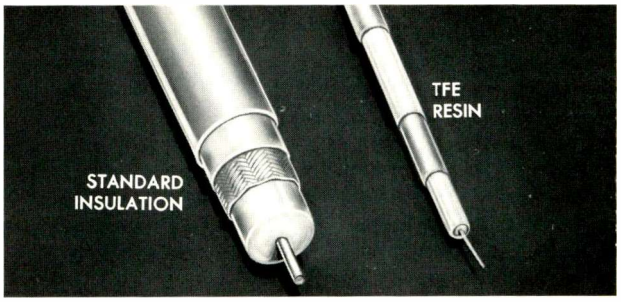


Wire insulated with TFE resin is unaffected by potting temperatures or soldering iron heat. Soldering time is shortened, inspection costs reduced, reliability improved.

IN ASSEMBLY, particularly of tightly spaced equipment where there is danger of injuring insulation, TFE resins are unsurpassed. They are unaffected by soldering iron temperatures, thus reducing danger of shorts. The insulation will not shrink back when soldering a connection. It can even be submerged indefinitely without damage during dip-soldering operations. This means economies for you, because assembly time is lowered, and wiring rejects are greatly reduced. Also, the cost of rejecting an entire potted assembly because of heat damage to the insulation is completely eliminated. One manufacturer of electronic components cut his inspection force to one-fourth its original size by changing to wire insulated with TFE resin.

DIFFICULT DESIGN PROBLEMS can be solved by TFE resins in areas where more power must be transmitted through the same space, such as underground wiring in municipalities, or increased power for existing structures. Since it is a superior moisture and electrical barrier, TFE resin permits design of wire and cable using less total insulation. Abnormal power surges are no problem because of mechanical strength and nonflammability of TFE resin at high temperatures.

MINIATURIZATION of electrical and electronic components is made possible by the heat resistance and high dielectric strength of TFE resins. For example, they solve the problem of getting more ampere turns into a winding. Finer wire can be used, so that miniaturized coils are possible. Smaller conductors transmit the same amount of power with less insulation.



Use of TFE resins in place of standard insulation in coaxial cable permits space saving of 4 to 1 and weight saving of 2 to 1. Smaller conductors transmit equivalent power with less insulation.

SEND FOR INFORMATION

Discover how well wire and cable insulated with Du Pont TFE resins help solve your design problems. For further information, contact a processor of fluorocarbon resins (listed in the Yellow Pages under "Plastics") or write to:

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How the man from Tensolite cuts assembly costs

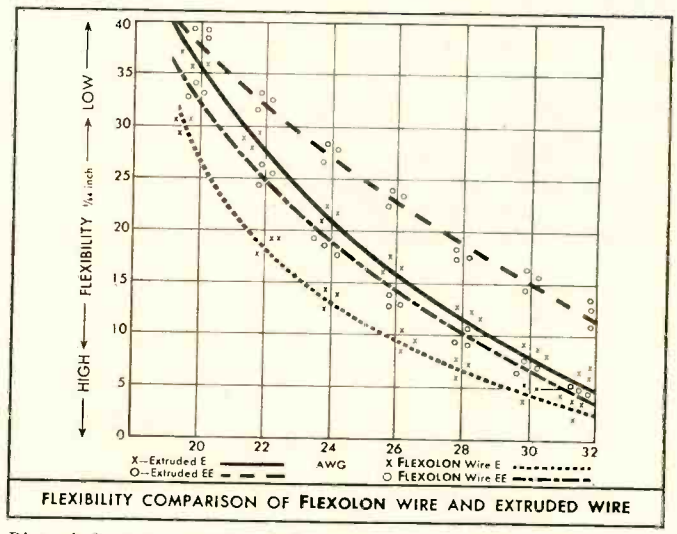
Westinghouse Aero 13 Armament Control System, mounted in nose of Navy F4D Douglas carrier-based interceptor, is typical of systems using FLEXOLON *wire for faster assembly, lower production costs.*

FLEXOLON wire's greater flexibility speeds up wiring of Westinghouse control unit

Greater flexibility of new FLEXOLON high temperature hook-up wire makes an easier job of wiring intricate harnesses for Westinghouse Air Arm's armament control systems. Meeting the flexibility requirements of Westinghouse engineers, Tensolite's new wire helps reduce production time and assembly costs.

FLEXOLON wire's greater flexibility was proven in a recent series of tests on the new hook-up wire and wires of other construction. In test after test FLEXOLON wire, insulated with DuPont "Teflon,"® proved consistently more flexible than all other high temperature hook-up wires tested.

Exceeding the requirements of MIL-W-16878B . . . and providing greater dielectric strength and higher average concentricity . . . new FLEXOLON hook-up wire is another example of Tensolite's continuous leadership in miniature wire development.



FLEXIBILITY COMPARISON OF FLEXOLON WIRE AND EXTRUDED WIRE

Plot of flexibility as recorded in tests proves greater flexibility of FLEXOLON *wire. For complete testing data, call the man from Tensolite, or write for free* FLEXOLON *hook-up wire bulletin.*

Tensolite INSULATED WIRE CO., INC.

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FLEXOLON is a trademark of Tensolite Insulated Wire Co., Inc.

CIRCLE 11 READERS SERVICE CARD

Production Techniques in New York last week.

One of many questions asked was the effect on components being purchased under existing MIL and Jan specs. Lane said the new specs would apply primarily to new components. However, components prepared under existing specs would be rated according to their conformity with the modular system and their volumetric efficiency.

For the time being, components may be made in their usual shape, so long as any dimension does not exceed the dimension of the building block. In time, Lane indicated, actually rectangular component shapes may be called for. Another new shape under consideration is double-ended, axial lead transistors.

The order of preference in hewing to modular dimensions will be height, length and width. Most waste space in assembled equipment is due to variations in component height. Standard heights will permit nesting parts back to back between two circuit boards.

Workers Follow Taped Orders

Step-by-step instructions from sender (lower right) go to hearing-aid receiver to teach worker complicated tasks

THIS WEEK, manufacturers are being invited to inspect a new method of instructing factory workers.

The new system announced this week is called AIMO (audibly instructed manufacturing operations). It uses prerecorded tape to supply oral step-by-step instructions.

The completed tape is placed in a playback unit controlled manually by the worker. Instructions are received through earpiece connected to an inductive pickup and transistorized pocket amplifier. When the playback unit is activated it sends its first instruction and automatically halts.

AIMO is a joint development of Westinghouse Electric Corp. and Dictaphone Corp. Demonstration units are located in Westinghouse's Pittsburgh laboratories.

Automobile Radar Seen as Market

ANTICIPATED ONE MILLION UNIT production of a recently conceived auto radar safety system promises to give parts manufacturers a new market for their products.

To date, only an experimental model has been built and tested. However, Bendix Research Labs, designers of the device, told the Electronic Controls and Highway Safety Conference last month that production models are presently being developed. The firms told ELECTRONICS that on the basis of the million-unit production figure, a complete system could be built for less than $200.

System consists of an elliptical radar antenna about the size of a steak platter, electronic chassis, driving condition selector and tone generator. Antenna is part of the auto's front grillwork. All electronic circuits are in a box smaller than a car radio, located just behind the antenna. Both the selector and tone generator are on the dashboard.

The antenna sends out a forward radiation pattern with small side lobes. If the radar-equipped car is approaching a car ahead at an unsafe speed, the low-volume 400-cycle beeps produced by the tone generator increase in volume as the danger becomes greater.

System operates on the Doppler principle, but uses computer circuits to calculate speed and distance relationships and compare them to those considered safe. Although installation could be accomplished more easily on auto production lines, plans have been made to modify existing autos.

MEETINGS AHEAD

June 22-27: Air Transport Conf., and AIEE Summer General Meeting, Statler Hilton, Buffalo, N. Y.

June 24: Connecticut Missile Sales Conf., open to all manufacturers interested in developing business in the missile field, Hartford Chamber of Commerce, Hotel Bond, Hartford.

July 16-18: Forestry Conservation Communications Assoc. (FCCA), Ninth Annual Conf., Parker House, Boston, Mass.

Aug. 6-8: Special Tech. Conf. on Nonlinear Magnetics and Magnetic Amplifiers, AIEE, Hotel Statler, Los Angeles.

Aug. 13-15: Conf. on Electronics Standards and Measurements, AIEE, IEE, NBC, National Bureau of Standards Labs., Boulder, Colorado.

Aug. 13-15: Seventh Annual Conf. on Industrial Applications of X-ray Analysis, Denver, Colo.

Aug. 19-22: Western Electronic Show and Convention, Los Angeles, Calif., WESCON, IRE, WCEMA, Pan Pacific Auditorium, Amdassador Hotel, L. A.

Aug. 26-Sept. 6: British National Radio Show, Radio Industry Council, Earls Court, London.

Sept. 3-5: Application of Electrical Insulation, First National Conf., AIEE, NEMA, Cleveland, Ohio.

Sept. 12-13: Communications Conf., IRE, Sheraton Monrose Hotel, Cedar Rapids, Iowa.

Sept. 15-19: Thirteenth Annual Instrument-Automation Conf. and Exhibit, ISA, Philadelphia Convention Hall, Pa.

Sept. 22-24: National Symposium on Telemetering, Americana Hotel, Miami Beach, and Patrick Air Force Base (Sept. 25).

Sept. 24-25: Seventh Annual Symposium on Industrial Electronics, Rackham Memorial Auditorium, Detroit, Michigan.

Oct. 1-2: Radio-Interference Reduction, U. S. Army Signal Research & Devel. Labs, IRE, Armour Research Foundation, Chicago, Illinois.

Oct. 6-7: Symposium on Extended Range and Space Communications, IRE and George Washington Univ., Lisner Auditorium, Wash., D. C.

Oct. 8-10: IRE Canadian Conv. and Exposition, Electronics & Nucleonics, Exhib. Park, Toronto.

two-channel rectilinear recording with direct time correlation!

Why synchronize two drive systems, handle two chart rolls, or for that matter, maintain two separate instruments? The DUAL "recti/riter" gives you two independent galvanometers, inking systems, and "recti/rite" linkages—with a single chart drive—enables you to record two variables simultaneously and visually correlate events to an accurate common time base. Record such variables as voltage and current, wind direction and velocity, temperature and pressure, torque and speed, input and output, and many others.

And, have the easiest of all recordings to read—true rectilinear side-by-side traces that you read at a glance with a simple ruler . . . no difficult interpretations so highly subject to reading errors as with old-fashioned curvilinear recordings.

Add these to the other outstanding features of the "recti/riters" . . . galvanometer accuracy, easy frontal access for all routine operations, fingertip control of 10 chart speeds, dependable closed inking system, AC, DC, spring, or external drives . . . and you have the most work-saving recorder available.

Remember, too, that *only* the "recti/riter" and matching accessories provide these wide ranges for recording electrical parameters:

10 millivolts to 1000 volts
500 microamperes to 1000 amperes
Monitor standard frequencies — 40, 60, 400 cps

When you write for specific information on the DUAL "recti/riter", Bulletin R-502, ask TI to include facts on the SINGLE "recti/riter", Line Voltage Monitor, and Model 301 All-Transistor DC Amplifier. You will be interested in the complete versatile line.

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INCORPORATED
INDUSTRIAL INSTRUMENTATION DIVISION
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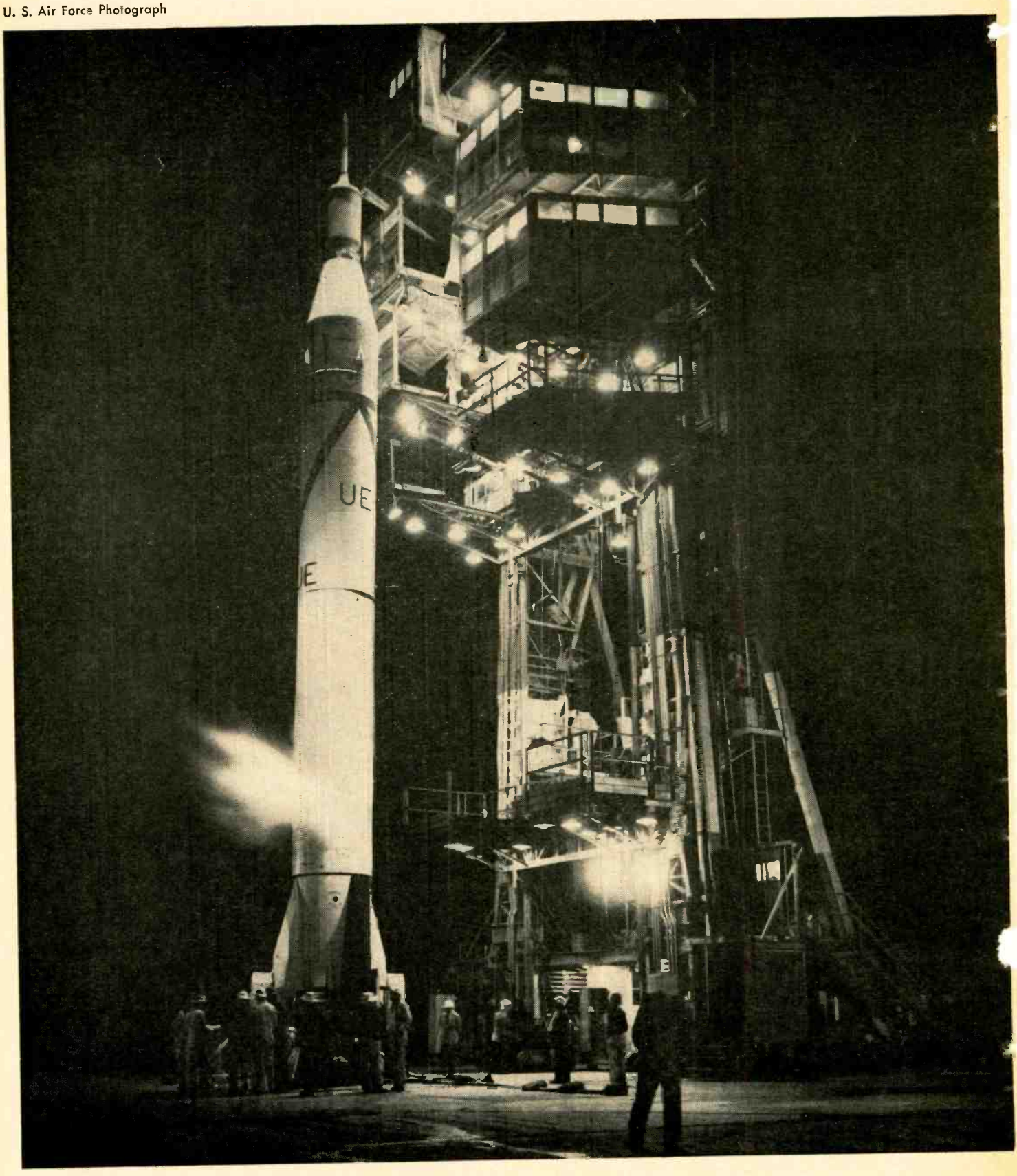
*Identical Twins
Ed and Gene Scroggins
are TI Engineers

114

FLORIDA...

U. S. Air Force Photograph

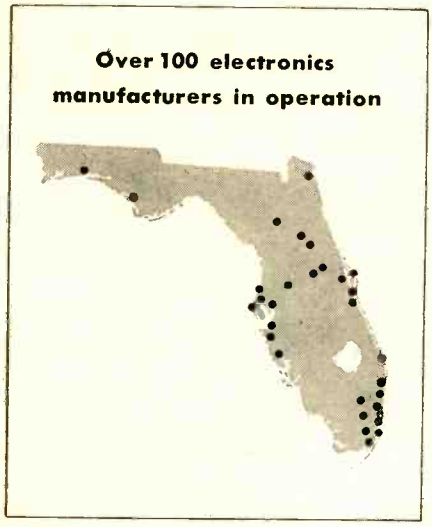


its place in the electronics-missile age

Site of satellite launchings; over 100 electronics manufacturers in operation; top choice, by actual record, of engineers and skilled technicians.

Thor, Bomarc, Snark, Vanguard, Atlas, Jupiter—every time another giant projectile lances skyward from the Cape Canaveral test launching pads, Florida demonstrates anew its missile-age mastery.

This "Space Capital, U.S.A." is making spectacular gains in America's newest industrial field. Almost overnight, Florida has attained top status in the Southeast in electronics manufacturing. Sperry-Rand Corp., for example, began klystron tube production at Gainesville in 1954. Its original labor force of 80 (60,000 square feet) has jumped to over 400



Florida's missile and electronics-related industries: their annual business volume tops $150 million.

(96,000 square feet) . . . and plans are under way for a further expansion to 160,000 square feet by 1960. Still another Sperry facility recently opened in Oldsmar — a $2 million research laboratory working on microwave instrumentation, research, and ferrites.

Over 100 Florida companies are engaged in avionics, marine communications, missile tracking and computing, and industrial control and instrumentation, with corollary rapid growths in components and sub-contracting. Typical case histories:

Martin Co., Orlando—New $27 million plant (guided missiles, Missile Master control systems) advertised for skilled technicians, received a flood of qualified applicants from all over the country —a common experience in Florida.

Florida boasts a veritable "Who's Who" in the missiles-aviation-electronics world.

Radiation, Inc., Melbourne — Has grown from one to nine plants since 1950, employs over 700. Working on antenna and telemetry research, is participating in the "Tall Tom" electronic reconnaisance system contract.

Others doing equally well: Minneapolis-Honeywell, St. Petersburg; Electro-Mechanical Research, Sarasota; Electron-Machine, Umatilla. Companies report five basic factors responsible for success here: proximity to Cape Canaveral, climate that attracts skilled manpower, good labor market, decentralization advantages, nearness to Latin American markets.

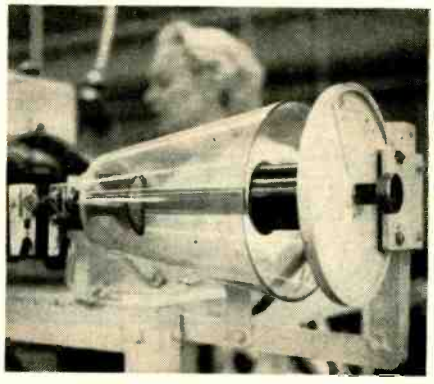
Aircraft maintenance, including tele-communications and electronics, is a flourishing field, too. Overhaul operations of Aerodex, Inc., Miami, are virtually on an "assembly line" basis.

MORE FLORIDA NOTES: Nuclear research and development proceeding apace, aided by a 1957 legislature appropriation of $5,200,000 . . . no state income taxes . . . permanent population increasing by more than 16,000 a month . . . 1957 building permits up 22% in number over 1956.

Florida facts, figures . . . and surveys

The Industrial Services Division of the Florida Development Commission has prepared all-new factual studies on Markets, Manpower, Taxes, Transportation, Resources, Living Conditions, Research, Power and Water. These studies are available to you at your request.

In addition, the Industrial Services Division will gladly conduct special studies and assist in selecting sites. All inquiries are held in strictest confidence. Write today to Florida Development Commission, 3715-3A Caldwell Building, Tallahassee, Florida.



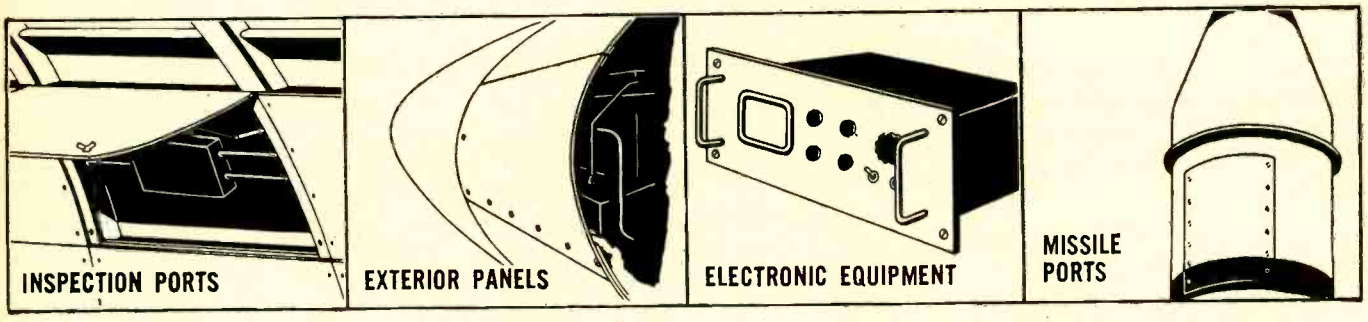
Merit Coil & Transformer Co., world's largest independent manufacturer of transformers, recently moved its complete plant from Chicago to Hollywood, Florida.

Come see Industrial Florida for yourself. Write State of Florida, Dept. M, Caldwell Bldg., Tallahassee, for new 100-page color Vacation Guide Book to help plan an all-Florida tour.

Cape Canaveral is a dramatic symbol of Florida's leadership in the electronics-missile age.

FLIGHT-PROVED RELIABILITY . . .

LION *Quarter-turn* FASTENERS FOR SECURING REMOVABLE SECTIONS

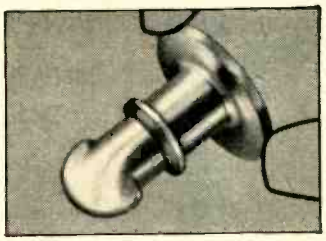


Southco's Lion Quarter-turn Fasteners provide quick access and reliable securing of hinged or completely removable panels. Resistance to severe heat, shock and vibration, and a high strength-weight ratio make these unique fasteners ideal for use in private, commercial or military aircraft and missiles . . . for ground production and control or airborne applications.

Lion Fasteners consist of three parts . . . a one-piece, swaged-nose stud; a retainer; a floating receptacle which is riveted or welded in place. Installation requires no special tools . . . is simplified by a permissible float of .070".

SWAGED NOSE

Case hardened one-piece stud with swaged nose has no milled sections, inserts, or cross pins . . . requires no wire spring to hold it in locked position. Lion Fasteners offer the highest weight-strength ratio available.



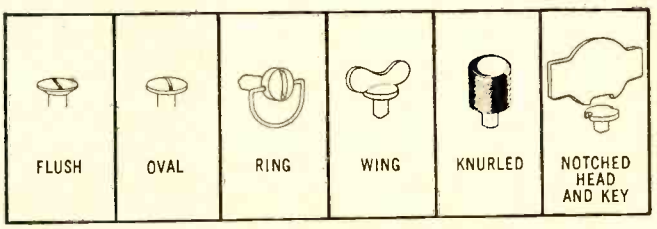
2 TYPES AVAILABLE

LION NO. 2 FASTENER
For use where space is limited and where weight must be kept at a minimum.

LION NO. 5 FASTENER
For heavy-duty applications where good tensile and shear strength are required.

FULL RANGE OF HEADS

Lion No. 2 Fastener available with flush, oval or wing type. No. 5 with flush, oval, ring, wing, knurled or notched head and key.



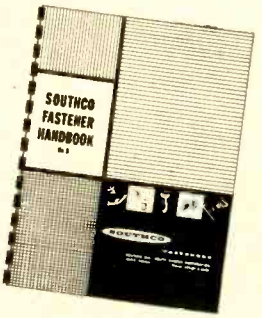
OTHER SPECIFICATIONS

LION NO. 5 QUARTER-TURN FASTENERS CONFORM TO MIL. SPEC. MIL-F-5591A (ASG) . . . ARE ON THE GOVERNMENT'S QPL . . . ARE CAA APPROVED FOR COMMERCIAL AND PRIVATE AIRCRAFT USE.

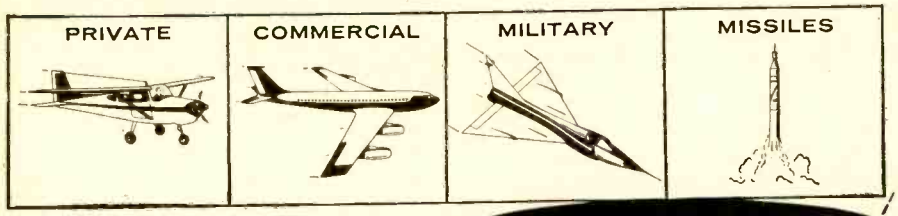
MATERIAL: Cadmium-plated case-hardened steel.

FREE!

FASTENER HANDBOOK



Send for your free copy of Southco Fastener Handbook No. 8. Gives complete engineering data on Lion Fasteners and many other special fasteners. Write to Southco Division, South Chester Corporation, 233 Industrial Highway, Lester, Pa.

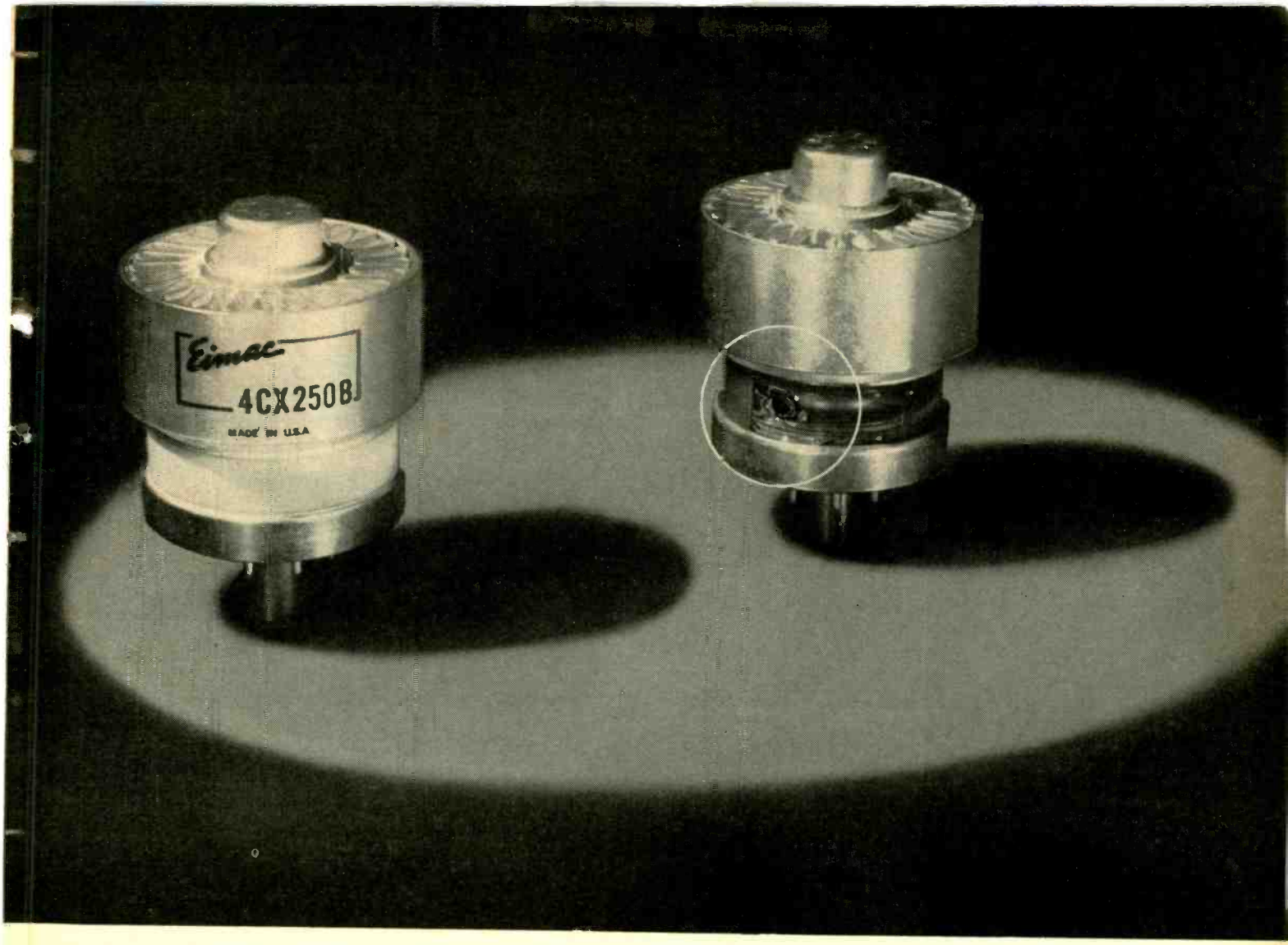


LION *Aviation* **FASTENERS**

one of the SOUTHCO FASTENERS LION

CIRCLE 15 READERS SERVICE CARD

CIRCLE 16 READERS SERVICE CARD →



Lower Dielectric Loss
is an Eimac Ceramic Tube Extra

Fifth in a series describing the advantages of ceramics in electron tubes. Previously discussed: impact, heat, vibration, compactness.

Ceramic is considerably superior to glass in terms of dielectric loss at high frequencies. The ceramic Eimac 4CX250B and the glass envelope 4X250B shown above were operated in identical 500 megacycle RF amplifier circuits, under identical operating conditions. The glass envelope tube failed catastrophically within a few minutes due to RF heating and puncture of the glass envelope. Further tests of the 4CX250B at 500 Mc. with higher applied voltage showed no appreciable heating of the ceramic envelope material from dielectric loss effects.

Other tests compared glass envelope 2C39A tubes with 3CX-100A5's, their ceramic envelope counterparts. These tubes were operated as oscillators at 2.5 KMc., under identical conditions. The 3CX100A5 ceramic tubes consistently showed a 10% greater output power than the glass envelope type, due to the lower dielectric loss of the ceramic material.

These ceramic tubes are just two of more than 40 Eimac ceramic tube types whose compactness, and resistance to damage by impact, heat, and vibration make them ideal for use wherever exceptional reliability and high performance are demanded.

Write our Application Engineering Department for a copy of the booklet "Advantages of Ceramics in Electron Tubes".

EITEL-McCULLOUGH, INC.
SAN BRUNO CALIFORNIA

Eimac First with Ceramic Tubes that can take it

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Products Designed and Manufactured by Eimac

Negative Grid Tubes
Reflex and Amplifier Klystrons
Ceramic Receiving Tubes
Vacuum Tube Accessories
Vacuum Switches
Vacuum Pumps
Traveling Wave Tubes

Includes an extensive line of ceramic electron tubes

New! Calorimetric

Just connect and read powers 10 mw to 10 watts!

-hp- 434A

Covers dc to 10 KMC

No barretter or thermistor needed

No external terminations or plumbing

Measures CW or pulsed power

No technical skill required

Only two simple controls

hp representatives offer complete

power meter

Stated simply, the new *-hp-* 434A Calorimetric Power Meter offers you this:

The fastest, easiest means yet devised to measure powers accurately from 10 mw to 10 watts between dc and 10 KMC.

With the 434A, measurement is literally as simple as connecting to a 50 ohm, type N front panel terminal and reading power directly. The instrument is particularly ideal for use by non-technical personnel.

The new meter fills the important range between bolometer-type microwave power meters (such as *-hp-* 430C at right) and conventional calorimeters whose lower range is approximately 10 watts. But unlike previous cumbersome equipment suggested for its range, the *-hp-* 434A is completely self-contained and requires no external detectors or plumbing of any type.

Rapid Response Time

Model 434A employs a self-balancing bridge and a high efficiency heat transfer system to and from an oil stream to provide a full scale response time of 10 seconds or less. This fast response, a fraction of the reaction time needed by ordinary calorimeters, means the 434A quickly follows small adjustments in input tuning circuits. Further, the use of twin power sensitive elements in one oil stream plus a feedback system makes the accuracy virtually independent of variations in oil flow rate or ambient temperature, and prevents fluctuations due to changes in oil flow rate or oil temperature.

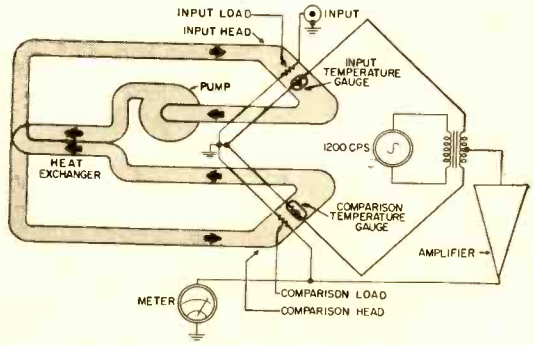


Figure 1. *-hp-* 434A Calorimetric Power Meter

New *-hp-* 434A comprises two load resistors, one for input and one for comparison power, a self-balancing bridge with temperature sensitive gauges in input and comparison legs, and an indicating meter. Heat dissipated in the input load resistor heats the gauge in the input leg and unbalances the bridge. The unbalanced signal is amplified and applied to the comparison resistor. The heat thus generated is transferred to the gauge in the comparison leg and rebalances the bridge. The meter measures the power supplied to the comparison gauge to rebalance the bridge. Since heat transfer and temperature sensitivity are identical, the meter reads input power direct, with presentation in watts or DBW.

For complete details, see your -hp- representative or write direct.

HEWLETT-PACKARD COMPANY

4652A PAGE MILL ROAD • PALO ALTO, CALIFORNIA, U.S.A.
CABLE "HEWPACK" • DAvenport 5-4451
FIELD ENGINEERS IN ALL PRINCIPAL AREAS

power measuring instrumentation

SPECIFICATIONS

-hp- 434A Calorimetric Power Meter

Input Power Range:	7 ranges; full scale readings of 0.01, 0.03, 0.1, 0.3, 1.0, 3.0 and 10 watts. Meter calibrated −10 to 0 DBW, continuous readings −30 to + 10 DBW.
Frequency Range:	dc to 10 KMC
dc Input Impedance:	50 ohms ± 5 ohms at Type N input jack
Input SWR:	Less than 1.5 full range
Meter Response: (Full Scale)	Approximately 10 seconds on highest range, approximately 2 seconds on lower ranges.
Controls:	Zero Set and Meter Range
Accuracy:	Within 5% full scale
Power:	115/230 v ± 10%, 50/60 cps, approximately 155 watts.
Size:	Cabinet: 20½" wide, 12½" high, 14¾" deep. Rack: 19" wide, 10½" high, 13½" deep. Wt. 50 lbs.
Price:	$1,115.00 (cabinet) $1,100.00 (rack mount)

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

Microwave Power Meter

0.1 to 10 mw, CW or pulsed, without calculations!

-hp- 430C Microwave Power Meter is the finest, most dependable source of milliwatt power measurements offered. It gives you power readings direct in db or mw and eliminates all computation or adjustment during measurement. The instrument measures either pulsed or CW power, on either coaxial or waveguide systems. Operation is entirely automatic, and accuracy is ± 5% of full scale reading. For CW or pulsed power measurements, *-hp-* 430C uses either an instrument fuse, barretter or thermistor as a bolometer element. Operation may be at either 100 or 200 ohms. Power is read direct in mw from 0.02 to 10 mw, or in dbm from —20 to + 10 dbm. The broad nominal range may be extended by means of directional couplers and attenuators.

SPECIFICATIONS

Power Range: 5 ranges, front panel selector. Full scale readings of .1, .3, 1, 3, and 10 mw. Also continuous readings from —20 to +10 dbm. (0 dbm = .001 watt). Power range may be extended with attenuators or directional couplers in microwave system.

External Bolometer: Frequency range depends on bolometer mount. Bolometers can operate at resistance levels of 100 or 200 ohms and can have positive or negative temperature coefficients. Any dc bias current up to 16 ma is available for biasing positive or negative temperature coefficient bolometers. Dc bias current is continuously adjustable and independent of bolometer resistance and power level range.

Suitable bolometers are:

Instrument fuses: *-hp-* G-28A and G-28B 1/100 amp fuse.

Barretters: Sperry 821, Narda N821B or N610B, PRD 610A, 614, 617 or 631C.

Thermistors: Western Electric D166382, Victory Engineering Co. 32A3, 32A5, Narda 333, 334.

Accuracy: ± 5% of full scale reading.

Power: 115/230 v ± 10%, 50/1,000 cps, 75 watts.

Dimensions: Cabinet Mount: 7⅜" wide, 11½" high, 14" deep. Rack Mount: 19" wide, 7" high, 12½" deep.

Weight: Net 14 lbs. Shipping 32 lbs. (cabinet mount).

Price: $250.00.

Data subject to change without notice.

How You Can Cut Product Costs With Indox V Ceramic Magnets

Experience in the design and production of Indox V, for such products as the loudspeaker below, points the way to substantial savings in manufacturing costs for other products using permanent magnets.

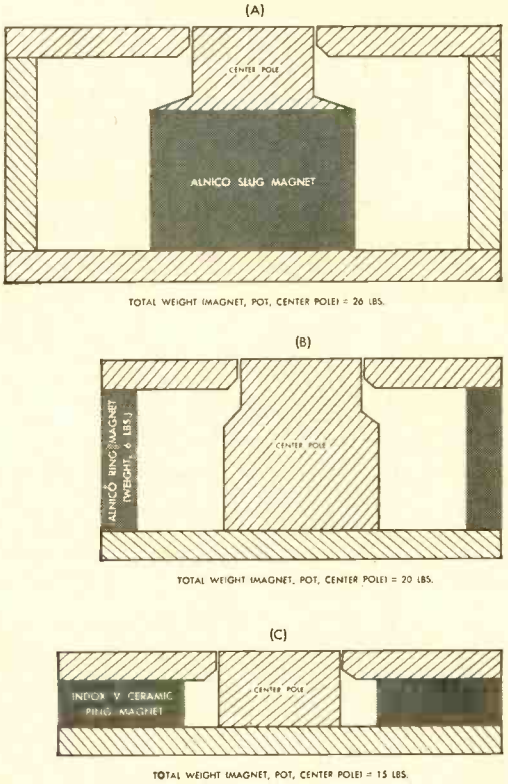
WHAT IS INDOX V

Indox V is a highly oriented barium ferrite material. Its energy is comparable, on an equivalent weight basis, to that of Alnico V—the most powerful permanent magnet material available. Indox V magnets possess unique advantages — light weight, high-electrical resistivity, great resistance to demagnetization, and inexpensive, non-critical raw materials — plus an energy product over three times that of non-oriented ceramic magnets.

NEW INDOX V LOUDSPEAKER DESIGN...

• Cuts magnet cost 20% • Saves 25% on weight • Reduces length 46%

High fidelity, permanent magnet loudspeakers normally use an Alnico slug (A) or ring (B) magnet. Assembly (C) illustrates how one loudspeaker was redesigned to use Indox V, with the results indicated. Assemblies shown in proportion.



APPLICATIONS

Indox V's excellent magnetic qualities and special properties suggest wide usage in many applications.

Among them:

D. C. Motors of Medium Size with Indox V fields have a high efficiency and show high starting and stall torques characteristic of series wound motors.

Holding Devices can take advantage of Indox V's total potential energy which, per pound of magnet weight, is appreciably higher than that of Alnico V.

Torque Drives using Indox V discs can be magnetized with multiple-pole faces.

The list of other promising applications is growing.

WHO MAKES INDOX V

Only Indiana Steel Products makes this oriented ceramic magnet, with an energy product of 3.5 million B_dH_d. And, because Indiana also produces Alnico and all other permanent magnet materials, it is uniquely qualified to recommend the *one* best material for your design. You are invited to consult with Indiana's design engineers for expert help on any application involving permanent magnets.

SEND FOR FREE LITERATURE

Write for your copy of the bulletin "Indox V Ceramic Permanent Magnets," describing magnetic properties, design considerations, and sizes and shapes available from stock for experimental work. Ask for Bulletin No. 18-A6.

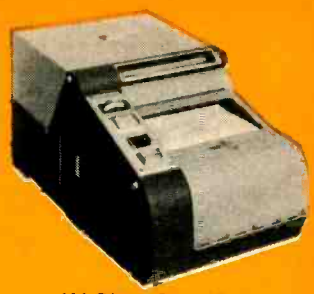
THE INDIANA STEEL PRODUCTS COMPANY
VALPARAISO, INDIANA

WORLD'S LARGEST MANUFACTURER OF PERMANENT MAGNETS

INDIANA PERMANENT MAGNETS

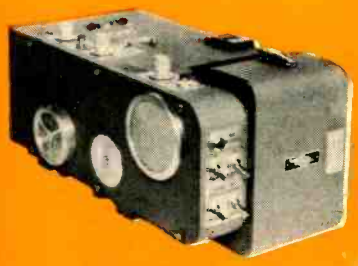
IN CANADA: The Indiana Steel Products Company of Canada Limited, Kitchener, Ontario

602 Direct Recording
Oscillograph 50 Channels



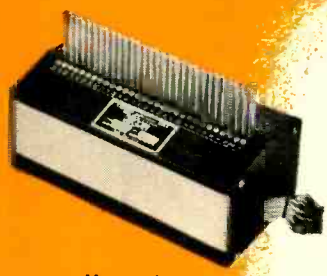
616 Direct Recording
Oscillograph 25 Channels

MIDWESTERN'S specialization is the design and manufacture of instructments with unexcelled operational characteristics. MI instruments are engineered to deliver uninterrupted accurate results under the stresses of multiple "G's" produced by vibration, shock, and extremes in adverse environmental conditions.



581 Oscillograph
14 Channels

590 Oscillograph
36 Channels

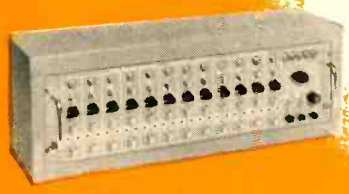


Magnetic Structures
Choice of Sizes

Sub-Miniature
Galvanometers

An Index to MI Instruments

MIDWESTERN INSTRUMENTS
41ST AND SHERIDAN / TULSA, OKLAHOMA



Bridge Balances
Many models

Data Repeaters
Synchro and helipot

Catalogs and Brochures upon Request

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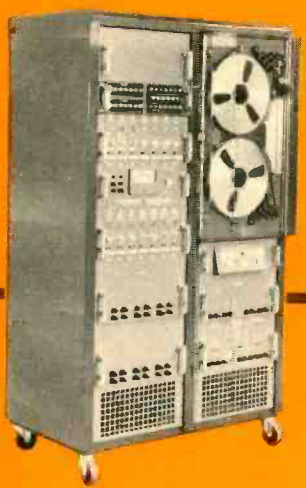
La Canada, California
Ph. SYlvan 0-3195, RYan 1-5845

Servovalves
Torque Motors



Instrumentation
Tape Recorders

MIDWESTERN INSTRUMENTS

41ST AND SHERIDAN / TULSA, OKLAHOMA

Phone Riverside 7-1331

Magnetic Heads
and Drums

Radio Receptor...

your prime source for every type of

SILICON

and

GERMANIUM

high speed
high conductance
high temperature
high voltage
high back resistance

DIODES

Code No.	Fwd. DC Cur. (MA) @ Indicated Voltage	Rev. DC Cur. (u A) @ Indicated Voltage	Max. Inv. Voltage	Reverse Recovery
SILICON DIODES *(All ratings and characteristics are at 25° C.)*				
1N658	100 @ 1.0V	.05 @ 50V 25 @ 50V @ 150° C.	100V	80K in 0.3 usec•
DR672	100 @ 1.0V	.5 @ 35V 10 @ 35V @ 100° C.	50V	400K in 1.0 usec†
DR670	200 @ 1.0V	.025 @ 175V 5 @ 175V @ 150° C.	180V	—
GERMANIUM DIODES *(All ratings and characteristics are at 25° C.)*				
1N276‡	40 @ 1.0V	100 @ 10V @ 75° C. 100 @ 50V	50V	80K in 0.3 usec•
DR435	10 @ .34V Min. .37V Max.	10 @ 10V	20V	—
DR312	100 @ 1.0V	5 @ 10V; 20 @ 100V	100V	—

• When switching from 5 mA to 40V. † When switching from 30 mA to 35V.
‡ JAN type.

The specs shown here are just a small sampling of the complete Radio Receptor diode line which covers every combination of characteristics needed for your circuitry. For full information, write today to Section d7

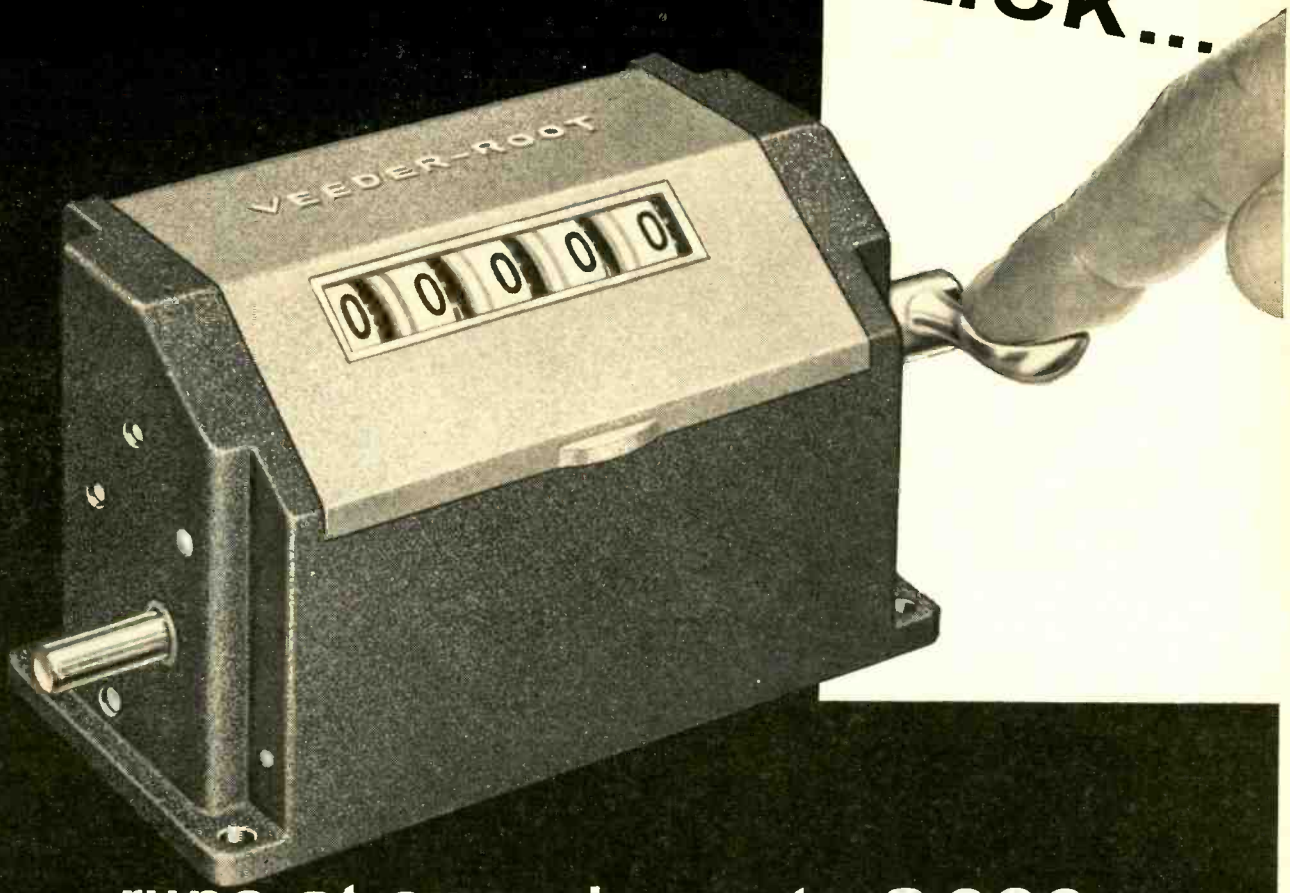
SEMICONDUCTOR DIVISION **RADIO RECEPTOR COMPANY, INC.**

Subsidiary of General Instrument Corporation
240 Wythe Avenue, Brooklyn 11, N. Y., EVergreen 8-6000

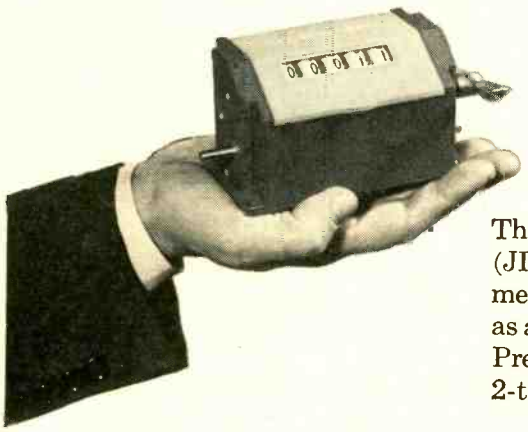
GENERAL INSTRUMENT SEMICONDUCTORS

General Instrument Corporation also includes: Automatic Manufacturing Division, F. W. Sickles Division, Micamold Electronics Manufacturing Corporation (Subsidiary)

Resets at a Finger-FLICK...



runs at speeds up to 8,000 counts per minute!



Here's a new Veeder-Root high-speed predetermining counter *with instant resetting*. Easily preset to the required number of pieces or performance-units, the counter subtracts to zero . . . *then resets with a finger-flick back to the original preset number.*

This new counter meets standard U. S. electrical requirements (JIC Codes) . . . and is available with either electrical switch or mechanical stop. Also available *without the predetermining feature,* as a high-speed reset revolution counter. Series 1522 High Speed Predetermining Counters come in a rugged, handsome 2-tone gray case that looks well everywhere. *Write:*

EVERYONE CAN COUNT ON

Veeder-Root
INCORPORATED
Hartford 2, Connecticut

*Trade-mark registration applied for.

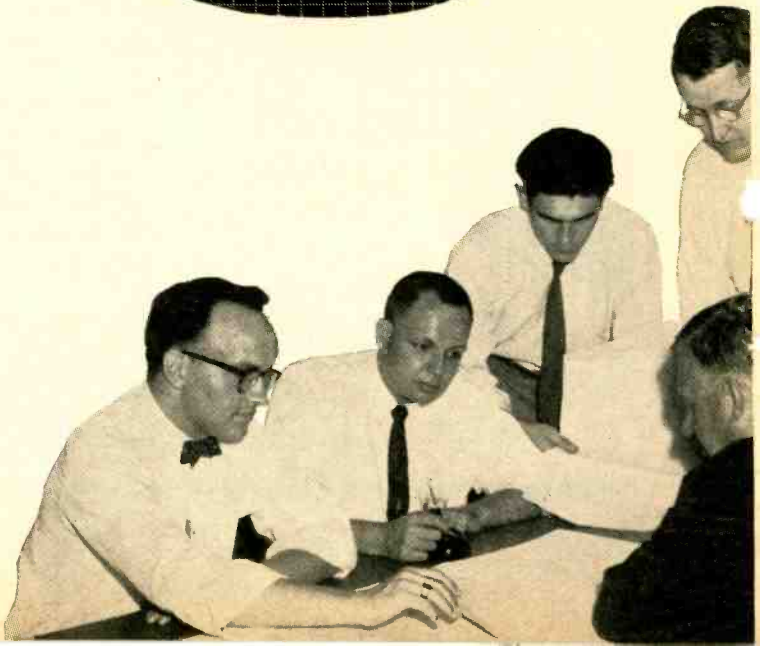
Hartford, Conn. • Greenville, S. C. • Altoona, Pa. • Chicago • New York • Los Angeles • San Francisco • Montreal • *Offices and Agents in Principal Cities*

LINK YOUR CAREER TO TOMORROW

we speak

your language

at Link



Sure, there's a lot of dreaming still to be done in electronics! But there's an awful lot that needs *doing*. Link Aviation, Inc., pioneer of flight simulation, is now operating fine new laboratories at Binghamton, New York and Palo Alto, California, for that very purpose... to put electronics to work at new exciting jobs. A selected number of engineers are needed at this time.

There are many reasons why Link chose these communities for their laboratories.

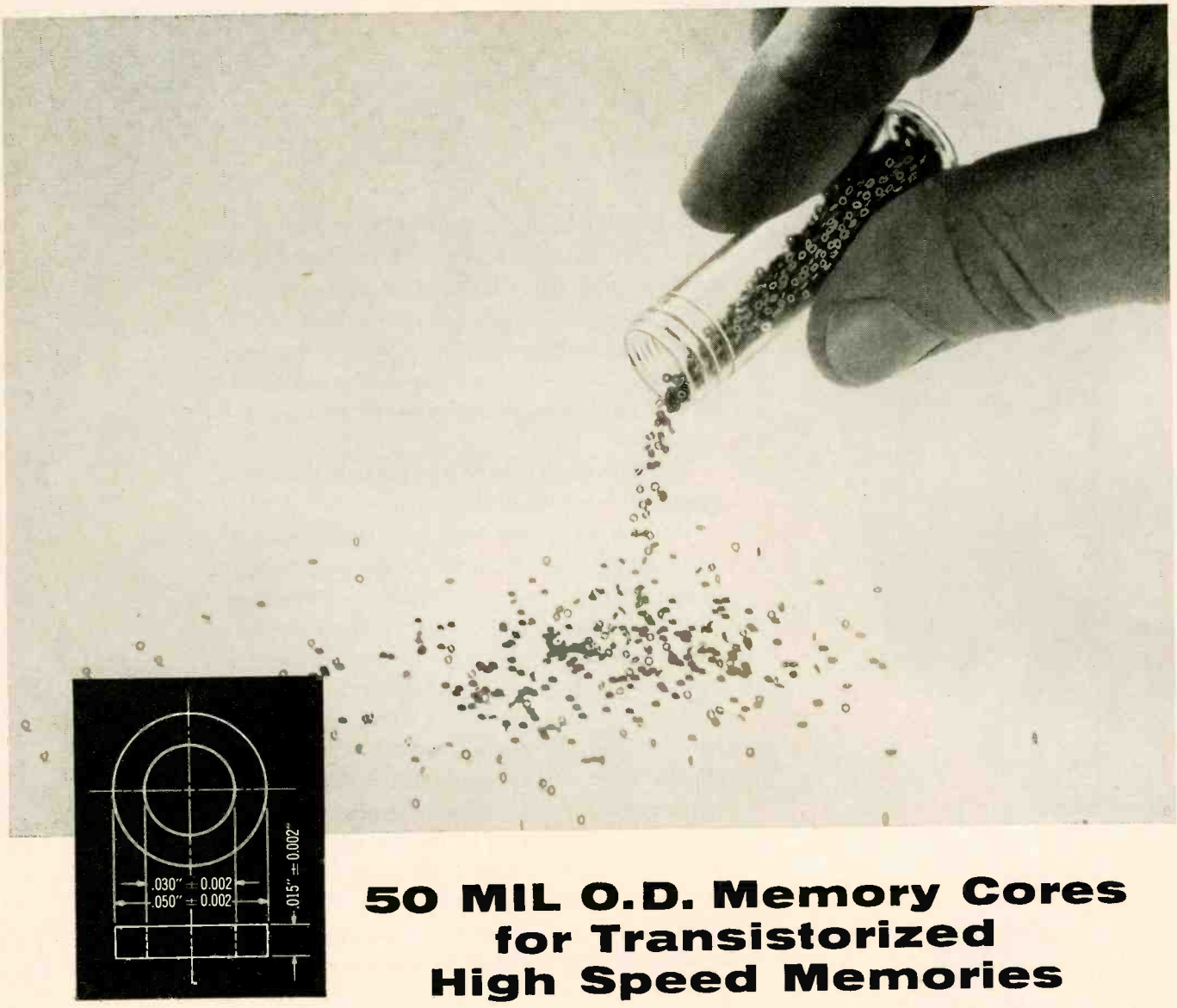
You can settle down and raise a family. And, if you intend to continue advanced technical study, you can benefit from the Honors Cooperative Program that provides advanced study, under regular University curriculum, during working hours with all tuition expenses paid by Link. The engineers Link selects will not be the type who have mere "competency" as their standard. Nor will they be the ivory-tower genius type (though some works of genius may be expected). What Link needs is men who will carry projects through from concept to development. In addition to providing you with a comfortable physical climate in which to live, an ideal mental climate in which to work, and an enviable academic climate in which to advance your studies, Link furnishes you with all those employee benefits you associate with the most advanced management practice. Fine pay. Good vacations. Generous hospital, health and retirement benefits. Link is right in believing "we speak your language" because management men are engineers. They understand your work and point of view. This kind of administration provides engineering thinking right up to policy level. If this stimulating climate appeals to you...

Write:
Mr. M. E. Jenkins
Link Aviation, Inc., Dept. X-1
Binghamton, New York
Or:
Mr. Joe Larko
Link Aviation, Inc., Dept. X-1
P.O. Box 1313
Palo Alto, California

LINK

GENERAL PRECISION EQUIPMENT CORPORATION

LINK AVIATION, INC.
Binghamton,
New York

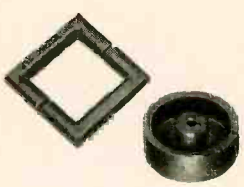


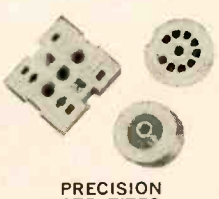
50 MIL O.D. Memory Cores for Transistorized High Speed Memories

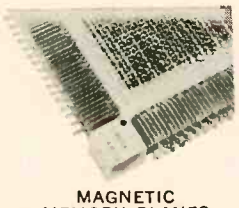
These new 50 mil O.D. cores are now available in General Ceramics S-4, the material that has proven so successful in such vitally important systems as the SAGE computer. Switching time is less than one microsecond with 550 ma full drive. At recommended operating conditions, the "ONE" output voltage is greater than 60 millivolts; the "ZERO" output voltage is less than 6 millivolts. Cores are provided in two quality levels, to .015 AQL and to 6.5 AQL. Dimensions are .050" O.D., .030" I.D. and .015" in height, all with tolerances of ± .002". General Ceramics has designed and built special equipment for core testing to insure that each unit meets established electrical properties. 50 mil O.D. cores are supplied in production quantities in two quality levels. Parts are shipped according to MIL Specification 105A to 0.015 AQL or 6.50 AQL. For complete information on this core write General Ceramics Corporation, Keasbey, New Jersey, for Bulletin 326; address Dept. E.

GENERAL CERAMICS

Industrial Ceramics for Industrial Progress... Since 1906


FERRAMIC CORES


PRECISION STEATITES


MAGNETIC MEMORY PLANES


"ADVAC" HIGH TEMPERATURE SEALS


SOLDERSEAL TERMINALS

CIRCLE 25 READERS SERVICE CARD

CIRCLE 26 READERS SERVICE CARD →

NOW the leaders in direct oscillographic recording offer you new standards in dynamic measurement with a *complete family* of

Honeywell Visicorders

featuring the *all-new*

Model 1012 36-channel direct recording

VISICORDER® OSCILLOGRAPH

designed from the base up to make fullest use of the completely proven and unsurpassed Visicorder principle pioneered by Honeywell.

The dry and dustless direct-recording oscillograph that records without the use of powders, liquids, vapors, or other processing . . .

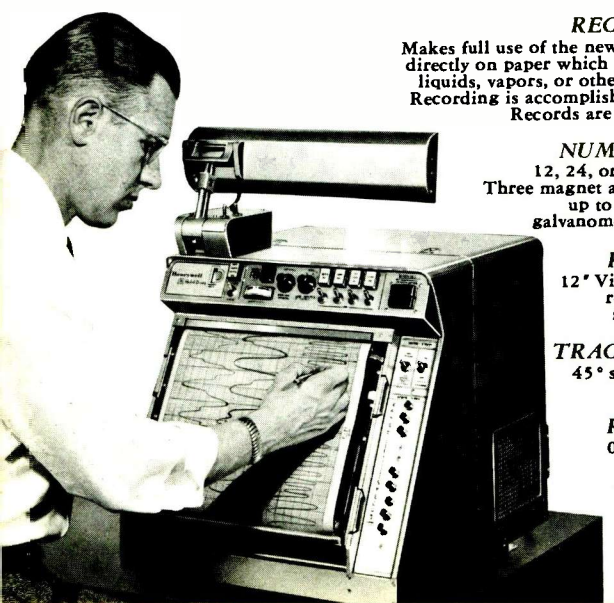
The new 36-Channel *Model 1012*

VISICORDER OSCILLOGRAPH

is the only direct-recording oscillograph . . .

* that provides a consistently accurate grid line system (amplitude reference coordinates). By recording longitudinal reference lines *simultaneously* with galvanometer traces and timing lines, the reference is always accurate, even if the paper should shift slightly during recording, or is susceptible to subsequent dimensional changes.
* that can be loaded and unloaded *in a matter of seconds,* in daylight, without separate magazines.
* that permits running the record backward, as well as forward, for closer study and analysis.
* that gives you a choice of 5 time lines intervals (.001, 0.01, 0.10, 1.00, 10.0 second) recorded by means of a flash tube, with provision for external synchronization. External signals applied simultaneously to galvanometers and timing system are in exact time relationship on the record.
* that offers complete push-button control of record speeds, without changing gears, in 15 steps from 0.1 to 160 in./sec., with automatic recording intensity control.
* that provides "center galvanometer" performance in all galvanometer positions.
* that utilizes hermetically sealed plug-in galvanometers that do *not* require dummies in unfilled positions, and that are completely interchangeable between various models (700C, 906A-1) because optical arms (11.8″) and, consequently, sensitivities are identical.
* that provides loading, operation and control from one surface.

. . . And these are just a few of its versatile features! The Model 1012 Visicorder is the most versatile instrument ever devised for converting dynamic data into immediately readable analog records. It has been specifically designed to make full utilization of the direct-recording Visicorder Principle that Honeywell pioneered and introduced with the Model 906 (see back cover). With the 1012, you can take records up to 200 feet in length with a wide selection of record speeds that provide maximum readability of the galvanometer traces even at the highest frequencies. You can record at frequencies from DC to 5000 cycles per second, at sensitivities identical to photographic-type oscillographs, and monitor the information as it goes on the record. The features of the Model 1012 give you conveniences never before possible in analog recording. Paper loading and unloading is quick and foolproof. A complete system of readily accessible controls, with indicator lamps, provides simple, positive control of recording. The 1012 records with or without longitudinal grid lines, as desired. Time lines may be varied through a choice of five ranges or not used at all; provisions for external timing are included. Galvanometer traces may overlap, with deflections as great as 8 inches peak-to-peak, and trace identification occurs on a 45° slope, interrupting galvanometer traces one at a time so that records are easy to read and analyze.



GENERAL FEATURES

FREQUENCIES & SENSITIVITIES
From DC to 5000 cycles per second without peaked amplifiers of any kind. Identical to photographic-type oscillographs.

RECORDING METHODS
Makes full use of the new Visicorder Principle. Records directly on paper which requires no powder magazines, liquids, vapors, or other processing. Daylight loading. Recording is accomplished in full view of the operator. Records are immediately visible and usable.

NUMBER OF CHANNELS
12, 24, or 36 active channels, as desired. Three magnet assemblies, each of which holds up to twelve ⅛″ Series M Honeywell galvanometers, plus two reference traces.

RECORDING WIDTH
12″ Visicorder paper (11⅜″ for active recording; ⅜″ margin for record numbering and event marking).

TRACE IDENTIFICATION
45° slope, interrupting galvanometer traces in sequence.

RECORDING SPEEDS
0.1 to 160 in./sec. Five speeds in each of 3 ranges (15 steps) via push-button control. No manual change of gears is required.

TIME LINES
Flash tube system. Choice of 5 intervals (.001, 0.01, 0.10, 1.00, 10.0 second) with each 10th line heavier. May be turned "off" or synchronized with external signals. With optical parallax being held to a minimum and negligible delay in initiating flash tube, timing lines and other data are recorded in exact time relationship.

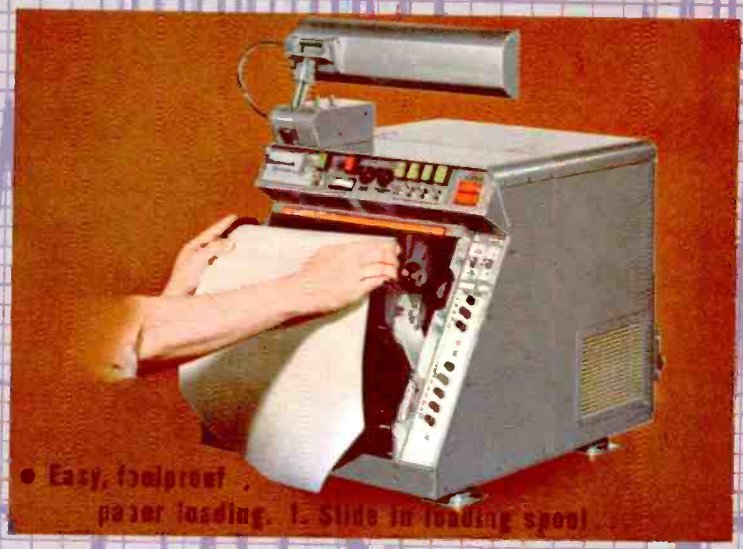
RECORDING INTENSITY CONTROL
Proper aperture automatically established with record speed selection, or manually controlled as desired.

"NO RECORD" INDICATOR
Red indicator lamp and automatic shut-down of drive system indicates "No Record" if operator fails to turn on all necessary switches, if lamp fails, or if recording paper supply is exhausted. A separate lamp indicates when less than 25 feet of paper remains in supply.

PAPER LOADING
Simply done in a matter of seconds even by untrained personnel. All paper transport and take-up functions are integral. No separate magazines or other units required.

OTHER FEATURES
Automatic record length, adjustable 0-25′ (forward or reverse). Unused paper indicator. Paper knife. Push-button jump speed control. Record numbering system with provision for external actuation. Integral fluorescent light latensifier. Rack, table, or shock mounting. Provision for remote and/or multiplexed operation.

Time lines (every 10th line accented)



Trace identification

Longitudinal grid lines (every 5th line accented)

a representative record produced by the Model 1012 Visicorder. Note clear, accurate longitudinal grid lines, time lines, dynamic traces, and 45° sequential interruption of galvanometer traces for easy identification.

10-249 ← Record numbering
9 3 7

NEW MODELS OF THE *906* VISICORDER

The original 8-channel Model 906 Visicorder was the first successful oscillograph to break the barriers of frequency response and writing speed, and produce immediately readable records out to 2000 cps without the intervening steps of chemical processing.

Now the new Model 906A provides higher recording frequencies (DC to 3000 cps) and up to 14 channels of data. Factory-installed optional features and a wide variety of accessories are available as described at right. This means that you can select an instrument suited precisely to your requirements without price penalty for built-in or "special" features that may not be required.

The 906A Visicorder is provided in two models:

Model 906A-1 The basic instrument with high-sensitivity miniature plug-in galvanometers and magnet assembly. The use of subminiature galvanometers permits 14 simultaneous channels of data to be directly recorded at frequencies from DC to 3000 cps. These galvanometers are interchangeable in Honeywell-Heiland Model 906A-1, 708C, 712C, and 1012 oscillographs.

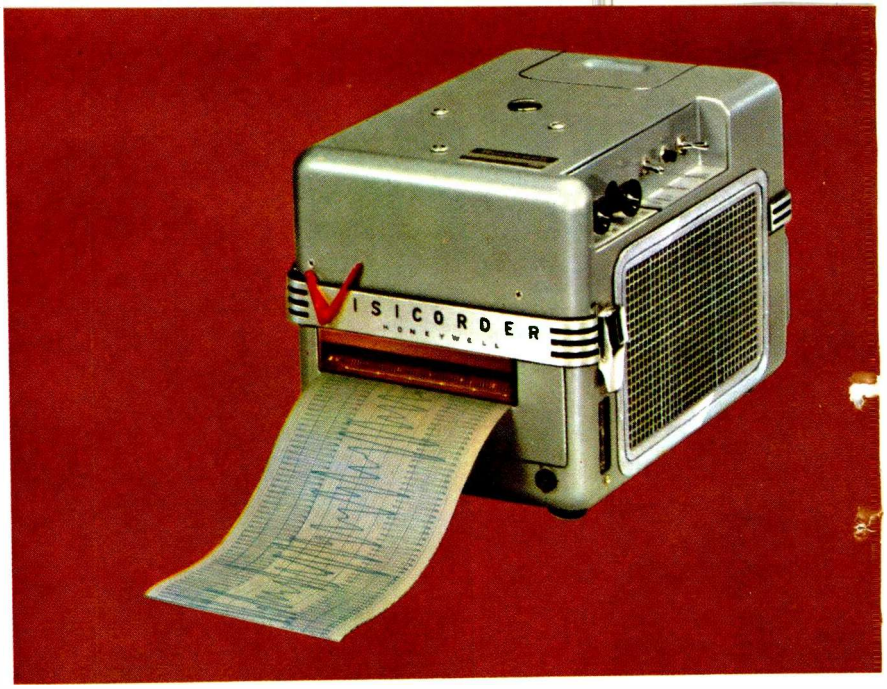
Model 906A-2 The basic instrument with "solid-frame" galvanometers and magnet bank from the original Model 906 Visicorder, providing for 8 channels of data to be directly recorded at frequencies from DC to 2000 cps. Galvanometers interchangeable in Model 906 Visicorder.

Reference Data: Write for Visicorder Bulletin

Minneapolis-Honeywell Regulator Co.,
Industrial Products Group, Heiland Division
5200 E. Evans Ave., Denver 22, Colo.

Honeywell

Heiland Division



Factory-installed optional equipment for both models includes:

Reducing collector lens to reduce static trace width to a minimum and concentrate maximum light source energy on galvanometers for normal writing speeds.

Standard collector lens to concentrate maximum light source energy on galvanometers for high writing speeds.

Recording intensity control to reduce spot intensity and record-trace breadth at low record travel and writing speeds.

Trace identification of the light-beam interruptor type for positive trace identification.

Grid line system—this exclusive feature provides longitudinal reference lines recorded simultaneously with data traces.

Timing unit provides timing pulses on .01, 0.1, or 1.0 second intervals.

Additional accessories for both models include:

Timing galvanometer provides maximum-density time lines (906A-1 only).

Record drive systems—your choice of 5 interchangeable systems, each covering 4 speeds.

Collector lenses (standard or reducing), recording intensity control, trace identifier, grid-line system (see above).

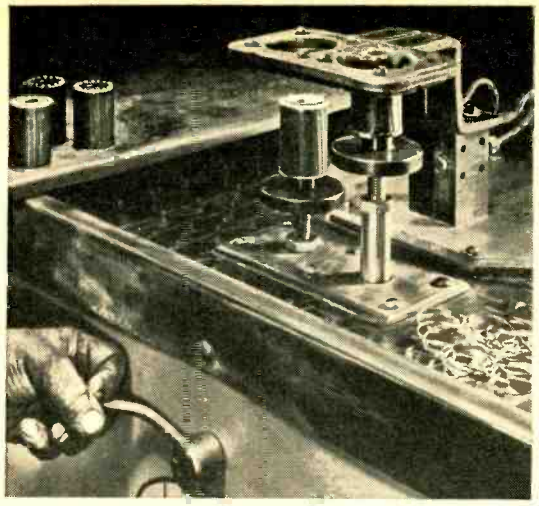
Relay rack adapters, bracket or gusset type.

Record takeup and latensifier to respool record paper after latensifying.

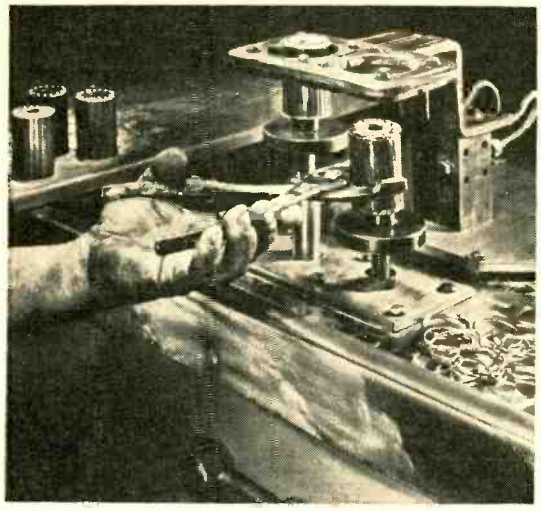
Record takeup unit to respool record paper.

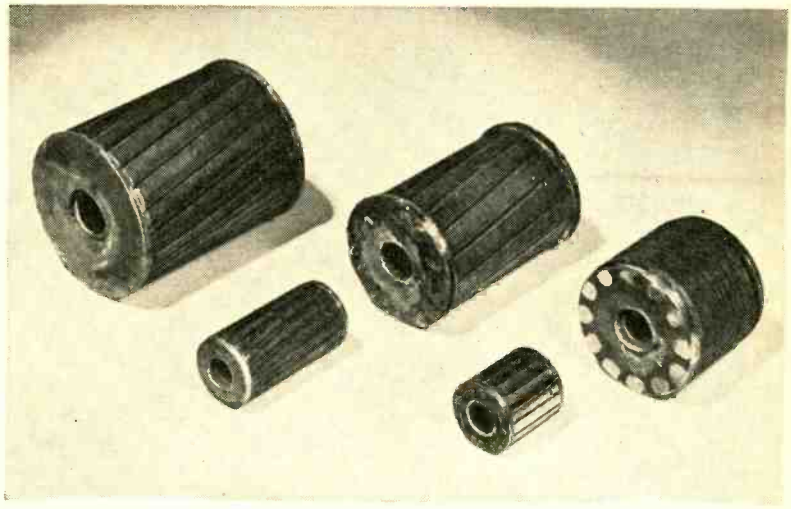
USES OF THE VISICORDER

- *In control* for continually monitoring and recording reference and error signals.
- *In nuclear applications* to monitor and record temperatures, pressures, and other phenomena.
- *In production test* to provide a final dynamic inspection of electrical and mechanical devices.
- *In computing* to provide immediately-readable analog recordings.
- *In pilot and component testing* to accomplish more rapid evaluation of design and prototypes.
- *In medical applications* for dynamic blood pressures, electrocardiograms, and other physiological measurements.
- *In all test applications* which involve the assembly of considerable equipment and the gathering of personnel, the immediate Visicorder record will prove the success of the test at once before the test equipment is dispersed.



Handy & Harman Sil-Fos Silver Brazing is Used by Induction Motors Corp. in 5427 Different Motors





FIRST, BULLETIN 20

This informative booklet will get you off to a good start on the values, techniques and economies of low-temperature silver brazing. A copy awaits your request.

Induction Motors Corp. of Westbury, New York, and Maywood, California, has built an outstanding reputation as a designer and manufacturer of sub-fractional horsepower motors...for 5427 high performance reasons.

This large variety of motors, blowers and fans for an equally large variety of applications, stems from 15 basic motor frame sizes, depending on length, pole materials, windings, groove angles and the like.

Handy & Harman silver alloy brazing is concerned with brazing the rotors. Each rotor (whatever the size) is joined by a preformed ring of Handy & Harman SIL-FOS, by induction heating – at an alloy cost that is reckoned in pennies. For example, the alloy cost per ⅞" frame is two cents per joint, or four cents per complete assembly.

That's an example of the economics of silver alloy brazing. Performance requirements are quite another thing – and they are unquestionably stringent. Many of these motors are used in aircraft and missile work and must, of course, meet the most extreme environmental conditions.

Strength alone would be reason enough to discuss the merits of silver alloy brazing . . . and to point out as a reason for its wide acceptance throughout industry. The facts are that there are many more benefits; gas- and leak-tightness, thermal and electrical conductivity, ductility, and production economy – are all *joint qualities* of silver alloy brazing. At any time, we will be happy to discuss any or all of these qualities (and others), as applied to your product or production method. The benefits are large and you can enjoy them.

Your No. 1 SOURCE OF SUPPLY AND AUTHORITY ON BRAZING ALLOYS

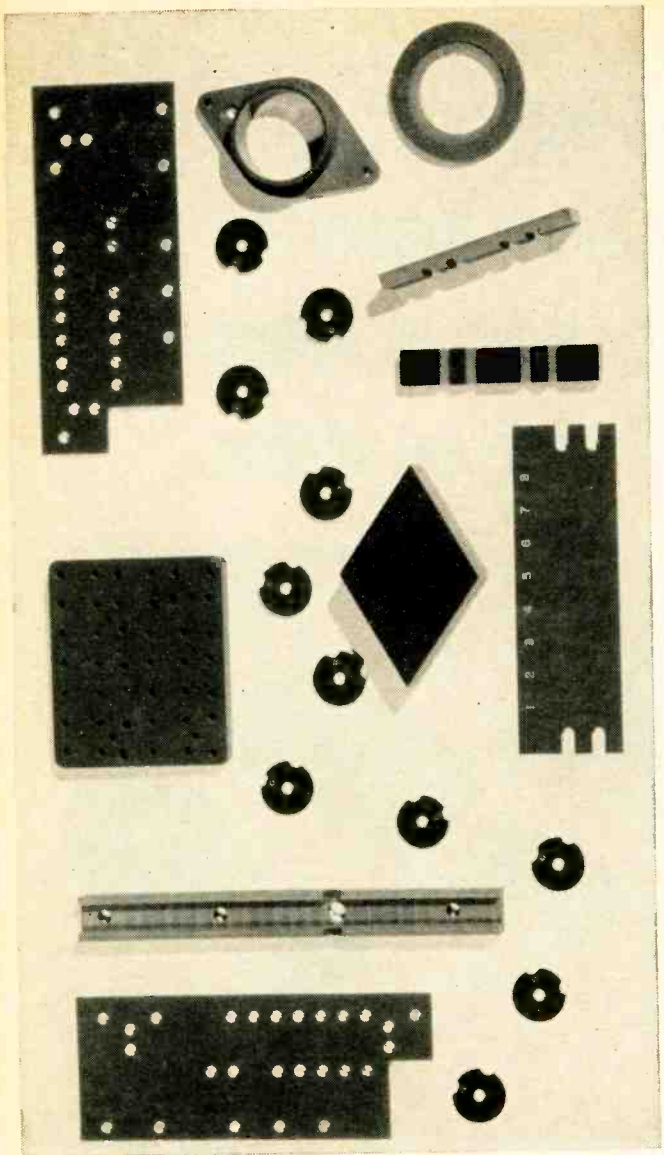
HANDY & HARMAN
FOUNDED 1867
QUALITY · SERVICE

HANDY & HARMAN

General Offices:
82 Fulton Street, New York 38, N. Y.
Distributors in Principal Cities

Offices and Plants: Atlanta, Georgia • Bridgeport, Connecticut • Chicago, Illinois • Cleveland, Ohio • Detroit, Michigan • El Monte (Los Angeles), California Oakland, California • Providence, Rhode Island • Toronto, Canada • Montreal, Canada

←CIRCLE 27 READERS SERVICE CARD CIRCLE 28 READERS SERVICE CARD



Fabricated by CDF. Near the presses that produced the Dilecto laminates, these paper-base parts were machined to close tolerances by CDF specialists . . . quickly, accurately, economically for the purchasers. This is a random selection from the five grades described in the table below.

CDF Dilecto® paper-base laminates for the workhorse insulation jobs

For everyday mechanical-electrical parts that receive tough punishment and must have excellent physical and dielectric properties at low cost, the CDF phenolic paper-base line is outstanding.

Economy. CDF paper-base grades machine readily into intricate parts. Some are flame-retardant. Others are especially adaptable for punching. All are economical for the value delivered.

Fabrication Facilities. CDF has excellent and extensive plastics-fabrication facilities for turning out finished Dilecto parts to your specifications—better and more economically than you can do it yourself. Save the time and trouble of intricate fabrication by using CDF's specialized facilities.

See Sweet's, Electronics Buyers' Guide, and the other directories for the phone number of the CDF sales engineer nearest you. Or send us your print or problem direct, and we'll return a recommendation of the right Dilecto grade for your need.

CDF makes Di-Clad* printed-circuit laminates, Diamond® Vulcanized Fibre, CDF products of Teflon†, flexible insulating tapes, Dilecto® laminated plastics, Celoron® molded products, Micabond® mica products, Spiral Tubing, Vulcoid®.

*Trademark of Continental-Diamond Fibre Corporation
†Du Pont trademark for its TFE-fluorocarbon resin

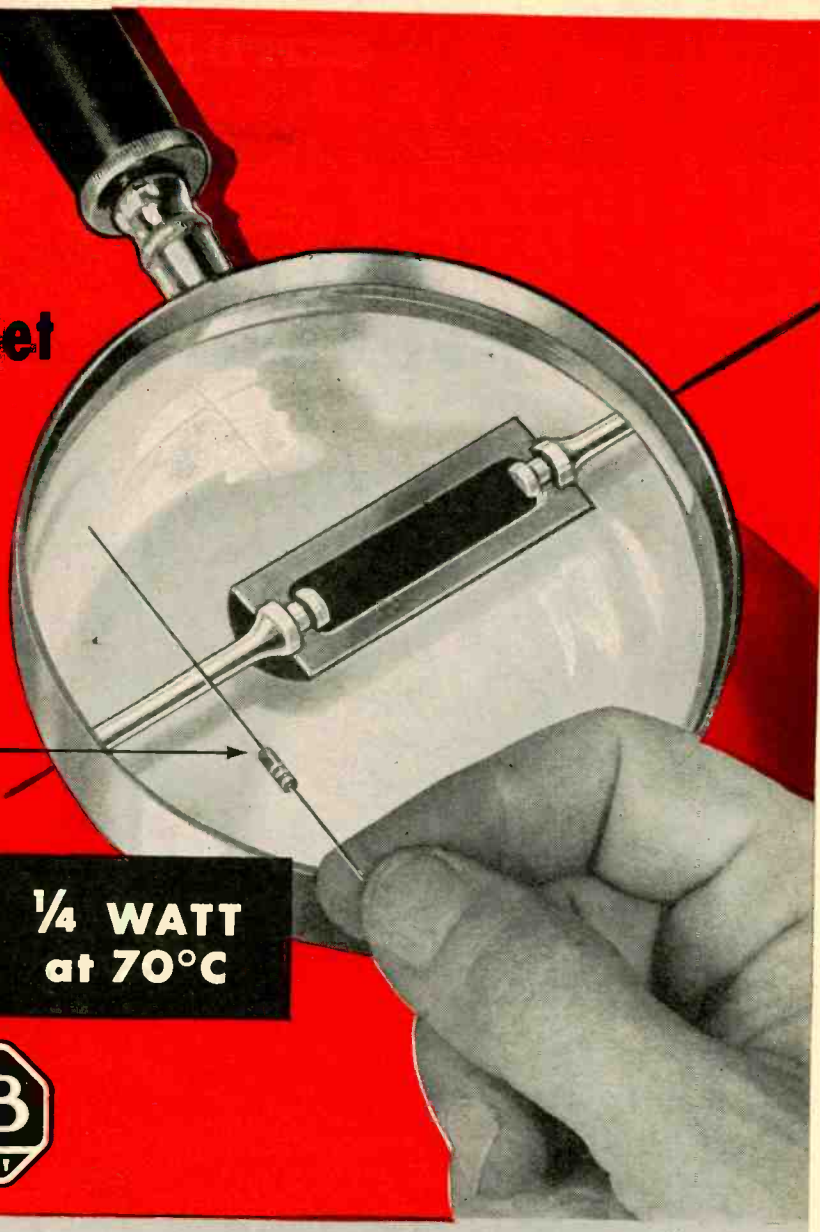
CONTINENTAL-DIAMOND FIBRE
A SUBSIDIARY OF THE Budd COMPANY • NEWARK 16, DEL.

Typical Property Values—Dilecto Paper-Base Laminates in Sheet Form

	X-13 (NEMA X)	XP-13 (NEMA P)	XX-13 (NEMA XX)	XX-13 FR (Fire-retardant) (NEMA XX)	XXXP-28 (NEMA XXXP)
ROCKWELL HARDNESS	100	95	110	108	90
TENSILE STRENGTH lw (1000 psi.)	20	12	16	17	12
FLEXURAL STRENGTH lw (1000 psi.)	27	16	17	20	18
COMPRESSIVE STRENGTH (1000 psi.)	40	25	35	41	22
WATER ABSORPTION (% in 24 hrs.) 1/16" thickness	3.5	3.0	1.4	1.2	0.6
MAXIMUM CONTINUOUS OPERATING TEMPERATURE (°C.)	120	120	120	120	120
DIELECTRIC STRENGTH perp. to lam. (VPM)	800	800	650	700	800
DIELECTRIC STRENGTH parallel to lam. (Kv.)	50	50	60	70	75
DISSIPATION FACTOR at 1 mc, Cond. A	0.042	0.038	0.034	0.038	0.027
DIELECTRIC CONSTANT at 1 mc, Cond. A	5.5	4.6	4.7	4.8	3.6
ARC-RESISTANCE (seconds)	8	4	4	10	10
INSULATION RESISTANCE (megohms) ASTM D-257, Fig. 3	100	100	1,000	1,000	600,000
AIEE insulation class	A	A	A	A	A

The same hot-molded insulating jacket as larger Allen-Bradley resistors

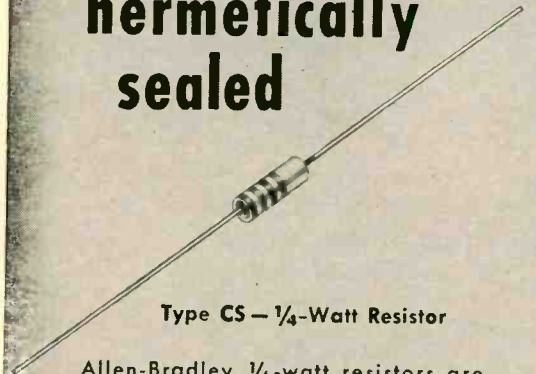
yet it's only ¼ inch long!



TYPE CB **¼ WATT at 70°C**

A-B QUALITY

Also hermetically sealed



Type CS — ¼-Watt Resistor

Allen-Bradley ¼-watt resistors are available enclosed in a ceramic tube with high temperature end seals, making them impervious to humidity and moisture. Derated linearly from +70°C rating to 0 at +150°C. Available in 2% and 5% tolerances, and in resistance values from 47 ohms to 22 megohms.

These ¼-watt composition resistors—ONLY ONE QUARTER OF AN INCH LONG—have the same hot-molded insulating jacket . . . the same reliability . . . the same physical uniformity . . . that have made the larger Allen-Bradley resistors the quality standard of the electronics industry for so many years!

Although exceptionally small, Allen-Bradley Type CB resistors are rated for continuous operation at 70°C ambient temperatures. The hot-molded insulating jacket of these resistors makes impregnation unnecessary . . . yet it provides the most reliable protection against extended periods of high humidity, as encountered in actual service. Available in all EIA resistance values from 47 ohms to 22 megohms. Tolerances: 5%, 10%, and 20%.

You can save space—with no sacrifice in performance or reliability—when you specify Allen-Bradley Type CB resistors. Write today for complete specifications.

Allen-Bradley Co., 1315 S. First St., Milwaukee 4, Wis.
In Canada: Allen-Bradley Canada Ltd., Galt, Ont.

ALLEN-BRADLEY
QUALITY

HOT-MOLDED COMPOSITION RESISTORS

MICRO SWITCH Precision

"50 PB" Series Lighted Provide More Versatility

MOMENTARY
LONG TRAVEL SERIES

TWO POSITION
ALTERNATE-ACTION SERIES

PUSH-AND-TURN-TO-HOLD
SERIES

MAGNETICALLY-HELD
SERIES

SHORT TRAVEL
ALTERNATE-ACTION SERIES

MOMENTARY SHORT
TRAVEL SERIES

BUTTONS

Buttons for "50 PB" Series switches are available from MICRO SWITCH in four sizes and shapes, as illustrated, and in a selection of colors, as listed.

¾-inch Round. Available in red, yellow, blue, green and white.

⅝-inch Hex. Available in red, yellow, and green.

½-inch Round. Available in red, yellow, blue, green, white and clear.

¾-inch Square. Available in red, yellow, blue, green and white.

Switches have uses unlimited

Pushbutton Switches ...More Flexibility ...Require Less Panel Area

These switches combine indicating light and switch in one unit, have separate lamp and switch terminals for maximum freedom in circuitry, and are available in more than 200 variations to meet your requirements.

The six switches shown are representative of only one of the several families of lighted pushbutton switches. All are panel mounting designs, and are easily mounted on one-inch centers. Indicating light and switch are combined in one unit to further conserve panel space and simplify design. Separate terminals for the light and the switch assure widest circuit adaptability. Basic switching element is the well-known MICRO SWITCH sub-miniature switch. Each is a single-pole double-throw unit. Number of SPDT circuits is given in the description of each series. These switches have qualified under many of the Military environmental specifications.

Request Data Sheet No. 133 which covers all details.

MOMENTARY LONG TRAVEL SERIES

Provides excellent positive "feel" action with long travel—more than ¼ inch including lost motion—to guard against false actuation. The longer travel and positive "feel" action fit the accepted human engineering concept of push-button switch operation. Available in 2-, 3-, or 4-pole construction.

TWO POSITION ALTERNATE-ACTION SERIES

Combines visual mechanical indication and visual electrical indication in one unit. Has simple action with long operating life. Gives excellent positive "feel" in operation. Available in 2-, 3-, or 4-pole construction.

PUSH-AND-TURN-TO-HOLD SERIES

A combination momentary and optionally maintained-contact action switch. Locks and releases with the turn of a fingertip. Available in 2-, 3-, or 4-pole construction.

MAGNETICALLY-HELD SERIES

Combines a switch, a light, and a magnetic coil in one unit. Coil is available in 6, 28, or 48 vdc. Coil, lamp and switch terminals are electrically isolated. Energizing of coil does *not* operate switch, but does hold switch in ON position after manual operation. De-energizing of coil returns switch to normal. Available in 2-, 3-, or 4-pole construction.

SHORT TRAVEL ALTERNATE-ACTION SERIES

Push to turn "on," push to turn "off." In this series, the back-of-panel space is 2¼ inches. Available in 2-pole construction only.

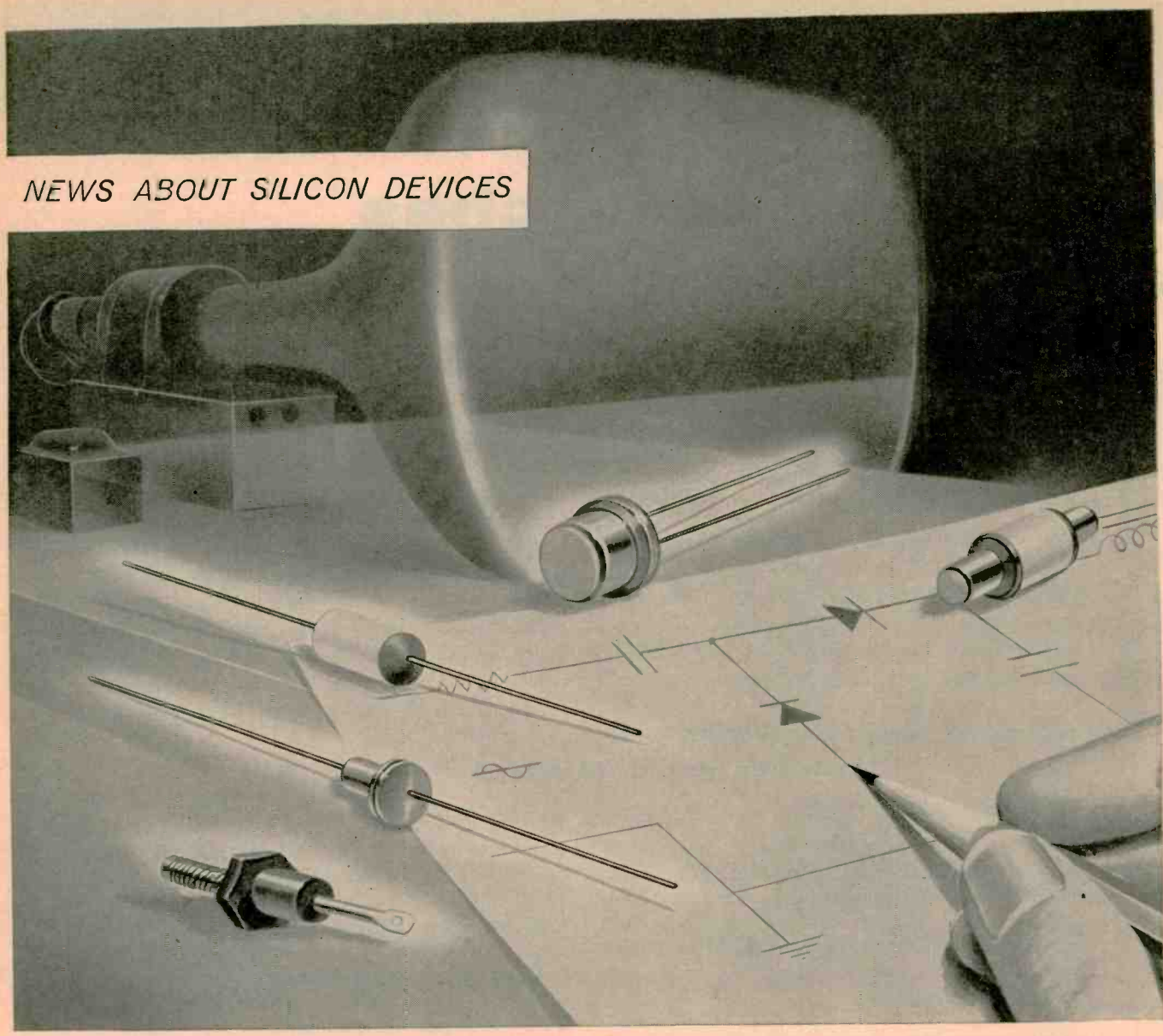
MOMENTARY SHORT TRAVEL SERIES

A short-length switch with back-of-panel length less than 2 inches. Available in 2-, 3-, or 4-pole construction.

MICRO SWITCH . . . FREEPORT, ILLINOIS
In Canada: Leaside, Toronto 17, Ontario
A division of Honeywell

The two-word name MICRO SWITCH is NOT a generic term. It is the name of a division of Honeywell.

Honeywell
MICRO SWITCH PRECISION SWITCHES



Reverse current: 10^{-7} amp. Rectification ratio: 10,000,000:1

Now... new efficiency for TV power supplies with dependable diodes of Du Pont Hyperpure Silicon

More efficient power supplies . . . savings in space and weight . . . important reasons why TV manufacturers are replacing conventional rectifying systems with silicon diodes. Today, several types of silicon diodes and rectifiers are readily available for TV circuits. TV manufacturers have tested silicon rectifiers and report no noticeable change in output voltage under continuous load conditions over long periods of time. Silicon components can operate in ambients from −65° to 150° C. They maintain excellent electrical stability and resist aging.

Silicon components have high shock and vibration limits. They are up to 99% efficient in units operated at 60 cps. and require little maintenance. Silicon cells permit a rectification ratio as high as 10 million to 1—almost negligible reverse conductance. Silicon bridges are available with ratings from 1 to 1,000 amperes and more than 600 volts rms.

Note to device manufacturers: You can produce silicon transistors, rectifiers and diodes of the highest quality with Du Pont Hyperpure Silicon. It's now available in three grades for maximum efficiency and ease of use . . . with a purity range of 3 to 11 atoms of boron per billion. Technical information on crystal growing is available from Du Pont . . pioneer producer of semiconductor-grade silicon.

NEW BOOKLET ON DU PONT HYPERPURE SILICON

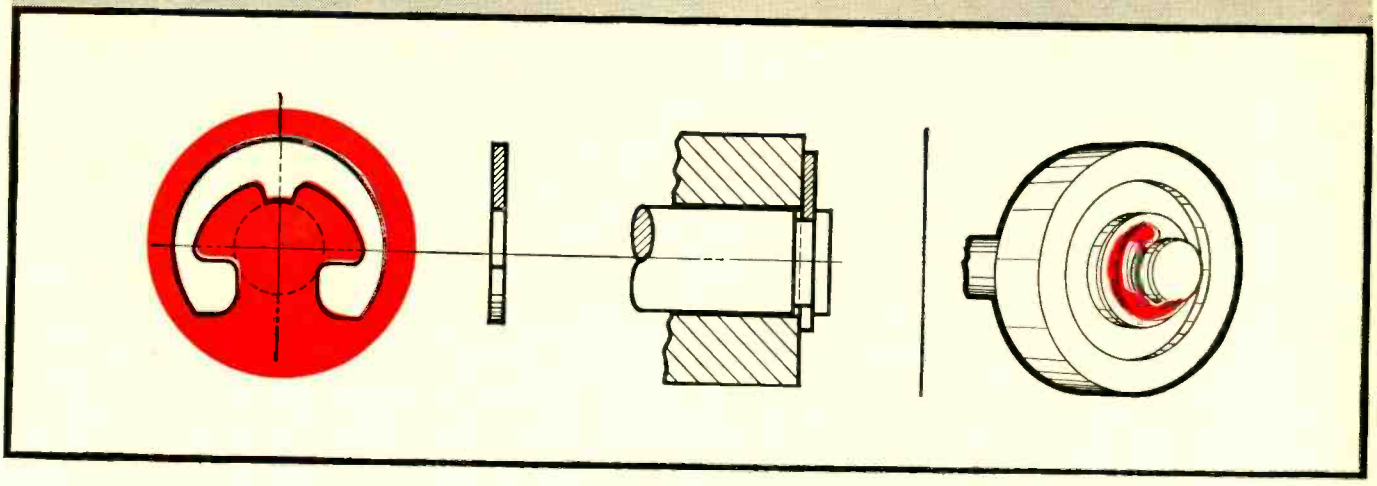
You'll find our new, illustrated booklet about Hyperpure Silicon helpful and interesting—it describes the manufacture, properties and uses of Du Pont Hyperpure Silicon. Just drop us a card for your copy. E. I. du Pont de Nemours & Co. (Inc.), Pigments Department, Silicon Development Group, Wilmington 98, Delaware. (This offer limited to United States and Canada.)

PIGMENTS DEPARTMENT

DU PONT HYPERPURE SILICON

BETTER THINGS FOR BETTER LIVING . . . THROUGH CHEMISTRY

New Waldes Truarc Reinforced "E-ring" Provides 5 Times More Gripping Power, 50% Higher RPM Limits Than Conventional E-Type Rings



The new Waldes Truarc Series 5144 is a radially-installed reinforced "E-ring." It is designed for use in assemblies where the ring is subject to strong push-out forces resulting from heavy vibration and shock loads, high rotational speeds or relative rotation between the retained parts.

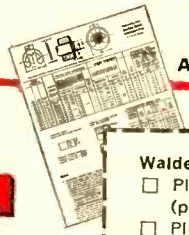
Series 5144 provides the following application advantages over conventional E-type fasteners:

1. GREATER GRIPPING STRENGTH—approximately five times greater than conventional "E-rings" of the same metal and thickness.
2. HIGHER RPM LIMITS—approximately 50% higher in most sizes.
3. POSITIVE LOCKING IN THE GROOVE—large corner radii or chamfers can be accommodated without separator washers.
4. LOWER GROOVE COSTS—because recommended groove tolerances have been increased, machining grooves for the series 5144 is less expensive.
5. WIDER APPLICATION—because series 5144 rings made of aluminum are stronger than conventional "E-rings" made of steel, the fastener may be used in applications where corrosion resistance or weight are factors.

Truarc Series 5144 Reinforced "E-rings" are available for shaft diameters from 3/32—7/16 in. in carbon spring steel, stainless steel, beryllium copper, aluminum, and phosphor bronze. They are available stacked on rods for high speed installation with Truarc applicating and dispensing equipment.

As in all Truarc rings, you get statistically controlled quality from engineering and raw materials to the finished product. Complete selections are available from leading OEM distributors in 90 stocking points throughout the U. S. and Canada. Design Engineering Service is available to you. Send us your blueprints. Let our Truarc engineers help you solve design, assembly and production problems...without obligation.

SEND FOR FREE SAMPLES AND ENGINEERING DATA



WALDES

TRUARC®

RETAINING RINGS

WALDES KOHINOOR, INC., LONG ISLAND CITY 1, N. Y.

Waldes Kohinoor, Inc., 47-16 Austel Place, L.I.C. 1, N.Y.
☐ Please send me sample Reinforced "E-rings." (please specify shaft size)_____
☐ Please send me Engineering Data Sheet

Name_____

Title_____

Company_____

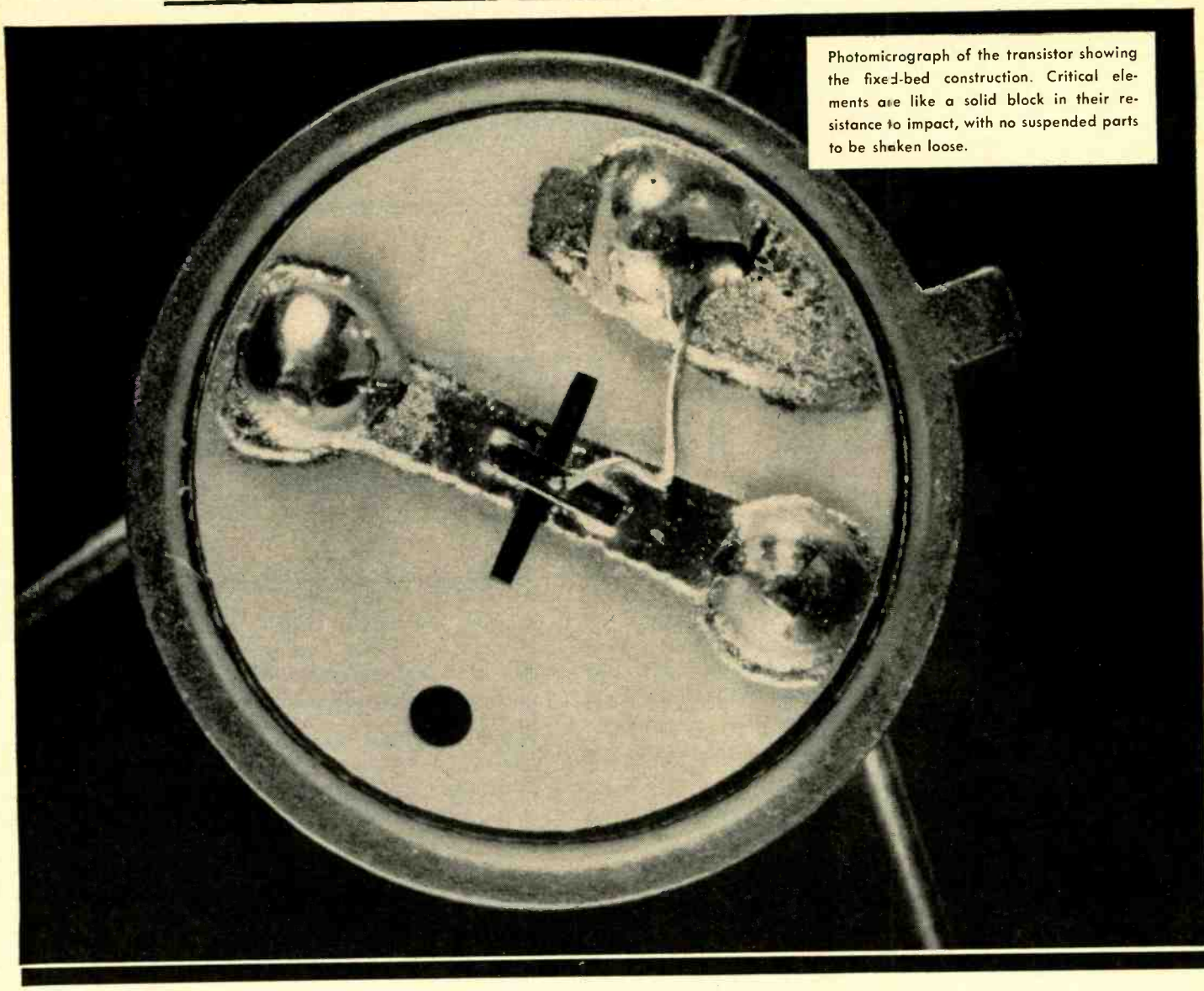
Business Address_____

City_____ Zone_____ State_____

E-060

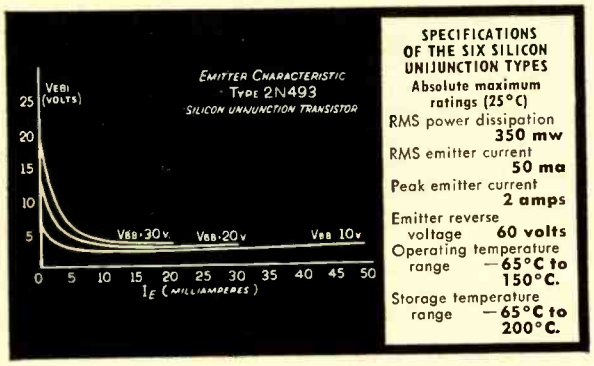
Consult the Yellow Pages of Your Telephone Directory for Name of Local Truarc Factory Representative and Authorized Distributor. Look under "Retaining Rings" or "Rings, Retaining."

New fixed-bed mounting withstands



Photomicrograph of the transistor showing the fixed-bed construction. Critical elements are like a solid block in their resistance to impact, with no suspended parts to be shaken loose.

New data on the silicon Unijunction transistor



SPECIFICATIONS OF THE SIX SILICON UNIJUNCTION TYPES

Absolute maximum ratings (25°C)

RMS power dissipation	**350 mw**
RMS emitter current	**50 ma**
Peak emitter current	**2 amps**
Emitter reverse voltage	**60 volts**
Operating temperature range	**—65°C to 150°C.**
Storage temperature range	**—65°C to 200°C.**

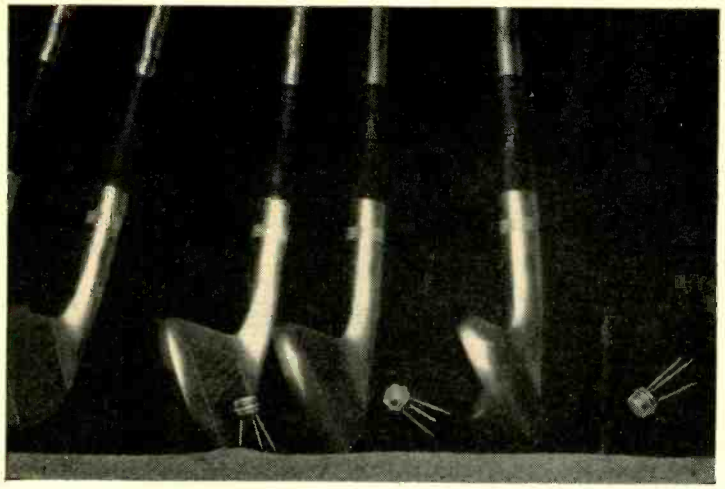
The unijunction features open-circuit-stable negative resistance characteristics. In switching and oscillator applications, one unijunction not only does the work of two transistors with less circuitry, but the circuit is also more stable over a wide temperature range.

To help you in your use of the unijunction, a new series of curves has been developed as shown. It points up emitter characteristics at different base-to-base voltages. The unijunction is also the first G-E transistor to be converted to the new impact-resistant Fixed-Bed Mounting process as described above.

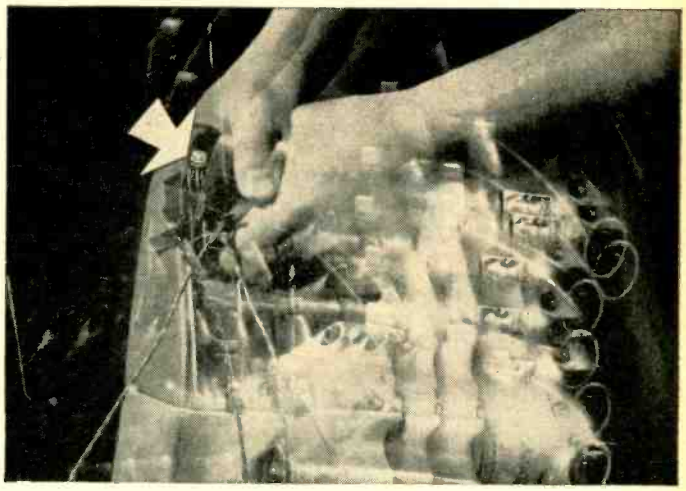
Please send for complete data on the six unijunction types — sample circuits, theory and specifications.

YOUR G-E SEMICONDUCTOR SALES REPRESENTATIVE will be glad to give you further information and specifications on General Electric transistors and rectifiers. Spec sheets, bulletins, and other data can also be obtained by writing Section S2578, Semiconductor Products Dept., General Electric Company, Electronics Park, Syracuse, N. Y.

tremendous impact and vibration



"GOLF CLUB TEST" General Electric transistors with Fixed-Bed Mounting have been struck full force with a No. 2 Iron. After traveling forty yards, tests showed they still worked perfectly.



"JACKHAMMER TEST" Another G-E transistor with Fixed-Bed Mounting was taped to a pneumatic drill, which was then operated for ten minutes. When the transistor was removed, tests showed it still worked perfectly.

Ceramic disk guards against major causes of transistor failure

In General Electric's new Fixed-Bed Mounting, critical elements of the transistor are welded flat on a disk of ceramic. Thus any impact must be great enough to damage the disk itself before transistor failure can occur. In conventional methods of manufacture, impact need only penetrate the transistor's metal case in order to damage the standard upright header.

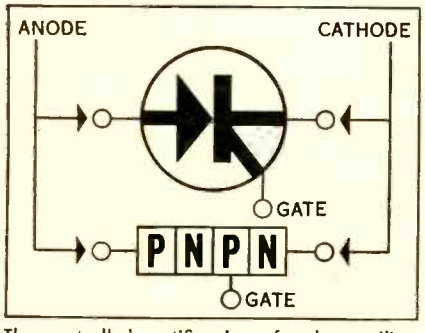
Because of their many suspended parts, standard upright headers are also subject to inertial stress at a number of points. General Electric's Fixed-Bed Mounting eliminated *all but one* of those parts—the suspended aluminum emitter lead. And this is provided with enough slack to absorb inertial stress, with connection points so securely welded that the unit withstands far more than the military centrifuge test of 20,000 G's.

To eliminate thermal stress, the coefficient of expansion of G.E.'s ceramic disk has been made equal to that of the semiconductor metal. Previously, enough "play" had to be allowed to absorb alternate expansions and contractions, thereby reducing the strength and stability of the unit.

The Fixed-Bed Mounting's electrical elements lie flat, in close contact to the transistor case, providing greater heat conduction out through the case. Therefore, the fixed-bed construction cuts down junction temperature, making it possible to double the power dissipation of the same transistor made with upright-header construction.

Fixed-Bed Mounted units have exceeded all standard shock, centrifuge and temperature-cycling tests. General Electric's unijunction transistor (see below) now has this feature.

New G-E Controlled Rectifier rectifies and controls current up to 5 amperes at 300 v.



The controlled rectifier is a four-layer silicon device with a "gate" to which a signal can be applied to control forward current. It can handle more than one kw of power.

NEED A FEW SEMICONDUCTORS IN A HURRY? Check your local G-E distributor *first*. You'll find his delivery, service facilities and prices are hard to beat.

General Electric's new silicon controlled rectifier acts like a thyratron. In the reverse direction, it's a standard rectifier. But it will also block forward current until either a critical breakover voltage is exceeded or a signal is applied to the third lead. Then it switches to a conducting state and acts as a forward-biased silicon rectifier.

The controlled rectifier can be actuated by a little as 15 mw. Breakdown occurs at speeds approaching a microsecond, after which voltage across the device is so low that current is determined by the load. This enables the user to control a large anode-to-cathode current with an extremely small amount of power, or to switch power from high impedance to low impedance in microseconds.

Applications include replacement of relays, thyratrons, magnetic amplifiers, power transistors and conventional rectifiers. Sample quantities of the controlled rectifier are now available. Prices will be sent on request.

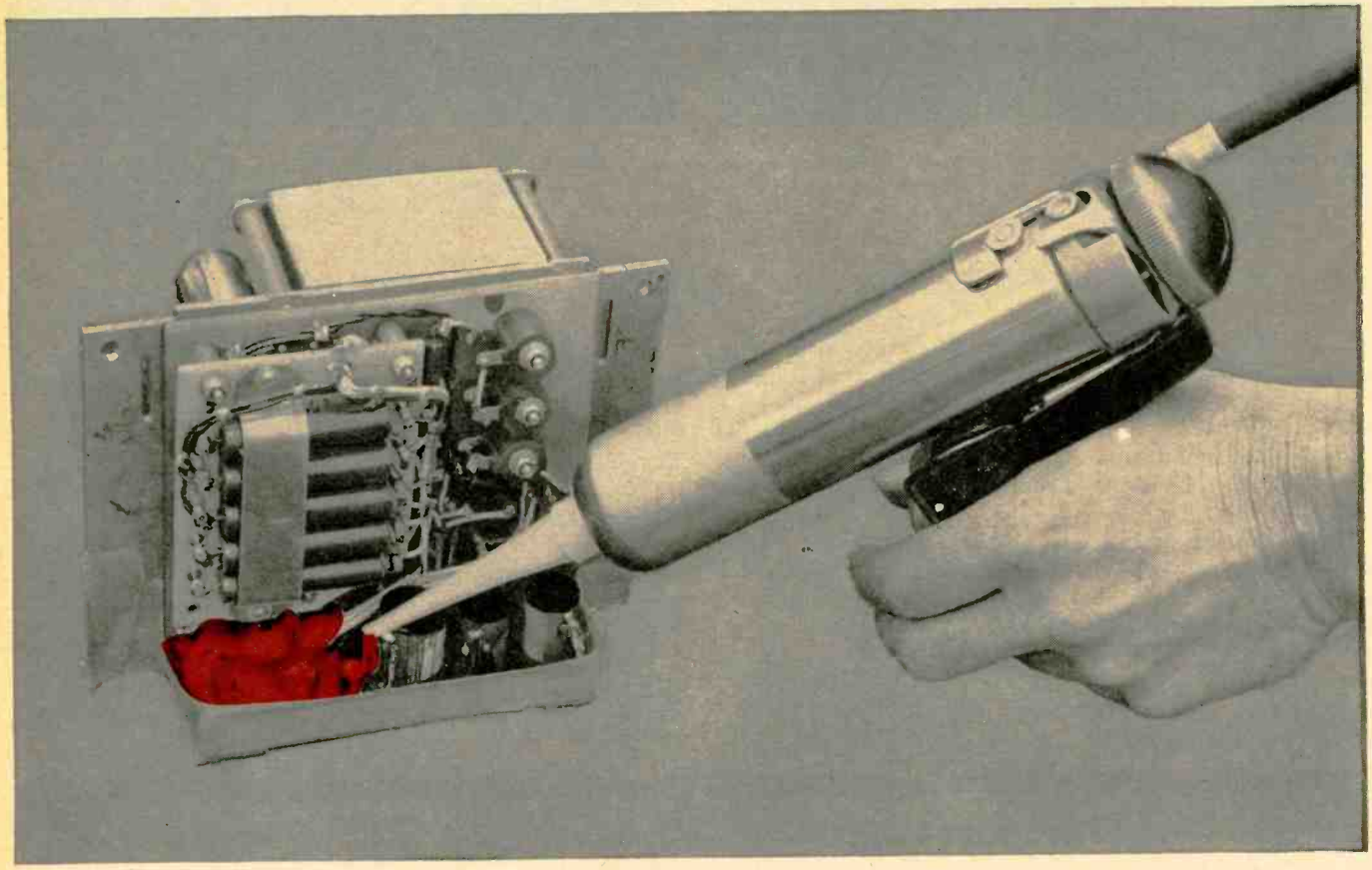
GENERAL ELECTRIC

Design better products with

SILASTIC RTV

SILICONE RUBBER

...seals and cushions delicate circuits



High impedance circuits in Northrop's Snark missile are coated with Silastic RTV for protection against moisture and vibration at temperature extremes. Silastic RTV is easy to apply . . . vulcanizes at room temperature.

Sensitive electronic components are sealed against moisture and cushioned against vibration with a coating of Silastic* RTV, the Dow Corning silicone rubber. Silastic RTV forms a rubbery silicone solid in 24 hours at room temperature. Stays resilient from —70 to 260 C. This "do-it-yourself" material is used for a wide range of encapsulating, potting and caulking applications. Write for free sample and complete information.

If you consider ALL the properties of a silicone rubber, you'll specify SILASTIC.

*T.M.REG.U.S.PAT.OFF.

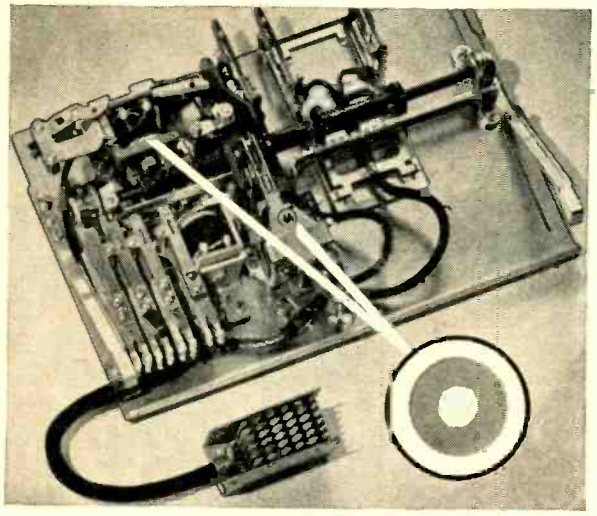
TYPICAL PROPERTIES OF SILASTIC RTV

Temperature range, °C	—70 to 260C
Dielectric strength, volts/mil	300 to 500
Surface resistivity at 50% Relative humidity, ohms	2.8×10^{13}
Dielectric constant, 10^5 cycles per second	2.5
Dissipation factor, 10^5 cycles per second	0.003

first in silicones

Dow Corning CORPORATION
MIDLAND, MICHIGAN

Dow Corning Silicone Dielectrics

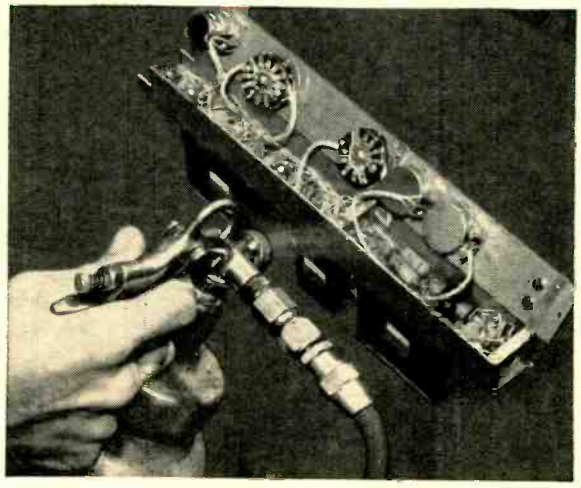


Stromberg-Carlson telephone switch insulator

SILICONE-GLASS LAMINATES INCREASE LIFE AND DEPENDABILITY

Laminates made by bonding glass cloth with Dow Corning silicone resins have high arc resistance, low loss factor, low moisture absorption, excellent retention of dielectric properties at high temperatures. Strong, lightweight—produced by leading laminators.

SILICONE FLUIDS PROTECT ASSEMBLIES FROM MOISTURE

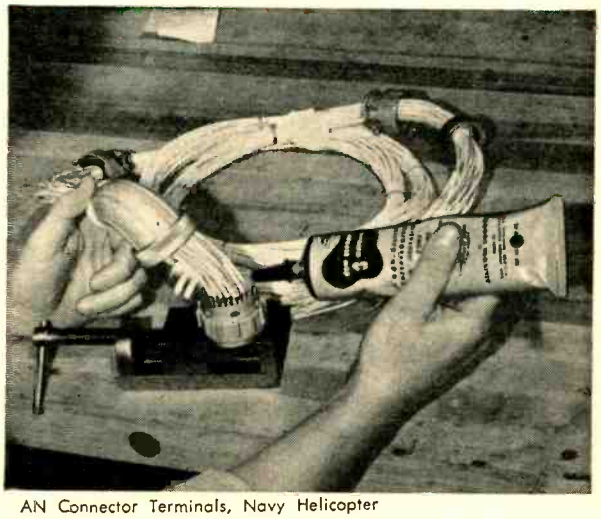


Southwestern Industrial Electronics seismographs

A protective film of Dow Corning 200 Fluid spray coated on electronic assemblies protects terminals, clips, switches and other exposed connections from the harmful effects of condensation. Glass and ceramic insulators coated with silicone fluid have low current leakage and a high degree of surface resistivity, even under very humid conditions.

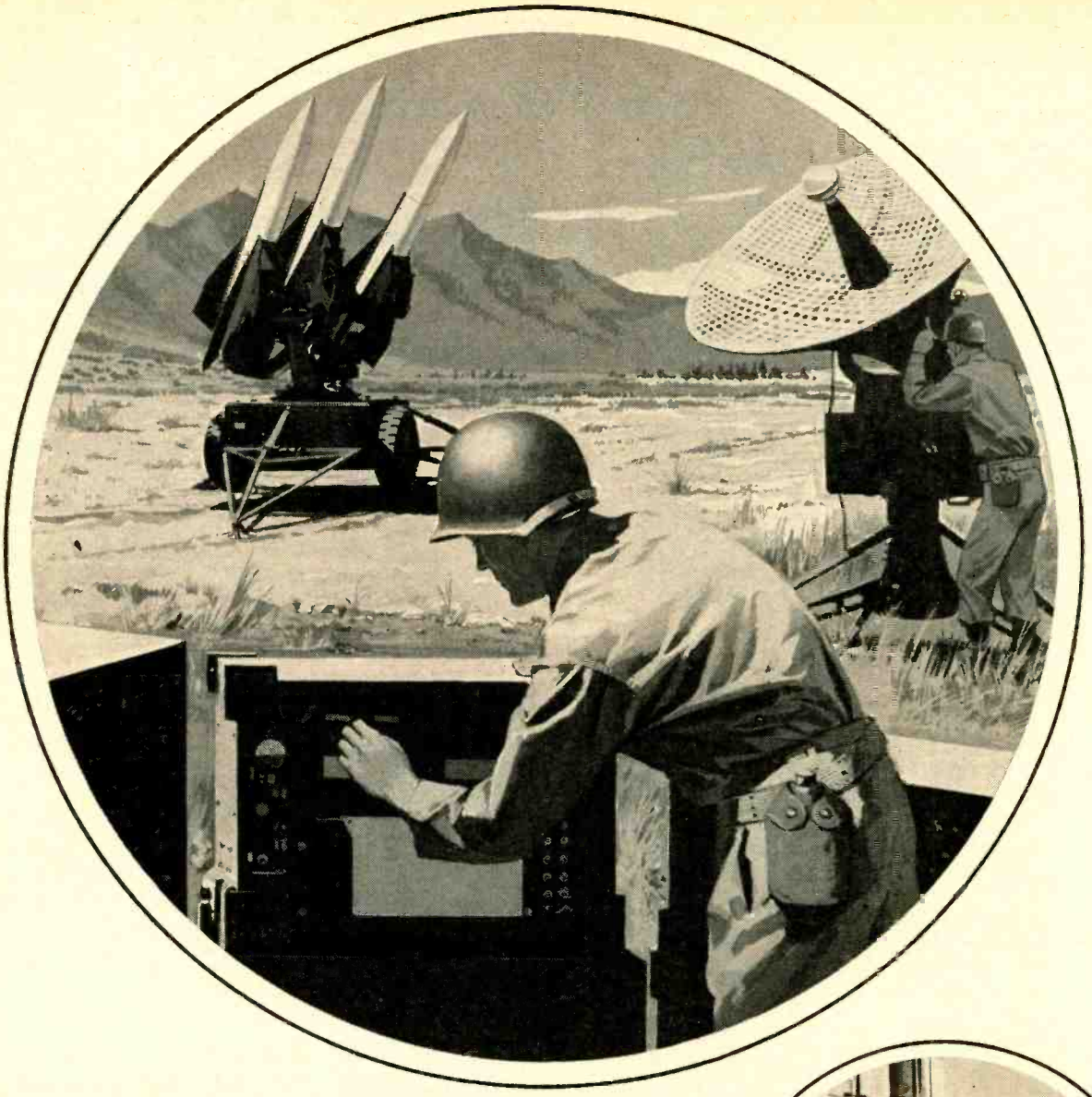
SILICONE COMPOUND PREVENTS ARCS, GROUNDS, SHORTS

Nonmelting, nongumming Dow Corning 3 Compound stays in place . . . provides an effective, moisture-proof dielectric seal for all types of electronic equipment. As a potting or filling material for electronic components and assemblies, silicone compounds flow into place with gentle pressure . . . have a serviceable temperature range of —40 to 205 C. Free sample available.



AN Connector Terminals, Navy Helicopter

For further information on these products write Dept. 486



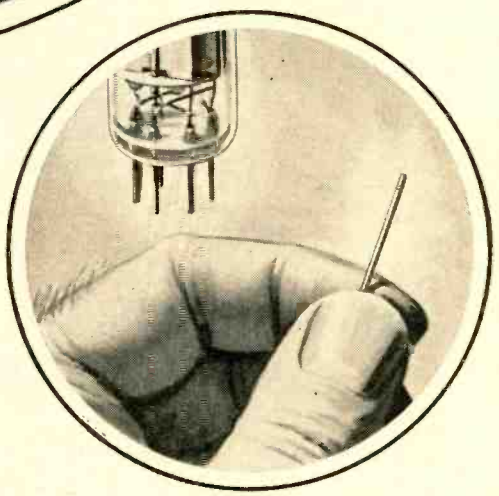
100% stronger cathodes

soak up impact — tubes last far longer

New electronic equipment can be built to take greater abuse than ever. Because with new-type cathodes from Superior Tube, electron tubes can live through far heavier impacts.

These cathodes are made of Superior's recently developed cathode alloy Cathaloy® P-51. Under actual operating conditions, carefully controlled tests prove Cathaloy P-51 to be 100% stronger than standard passive alloys. For the active series, Superior has already provided Cathaloy A-31. In countless high impact applications, now electron tubes can give longer, more dependable service.

Superior Tube engineered this latest advance to help you . . . in line with its constant effort to develop ever better cathodes for the improvement of electron tubes. For information about Superior Cathodes, write for Catalog Section 51, Superior Tube Company, 2500 Germantown Ave., Norristown, Pa.



Magic in Metal. Tiny cathode shown has a blend of exactly the right ingredients to produce new strength, with the desirable electrical characteristics.

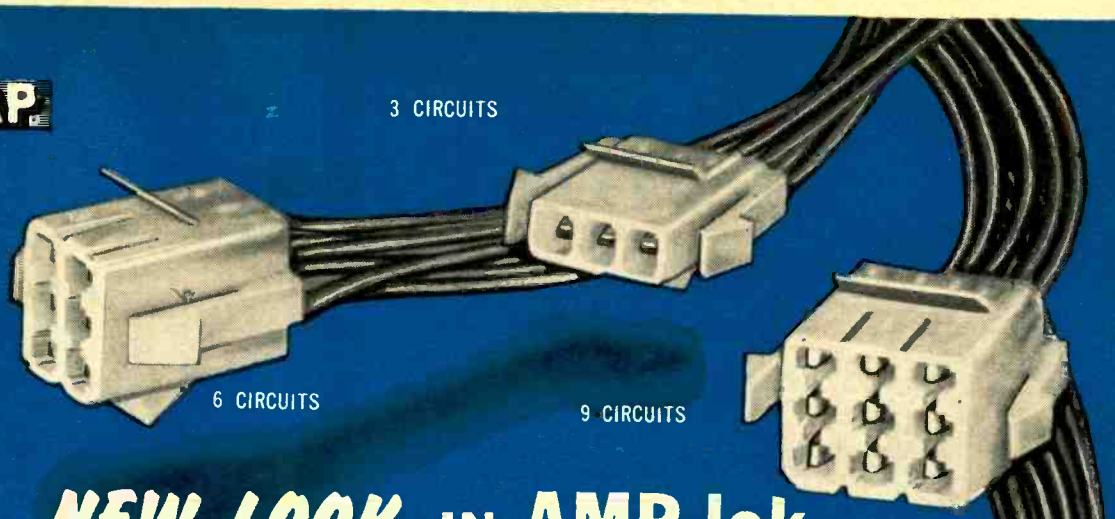
Superior Tube

The big name in small tubing

NORRISTOWN, PA.

Johnson & Hoffman Mfg. Corp., Mineola, N.Y.—an affiliated company making precision metal stampings and deep-drawn parts, such as those used in the electron guns that go with this new cathode.

AMP

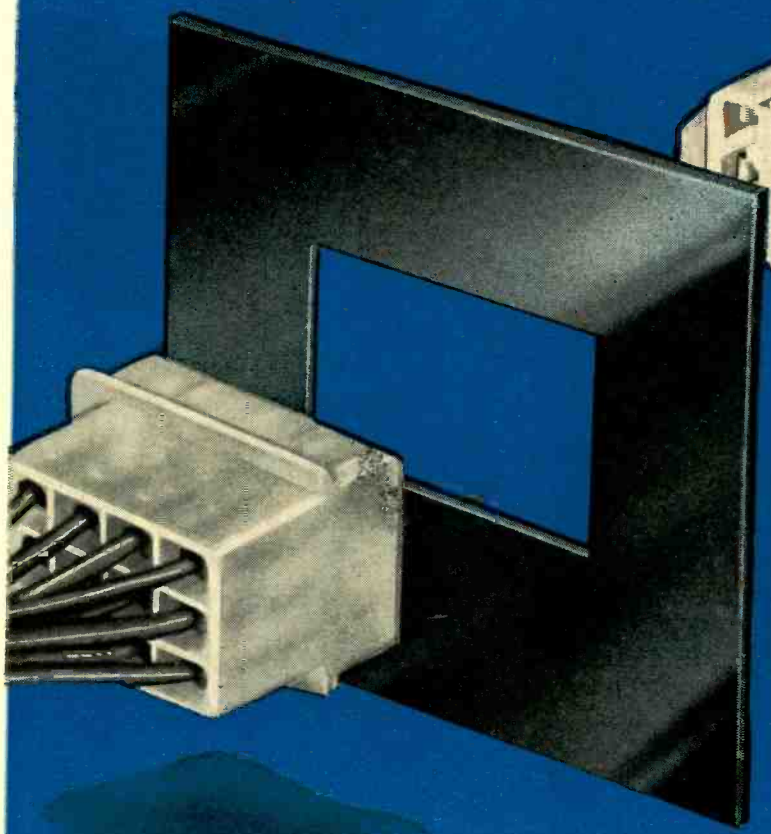


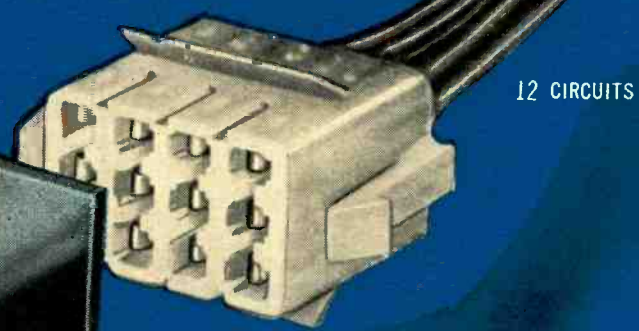
THE *NEW LOOK* IN AMP-lok

Now . . . connect 3, 6, 9 or 12 circuits simultaneously with the AMP-lok multiple connector and a simple push of the fingers.

All units are self-anchoring and require no supplementary mounting parts in through panel multiple connector applications.

AMP-lok can be used as a safe, free-hanging multiple connector also.





AMP-lok obsoletes all it replaces because of the following design features:

- contacts are identical . . . self cleaning . . . recessed for safety
- finger grip engagement and disengagement
- polarized to eliminate circuit error
- wide panel thickness accommodation—one simple mounting hole required
- color coding available

Additional literature and samples available on request.

AMP INCORPORATED

GENERAL OFFICES: HARRISBURG, PENNSYLVANIA

A-MP products and engineering assistance are available through wholly-owned subsidiaries in: Canada • England • France • Holland • Japan

Here profitable products

In ELECTRONICS, editorial features help trigger the creative process

In the fast moving, $7 billion electronics industry, one new idea can easily generate the simultaneous development of several different products. Creativeness most often begins with a circuit design, the schematic diagram that accompanies almost every ELECTRONICS feature article.

Electronics engineers *must* keep abreast of these latest ideas as they develop. The industry's rapid growth demands it. To meet this vital information need, ELECTRONICS publishes two editions on an alternating weekly basis. One is technical, the other a business edition. Between them, they assure complete, timely coverage of all significant data relating to design, production, marketing and management.

Backing 24 full-time ELECTRONICS editors are McGraw-Hill's World News Service and Department of Economics, and 550 business-news reporters at home and abroad. All these editorial services concentrate on speeding the delivery of profitable new ideas to the working electronics engineer.

Creative editorial coverage . . . helping readers spark ideas . . . is the kind of leadership that distinguishes every McGraw-Hill magazine. To reach the key men in your major markets most efficiently and economically, *concentrate* your advertising in the McGraw-Hill magazines serving these fields.

McGraw-Hill Publications

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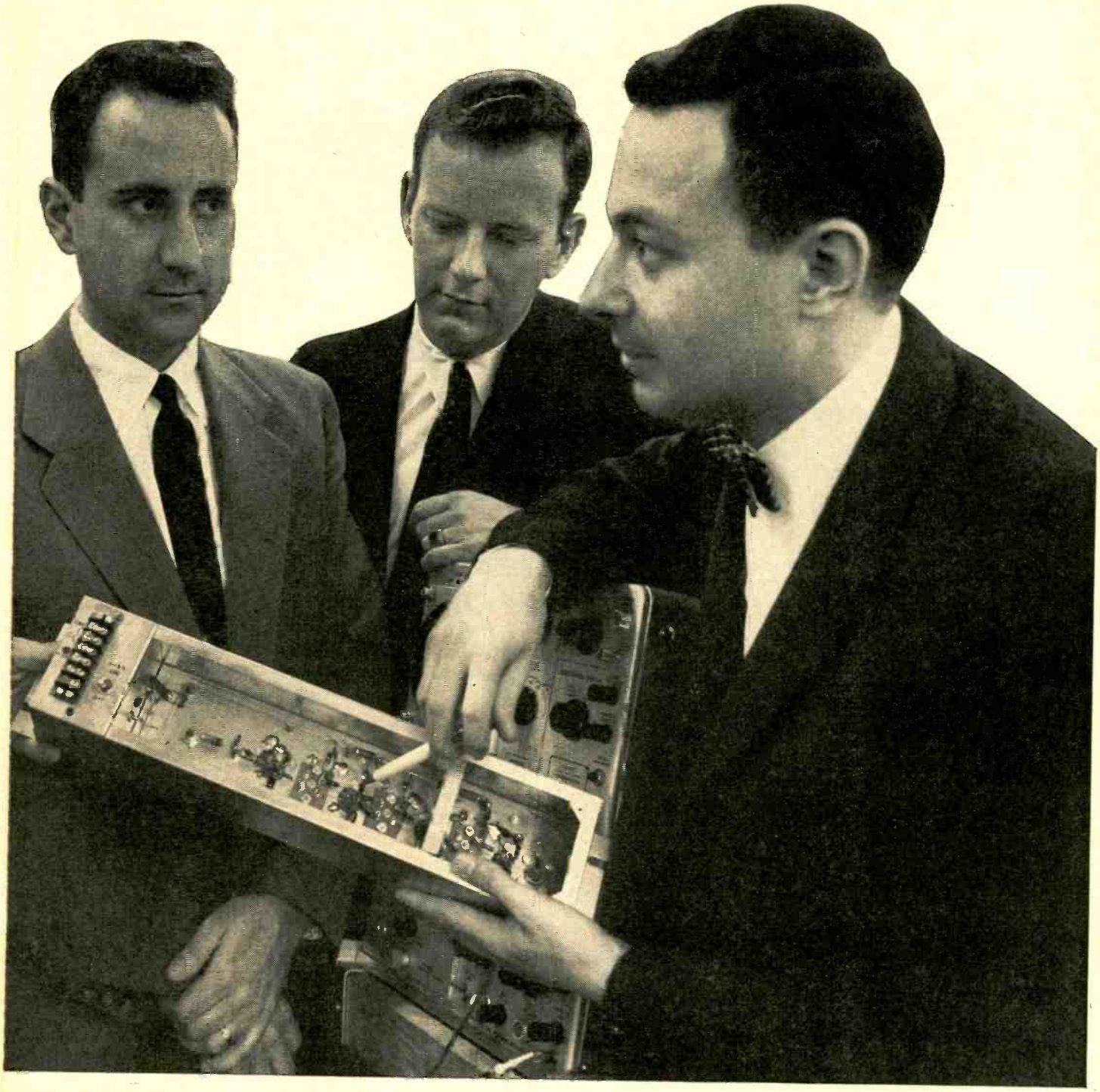
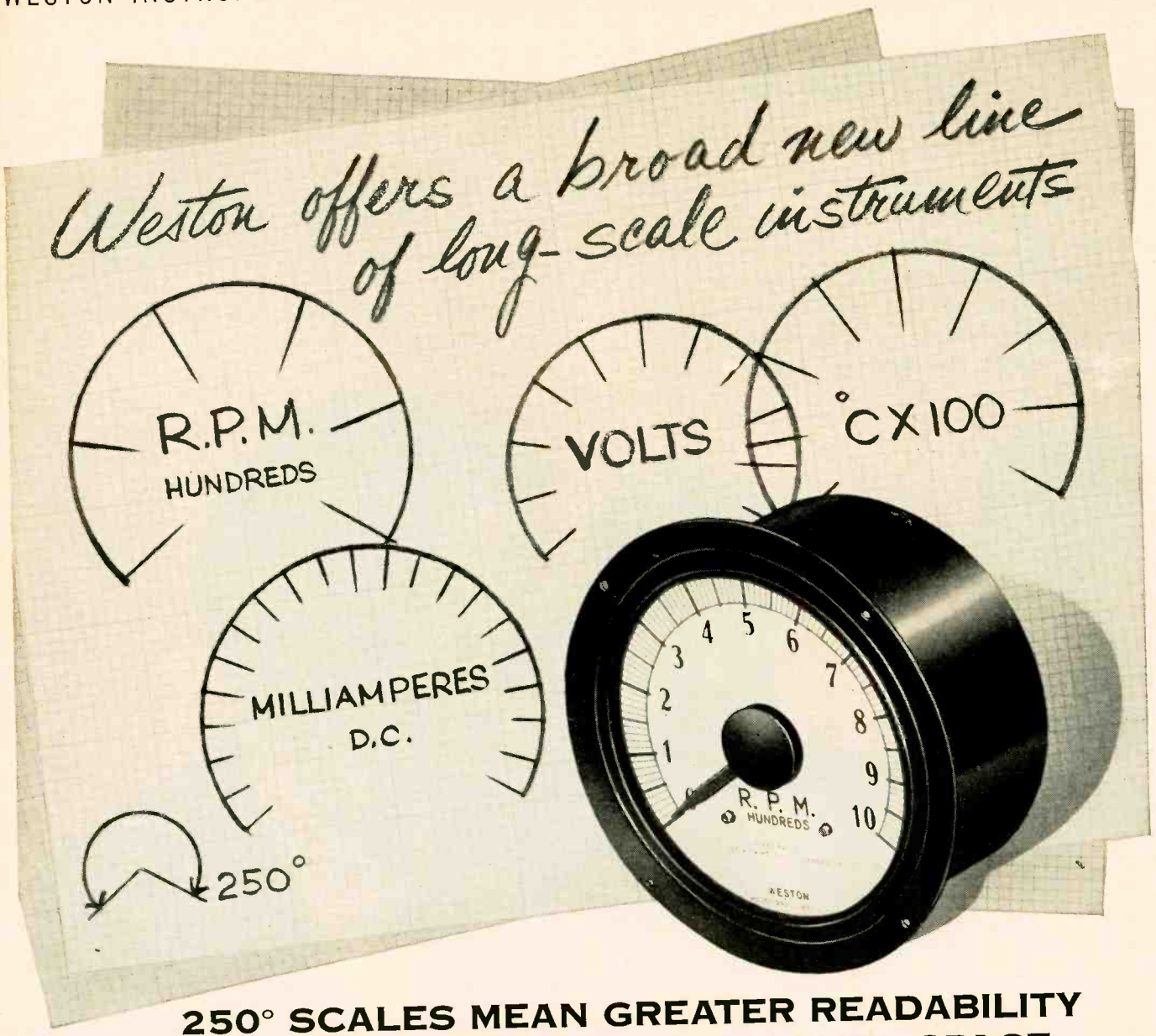
330 West 42nd Street, New York 36, N.Y.

are sparked by ideas

The story of Federal Scientific Corp. demonstrates the explosive growth potential of this industry. In October 1956, ELECTRONICS published a report on a new Search Radar Simulator development. It generated so much interest that the company went into the manufacture of simulation equipment. Here ELECTRONICS' editors Haig Manoogian (*left*) and Ronald Jurgen (*third from left*) examine a special new simulation device with the inventors of the original equipment, Henry Bickel, Vice President, (*second from left*) and Robert Bernstein, consultant to the company. Federal Scientific estimates the sales potential in 1958 as $1 million worth of simulation equipment.



WESTON INSTRUMENTS: STANDARDS OF STABILITY IN SCIENCE AND INDUSTRY



250° SCALES MEAN GREATER READABILITY FROM EACH SQUARE INCH OF PANEL SPACE

Weston's new series of Long-Scale Instruments now fills the requirements of a wide variety of special applications. Rugged, spring-backed-jewel mechanisms are self-shielded for immunity to the effects of stray magnetic fields. The instruments may be mounted without concern for panel thickness or material. Thus, exceptional stability (both mechanical and electrical) teams up with unequalled readability for a new high in panel instrument value. Accuracies are within ±1% of full-scale range.

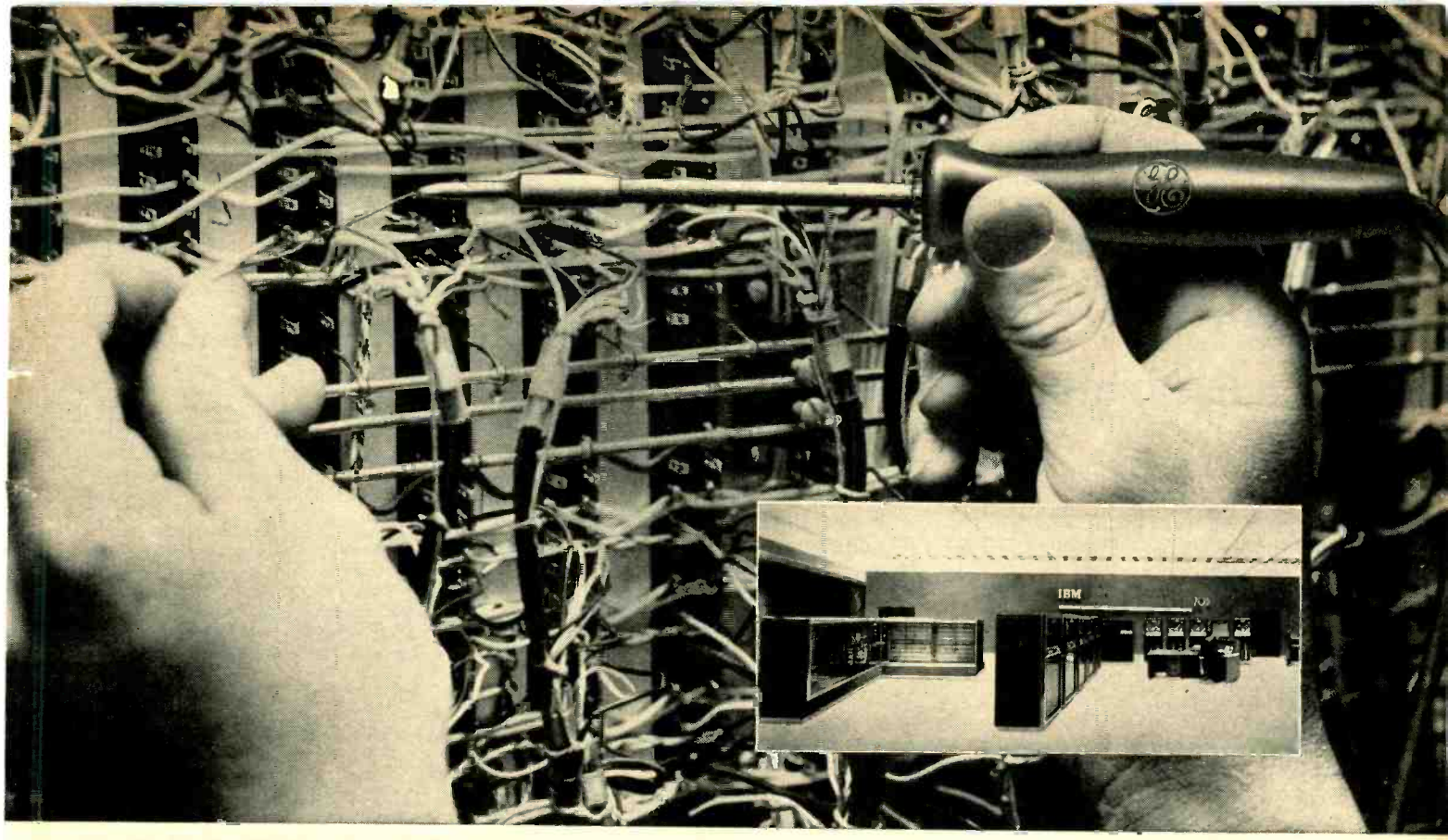
Weston Long-Scale Instruments are available in Aircraft and Standard Flanged cases for a wide range of current, voltage, tachometric and temperature indications. Consult your local Weston representative for complete details on Long-Scale Instruments . . . or write for Catalog A-50. Address: Weston Instruments, Division of Daystrom, Inc., Newark 12, N. J. *In Canada: Daystrom Ltd., 840 Caledonia Rd., Toronto 10, Ont. Export: Daystrom Int'l., 100 Empire St., Newark 12, N. J.*

Take advantage of Weston's unusually fast prototype service!

WESTON *Instruments*

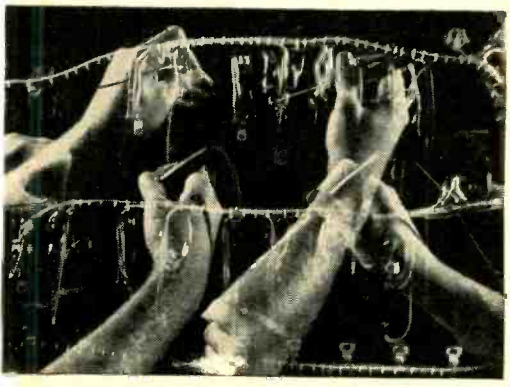
A DAYSTROM UNIT

CIRCLE 43 READERS SERVICE CARD



NEARLY 500 G-E MIDGET SOLDERING IRONS are helping to speed assembly of IBM's giant 704 and 705 "electronic brains" by providing fast, efficient heat to thousands of intricate joints. Each complex data processing machine demands perfectly soldered joints to assure dependable operation. IBM found that the G-E Midget irons provide excellent heat recovery, even with repetitive soldering. Result: uniform temperature with minimum loss of heat from joint to joint. Heat can be varied by simply setting transformer taps. In addition, the G-E Midget is multi-purpose, since tips are interchangeable. Its maneuverable, light-weight design speeds soldering, even in almost inaccessible areas, with reduced risk of damage to adjacent parts.

500 General Electric midget irons speed assembly of giant IBM "Electronic Brains"



FASTER HEAT RECOVERY and lower maintenance of G-E soldering irons have been proved by many manufacturers under their own production conditions—along with competitive soldering irons. If you would like to compare General Electric irons with the irons you are now using, call your G-E distributor.

DELIVERY TODAY is now possible on popular soldering irons and other General Electric heaters and devices from a local distributor near your plant. Your replacement inventory may be reduced. For the name of your nearest stocking distributor for G-E heaters and devices, call your General Electric Apparatus Sales Office.

SAVINGS ACHIEVED by several users and information about the construction features of General Electric soldering irons are included in a new bulletin, "Save While You Solder," GED-3553. For a copy, call your G-E distributor or write Section 724-6, General Electric Company, Schenectady 5, New York.

GENERAL ELECTRIC

CIRCLE 44 READERS SERVICE CARD

VICTOR DIGIT-MATIC PRINTERS

Proved by over 16,000,000 printings without repairing, adjusting or cleaning!

The adding machine in the Digit-Matic has been tested with over 16,000,000 continuous printings, with no failure, no service other than periodic oiling. Forty years of experience in producing 1,500,000 adding machines—as well as precision instruments such as the Norden Bombsight—has given Victor Adding Machine Co. outstanding qualifications for producing rugged and reliable digital printers.

CHECK THESE 4 VICTOR ADVANTAGES

Reliability: Examine the rugged construction of a Victor machine. Each part is conservatively designed to provide extended life and reliability. Wearing surfaces heat treated, cyanide hardened to stand up under constant use. All steel parts cadmium plated to prevent rusting.

Immediate Service: Factory-trained servicemen (and parts) are on call in more than 725 cities coast to coast.

Flexibility: At least 500,000 different combinations available, with speeds up to 33 characters per second. With Victor Digit-Matics you have your choice of listers, accumulators, or calculators *plus* an almost infinite number of other variations ranging from electrical noise filters to upside-down printing.

Fast Delivery, Low Price: Because of Victor's continuous high volume of adding machine production, we can ship almost any quantity of Digit-Matics—built specifically to your order—within 30 days. Victor Digit-Matics, from only $425.00, are the value buy in the digital printer field.

VICTOR SERIAL ENTRY DIGIT-MATIC PRINTER

10 Digit solenoids. Digits are entered in sequence with most significant digit first. Accepts digits at a rate up to 20 per second. Print cycle: listers 0.27 seconds; accumulators 0.35 seconds. Available in up to 11 column entry capacity.

COIL DATA

Voltage	21-28VDC	42-54VDC	125-160VDC
Resistance, ohms			
Digit solenoid	25.5	75.0	490.
+ or − Print solenoid	25.5	75.0	450.
Minimum on time, seconds	.02	.02	.02
Maximum on time, seconds (continuous printing)	.05	.05	.05

Minimum off time between digits—all serial entry machines—.025 seconds.

COVER REMOVED

VICTOR PARALLEL ENTRY DIGIT-MATIC PRINTER

All digits 1 through 9 of each column equipped with solenoids. Digit and print command solenoids may be simultaneously energized. Print cycle:—listers 0.30 seconds; accumulators 0.35 seconds. Available in up to 10 columns entry capacity.

COIL DATA

Voltage	20-28VDC	35-56VDC	125-160VDC	105-125VAC
Resistance, ohms				
Digit solenoid	17.6	53.0	700.	125.
+ Print solenoid	17.6	89.0	375.	125.
− Print solenoid	17.6	53.0	375.	125.
Minimum on time, seconds	.020	.020	.015	.025
Maximum on time, seconds (continuous printing)	.050	.050	.035	.050

A few popular model variations:—columnar spacing; right side of machine accumulating and left side listing data identification; Non-Add printing; Non-printing adding; MIL-I-17623 Electrical Motor Noise elimination; Induction Motors; Manual Keys over the solenoids; "digit key depressed" switch (serial entry Digit-Matics); tag and label printing; and all kinds of alphabetic and special types.

Write today! Victor's electronics-trained staff will gladly help you solve any digital printing or calculating problem.

Write for technical manual No. A6-71.

Electronics Division

VICTOR ADDING MACHINE CO.

3900 N. Rockwell Street, Chicago 18, Ill.

TUNG-SOL POWER TRANSISTORS IMPROVED THREE WAYS BY:

NEW

Cold-Weld SEAL

Tung-Sol's new true cold-weld seal represents a major advance in transistor technology. An exclusive Tung-Sol development, cold-weld sealing increases TO-3 outline package efficiency and brings designers a threefold bonus in over-all transistor performance.

Improved thermal qualities. The cold-weld process produces a hermetic, copper-to-copper seal and makes possible a 100% copper transistor with thermal properties superior to previous high power types.

Improved reliability. Cold-weld encapsulation eliminates heat damage, "splash", and heat-caused moisture that can impair transistor performance.

Longer efficient life. Even through temperature fluctuations that cause "breathing", the cold-weld seal stays vacuum-tight, moisture-proof—result of actual integration of the copper molecules during sealing.

Tung-Sol power switches with the new cold-weld seal withstand the most rigid combination of tests given any transistor—the 100 psi "bomb" immersion test and the critically sensitive Mass Spectrometer leak test. Further, they meet all military environmental requirements. For full data on the improved Tung-Sol types . . . to fill any transistor need, contact: Semiconductor Division, Tung-Sol Electric Inc., Newark 4, New Jersey.

THESE TUNG-SOL HIGH POWER (TO-3 OUTLINE) TRANSISTORS FEATURE THE NEW, COLD-WELD SEAL

Type	BVCES (V_{BE} = +1.0v) Volts (Min)	BVCEO (I_B = 0) Volts (Min)	hFE (I_C = 1.0 A)	hFE (I_C = 2.0 A)
2N378	−40	−20	50	30
2N379	−80	−40	50	30
2N380	−60	−30	70	50
2N459	−105	−60	50	30

TO-3

IMPROVED SPECIFICATIONS OF TUNG-SOL COLD-WELDED HIGH POWER TRANSISTORS.

Collector Dissipation @ 25°C*...50 Watts
Collector Dissipation @ 55°C*...25 Watts
Thermal Resistance.....1.2° C/Watt Max.
I_{CBO} @ V_{CB} = −25v T = 25°C...0.5 Ma Max.
I_{CBO} @ V_{CB} = −25v T = 85°C...7.5 Ma Max.
Storage Temperature.....−55 to +100°C

*Mounting base temperature

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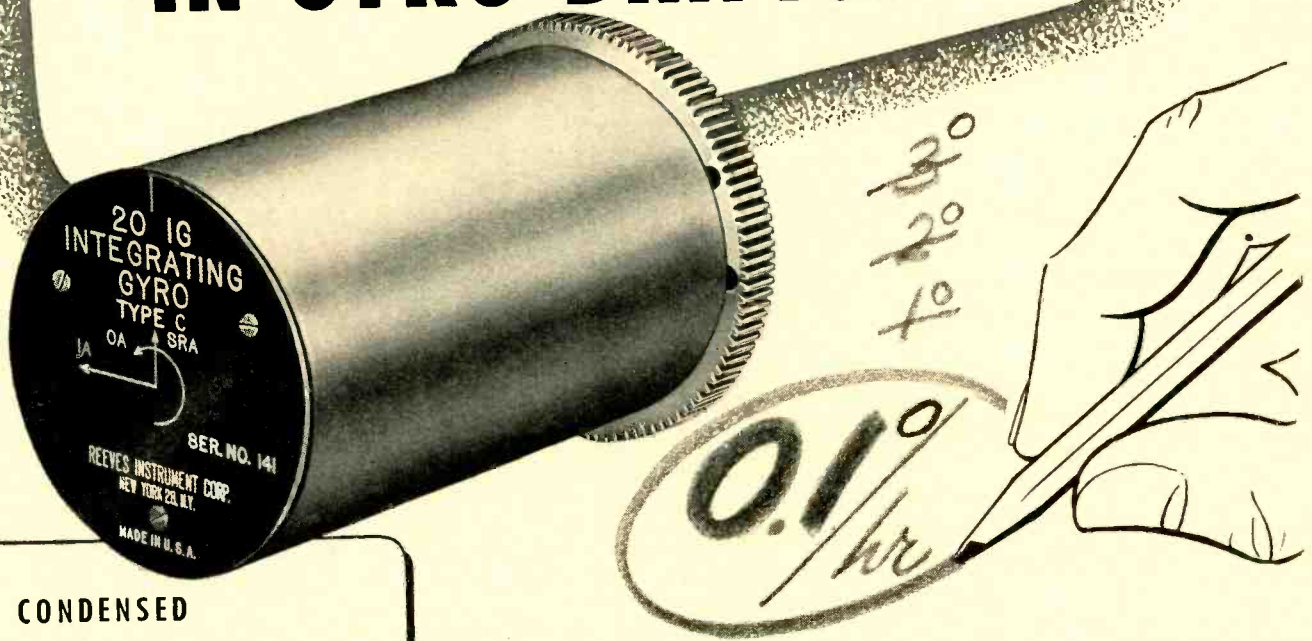
Reeves INSTRUMENT CORPORATION

achieves

DRAMATIC REDUCTION IN GYRO DRIFT...



CONDENSED PERFORMANCE DATA

Trimmed drift rate:
0.1°/hr. rms
0.3°/hr. max.

Mass unbalance:
5.0°/hr./g

Anisoelastic constant:
0.025°/hr./g^2 rms

Maximum command turning rate:
over 20°/sec.

Dimensions:
2" dia., 4" long

IN NEWEST DESIGN 20 IG INTEGRATING GYROS

Representing a major breakthrough by Reeves' gyro research laboratories, these advanced instruments show a small fraction of the drift rate hitherto considered low for high-performance units in this class.

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Other Reeves Gyros and Accelerometers meeting equally exacting standards for performance and reliability include a comprehensive series of 10 IG, 20 IG and HIG 5 Integrating Gyros; 20 PIG Pendulous Integrating Gyros and 10A and 20A Linear Accelerometers. Technical information on request.

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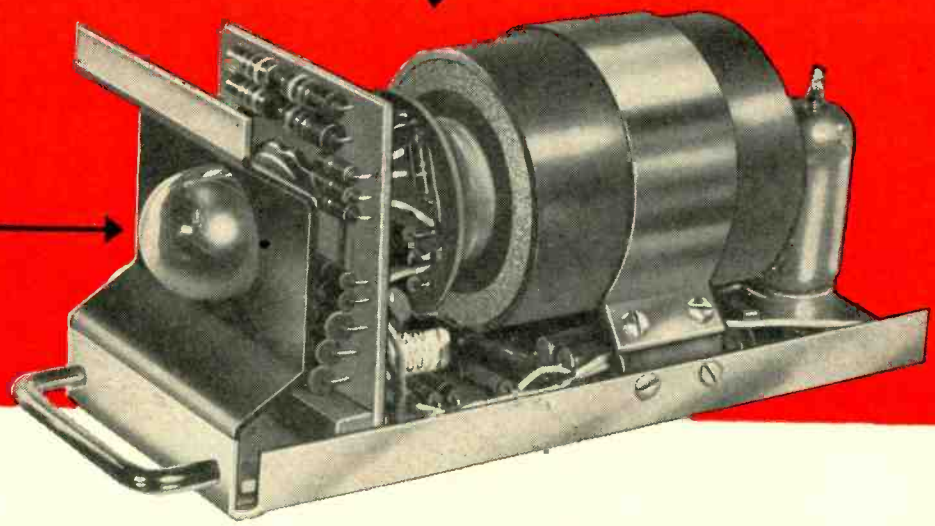
NIXIE ALL ELECTRONIC READOUT TUBE



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- OPERATION WITH FULL TOLERANCE VARIATION OF ALL COMPONENTS
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MODEL	DC-101	DC-102	DC-103	*DC-105
Input	Negative 2.5 μs 125V ½ Sine Wave Or Output of DC-101 DC-102	Negative 50 Volts Less than 1 μsec rise time Duration at least 2 μsec	Negative 110 Volts Less than 0.5 μsec rise time	Negative 110 Volts Less than 0.5 μsec rise time
Output	Drive DC-101	Drive DC-101	Drive DC-102	Drive DC-105 and 10 Individual Outputs
Resolution of Paired Pulses	Less than 10 μsec	Less than 10 μsec	Less than 1 μsec	Less than 1 μsec
Reset to Zero	Manual on Switch Closure or Electronic with Suitable Pulse	Manual on Switch Closure or Electronic with Suitable Pulse	Manual on Switch Closure or Electronic with Suitable Pulse	Manual on Switch Closure or Electronic with Suitable Pulse
Construction	Plug-In-Winchester Type MRE9P For Insertion in Type MRE9S	Plug-In-Winchester Type MRE9P For Insertion in Type MRE9S	Plug-In Winchester Type MRE9P For Insertion in Type MRE9S	Plug-In Printed Circuit Board For Insertion in U. S. Components UPCR93-D10
Maximum Counting Rate	10 KC	100 KC	1 Mc	1 Mc
Count Indication	Nixie "in-line" Numerical Readout — Type 6844A	Nixie "in-line" Numerical Readout — Type 6844A	Nixie "in-line" Numerical Readout — Type 6844A	Nixie "in-line" Numerical Readout — Type 6844A
Power Requirements	300 V — 18 ma DC 6.3 V — 0.3 A AC	300 V — 28 ma DC 6.3 V — 0.6 A AC	300 V — 30 ma DC 6.3 V — 0.9 A AC	300 V — 30 ma DC 6.3 V — 0.9 A AC
Tube Complement	Type BD300 Beam Switching Tube Counter — 6844A Indicator	Type BD300 Beam Switching Tube Counter — 6844A Indicator — Type 6201 Flip-Flop	Type BD300 Beam Switching Tube 6844A Indicator 5670 Flip-Flop 5963 Buffer	Type BD300 Beam Switching Tube 6844A Indicator 5670 Flip-Flop 5963 Buffer

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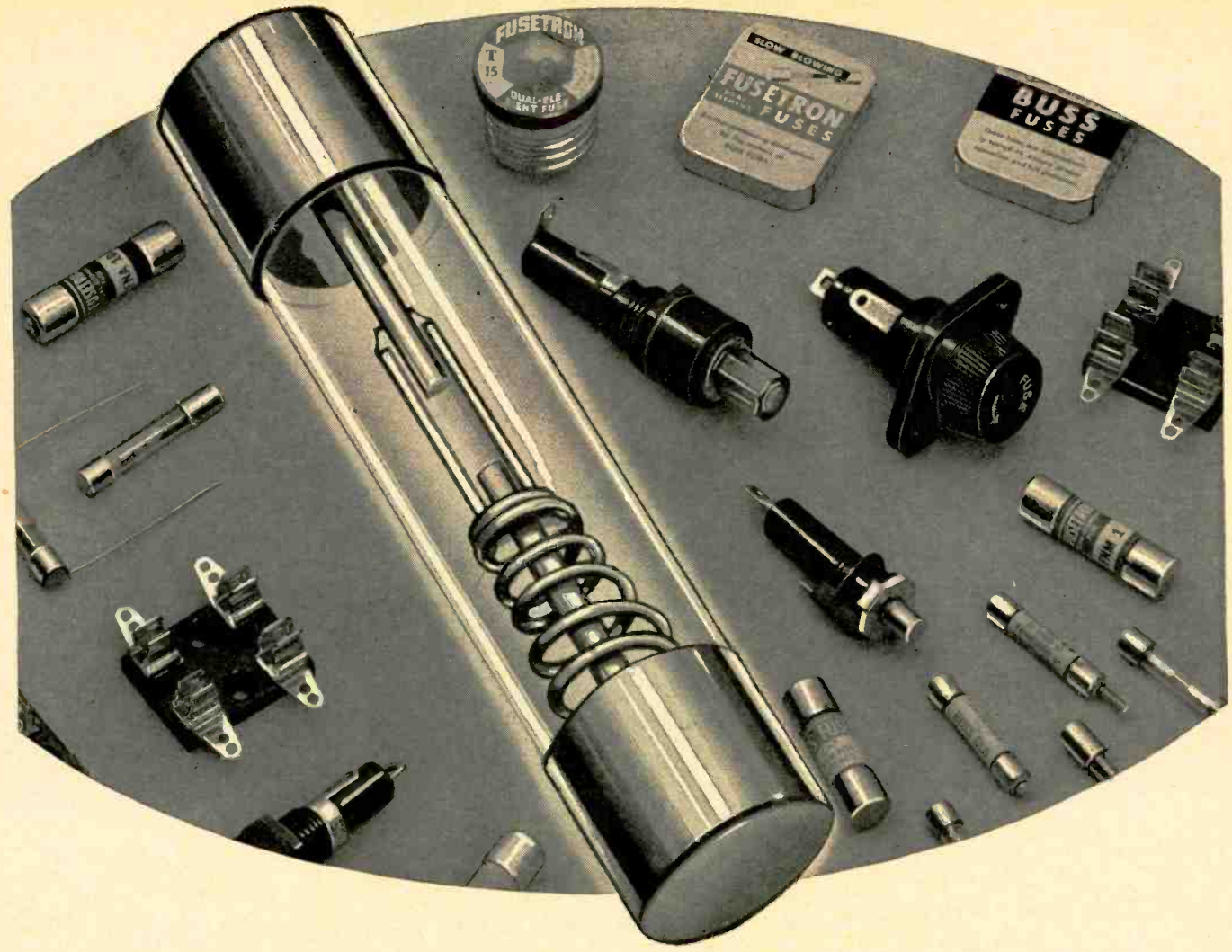

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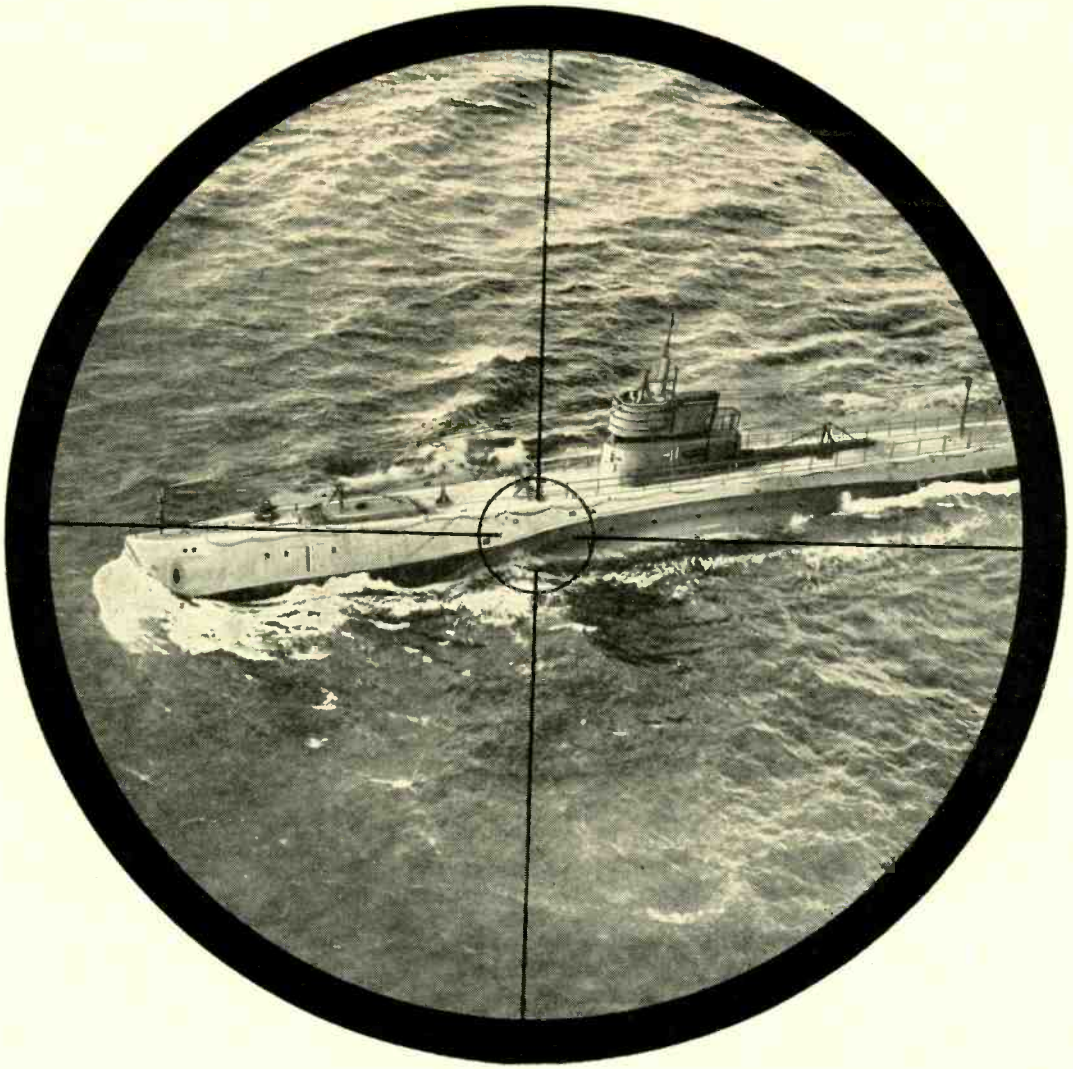
submarines are how you look at them



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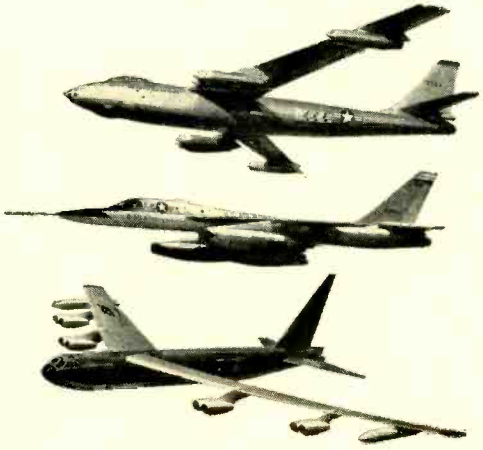

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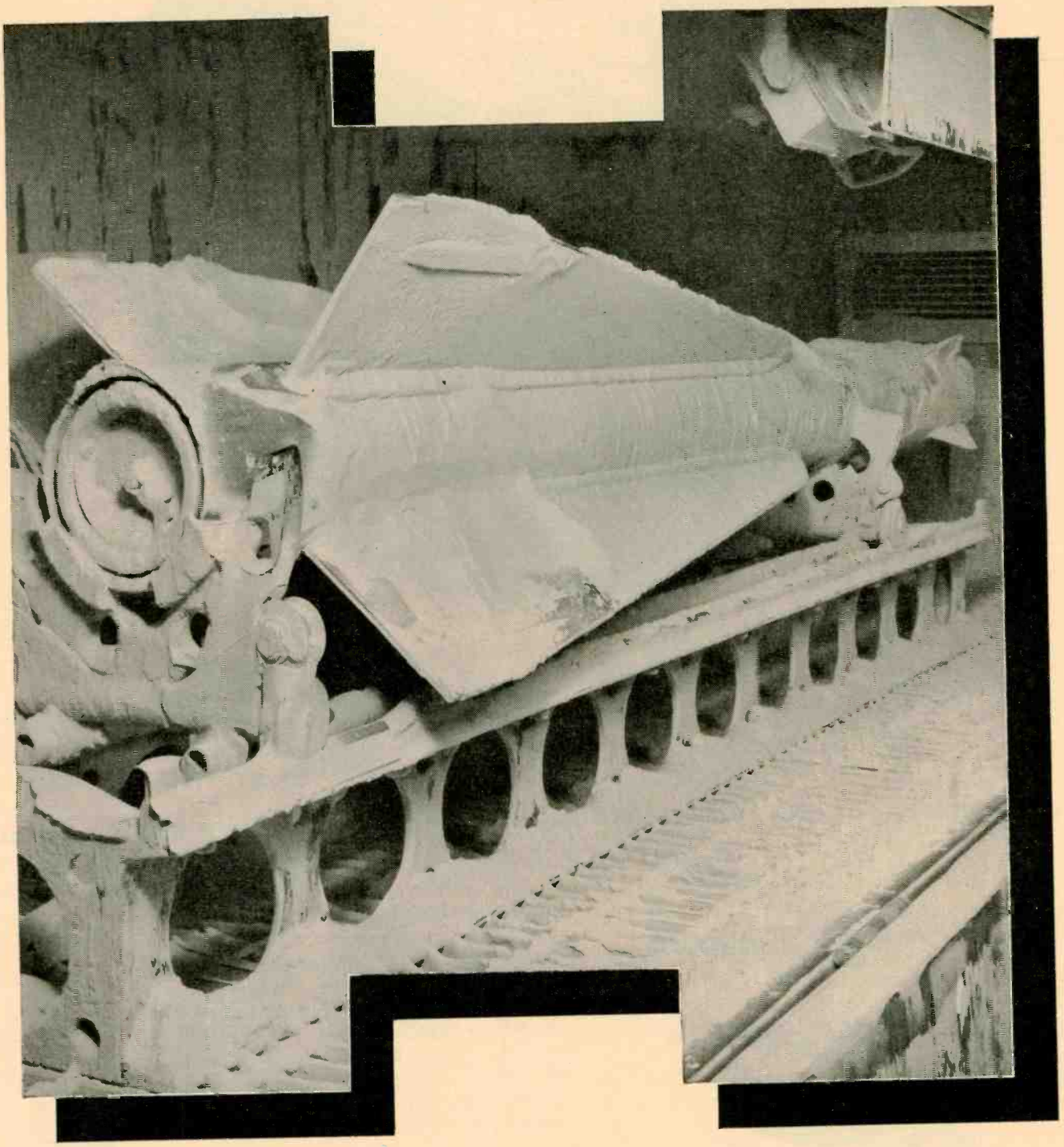


TO NEST IN THE SAND

They try to "make life difficult"

The brittle cold of the stratosphere . . . the heat of air-skin friction . . . the acceleration and vibration of launch and flight . . . the unfavorable conditions inherent to storage and handling . . . all these factors can play havoc with a guided missile.

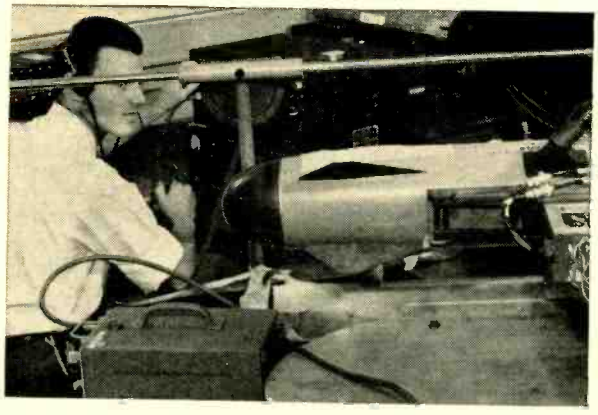
Hughes Research and Development engineers have designed the Falcon air-to-air guided missile to operate under the most severe conditions. Environmental testing (see Sand & Dust Test at left) subjects missiles to extremes in temperature, shock and other trouble-making conditions.

The Falcon missiles, with either infrared and radar guidance systems, measure only about 6½ inches in diameter. Complex guidance, control and auxiliary systems of each missile are installed in a space no bigger than a stovepipe.

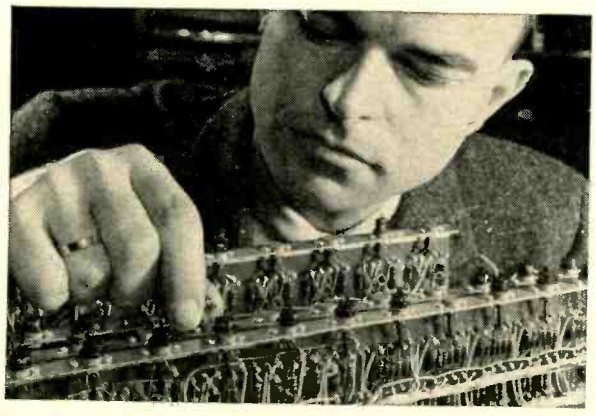
The research and development skill required to successfully engineer the Falcons typifies the challenge present today in other Hughes guided missile assignments of a more classified nature. A few of the areas being emphasized by the Hughes Research and Development Laboratories include missile launchers and power plants, guidance systems, reliability, product design, microwaves, aerodynamics, field test and telemetering, stress analysis and related areas.

High orders of engineering skill are also manifest in other Hughes activities. The commercial area, Hughes Products, has recently announced the development of a numerical control system which will automate a complete and integrated line of machine tools. The Hughes Ground Systems Division has developed a radar antenna which provides three-dimensional target data from a single antenna, transmitter and receiving channel.

Apart from the diversity of activity and the highly rewarding type of work, prospective employees may have confidence in the fact that Hughes will retain its leadership in the field of advanced electronics.



Collapsing the time between missile development and its effective tactical use is a project assigned to the Hughes Tucson Engineering Laboratories.



So advanced is the test equipment being designed by Hughes engineers in the El Segundo Manufacturing Plant that the test equipment is often as complex as the advanced systems being tested.

An immediate need now exists for engineers in the following areas:

Circuit Design	Computer Engineering
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Philco is proud to introduce the 2N671, a new power transistor, rated conservatively at one watt maximum dissipation in a studded version of TO-9 (JETEC 30) type package.

With collector and emitter voltage ratings of —40 V dc and a maximum current rating of 2 amps., the 2N671 is especially engineered for high powered relays, relay drivers, drum or tape writers, pulse amplifiers, communications and core switching applications.

For applications with lower power requirements the 2N670 is available, without stud mounting, at dissipations of 300 mw.

New Philco production techniques enable increases in thermal conductivity up to 8 times . . . power ratings as much as 4 times conventional ratings. These performance advantages can be applied to all classes of Philco transistors from audio frequencies through UHF.

If your application needs an optimum approach to semiconductor performance . . . more power, greater heat dissipation, or increased reliability . . . consult Philco first.

Make Philco your prime source of information for all transistor applications.

Write to Lansdale Tube Company, Division of Philco Corporation, Lansdale, Pa., Dept. E 658

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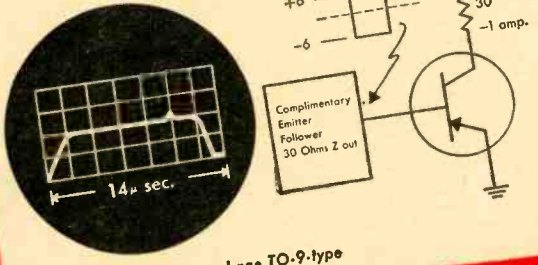

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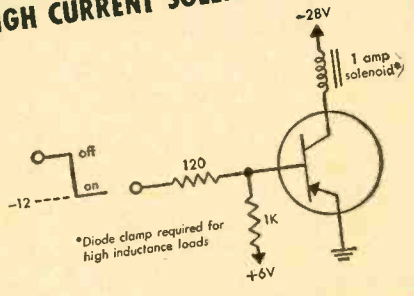

† 200 mil. pin circle package TO-9-type

* more transistor power in standard† packages!

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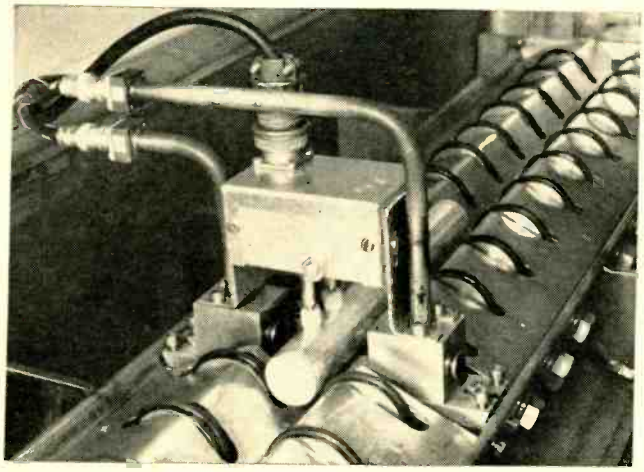
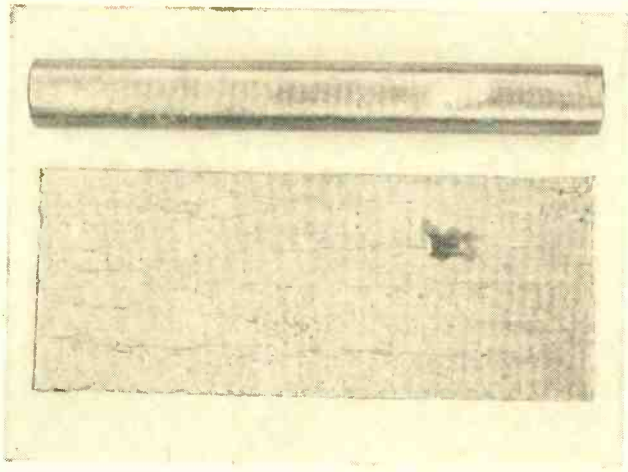


Atomic reactor fuel elements being tested for nonbonds between the aluminum cladding and uranium core



Jacket stripped from reactor slug shows nonbond areas detected by ultrasonic tester described here

Ultrasonic Pulses Detect Reactor-Slug Flaws

Attenuation of ultrasonic pulses beamed through a test piece indicates the presence and extent of internal defects. Area over which a defect extends is determined by counting or mapping the abnormally attenuated pulses on electrosensitive paper in a recorder

By J. D. ROSS and R. W. LEEP,
Savannah River Laboratory, E. I. du Pont de Nemours & Co. Aiken, South Carolina

A THROUGH-TRANSMISSION test to determine flaws in materials is simple to make following the technique described here and provides information which is easy to interpret. As the test piece is scanned by the tester, defects produce pulses which can be counted, or else they energize a pen which maps the defective area on electrosensitive paper. A neon lamp which glows when a gate circuit is open also serves as an indication of a defect.

A block diagram of the instrument is shown in Fig. 1. The test piece and transducers are submerged in water to provide good coupling for the ultrasonic wave. A pulser periodically excites the transmitting transducer, which sends a train of ultrasonic waves through the object under test. The waves are received by a second transducer and the resultant electrical signal is fed to a discriminator. An output pulse is produced by the discriminator whenever the input signal exceeds a fixed value. Absence of an output pulse indicates an interruption of the ultrasonic signal hence a flaw or discontinuity in the test piece. Absence of a discriminator pulse is indicated by the state of a flip-flop that is reset by this pulse.

Flip-flop Control

The flip-flop, which controls a gate tube, is triggered by a timing signal from the pulser. If it is not reset in a time equal to the transit time of the ultrasonic signal between the transducers, the gate is opened and passes the next timing

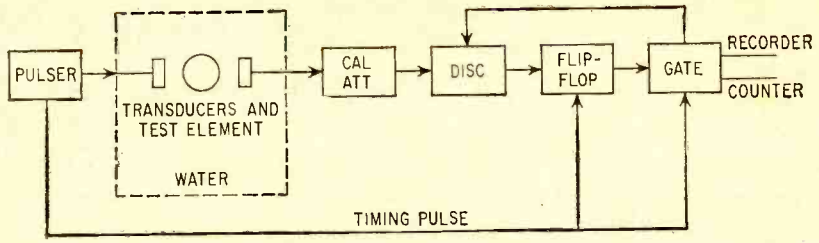


FIG. 1—Ultrasonic transmission tester. Test piece and transducers are submerged in water to provide good coupling for the ultrasonic wave

signal. When the test piece is scanned, the number of pulses passed by the gate is a measure of the size of the defect. An alternative output is obtained when the gate tube controls the writing current to a recorder.

The circuit diagram for the tester is shown in Fig. 2. The pulser is a conventional blocking oscillator. It is free running with a repetition rate of 1,000 pulses per second. The load presented by the transmitting transducer causes the oscillator to ring at the transducer resonant frequency. Static capacitance of the transducer and cable is tuned out by a variable inductor.

The transmitting and receiving transducers are electrostrictive elements of barium titanate. Both transducers are identical and have a natural frequency of approximately 900 kc. They are potted in a stainless steel holder with epoxy resin and then screwed into a mounting block attached to the mechanical feeder. Fig. 3 is a cross section of a typical transducer mount.

The attenuator is a voltage divider with two taps. The fixed tap is selected so that the received signal falls within the discriminator range. When a piece is being tested the discriminator is connected to this tap. For calibration, a relay switches the discriminator to the adjustable tap, which has been set to give a signal equal to that produced by a questionable test piece.

Circuit

The discriminator[1] has an adjustable threshold of from 30 to 300 mv. Whenever the threshold is exceeded, 20-v negative output is developed.

A flip-flop circuit senses the absence of a discriminator pulse. The unit is triggered by a signal from the pulser and reset by discriminator pulse. If the flip-flop is not reset the gate opens. Time delay of the ultrasonic wave traveling between the transducers allows the flip-flop to respond to the separate signals.

Two pentodes biased below cutoff are used for the gate. Output from the flip-flop is direct-coupled to the gate tubes. When the flip-flop is not reset, due to a defect in the piece being examined, the gate tubes conduct. An R-C network prevents shorter duration flip-flop

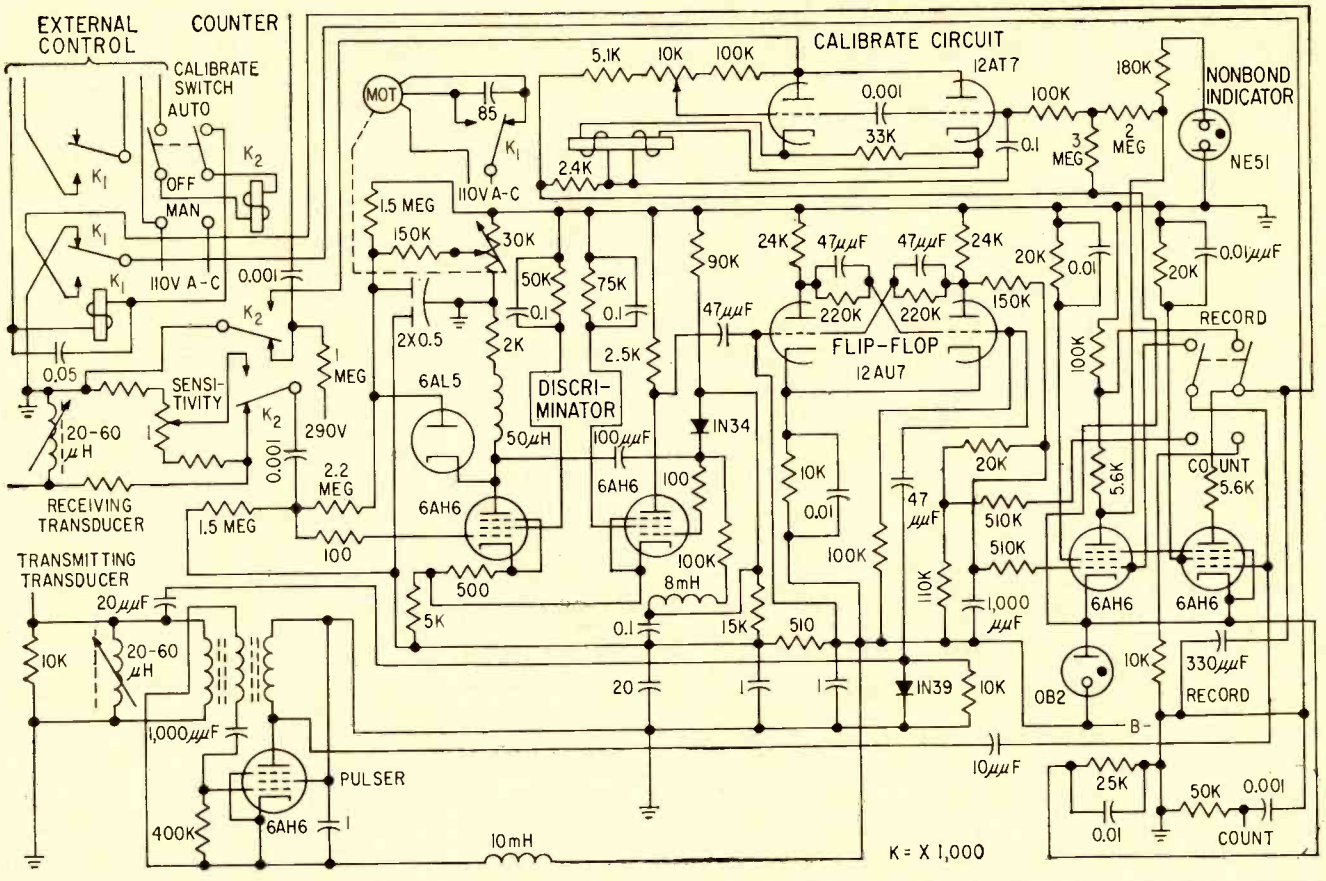
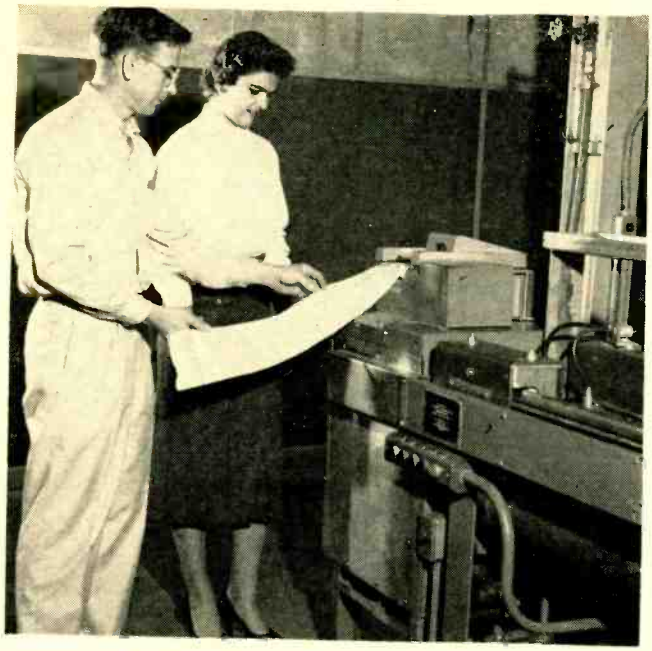


FIG. 2—Schematic of ultrasonic detector. The motor sets discriminator threshold to equal the signal received from the attenuator



Flaws show up as irregularities in the plot of transmitted signal. Extent and location of defect is determined by attenuation

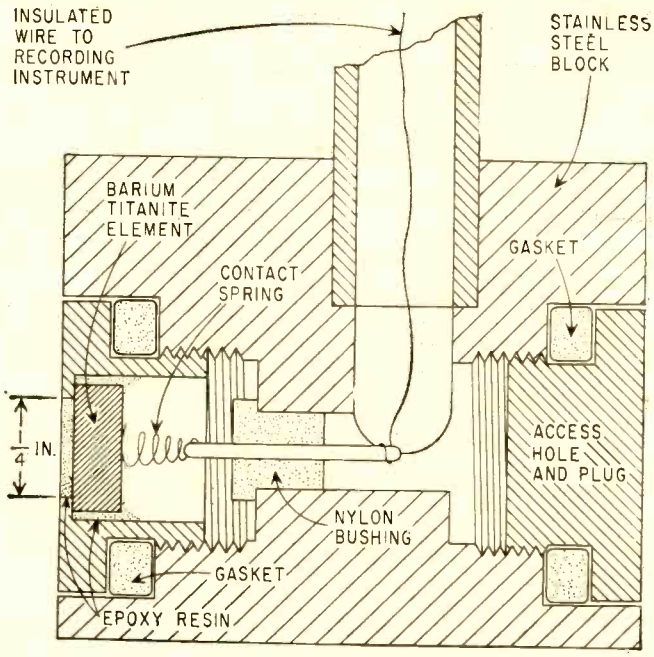


FIG. 3—Transducer mount showing access hole and lead wire to recording instrument

pulses from putting the gate in a conducting state. Waveforms at critical points in the circuit are shown in Fig. 4.

When the output switch is in the record position, the plates of the gate tubes are connected directly through the output jack to a recorder pen. When the output switch is in the count position, the gate tubes are separated and only one tube is connected to the output jack. The switch also changes bias on this tube so that it is brought near conduction by the flip-flop action. A signal from the pulser is fed to this tube and the positive swing of the signal is passed when the tube is near conduction. The other gate tube functions as before so that the calibration circuit and neon indicator will continue to operate.

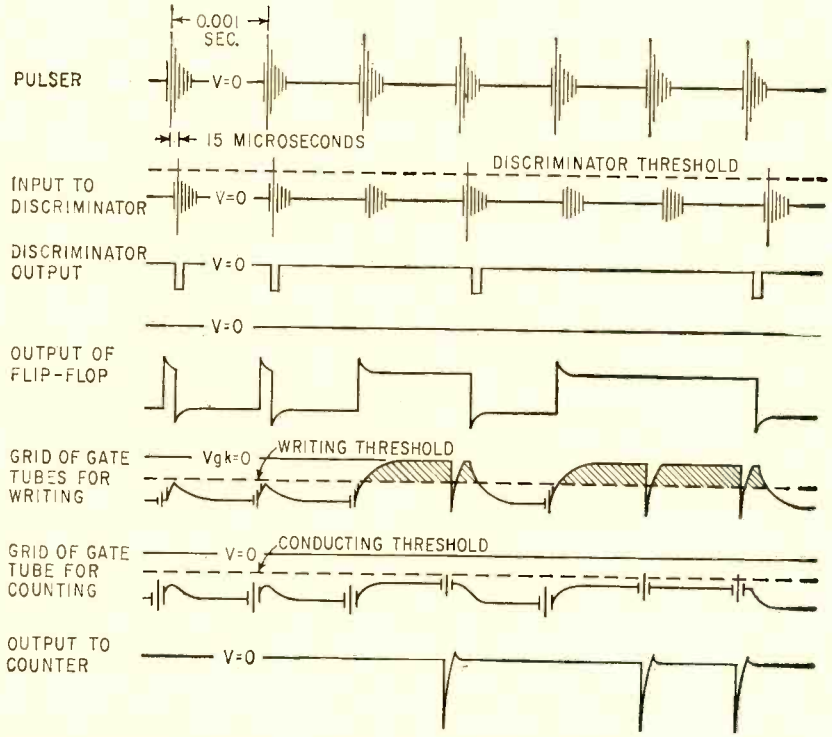


FIG. 4—Sequence diagram of waveforms at critical points in circuit

Calibration Circuit

A difference amplifier, a three-state relay and a motor make up the calibration circuit. The difference amplifier compares plate voltage at one of the gate tubes to a reference voltage. A relay connected in the amplifier cathode circuit controls a small motor which drives the discriminator threshold potentiometer. The calibration circuit is activated by grounding the difference amplifier plate and switching the discriminator input to the variable attenuator tap. If at this time the gate tube is conducting, the three-state relay energizes the motor and reduces the threshold voltage. If the gate tube is cut off, motor rotation is reversed and raises the discriminator threshold, hence the motor sets discriminator threshold to equal the attenuator signal.

This information was developed during work under contract AT (07-2)-1 with the AEC whose permission to publish is acknowledged gratefully.

Reference

(1) K. Kandiah, A Sensitive Pulse Trigger Circuit with a Stable Threshold, *Proc IEE* Part II, 101, p 239.

Bibliography

J. D. Ross and R. W. Leep, Ultrasonic Transmission Tester. Nondestructive Testing, 15, p 152 (May-June 1957).

Interruption of high-energy beam from radioactive source changes resistance across cadmium-sulphide detector. Transistor amplifier converts variation into signal capable of actuating limit switches and positional devices. Photocell system is unaffected by most environmental conditions, is small, inexpensive and reliable. Source-detector separation must be less than two in. to insure consistent detection

By **PAUL WEISMAN, and STANLEY L. RUBY,**

New Products Engineering Dept., Materials Engineering Dept., Westinghouse Electric Corp., Pittsburgh, Pa.

Solid-State Photocell

WEAK LINK in conventional photoelectric systems — the light source—is characterized by easily obscured light beams and lamps which require a power supply. To overcome these shortcomings, the photoelectric system discussed here uses a radioisotope source to furnish high-energy radiation and a solid-state photocell to detect the radiation. The beam formed cannot be obscured by hazy atmospheres; components are unaffected by temperature and shock and do not require a power supply.

Best known commercial application of radioisotopes is in beta-ray thickness gages used for measuring and controlling fast-moving, continuous sheet materials to within one percent of sheet thickness. The isotope used in most of these gages is strontium-90. This material retains half its radioactive energy after 25 years—a convenient decay rate for the present application.

Radioactive material is produced at a pile operated by the Atomic Energy Commission and is in the form of an aqueous solution. Chemical processing can be used to concentrate the material to a solid, compact consistency. In this form, the radioactive material can be permanently sealed into stainless steel containers which have one face thin enough to pass most of the emitted radiation.

A ten millicurie, strontium-90 source is used. It is cylindrically shaped and approximately $\frac{1}{8}$-in. thick and $\frac{1}{2}$-in. in diameter. If ultra-high resolution is desired, concentration of the source energy using radiochemical techniques could reduce the radioactive material to the size of a pinhead.

Photocell Detector

Detection of atomic radiation is most commonly done on an individual basis; that is, each disintegration is counted singly. This method gives great sensitivity but requires delicate, sensitive and expensive detection equipment. Scintillation counters, proportional chambers and the like are not, therefore, readily adaptable for use as small, low cost, rugged photoelectric devices.

A simpler method of detection is to measure the total ionization produced by the radiation absorbed in a volume of material. In this case the ions are collected and averaged into a d-c current representing the average ionization rate. The material generally used is a low pressure gas in which ions are free to move.

In the photoelectric circuit described here, the change in resistance caused by ionization in an appropriate solid is used to detect the high-energy beam. The solid used is a cadmium-sulphide photocell which features compactness, low cost and reliability. Several types of commercially available cadmium-sulphide photocells are sensitive not only to visible light but also to atomic radiations.

The particular cadmium-sulphide photocell used is cylindrically shaped and approximately $\frac{1}{2}$-in. long and $\frac{1}{4}$-in. in diameter. Size of the active sensing area is less than $\frac{1}{16}$ sq in.

The completely solid-state photoelectric system consists of the

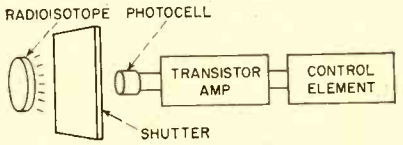
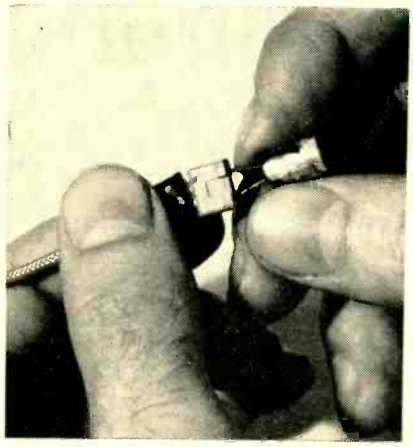


FIG. 1—Physical arrangement of photoelectric system. Radioisotope strontium-90 source generates high-energy beam which is detected by cadmium-sulphide photocell. Detected signal, after being amplified by bistable transistor amplifier, is used to operate control element in machines, elevator stops and the like

Complete photoelectric system. Bistable transistor amplifier is contained in chassis at top of photo. Slotted block holds radioisotope and shutter



Closeup of cadmium-sulphide photocell mounted in transistor socket. This detector features compactness, low cost and reliability. Several types are available

Internal construction of transistor amplifier. Pencil is pointing to 2N138A transistor. In left foreground are cadmium-sulphide photocell and cable

Sees Through Haze

radio-isotope source, the cadmium-sulphide detector and a bistable transistor amplifier. Physical arrangement of these components is shown in Fig. 1.

The radioisotope strontium-90 source generates a high-energy beam which is detected by the cadmium-sulphide photocell. When the shutter, which is made of $\frac{1}{32}$-inch aluminum and simulates the physical interruption of the beam, is inserted between the source and detector, the beam is interrupted and the resistance of the photocell increases.

The output state of the bistable transistor amplifier depends on the photocell resistance. When this resistance rises above a certain level, the output of the amplifier changes in a fraction of a millisecond from off to on. The resulting output signal is used to trigger alarms, actuate control elements or the like.

Bistable Circuit Operation

A power supply filter network formed by resistor R_1 and capacitors C_1 and C_2 provides a 100-v d-c supply across both the photocell-potentiometer R_6 and resistor R_4-R_5 voltage dividing networks. The off state of the circuit is caused by an absence of voltage across load resistor R_3, which is in series with transistor Q_2. Transistors Q_1 and Q_2 are a-c coupled to the photocell-potentiometer R_6 dividing network. When the photocell resistance is increased by interruption of the beam, a voltage is impressed across load resistor R_3 energizing a 20,000-ohm relay coil in the control device and converting the circuit to the on state. A slight amount of d-c coupling is provided by leakage through C_3 and C_4 allowing the output to follow slow shutter closures.

Many photoelectric applications such as assembly line counting or high-speed limit indicating require fast time response. In this respect, the strontium-90 isotope source and cadmium-sulphide photocell combination has its severest limitation.

The cadmium-sulphide photocell has a slow change of resistance after sudden application or removal of radiation.

The transistor circuitry can be adjusted to switch states at a photocell resistance only slightly below the dark value, giving a fast off-to-on response but a slow on-to-off response, or conversely.

Change in circuitry characteristics with temperature and age makes it inadvisable to balance too close to either extreme of the photocell resistance range. A reasonable compromise gives response times of about 0.05 sec and counting rate of about five pieces per second.

Maximum source-to-detector distance for consistent detection is about 4 in. A separation of 2 in. requires a source strength one-quarter that required at 4 in. With strontium-90 it takes over 50 years to reach this level.

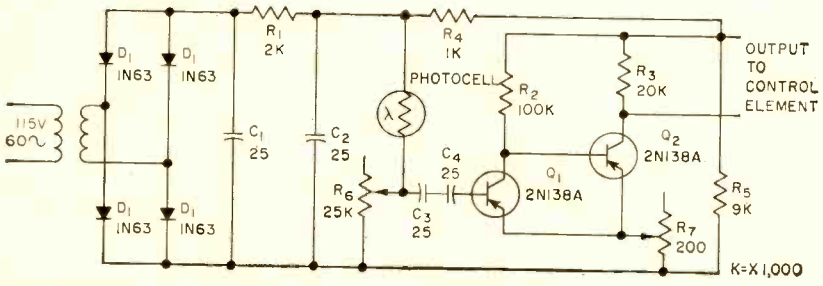


FIG. 2—Bistable transistor amplifier circuit. Isolating transformer is used in power line. Capacitors C_1 and C_2 are electrolytic; C_3 and C_5 are sintered electrolytic

Relay System Diplexes

Mobile microwave relay system uses two wide-band f-m transmitters for aural and visual carriers diplexed into common antenna. Modulated klystron is locked to crystal reference oscillator by afc. Calibrated wavetrap modifies sawtooth waveshape of afc to provide internal frequency monitoring. Diplexer in receiver is similar to that for transmission and enables balanced mixing of composite signal to provide better signal to noise ratio

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JACK SMITH Project Engineer
General Electric Company, Syracuse, N. Y.

INCREASING DEMANDS for a reliable television relay system and the requirements of color tv have necessitated the complete redesign of existing equipment. A fresh design approach has resulted in a modern tv relay which includes several novel circuits.

A main consideration is the system's ability to transmit picture and sound simultaneously. It is desirable to maintain independence between the audio and video systems so that announcements can be made during picture interruptions, the antenna serving both functions with both signals in the same band.

The performance of the video part of the system must be such that the total degradation introduced by the relay is about a fifth of that allowed for the main transmitter. The audio system must provide f-m broadcast quality.

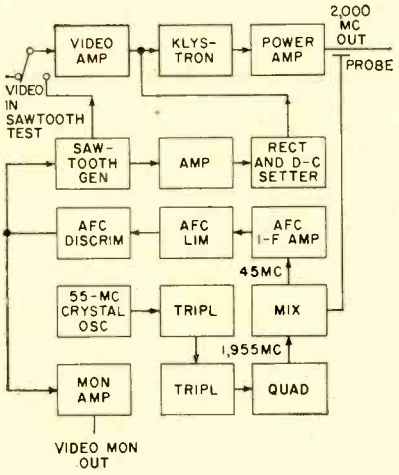


FIG. 1—Block diagram of aural transmitter that uses f-m modulaltion

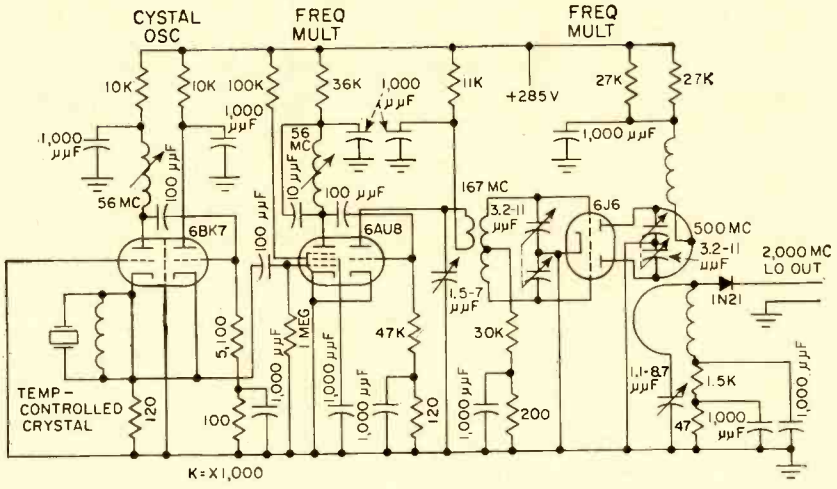


FIG. 2—Reference oscillator is followed by tube triplers and crystal quadrupler

In earlier equipment the audio is transmitted as f-m on a subcarrier, generally around 5 mc, and this combined with the video signal must be passed by both the transmitter and receiver. Nonlinearities in these units introduce cross products which generally appear in both the picture and sound channel. While it is possible to obtain the required performance with such systems, maintaining alignment demands unusual skill.

The transmission of color signals further complicates the crosstalk problem, since beat notes between the aural subcarrier and the color subcarriers fall both in luminence and chrominance channels. The filters required to suppress the audio introduce a phase delay which requires additional compensation for optimum operation.

The equipment to be described has separate visual and aural transmitters. The signal consists of two carriers fed to a common antenna which at the receiving end can be amplified and demodulated in much the same manner as in standard tv broadcasting. Although the system could have vestigial-sideband a-m as in standard broadcast tv, an f-m system offers greater freedom from ghosting with multipath conditions.

Visual Transmitter

A klystron with repeller-voltage modulation serves as the nucleus of the visual transmitter as shown in Fig. 1. The klystron output feeds a power amplifier which also isolates the oscillator from the an-

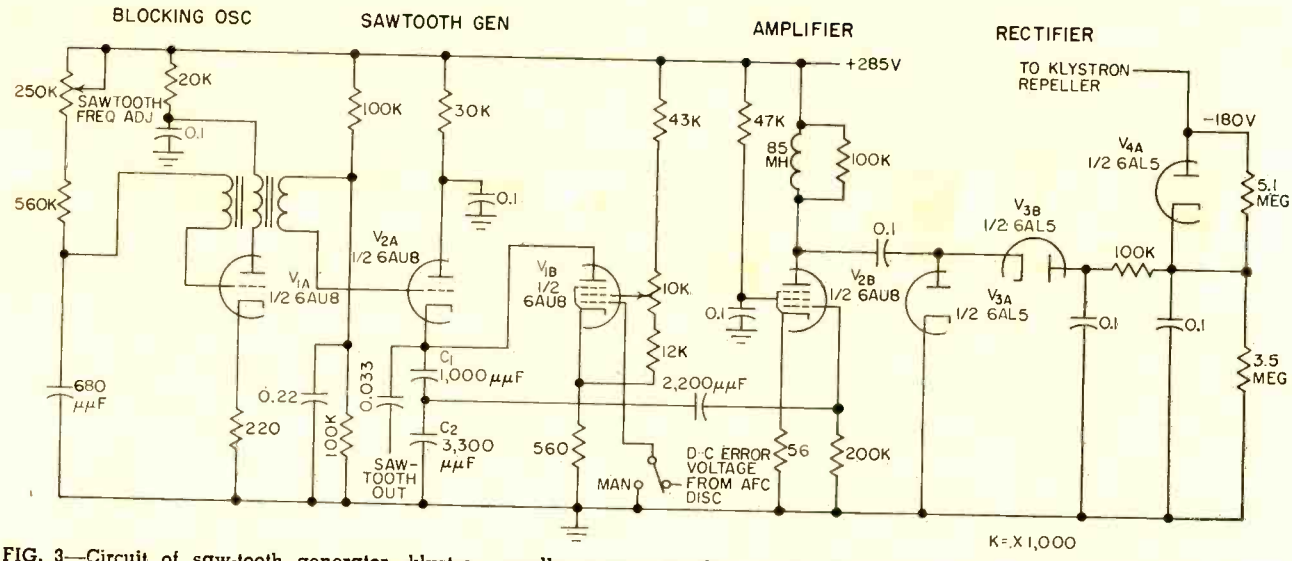


FIG. 3—Circuit of saw-tooth generator, klystron repeller power supply and afc of visual transmitter. Klystron locks to crystal i-f difference frequency to provide high-degree of stability needed in this type of relay system

tenna. This prevents frequency pulling of the klystron which might disturb its modulation characteristics if operated into long transmission lines.

The simplicity with which a klystron can generate f-m microwave power cannot be overlooked, but a device that can be easily frequency modulated doesn't exhibit good frequency stability. Since this system requires that two carriers occupy the same channel, the transmitter frequency control must be far better than in conventional microwave systems.

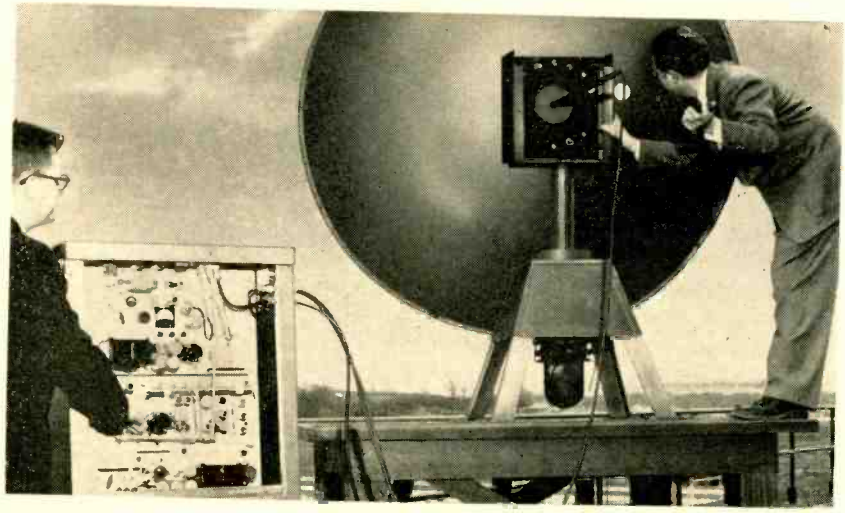
The equipment under discussion solves the problem of frequency stability by use of an afc system which locks the klystron to a crystal oscillator reference frequency. The oscillator starts with a quartz crystal in the 50-mc band and uses receiving-tube multipliers to obtain approximately 50 mw in the 500-mc region. A silicon crystal diode quadruples the 500 mc to provide about 0.25 mw in the 2,000-mc band. Details of this oscillator circuit are shown in Fig. 2.

The output of the local oscillator is combined with a sample of the klystron output, mixed in a silicon crystal diode, amplified in a four-stage i-f amplifier, and demodulated in a conventional discriminator to provide the afc error correction voltage. The discriminator output requires additional d-c amplification to provide the proper control voltage for the klystron repeller. This is accomplished by converting to a-c, amplifying the voltage and rectifying to recover the amplified d-c.

Sawtooth Generator

The circuit of Fig. 3 is unique in that the a-c is obtained from a pentode sawtooth generator which also serves other functions. Capacitors C_1 and C_2 are charged by cathode follower V_{2A} which is fed from constant-frequency blocking oscillator V_{1A}. The error voltage from the discriminator controls the discharge rate of pentode V_{1B} by varying its control-grid voltage. Since the pentode has a constant frequency trigger, the sawtooth amplitude is determined by the pentode current which in turn depends upon the d-c applied to the grid.

The output sawtooth is further amplified in V_{2B} and rectified to provide the klystron repeller voltage. The output of the discriminator determines the d-c voltage applied to the klystron repeller. Since the



Reasonably portable, system may be further reduced in size by using smaller dish

klystron frequency changes with repeller voltage the afc locks the klystron to the i-f difference from the crystal oscillator.

Transmitter Monitoring

To establish accurately the deviation ratio a simple monitoring scheme is built right in to the transmitter. The afc amplifier sawtooth serves as a test signal and the afc discriminator provides an excellent modulation monitor. With an oscilloscope connected to read the test signal output, a calibrated wavetrap in the discriminator absorbs a small amount of the i-f energy, producing a frequency-marking notch in the sawtooth. As the wavetrap is tuned the notch moves up and down, providing an indication of the frequency. This is shown in Fig. 4.

The wavetrap is calibrated in megacycles and the marker can thus indicate the actual frequency deviation of the test signal. Once the sawtooth amplitude has been set to the proper frequency deviation, the peak video level is adjusted to the same voltage and deviation. The monitor system thus permits tuning the transmitter and adjusting the deviation ratio with only an oscilloscope and a vtvm.

In addition to the frequency measuring function the monitor provides an excellent test point, as its output is actually a demodulated sample of the transmitted signal. The monitor has a frequency response of better than 2 mc and thus can be used to observe the transmitted picture. While the monitor jack does not provide the full resolution, it does prove useful for system trouble shooting.

Aural Transmitter

The audio transmitter uses a reactance-tube frequency modulator operating in the 25-mc region. The modulator output is fed through two doublers and an amplifier and then a sample taken and mixed with the output of the crystal oscillator. The oscillator output is fed to an i-f amplifier, demodulated by a discriminator, and better than 20 db is fed back to the modulator. This completes the loop forming an afc circuit to maintain the master oscillator on its assigned frequency.

The final multiplier stage in the aural transmitter is a sextupler. The power output is a little over a 100 mw, which considering its narrower bandwidth is compatible with the level of the visual transmitter.

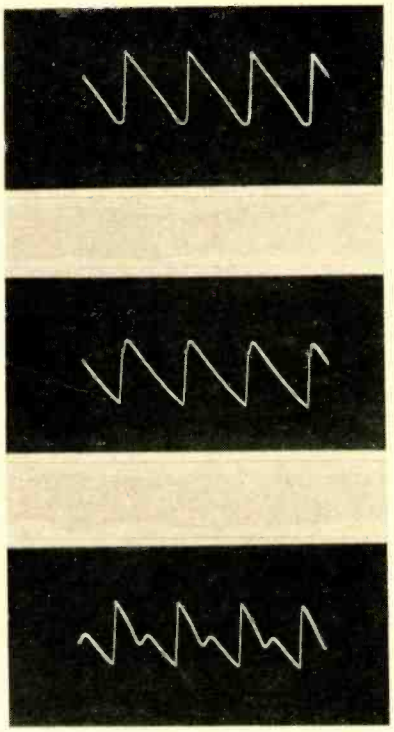


FIG. 4—Afc sawtooth (top) is notched (middle and bottom) by wavemeter absorption. Position of notch shows frequency deviation of test signal

Since both the visual and the aural transmitters are operated into a single antenna, a diplexer is required to prevent interaction between the two signals. The diplexer is a hybrid ring similar to that used with a batwing tv broadcast antenna. It is essentially a closed loop of coaxial transmission line 1.5 wavelengths in circumference. There are two inputs and two outputs, one for each transmitter signal. Each output terminal provides half the power from each of the transmitters. The transmission line formed has a surge impedance of 70 ohms at the carrier frequency.

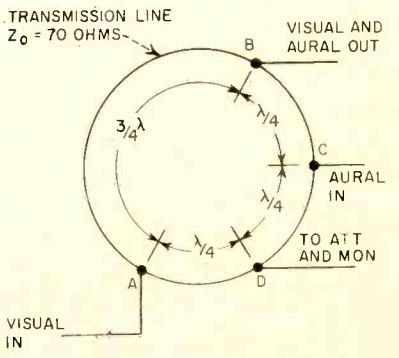


FIG. 5—Form of aural-visual diplexer

The diplexer is shown schematically in Fig. 5. A video signal fed in at *A* divides equally between terminals *B* and *D*, and since the path length from *A* to *B* is a half-wavelength longer than the path from *A* to *D*, the voltage appearing at *B* is 180 deg out of phase with that at *D*. The section of line connecting *B* and *D* is a half wavelength with a tap at its midpoint, and the voltages at *B* and *D* arrive at this point 180 deg out of phase and thus cancel at terminal *C*.

The voltage fed in at terminal *C* divides equally between terminals *B* and *D*, whose greater path is one wavelength long. Since the line from *B* to *A* is a half-wavelength longer than from *D* to *A*, the voltages from *B* and *D* arrive at terminal *A* 180 deg out of phase and thus cancel at that point.

The signal fed into the aural input is thereby isolated from the visual input. Half of the visual power and half of the aural power appear at terminal *B*. The signals at *B* then provide the combined output of the two transmitters. The signal at terminal *D* is fed through a pad to an r-f monitor. The design provides better than 30-db isolation between the two transmitters and yet requires no adjustments.

Visual Receiver

The same type of diplexer used for transmission also forms the nucleus of a balanced-mixer input circuit for the receiver. Referring again to Fig. 5 the receiving antenna signal is fed into terminal *A* and the local oscillator to terminal *C*. Two crystal mixers are used, one connected to terminal *B*, and the other to terminal *D*.

The functional arrangement is shown in Fig. 6. The output from an oscillator-multiplier unit provides the local-oscillator signal when the output of a silicon-crystal quadrupler is fed through a small filter cavity to the diplexer. The outputs of the two crystal mixer circuits are combined in a push-pull to single-ended transformer at the i-f input.

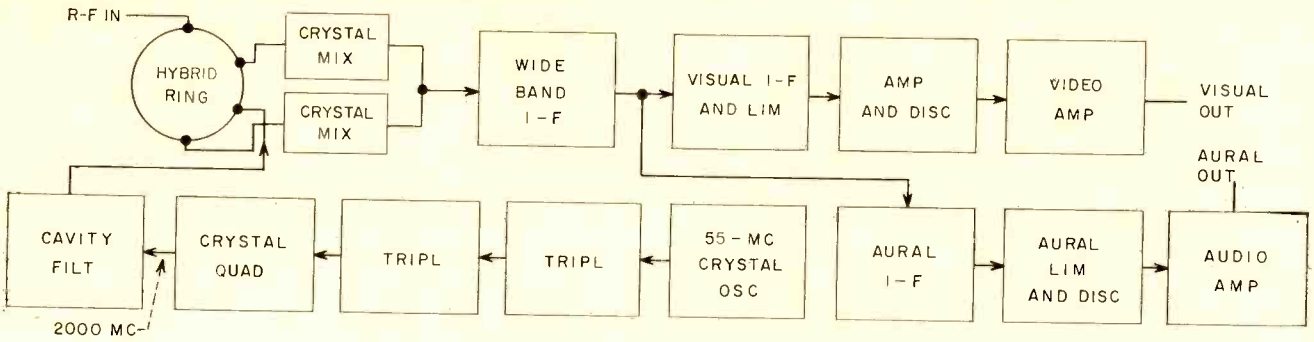


FIG. 6—Block diagram of relay receiver. Balanced dual mixer cancels local oscillator noise and prevents radiation by receiving antenna. Double-tuned and single tuned i-f transformers provide flat bandpass characteristic

The balanced-input type mixer has several advantages. It tends to cancel out any noise generated in the local oscillator. Furthermore the oscillator output is efficiently coupled to the mixer diodes, requiring a minimum of local-oscillator power. Finally, excellent isolation is provided between the local oscillator and antenna to suppress undesired radiation.

Since the relay receiver is generally located in the building with the main tv transmitter, and in some cases with an f-m broadcast transmitter as well, these frequencies must be avoided in the choice of i-f. The frequency must therefore be below channel 2 or above 108 mc. A lower frequency is preferable because of a better receiver noise figure, more effective trap circuits and more readily available test equipment and circuit components. The i-f band selected extends from 35 to 52 mc. The visual signal is assigned the range from 37 to 52 mc and the aural is tuned to 35.5 mc.

After conversion the signals are amplified by three stages of dual i-f covering the full 35 to 52-mc band. The mixer output is then fed to a low-noise amplifier. The signals are further amplified by two stages after which a separation filter permits the aural take-off. The coupling circuit gives some aural rejection in the visual side, and the remaining visual bandpass is further amplified by five additional stages.

An unusually flat bandpass characteristic is obtained by use of double-tuned and single-tuned i-f transformer circuits. Load resistors and variable mutual coupling in the tuned transformer circuits provide an ideal method for adjusting to flat response. A high-Q series-tuned trap in each of the last five i-f stages provides the aural rejection necessary in the visual i-f.

The screens of all i-f stages but the first are controlled by the agc regulator tube. Screen-controlled agc is preferable to grid-bias control since it produces considerably less detuning. Thus the i-f stages can be properly tuned without a change

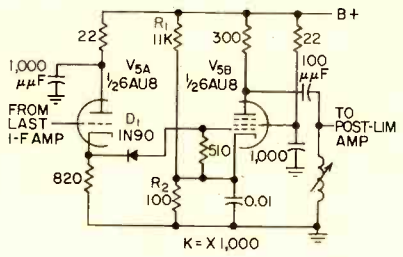


FIG. 7—Limiter circuit in visual receiver

in phase with varying signal level.

An agc system is a firm requirement in this type of receiver since the wide bandwidth imposes a severe restriction on the types of limiters used. The limiter in this receiver has a signal fed first through a triode cathode follower and then diode-coupled to the grid of a pentode as shown in Fig. 7. Diode D_1 cuts off on the positive r-f swing above the d-c bias set by R_1 and R_2. In this way the grid of V_{5B} is prevented from going positive and the sharp-cutoff pentode clips on the negative swing.

With the proper level fed to the pentode grid the circuit is adjusted to provide symmetrical clipping and optimum noise response to the weakest signals. The agc circuit is then adjusted to hold this level. The limiter output is fairly small since the stage operates in the sharp-cutoff region and a post-limiter amplifier is necessary to obtain a large signal output from the discriminator. The discriminator circuit is the conventional Foster-Seeley type using germanium crystal diodes, with an output virtually free of power-frequency hum.

The discriminator output is fed to a three-stage video amplifier which in addition to supplying voltage amplification acts as an impedance transformer permitting operation with a dual-matched 75-ohm output circuit. The dual output permits operating the video signal into both a 75-ohm line and a terminated line monitor.

Aural Receiver

The aural i-f is similar to that in a conventional f-m receiver operating at 35.5 mc. The unit employs three i-f stages and two limiters. The discriminator circuit is Foster-Seeley with a pair of germanium crystal diodes. The output is fed through a 75-μsec deemphasis network to a two-stage audio amplifier to provide a 600-ohm balanced output.

Since each of the transmitters weighs only about 40 lbs, the resultant packages are quite portable. The transmitter need not be mounted on the antenna and short paths can generally be operated with a fairly long length of cable between the transmitter and the antenna. If even greater portability is required a 2-ft diam dish may be used for distances involving only a few miles.

Neon Lamp Logic Gates

Elementary computer acts as silent adversary to a human opponent in an ancient pastime. Neon lamps perform the function of diode gates and also indicate moves and positions occupied on the board. A thyratron-relay combination comprises the memory and another series of relays referees the sequence to prevent two successive moves by either participant. Experience suggests the neon-lamp circuit may have many other computer applications

By **C. E. HENDRIX** Los Angeles, California **and R. B. PURCELL** China Lake, California

THE NEON LAMP has a great number of potential uses as a logical gate. Typical of these is a device which performs all logic and control functions needed to play the game tick-tack-toe.

The system is comprised of the elements of a large-scale computer, as shown in Fig. 1. The input-output control panel permits the operator to enter his desired moves on the board by push-buttons. Nine neon lamps indicate positions selected by the operator or board during the game.

The memory function is performed by a thyratron-relay combination, which stores positions occupied by the operator or board and makes this information available to the logic section for decision regarding successive plays. The sequencer unit referees the game, permitting the operator to make a move, followed by a board move and so forth to a win, lose or draw decision.

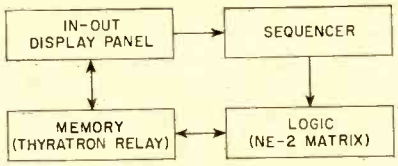


FIG. 1—Block diagram of complete system

Sequencer

A series of relays acts as a stepping switch in the sequencer and a thyratron switches control from board to operator as soon as the board completes a move. Conversely, control is switched from operator to board after the operator makes a play.

When the operator releases the pushbutton the sequencer sends an offense signal to the logic section. If the board has previously filled two positions in a line and the third position is vacant, the board will make an offensive move and win the game. If no such opportunity exists, the sequencer signals the logic section for a defensive move, which is required if the operator has filled two positions in a line and the third is vacant. If no defensive move is made, the sequence continues, filling the first vacant position in the order 5, 1, 6, 7, 2, 9, 4, 3, 8. A schematic of this circuit is shown in Fig. 2.

The order of independent play would make it possible to trap the board so that two defense moves are required simultaneously. A special-defense mode has been included in the sequencer and logic to prevent this situation from occurring. The

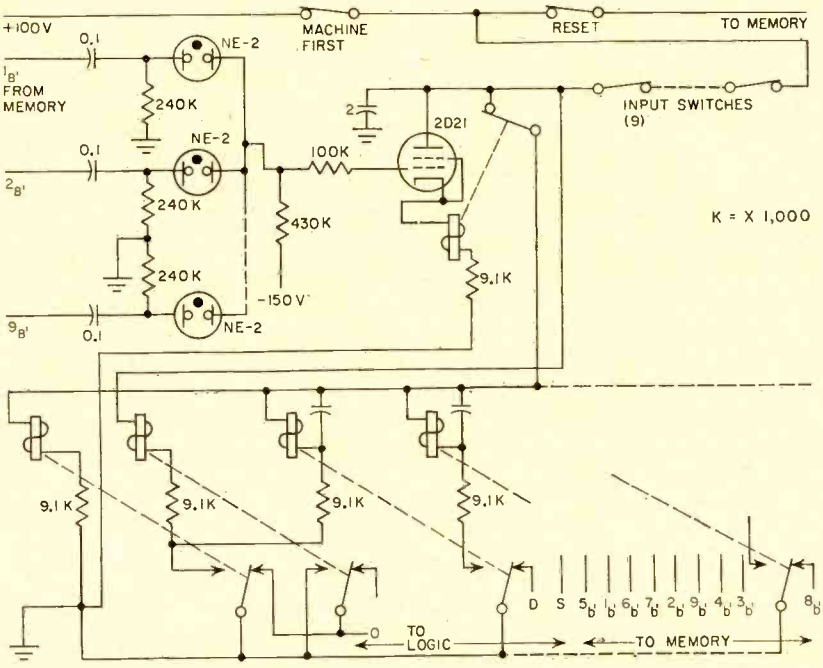
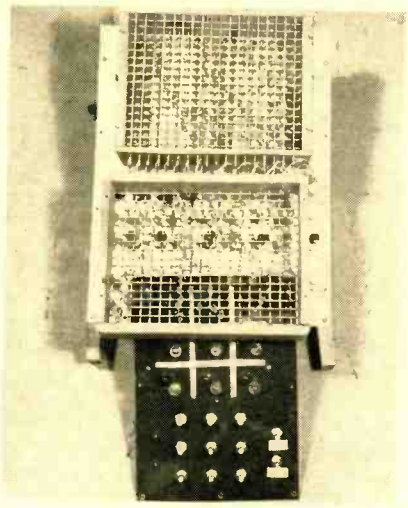


FIG. 2—Simplified schematic of the sequencer shows some of the stepping switches

Play Tick-Tack-Toe



Lamp matrices, play area and control switches of tick-tack-toe game

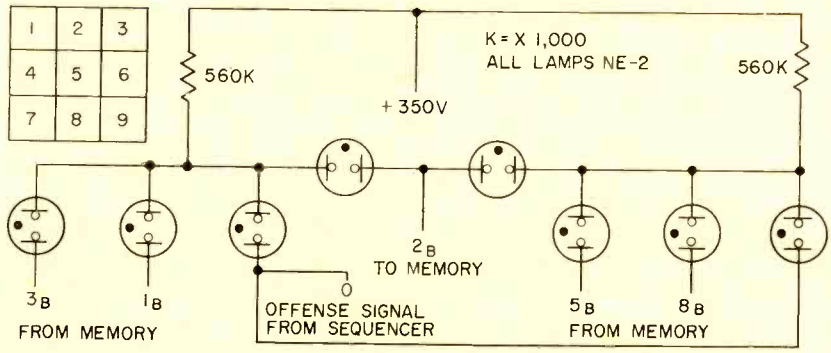


FIG. 3—Logic circuit for offensive move to position 2 of board in upper left

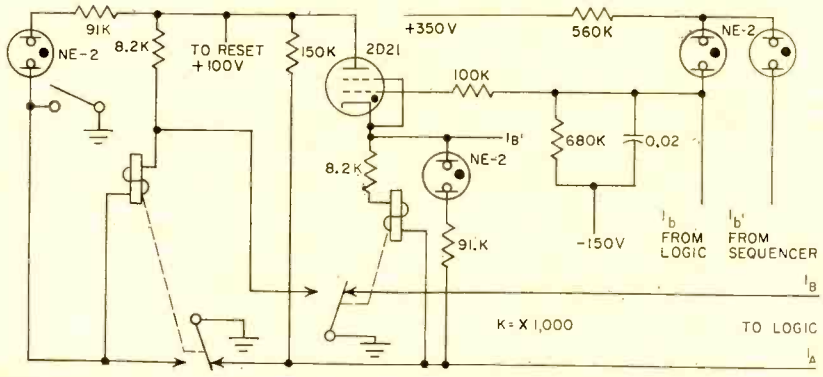


FIG. 4—Nine memory cells are used, one for each board position. Above is No. 1

board makes one move and stops until the operator completes the next play, and so forth until the game is completed. The rate at which the sequencer operates has been intentionally made slower than necessary, to give the effect of a thought process in the board.

The most important part of the game communicates with the memory, makes decisions as needed and matches wits with the operator. Although the decisions are simple, the use of neon lamps as logical gates is unique. A typical gate network, this one used to make an offensive move into position 2, is shown in Fig. 3.

The gate function is identical to the more familiar diode gate. When inputs 3_B, 1_B and 0 are all in a high voltage state, output 2_B becomes high, resulting in a board move into position 2. An output-signal change from low-state to high-state is also obtained when 5_B, 8_B and 0 are high. The *B*-subscripts refer to board-occupied positions. The 0-signal is received from the sequencer calling for an offensive move if such an opportunity exists.

This logic network is a combination of AND and OR gates satisfying the equation $2_B = (3_B \times 1_B \times 0) + (5_B \times 8_B \times 0)$. Similar logic networks, covering all nine positions, are used to make all the decisions of offense and defense as required during the progress of the game.

The neon-lamp matrix is constructed of three layers placed one atop the other in honeycomb fashion. Two layers, offense and defense, are identical. The third includes the special-defense matrix and provisions for future addition of win, lose, tie and game-end decisions.

Memory

The circuit diagram of one of the nine memory cells is shown in Fig. 4. Operator moves are entered into the board by push-buttons on the display panel energizing self-latching relays of the memory. Board moves are determined by the logic section triggering the thyratron of the memory and energizing the relay. Signals from memory to logic are in the form of grounded or open relay contacts, an open contact indicating an occupied position. The latching arrangement prevents an operator move into a position already occupied by the board or the player. Neon lamps on the display panel indicate the condition of each of the nine memory cells, whether the position is filled, and by whom.

Some modifications or additions to the game would be desirable for commercial use, aside from improving the appearance. The independent play program may be modified to add variety to the board's tactics. The machine may also be made vincible in some subtle ways. Logic and indicators for win, lose, draw and the like may be added.

Experience with this use of the neon lamp as a logical element has demonstrated some valuable properties of the component. Large deviations in electrical characteristics are tolerable and extremely long life may be expected. The lamps here were not pretested or selected in any way. None of the 187 lamps has required replacement after an estimated 1,000 hours of use.

Microwave thickness gage uses frequency-stabilized klystron to determine electrical thickness and dielectric constant of radomes. Apparatus measures insertion phase angle when radome is placed in path of electromagnetic wave. Angle depends on electrical thickness of radome, which is proportional to the actual thickness in the direction of wave energy and to the square root of the dielectric constant of the radome

By **A. H. Webber Jr.**, Microwave Engineer; **R. G. Crooks**, Resident Counsel; **A. C. Preston**, Electronic Equipment Engineer

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Radome Thickness Gage

MICROWAVE THICKNESS gages measure the insertion phase angle, or change in phase of an electromagnetic wave caused by the insertion of an object in its path. If the object is homogenous, isotropic, and nonmagnetic, the insertion phase angle ϕ for the wave upon emerging from the object is as follows:

$$\phi = 2\pi d/\lambda\,(\sqrt{K - p}) \qquad (1)$$

where: d is the physical thickness of the object in the direction of propagation of the wave; λ is the free-space wavelength of the wave in the same units as d; K is the magnitude of the relative dielectric constant of the object and p is $\sin^2\theta$, where θ is the angle of incidence of the wave upon the surface of the object.

Although Eq. 1 assumes that the object is loss-free and does not attenuate the wave passing through it, the absorption of a small amount of energy by the object does not seriously impair the validity of the equation.

The value of the insertion phase angle ϕ is not ordinarily read directly from the microwave thickness gage but may be computed from the following expression:

$$\phi = 2\pi\Delta/\lambda \qquad (2)$$

where Δ is a linear measurement taken directly from the microwave thickness gage. The quantity Δ should be expressed in the same units as λ, and represents a physical distance between the respective balance points of the gage before and after the insertion of the object to be measured. In as much as ϕ is a function of λ, and in as much as the relative dielectric constant K is also a function of λ, it is of great importance that λ be the same after the insertion of the object into the gage as before such insertion. For this reason, frequency stabilization of the microwave thickness gage described in this article is the most significant feature of the gage. Frequency stabilization permits λ to be maintained substantially constant before, during, and after the measurement of Δ.

Measuring Apparatus

The apparatus shown in Fig. 1 passes microwave energy from a reflex-klystron source through two different paths to a waveguide junction and detector, where a phase

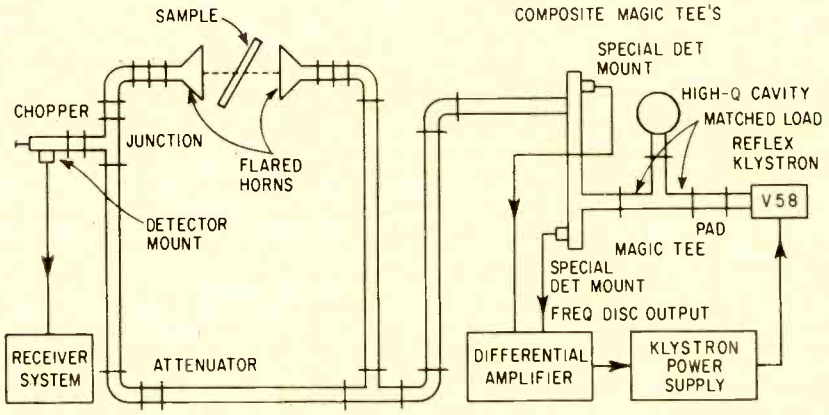
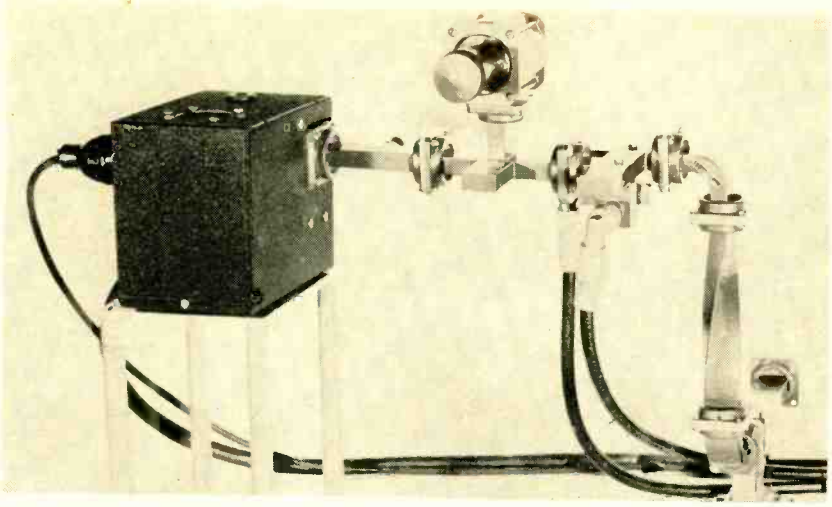


FIG. 1—Microwave thickness gage apparatus consists of reflex klystron V58, magic T with high-Q cavity and matched load, composite magic T's with special crystal detector mounts, differential amplifier, klystron power supply and flared horns. Gage is basically a bridge network measuring insertion phase angle



FRONT COVER—Waveguide path from reflex klystron to the junction where energy is divided into two horn paths. Shown are reflex klystron unit, magic T with high-Q cavity, composite magic T's and detector mounts

One form of microwave thickness gage uses a motor and reduction-gear train to achieve mechanical motion of horn

is Frequency Stabilized

comparison is made between the energy derived from the two respective paths. The first of the two paths is a simple waveguide path with suitable variable attenuation to permit balancing of the magnitudes of energy from the two paths.

The second path consists partly of waveguide and partly of a free-space gap in which the object to be measured can be inserted. The first measurement step is to pass energy from the klystron through the two paths, without the presence of the object to be measured, to the waveguide junction and detector. The variable attenuation and the length of the free-space gap are adjusted to obtain cancellation between energy arriving at the waveguide junction through the two respective paths.

The second step is to insert into the free-space gap the object to be measured and again closely adjust the length of the free-space gap until cancellation between energy arriving at the waveguide junction through the two respective paths occurs. The change in length of the free-space gap as brought about by the second measurement step is the quantity Δ.

The energy generated by the V58 reflex klystron passes through a pad that attenuates the energy by approximately 3 db and prevents any residual reflected output energy from influencing the output frequency of the klystron. The energy that passes the pad enters a magic T that has a matched load in its H arm and a high-Q cavity coupled to its E arm. The cavity has an unloaded Q of at least 25,000 and serves as a long-term frequency reference. The cavity is made with Invar to minimize frequency dependence upon temperature. The H arm of the magic T, because of the matched load, absorbs output energy reflections.

Energy Paths

Energy passing the magic T enters a series combination of two more magic T's arranged in composite relationship with one of the side arms of one magic T leading directly into the H arm of the other magic T. The first of the composite magic T's has a high-impedance termination in one of its side arms and has a special detector mount installed in its E arm. The second composite magic T is similar.

Its other side arm is coupled to the output waveguide, which conveys the energy successively through an E-plane bend, a 90-deg twist and another E-plane bend to the point of energy division.

The first of the composite magic T's is matched at a frequency slightly below the desired operating frequency of the apparatus, while the second of the composite magic T's is matched at a frequency slightly above the desired operating frequency. Thus, the composite arrangement of magic T's fulfills the function of a frequency discriminator and may produce unbalanced outputs in the detectors. The unbalance depends upon whether the energy passing through the composite magic T's has a frequency above or below the desired operating frequency. Only when the energy has exactly the desired frequency do the outputs of the two detectors balance each other.

The respective outputs of the two detectors are fed to the balanced, direct-coupled differential amplifier shown in Fig. 2. The output tubes of the differential amplifier act as a network to adjust the voltage from the klystron-reflector −500-v power supply for application to the reflector electrode itself. Undesirable ringing in the differential amplifier is minimized by capacitor C_1 connected from the reflector to ground. Instead of

operating the klystron with its anode grounded, as is generally done, the apparatus is operated with the klystron cathode grounded and with the anode separated from the waveguide by a Teflon insulator.

Feedback

The connection of the output of the differential amplifier to the reflector electrode of the reflex klystron completes a feedback loop. The frequency deviations of the klystron output power are sensed by the frequency discriminator comprising the composite arrangement of magic T's, and the discriminator output is amplified and fed back to adjust the klystron reflector voltage to a value that will cause the klystron to operate on a predetermined center frequency. By the combined effect of the high-Q cavity as a long-term reference and the feedback system as a means for correcting short-term frequency departures, the output frequency of the energy supplied for the test measurements can be maintained within one part in 10^5 at all times and within one part in 10^6 at most times.

In microwave thickness gages without frequency stabilization, a change in load conditions can cause power reflections to change the operating frequency of the klystron. In this frequency-stabilized microwave thickness gage, however, any such power reflected from the load is substantially dissipated in the frequency discriminator without reaching the klystron. Reflected power passing through the composite magic T's is sharply attenuated in each of the composite magic T's, and what little reflected power passes the composite magic T's is additionally attenuated in the magic T where the high-Q cavity is mounted, and in the pad. Thus, a negligible amount of reflected power reaches the klystron. Moreover, none of the power reflected from the load should reach the detectors.

Energy from the reflex klystron and the composite-magic-T assembly is divided by the series T and propagated through two paths to the waveguide junction and detector, where the phase comparison is made. Energy propagated from the series T through the simple waveguide path to the junction undergoes only one important modification enroute, the attenuation in the adjustable pad. This adjustable attenuation permits balancing of the magnitudes of the energy passing through the two respective paths. Energy propagated through the other path to the waveguide junction is directed by a horn onto the body to be measured and is collected by a second horn after passing through the body. Energy passing through the two paths merges and is compared at the waveguide junction. The net energy from this comparison passes through a short length of waveguide to a detector, where the magnitude of the net energy is evaluated.

In one form of microwave thickness gage, the net energy enroute to the detector is modulated by a chopper, which comprises a multiple-lobed cam rotated in such a way that the respective lobes successively intercept portions of the energy in the waveguide between the waveguide junction and the detector. In another form of microwave thickness gage, the reflex klystron itself is square-wave modulated. This latter form of gage, without mechanical modulation of energy, is the form shown on the cover.

Also illustrated is the unit that provides for mechanical motion of one horn assembly during physical thickness measurement. Motion is attained by a hand-crank mechanism, and the extent of the motion is determined by a mechanical dial gage mounted between the movable-horn assembly and a fixed reference point.

Other Gage Forms

In another form of microwave thickness gage, mechanical motion of the movable-horn assembly is achieved by a motor and reduction-gear train. The dial gage for indicating motion of the horn is mounted upon the horn assembly, while the dial gage bears against a reference point fixed rigidly to the pedestal of the movable-horn assembly.

In the measurement and test of radomes, the insertion phase angle for each of the various portions of each radome is of importance. If the insertion phase angle were not uniform over the entire surface of the radome, the wavefront of the wave passing through it would be distorted. The frequency-stabilized microwave thickness gage is an extremely useful quality-control instrument for use in radome production because it enables any nonuniformities in the radome walls to be detected and corrected. Measurement of the physical thickness of the radome walls would be neither so easy nor so satisfactory as the measurement of electrical thickness by this gage. In radomes, electrical thickness is the most important parameter, and this gage is a direct and precise tool for such measurement.

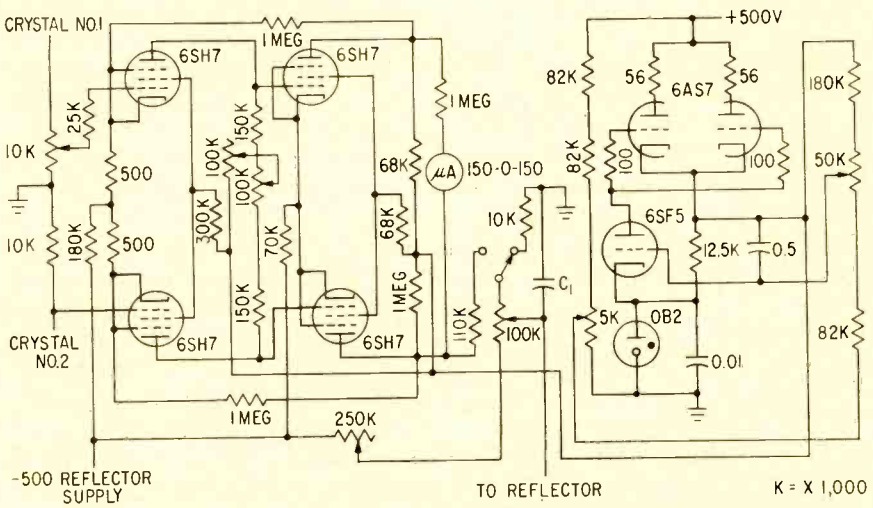
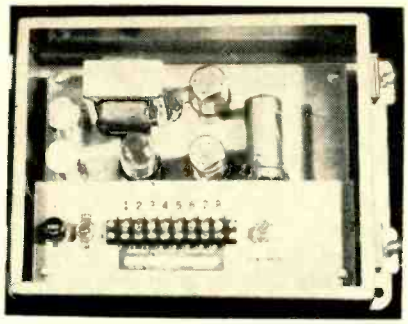


FIG. 2—Schematic of differential amplifier. Output tubes adjust the voltage from the klystron-reflector 500-v power supply to provide frequency stability



Proximity control unit, showing terminal strip for input and power output

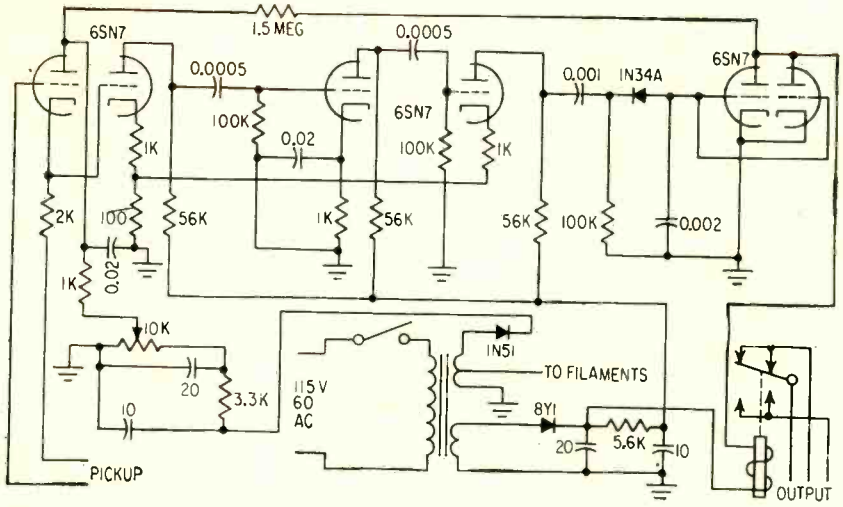


FIG. 1—Rapid-acting control unit of proximity transducer system can follow operations in excess of 3,600 per second and has a life expectancy of over a billion operations

Proximity Transducer Uses Rapid Relay

Gain of oscillator tube in Hartley circuit is set so that oscillation will be maintained only when Q of resonant circuit is normal. When metallic materials come near pickup, Q is reduced, oscillation stops and output tube conducts to count or control industrial machinery

By **DAVID ELAM** Chief Engineer, Electro Products Laboratories, Chicago, Ill

PROXIMITY TRANSDUCER systems for controlling or counting without physical contact consist of a proximity transducer or pickup, a shielded connecting cable and a control unit. The pickup is influenced by any metallic mass, whether ferrous or nonferrous, at distances ranging from ⅛ in. to 1 ft depending on the pickup which operates switches or drives electronic devices.

A variation of the conventional Hartley circuit detects objects with metallic content. Oscillator tube gain is reduced so that oscillation is maintained only when the resonant circuit Q is normal. Oscillator output is applied through two or more stages of amplification (depending upon the sensitivity required) and a germanium rectifier biases an output tube beyond cut off. Figure 1 summarizes the action.

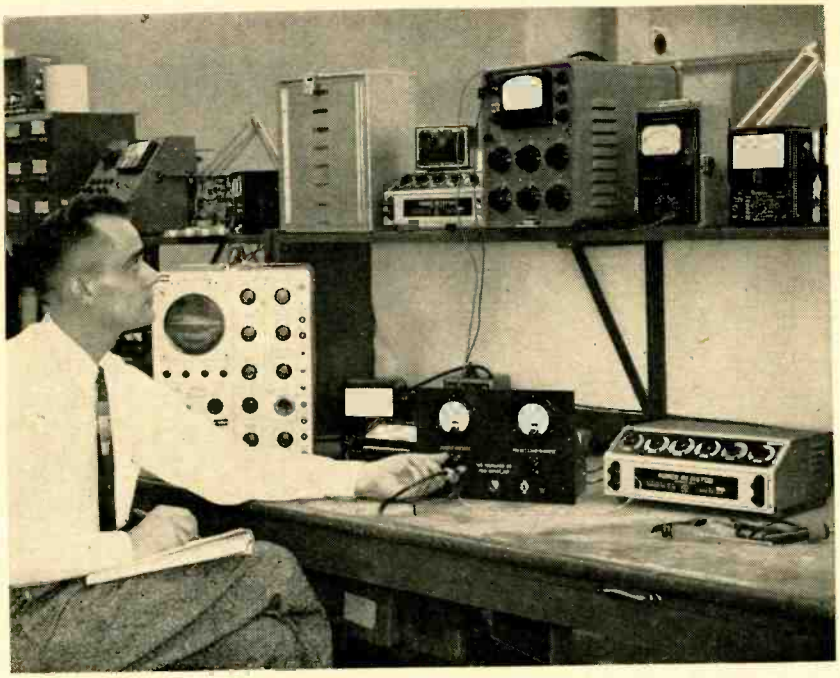
Metallic Sensing

When a metallic mass is within range of the resonant circuit of the oscillator, a reduction in Q stops oscillation and the output tube conducts. No minimum speed is required for the actuating mass. Output voltage remains constant while the exciting metal is in close proximity to the pickup and drops to zero when it is removed. Rapid rise and decay time of the voltage produces a definite on-off action.

The pickup is the resonant circuit of the oscillator. It is housed near the actuating material with enough clearance to ensure positive sensing. The resonant circuit consists of an r-f coil in parallel with the distributed capacitance of the coil windings and the capacitance of the leads of the shielded connecting cable.

The oscillator coil has a cathode tap for regenerative feedback. Inductance is chosen to provide a favorable L-C ratio for oscillation. Variable inductance accommodates connecting cables of different lengths. The Q of the coil is relatively unimportant, except that it must be high enough to maintain oscillation. Coil resistance may vary within broad limits without affecting the operation of the oscillator circuit.

The unit can follow operations in excess of 3,600 per sec. The relay used has a life expectancy of over a billion operations.



Author gives power supply operational test. Oscilloscope shows trace of ripple factor (10 mv) of power supply

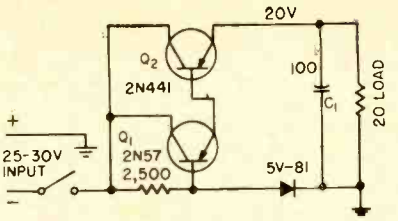


FIG. 1—Simple series-regulator power supply using transistors

Transistor Power Supply

Sharp current-limiting-characteristic protection circuit operates statically, without need for resetting and provides instantaneous response when supply is shorted or regulator transistor is overloaded. Circuit is also applicable to other circuits that are vulnerable to excessive current

By **HAROLD D. ERVIN,**
Staff Engineer, Advance Engineering Development Group, The Magnovox Co., Fort Wayne, Ind.

SAFEGUARDING TRANSISTORS from over-current conditions has long been a problem, especially in power supplies that are subjected to increased, shorted or capacitive loads.

In conventional power supplies using a series regulator transistor any capacitance present at the load must be charged through the transistor. When the switch in the circuit of the power supply shown in Fig. 1 is closed, the entire supply voltage appears across series regulator transistor Q_2 until C_1 starts to charge. The charging current will exceed the limits of Q_2 if the capacitor is too large and the transistor either will be destroyed immediately or will seek characteristics that may be unstable. A Zener diode across Q_2 would prevent voltages from exceeding the maximum ratings of the transistor; however, until the diode becomes active, Q_2 passes the entire charging current of C_1.

Overload Protection

Since the charging current of C_1 causes the greatest problem, the transistors must be protected by some means that will instantaneously limit the load current within safe values. The same device should also protect the transistor for extended periods under shorted load.

The protection circuit for the power supply shown in Fig. 2A prevents over-current by appearing as a negligible impedance across transistor Q_1 until excessive current flows. At a predetermined threshold load current the impedance of Q_1 increases sharply, as illustrated in Fig. 2B. The maximum load current is determined by the setting of potentiometer R_1.

Under normal conditions, the voltage dropped across R_1 is insufficient to allow forward current to pass through D_1. The base of Q_1 is heavily biased in the forward direction so the voltage drop across the transistor is negligible (about 0.1 v) and essentially all the voltage at point A is supplied to point

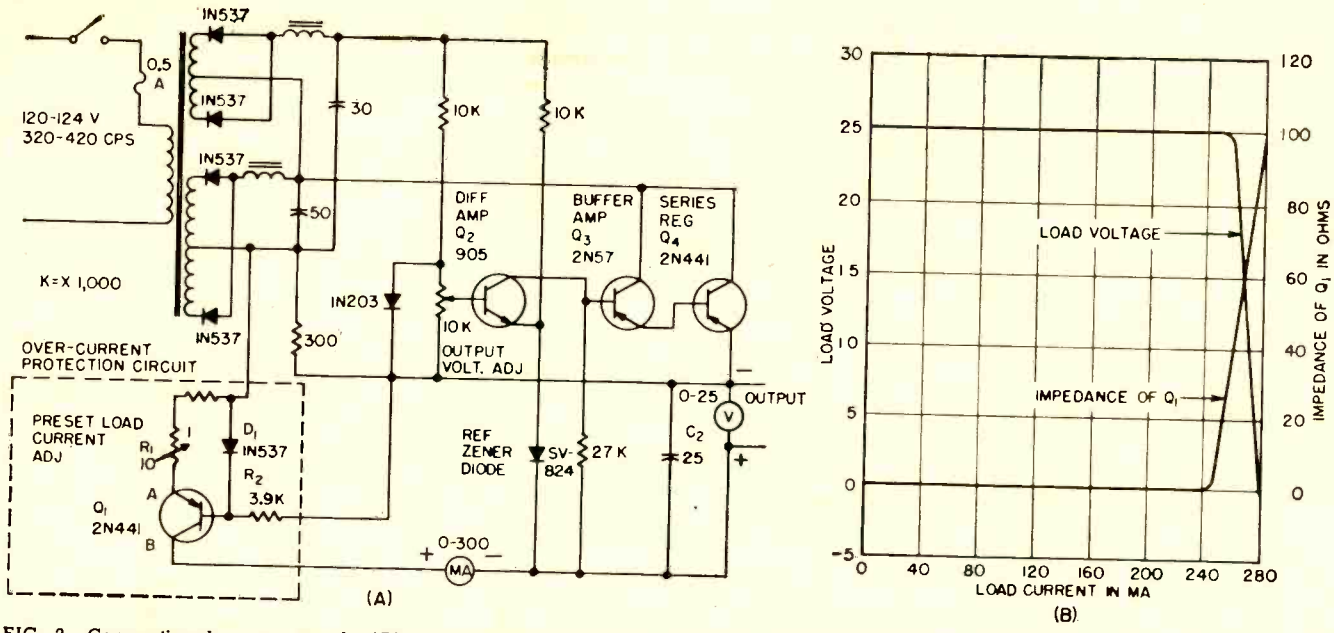


FIG. 2—Conventional power supply (A) is protected by addition of over-current circuit whose current-limiting characteristics can be preset over 50 to 250-ma range (B). Supply has line regulation of 0.001 percent and load regulation of 0.002 percent

Has Overload Protection

B. So long as the load current remains below the threshold setting of R_1, the voltage at point B appears as a low impedance.

When the load current reaches its threshold, D_1 conducts and forms a voltage divider with bias resistor R_2. The base current of Q_1 decreases and part of the supply voltage is dropped across Q_1 in proportion to the load current. After Q_1 becomes a high impedance, further increases in load current cause additional voltage to drop across the transistor. Should the demand for load current become infinite because of a shorted output, all the supply voltage is dropped across Q_1 at its highest dissipation point.

Transistor Parameters

Since the maximum unregulated d-c voltage times the load current produces high dissipation levels in Q_1, the transistor must be a power type. Its voltage rating must exceed the maximum d-c input voltage and its current rating should allow for the maximum current expected. Available germanium power transistors have voltage ratings as high as 100 v, with correspondingly high current and power ratings.

The 2N441 transistor used in Fig. 2A is rated at 40 v, 13 amp and 41 w at a mounting stud temperature of 25 C. At higher temperatures, the power rating is reduced since the junction temperature is limited to 95 C.

In determining maximum power ratings at a specific temperature: $P = (95 - T_M)/1.7$ where, P is power rating in watts, T_M is mounting-stud temperature in deg C and 1.7 is thermal resistance factor, including a 0.002-in. silicon-grease coated mica washer for mounting.

Power or current levels above the ratings of a single transistor can be attained by using two or more transistors in parallel. Paralleling usually requires that each transistor share an equal amount of current so as to divide the total dissipation evenly. If the power dissipation is only slightly higher than the rating of a single transistor, two transistors need not be matched. In other cases matching is necessary and should be performed at currents equal to the maximum load current anticipated for a particular application.

When the voltage rating of a single transistor is inadequate to accommodate the d-c input, two or more of the over-current protection circuits shown in Fig. 2A may be cascaded. The current threshold potentiometer should be so adjusted that under maximum current conditions each transistor drops equal voltages.

Power Supply Performance

The three-stage regulated power supply in Fig. 2A has an output voltage variable from 10 to 25 v and the maximum load current may be set at any value from 50 to 250 ma. Surges of over-current or a shorted load will drop the load voltage so the load current is limited to a preestablished level. Since the charging current of C_2 cannot exceed the current limit set by the protection circuit, any amount of capacitance may be placed across the load without damaging the series regulator transistor.

The over-current protection circuit may be classified with fuses and circuit breakers. It responds instantaneously to any type of overload and is completely static.

Series Triode Stabilizes

Million-volt high-current rectifier generator drives an injector for a linear high-frequency accelerator. As good stability is desirable, an all-electronic stabilizing system has been developed, using a high-voltage triode as a variable resistance. It is driven by a transmission system of f-m light pulses. A voltage divider on the high voltage output gives the error signal

By **GEORGES DOME** and **HERVE D'HOOP**

Center of Nuclear Sciences, Royal Military School, Brussels, Belgium

LARGE-MAGNITUDE direct voltages are used commonly in nuclear physics laboratories. These voltages are ordinarily obtained either from a van de Graaff or Cockroft-Walton generator. The van de Graaff generator is electrostatic and has good voltage stability but drives only a few hundred microamperes. The Cockroft-Walton generator uses vacuum-tube or selenium rectifiers and handles high currents but has poor voltage stability. Instability results from ripple remaining after rectification. In practice, the ripple cannot be removed practically by capacitors or filters.

An electronically stabilized Cockroft-Walton generator combines the advantages of both types—high current with good voltage stability. This article describes a stabilizing feedback loop, successfully tested, which reduces voltage ripple below 10^{-3} times the output.

Series triode regulation with high currents is not a new concept. But, for this application, several difficulties had to be overcome for the million-volt range. No commercial triode was available capable of withstanding at least 10 percent of the million-volt output. A standard X-ray kenotron with a special grid proved to be an excellent tube for this purpose. Specifications met by the tube include: peak anode to cathode drop, 100 kv (without current); maximum current, 5 ma; amplification factor, 150; anode-to-cathode capacitance, 10$\mu\mu$f; and heater, 6.3 v, 4 amp.

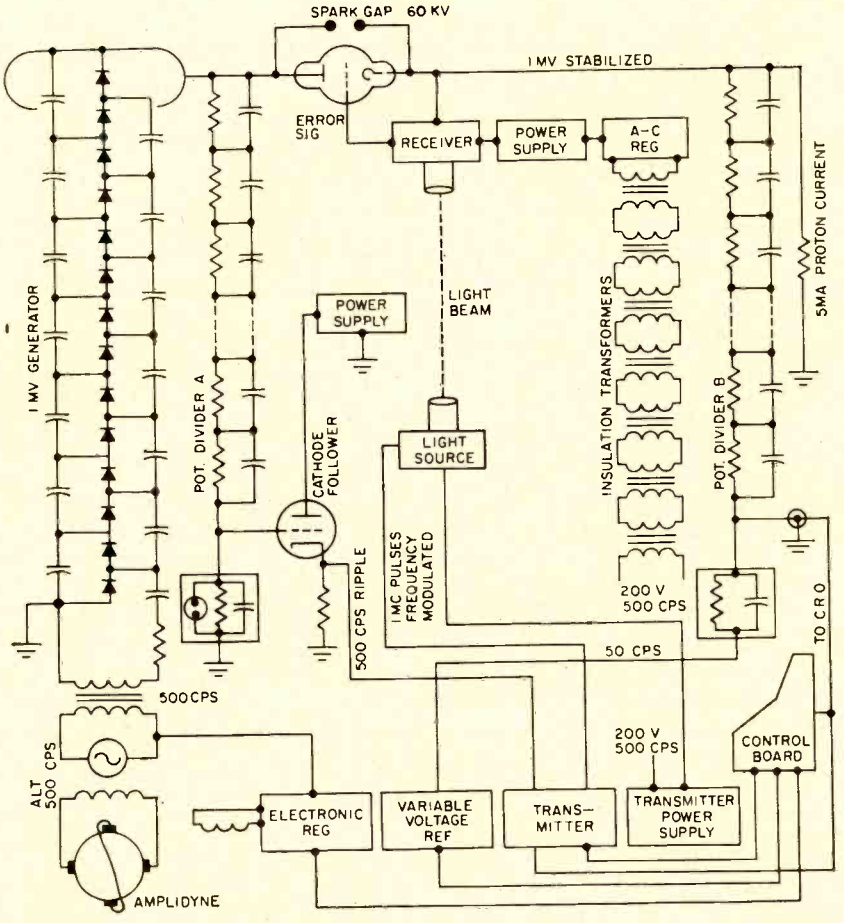


FIG. 1—Block diagram of the frequency-modulated light-pulse transmission system

Feedback Loop

Any regulating feedback loop needs a voltage reference. This reference is generally a few hundred volts above ground potential. In this application, an error signal must be transmitted from ground to the grid of the series triode. At the same time, million-volt insulation must be provided together with zero frequency amplification and negligible phase shift for quick transients.

Ordinary-wavelength radio waves

Million-Volt Generator

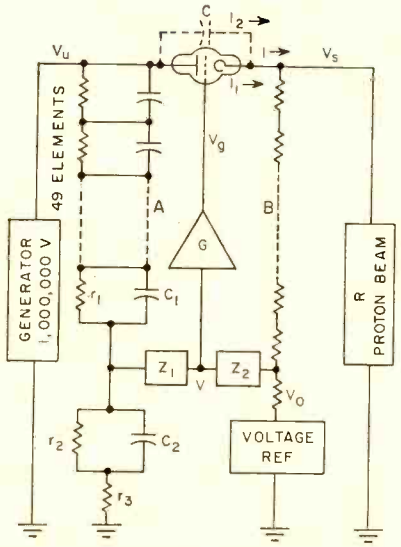
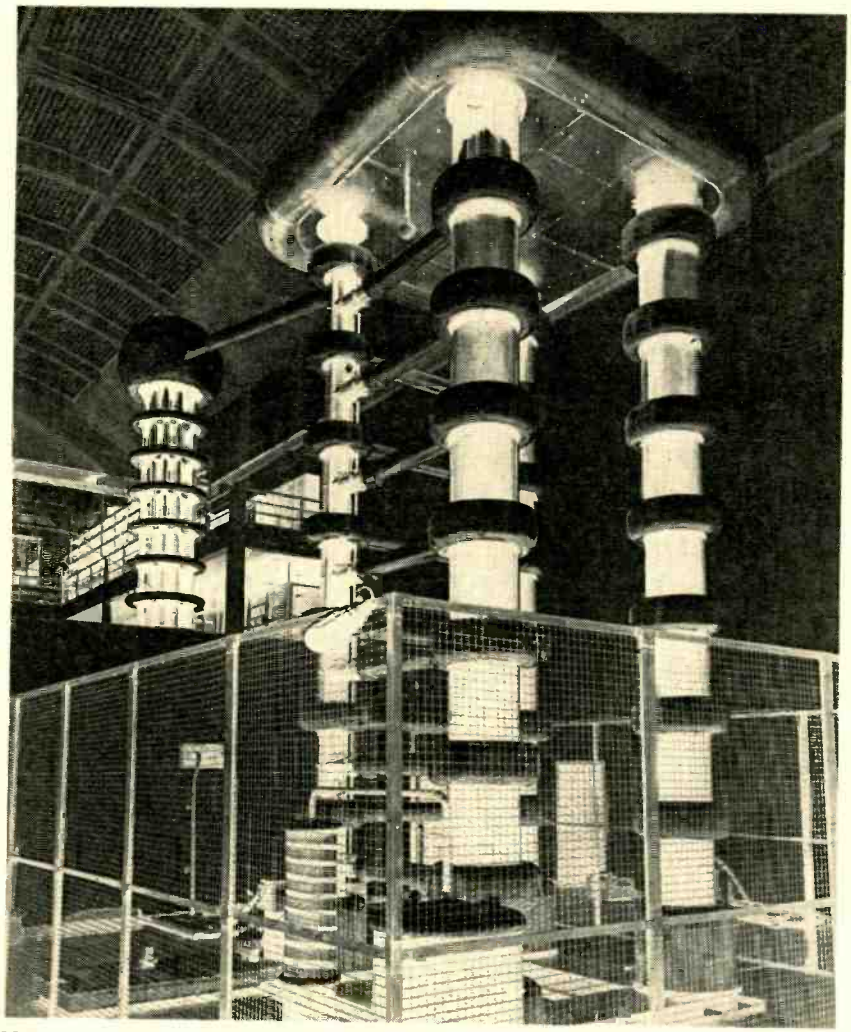


FIG. 2—Passive-network arrangement for feeding the input of the transmitter

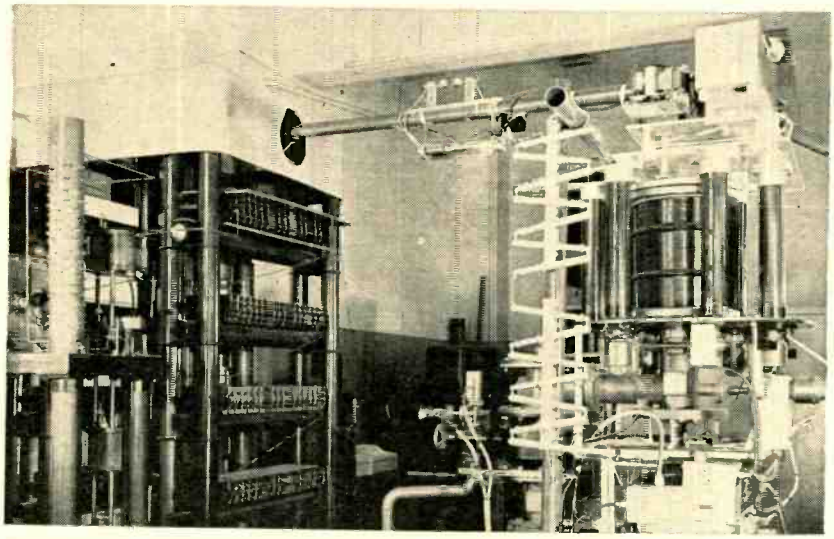
are impractical for transmission since they require transmitting and receiving antennas which would cause corona effect in the high electric field gradient surrounding all electrodes. Only light waves are practical for easy transmission. Frequency modulation of the carrier waves insures trouble-free operation necessary to deal safely with high voltages.

The transmission system developed modulates the repetition rate of short light pulses. Figure 1 is a diagram of the system. The Cockroft-Walton generator is shown on the left. On the right, the proton accelerator is represented by a bleeder resistance. Between them, the series triode acts as a variable resistance, evenly compensating every change, periodic or not, from the generator. Two R-C potential dividers of high resistance supply the error signal to drive the feedback loop.

On the generator side, divider A picks up only the 500-cps ripple signal. Since the time constant of the divider is high compared with the ripple period, the divider works chiefly as a capacitive network. The resistors are needed only for a regular voltage-gradient distri-



Million-volt Cockroft-Walton generator installed at the Military School in Brussels



Experimental setup on a 200-kv generator. Note the regulating triode with its spark gap at upper center of the photograph

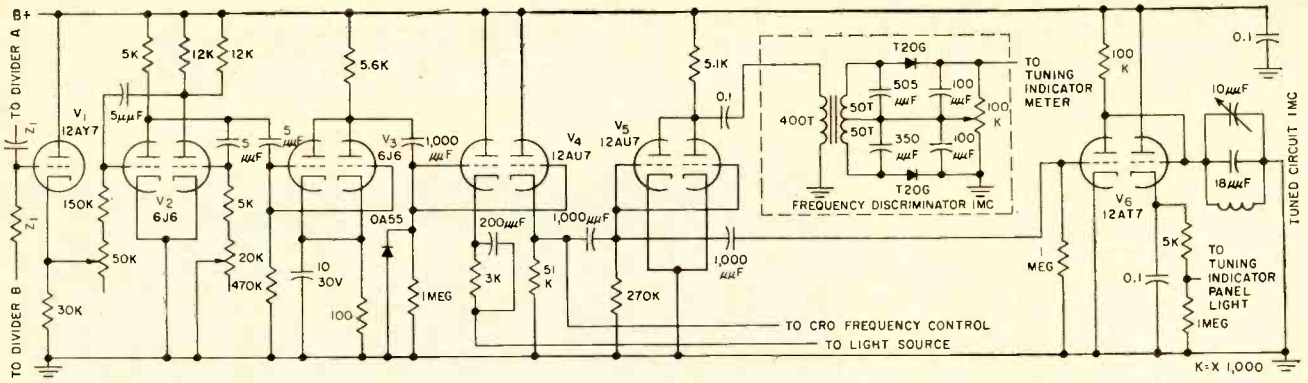


FIG. 3—Details of the circuitry of the light-beam transmitter used to provide regulator error signal to receiver

bution for the generating system.

On the proton-accelerator side, divider B gives the d-c level which is compared to the voltage reference. Divider B uses high-stability resistors. The two divider signals are mixed through a passive network, Fig. 2, which supplies the input of the transmitter. The transmitter is an f-m pulse generator with a carrier frequency of 1 mc.

Voltage pulses are sent through a terminated coaxial line to a light source unit. A gas-filled tube converts the pulses into light flashes. The light beam is focused and sent to the receiver where the sensitive element is a multiplier phototube. The receiver, enclosed in the high-voltage electrode, restores and amplifies the error signal. This signal is then fed into the regulating triode grid. Thus by the described feedback loop, voltage regulation is achieved.

System Performance

Referring to Fig. 2, the expression for the general output regulated voltage is

$$V_s = \frac{\mu\left(V_{g0}+GV_o\frac{Z_1}{Z_1+Z_2}\right)+V_u\left(1+\rho Cp+\mu GA\frac{Z_2}{Z_1+Z_2}\right)}{1+\rho Cp+\frac{\rho}{R}-\mu GB\frac{Z_1}{Z_1+Z_2}} \quad (1)$$

where parameters are as follows: C, total capacitance shunting the triode, including interelectrode capacitance of the tube and capacitance of external components; A and B, attenuator transfer functions; V_u, unstabilized high voltage; V_s, stabilized high voltage; I, load current; I_1, current passing in the triode; I_2, current passing through shunting capacitance C; G, transmission voltage gain (numerical value is negative since change of phase is 180°); V, input voltage to the transmitter (error signal); V_o, reference voltage; Z_1 and Z_2, series impedances with the two attenuator outputs; V_g and V_{g0}, signal to triode grid and fixed grid bias; V_u, voltage drop across the regulating triode; ρ, triode dynamic resistance; μ, triode amplification factor; R, load resistance including the accelerator tube and the B divider; and p, Laplacian operator equal to d/dt.

Equation 1 gives the general expression for output voltage. To obtain good regulation, all variable terms of Eq. 1 must vanish or at least be as small as possible. Since Z_1 is a large capacitance and Z_2 is a high resistance, the term $Z_2/(Z_1 + Z_2)$ approaches unity for the ripple frequency and vanishes for the d-c level. Similarly, $Z_1/(Z_1 + Z_2)$ approaches zero for the ripple frequency and unity for the d-c level.

According to the conditions just described, the transfer-function expression for good regulation is

$$A = -\frac{1}{\mu G}(1+\mu Cp) \quad (2)$$

This expression makes the second term of Eq. 1 equal to zero, and the ripple compensation theoretically perfect. Since B is represented in the denominator only, its value should be as large as possible, theoretically without restriction, except for loop stability. In practice, a value of $B = 10|A|$ is satisfactory.

The ratio ρ/R in the denominator of Eq 1 is small compared with the other terms. This shows that the voltage stability is fairly independent of load impedance. In this particular application, stability is also independent of any variation in the ion source output.

Frequency Response

To give divider A its particular frequency response, the circuit arrangement of Fig. 2 is satisfactory. Circuit components should be

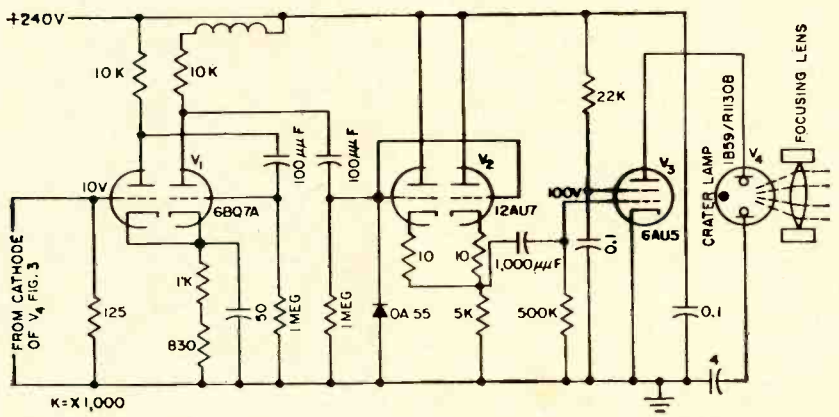


FIG. 4—Schematic diagram of the light-source unit

chosen so that $r_3C_2 = \rho C$ with $r_3 << r_2$ and $r_1C_1 = r_2C_2$ with r_1C_1 much larger than the ripple period.

The r_2C_2 time constant compensates the shunt capacitance C across the triode. Experience shows that C should not be greater than 80 $\mu\mu$f. This important restriction comes about because the charging current I_2 in the capacitance C must always remain smaller than the direct current I of the generators.

It is also possible to stabilize with a loop using only one potential divider, namely B. Then, Z_1 must be made infinite and Z_2 a short circuit. But ripple compensation is somewhat worse.

Light-Beam Transmitter

The f-m light-beam transmitter is shown schematically in Fig. 3. Inputs from dividers A and B are at the left. Tube V_2 is a multivibrator stage where the frequency is modulated by a variable grid-leak potential driven by V_1 acting as a cathode follower. Tube V_3 is a pulse amplifier and V_4 a cathode follower. Cathode resistance of V_4 is the terminating impedance for the coaxial cable going to the light source unit in Fig. 4. Carrier frequency of the pulse generator is one mc, pulse width is 0.2 μsec, and rise time is 0.02 μsec. Pulse slope must be as steep as possible to avoid noise in the final demodulated signal.

As a control means, tubes V_5 and V_6 (Fig. 3) are connected to a panel neon light and a meter to control correct frequency operating conditions. The meter is connected with a frequency discriminator identical to the one in the receiver. The panel light is connected to a tuned detector and is a quick means of control.

Figure 4 shows the circuitry of the light unit. Tubes V_1 and V_2 are a pulse amplifier and shaper, respectively. Tube V_3 is a power stage and V_4 a crater lamp. The crater lamp is a gas discharge glow modulator with a small and bright light spot. It was originally designed for a-f amplitude modulation. But in this application it was found that the light follows the current pulse shape exactly. A quartz focusing lens directs the beam towards the receiver and allows ultraviolet light to be used as well as visible light.

The light source has been separated from the transmitter since the source has to be located in the dangerous area of the million-volt generator. All the remaining electronic components, including the transmitter, are housed in a separate room.

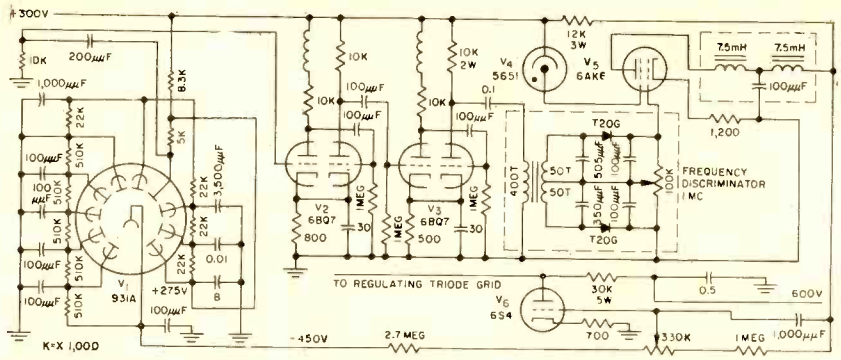


FIG. 5—Complete circuitry of the receiver located near the proton accelerator

Receiver

Receiver elements are housed in a spherical equipotential container near the ion source and the proton accelerator. The regulating triode is located in the line between the accelerator and the Cockroft-Walton generator.

The receiver circuit is shown in Fig. 5. The sensitive element in the receiver is a multiplier phototube where light is converted into voltage pulses. This tube is connected to a wide-band amplifier stage, V_2, and a limiter, V_3. A frequency discriminator with crystal detectors restores the initial modulating signal.

Following the discriminator is a low-frequency amplifier stage where the plate resistor is replaced by a matched-T low-pass filter. This filter achieves carrier rejection without introducing appreciable phase shift.

Tube V_6 is a second direct-coupled stage using a separate 600-v plate supply. The separate supply is necessary since V_6 has to deliver high-amplitude modulation to the regulating-triode grid. The 600-v terminal of the separate supply is connected to the regulating-triode grid and makes it negative. The passband goes from 0 to 50 kc and the receiver response to a step function applied to the transmitter input has a 5-μsec rise time.

Figure 6 shows the regulator circuit for the 500-cps alternator.

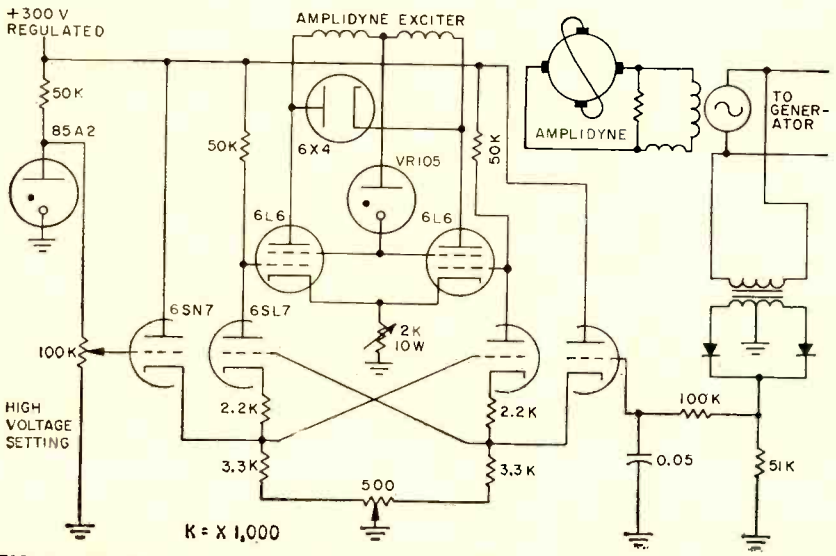


FIG. 6—Circuit arrangement used for prestabilizing the direct voltage fed into the Cockroft-Walton generator

Harmonic Amplifier for

Frequency tripler harmonic amplifier generates 10 kmc and delivers about 3 to 5 milliwatts. Amplifier operates in cascade with a crystal oscillator to form a phase-stable signal source in a precision X-band radar receiver that is stable over a 50-mc band centered at 9,370 mc

By WALTER J. DAUKSHER

Project Engineer, Dept. of Radar and Navigation, Airborne Instruments Laboratory, Inc., Mineola, New York

FREQUENCY STABILIZATION is often a problem in designing a signal generator for high-frequency communication equipment.

For low-frequency generation a crystal-controlled oscillator is used normally as a frequency-stable signal source. However, because of the physical limitations of the quartz-crystal resonator, direct crystal control of frequencies above 100 mc is not practicable. When a frequency higher than the crystal oscillator frequency is desired the technique used is to follow the crystal oscillator with a harmonic amplifier cascade, which makes possible useful power at multiples of the crystal oscillator frequency.

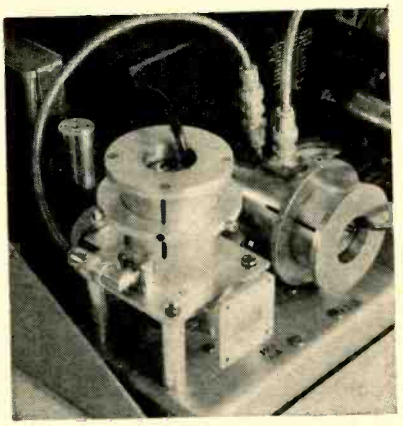
The crystal-oscillator, harmonic-amplifier cascade technique is used for the generation of stable signals, in both receivers and transmitters in the upper vhf and lower uhf regions. Some examples are VOR, Tacan, DME, scatter and in frequency measuring equipments. The cascade technique has also been used to derive a local oscillator signal of 3 kmc for an S-band radar.[1]

Harmonic Amplifier Operation

A harmonic amplifier essentially distorts the incoming signal to generate harmonics and filters and amplifies the desired harmonic.

Harmonics of the input frequency are contained in the pulsed or discontinuous plate current of a tube operating as a class-C amplifier. Harmonic-frequency power can be extracted from the tube plate current by resonating the plate-load impedance to the desired harmonic frequency.

As the operating frequency of an amplifier increases, gain decreases, the required driving power increases and, in general, the amplifier becomes less efficient.[2] These typical harmonic amplifier effects are attributed to parasitic interelectrode capacitance, lead inductance and electron transit time between tube elements.



Frequency tripler harmonic amplifier shown installed in low-frequency exciter for use in X-band radar system

Improvements in harmonic amplifier operation in the microwave region depend on advances made in microwave tube design. A major advance in tube design is illustrated in the 6280/416B ultrahigh frequency triode.[3] This triode incorporates a planar disk-seal type of construction to obtain minimum lead inductance and interelectrode spacing. The 6280/416B is particularly suitable for use in frequency multipliers to deliver output in the uhf and the lower shf regions.

Frequency Tripler

The 6280/416B was tested as a harmonic amplifier delivering an output power at 9,370 mc. To com-

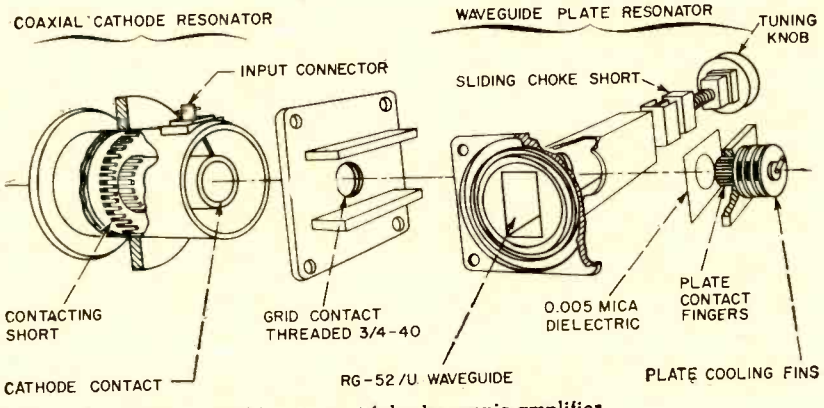


FIG. 1—Exploded view of frequency-tripler harmonic amplifier

X-Band Local Oscillator

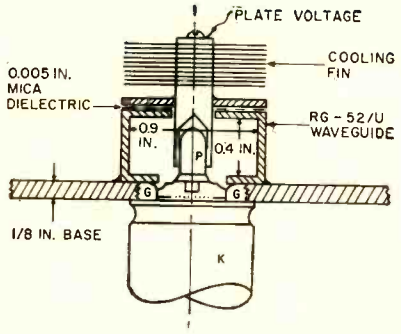


FIG. 2—Cross section of tube-to-waveguide connection showing orientation

promise between generating the excitation for the harmonic amplifier easily and obtaining reduced power output from a harmonic amplifier as the multiplication order is increased, the triode was operated as a frequency tripler. The use of a plate resonator constructed of RG-52/U waveguide simplified the output filtering problem. The second harmonic of the excitation frequency was below the waveguide low-cutoff frequency of 6,500 mc.

The frequency tripler is shown with a portion of the low-frequency exciter in the photograph. An exploded view of the tripler is shown in Fig. 1.

Plate Resonator

The tube is placed in the waveguide so that the plate post of the tube extends across the waveguide parallel to, and coinciding with, the maximum voltage vector of a TE wave in the waveguide. See Fig. 2. This permits convenient application of plate voltage to the tube and allows cooling fins to be used for removing plate heat.

The output capacitance of the tube can be considered connected across the waveguide if the inductance of the plate post is neglected. By using sections of the waveguide as inductive stubs, resonating with the tube grid-plate capacitance, the portion of the waveguide adjacent to the plate post becomes a resonating chamber. The resonant chamber couples the load, through the transmission line, to the tube.

Resonator Length

Figure 3 shows the tube placed in the center of a half-wave mode waveguide resonator that is capacitively shortened. Each inductive line length must resonate with half the tube capacitance. Accordingly, the length of waveguide necessary to behave as a half-wave mode resonator was determined to be 0.0612 cm.

Because of space limitations between chamber and plate post, mechanical construction of such a half-wave resonant chamber is impossible. The diameter of the plate-post connector is 0.635 cm.

The distorted field around the plate post is another factor in considering length of the resonant chamber. Because of these limitations, the resonant chamber has to be closed off. A variable choke short about a half guide wavelength from the plate post and a reactive post about a half guide wavelength from the plate post is used for this purpose. The choke short is intended as a tuning adjustment for use when shifting operating frequency or changing tubes. The reactive post closes off the resonant chamber and matches the tube to the waveguide transmission line.

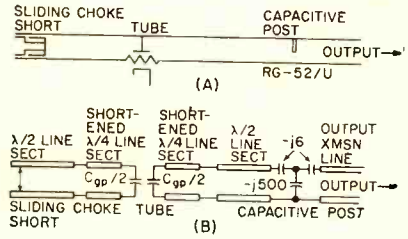


FIG. 3—X-band resonator showing (A) waveguide structure and (B) equivalent electrical circuit.

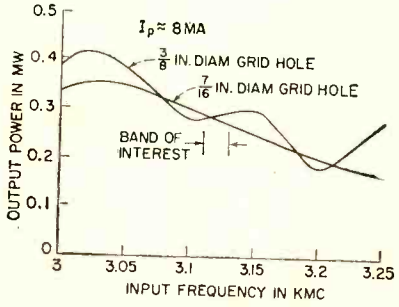
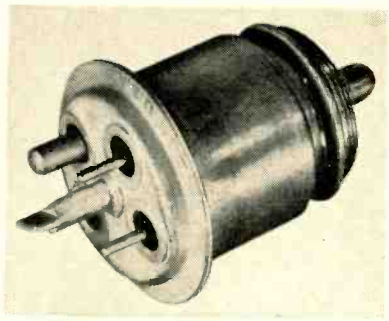


FIG. 4—Curves obtained at first test for undesired resonances in plate resonator



6280/416B triode used in frequency tripler

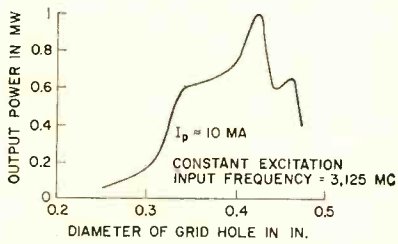


FIG. 5—Curve of output power versus diameter of grid hole is used to determine optimum grid hole diameter at center of desired operating frequency band

Spurious Resonance

Some of the earlier measurements made on the plate resonator were intended to test the tube-to-waveguide connection for spurious resonances. These resonances were indicated when output power changed with frequency, a condition that is undesirable. One spurious resonance was discovered in the hole in the waveguide directly over the tube grid. Changes in grid-hole diameter profoundly affected performance of the harmonic amplifier over a large band.

To eliminate all possible vari-

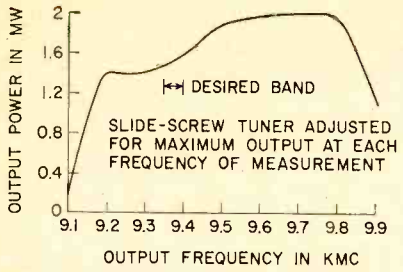


FIG. 6—Curves obtained at second test for undesired resonances in resonator

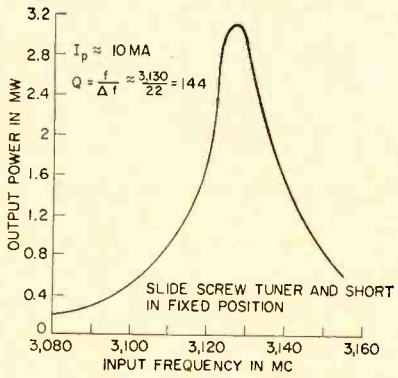


FIG. 7—Response curve of plate resonator

ables, measurement was made with only the choke short acting as a tuning element. A bolometer power bridge matched to the waveguide was connected to the waveguide resonator with no matching device between the load and the tube. Figure 4 shows the power output obtained over the 9,000-to-9,750-mc range with two sizes of grid holes. The 3/8-in. diam grid-hole curve exhibits resonances at input frequencies of 3.025, 3.1, 3.15, and 3.2 kmc. Measurements were also taken to determine the grid hole size in the waveguide that would yield the maximum output power at the center of the desired band.

A curve showing the result of such a measurement is given in Fig. 5.

Improving Efficiency

These measurements were made with the tube working into a flat waveguide transmission line that represented a plate load of 530 ohms. Theoretically, insertion of a matching network should improve the efficiency of the frequency tripler and permit the realization of more output power. This was tried, experimentally, by placing an HP X870A slide-screw tuner between the plate waveguide structure and the bolometer load. A test was made to determine if any stray resonances were present. None were found that were close to the operating band. The curves of Fig. 6 attest to this fact.

The operating Q of the resonator was measured by placing the tuner and the choke short in a fixed position and by varying the excitation frequency, Fig. 7. An operating Q of about 140 was measured with the tuner probe 1-1/2 guide wavelengths from the plate post of the tube.

Substituting another equivalent probe for the tuner half of a guide wavelength from the plate post of the tube would lower the operating Q somewhat. Operation would then be permitted over the desired band with slightly reduced efficiency and with only one tuning adjustment—the choke short. As shown in Fig. 3, the probe was found to be capacitive.

Cathode Resonator

A grounded-grid amplifier has a low input impedance. In particular, the input impedance of the 6280/416B tube is equal to about 50 ohms.

The tripler input cable was connected directly to the cathode. The cathode resonator, Fig. 8 shields the tube and resonates with the cathode grid capacitance of the tube. A coaxial transmission line with a characteristic impedance of about 24 ohms was chosen for use as the cathode resonator. The length of line necessary for resonance was determined as 0.362 cm.

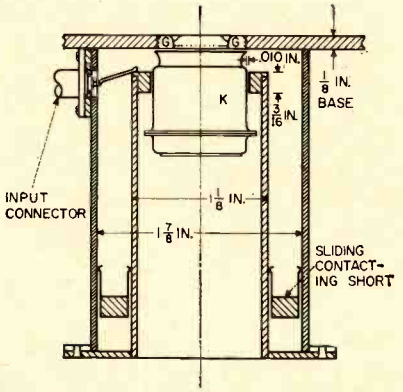


FIG. 8—Cross section of cathode resonator which also shields the tube

The distorted fields in the immediate vicinity of the cathode and grid connections of the tube and the end of the coaxial line may not make a line 0.362 cm in length truly coaxial. Furthermore, a line of the calculated length is mechanically impossible to couple and to tune. Hence, the contacting short was placed an additional half wavelength, $\lambda/2$ equals 4.8 cm, down the line and made adjustable in position to permit tuning of the coaxial transmission line.

The capacitance-coupling method was used to connect the tube cathode to the coaxial-line inner conductor. The 0.01-in. radial gap between the tube cathode and the coaxial inner conductor produces a capacitance of about 11 $\mu\mu$f. Eccentricities tend to increase the capacitance.

For several of the tubes tested the capacitance connection showed no difference in input swr from the direct connection. The gap resulting from a capacitance connection permits easier insertion and removal of the tube.

Results

Operation of the frequency tripler is satisfactory. The tripler delivers about 3 mw at about 10 ma of plate current when driven with about 150 mw of excitation, and about 5 mw at about 15 ma of plate current when driven with about 250 mw of excitation. Plate dissipation sets a limit on the obtainable output power. If a blower is used to cool the plate, the present conservative plate input of about 2.5 watts may be increased to the maximum plate input allowed for the tube.

This article was partially derived from a paper presented at the NEC, Oct. 1957.

The author thanks fellow staff members of AIL for their help. Work on the frequency tripler was done under P. O. 36894 for the University of Illinois.

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(1) W. J. Dauksher, Stable Local Oscillator for S-Band Radar, ELECTRONICS, p 179, Sept. 1956.
(2) K. R. Spangenberg, "Vacuum Tubes," Chap. 16, McGraw-Hill Book Company, Inc., New York, 1948.
(3) J. A. Morton and R. M. Ryder, Design Factors of the BTL 1553 Triode, BSTJ, 29, p 496, 1950.
(4) N. Marcuvitz, "Waveguide Handbook," *Rad. Lab. Series*, 10, p 271, McGraw-Hill Book Co. Inc., New York.

Jamming Nomograph

Radar free-space noise jamming susceptibility nomograph determines susceptibility of radar to noise jamming rather than effectiveness of the jamming. Nomograph is based on principle that noise jamming increases the receiver's inherent noise thereby reducing maximum radar detection range

By GEORGE MINTY
Operations Research Dept., Engineering Research Institute, University of Michigan, Ann Arbor, Mich.

THE SUSCEPTIBILITY nomograph differs from existing jamming nomographs in that susceptibility of the radar to noise jamming rather than effectiveness of the jamming is the object of the calculations. For this reason, several scales have been allotted to parameters of the radars, but only two to the jammer. Consequently, the nomograph should be used only in making a comparative evaluation of the susceptibilities of radar sets. To determine actual radar range under jamming, the maximum unjammed range must be known since the nomograph gives the percent reduction in normal range due to jamming.

Application Notes

In the application of the nomograph to conical-scan tracking radars, the target should be considered as not in the middle of the beam. Consequently, if the jammer is located on the target, the relative gain of the radar antenna for the jamming signal should be taken as approximately $-1\frac{1}{2}$ db.

For three-dimensional radars, it may be necessary to take collapsing-losses into account. The method of doing this must be determined for each radar individually. These and various other losses and gains can be taken into account by adding them to, or subtracting them from the radar antenna-gain.

If it is desired to consider noise-jamming with clipped a-m noise, f-m noise, etc., the equivalent thermal noise should be determined and the difference in db added to or subtracted from the jammer antenna gain. Accuracy of this figure is not essential if radars are to be compared under identical jamming conditions.

The nomograph assumes that the jammer polarization is the same as that of the radar and that the radar rejects perfectly any image-frequency signals or beat components between various parts of the jamming spectrum. For barrage jamming, this possibility must be considered as affecting the accuracy of the results. If the jammer is circularly polarized, 3 db should be subtracted from the jammer antenna gain.

Example

For the radar specified on the chart, the following example for a target without jammer may be used. Establish a straight line through the scale points corresponding to the known values of the distance from radar to jammer in miles and the receiver noise figure on the scales so designated. Note the point of intersection of this line with the index *A* line.

Determine a straight line through the scale point corresponding to the known values of the jammer power and the jammer antenna gain in their respective scales. Note the point where this line intersects the index *B*.

Connect the point on the index *B* line and the appropriate scale point on the radar antenna gain scale. Intersect the line thus formed with the index *C* line.

Establish a straight line between the scale points for the known values of the wave length and the radar relative gain on the scales so designated. Note the intersection with index *D* line.

Form a straight line through the point on the index *D* line and the point on the index *C* line. Note the point where this line intersects the index *E* line.

Determine the straight line through the point on index *E* and the point on index *A*. Intersect this line with the index *F* line and mark the point.

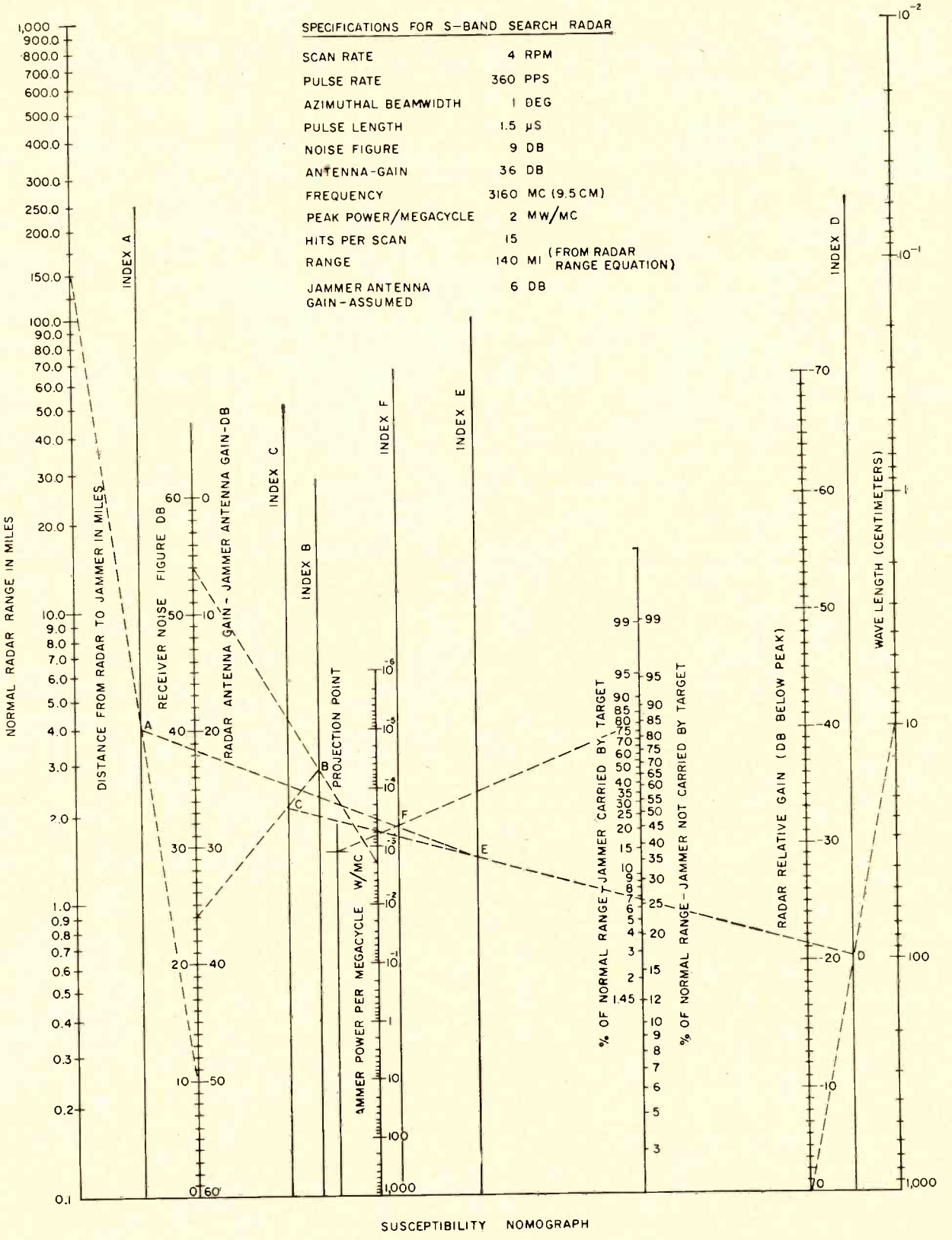
Join the point marked on index *F* with the reference point on the projection line to form another straight line. Intersect this line with the percent of normal range-jammer not carried by target scale and at the point of intersection read the percent reduction in range.

Target With Jammer

For a target with jammer, establish a straight line through the known values of normal radar range in miles and re-

(continued on page 84)

Jamming Nomograph (continued from page 83)



ceiver noise figure. Note the point of intersection of this line with the index *A* line. Repeat the procedure given above.

Join the point marked on index *F* with the reference point on the projection line. Intersect this line with the percent of normal range jammer carried by target scale and at the point of intersection read the percent reduction in range.

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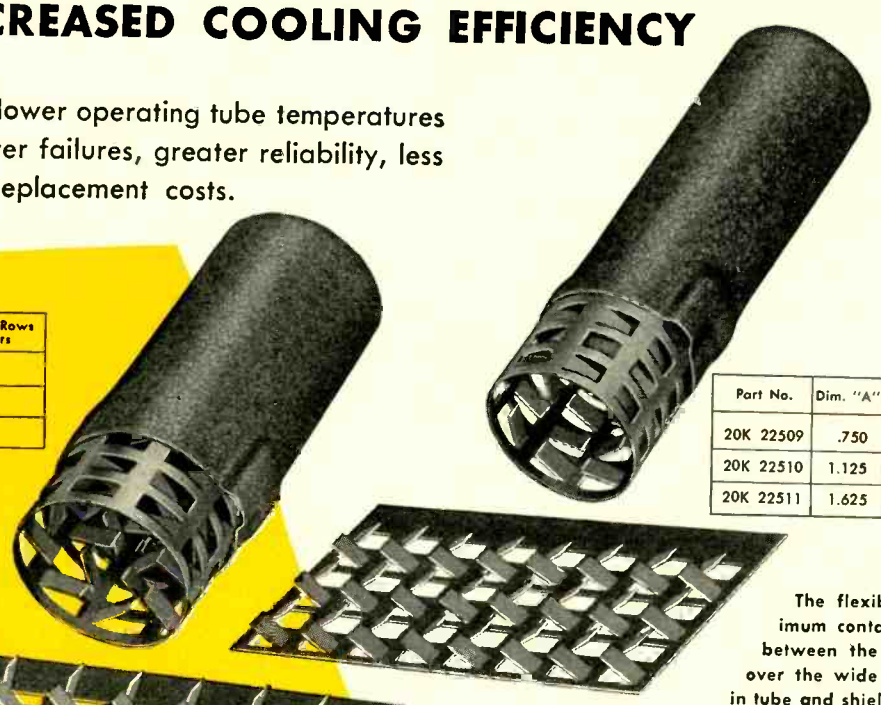


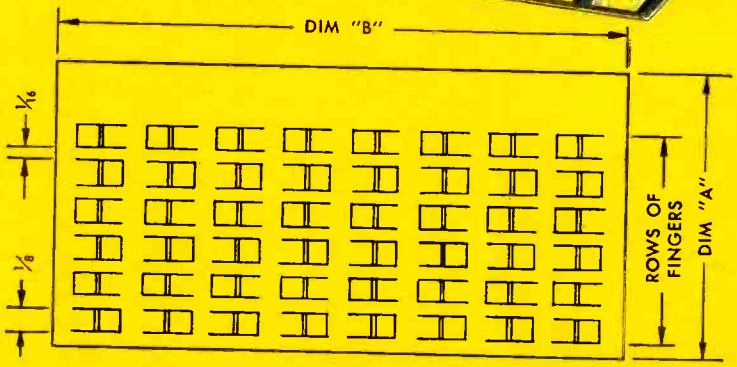
Miniature Tube Shield and Insert Assembly (Type 1, See Chart)

Part No.	Dim. "A"	Dim. "B"	Number of Rows of Fingers
20K 22509	.750	2½	3
20K 22510	1.125	2½	4
20K 22511	1.625	2½	6

Part No.	Dim. "A"	Dim. "B"	Number of Rows of Fingers
20K 22512	.860	2 23/32	3
20K 22513	1.312	2 23/32	5
20K 22514	1.750	2 23/32	6

Noval Tube Shield and Insert Assembly (Type 2, See Chart)

The flexible fingers insure maximum contact of the cooling insert between the tube and outer shield over the wide tolerances encountered in tube and shield assemblies.



CINCH corrugated inserts are made from 0.003 inch cadmium-plated Beryllium Copper with black matte heat resistant finish; bent into a circular shape, the ends fitted together, and then inserted into the proper shield. The insert makes contact with the circumference of the glass bulb and the shield on the other side, conducting the heat to the shield with a greater radiating surface.

Meet requirements of MIL Standard 242A and MIL-S-19786A (Navy)

These inserts may be adapted to operating equipment presently in use with no chassis modificatio or additional space requirements.

Shield & Insert No.	Type	Tube Shield No.	Shield Insert No.	Shield Length	JAN No.
13A 22699	1	13A 963	20K 22509	1 3/8	TS 102U01
13A 22700	1	13A 964	20K 22510	1¾	TS 102U02
13A 22701	1	13A 965	20K 22511	2¼	TS 102U03
13B 22702	2	13B 17873-1	20K 22512	1½	TS 103U01
13B 22703	2	13B 17874-1	20K 22513	1 15/16	TS 103U02
13B 22704	2	13B 17875-1	20K 22514	2⅜	TS 103U03

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CIRCLE 54 READERS SERVICE CARD

Close-Tolerance Temperature Tests

HIGH ACCURACY and reliability in electronic missile systems and in computing equipment often demand a means for precise temperature measurement. Recent experimentation with electromechanical components, such as liquid-cooled gyros and accelerometers, has led to the development of techniques for dynamic temperature measurement to relative accuracies of 0.01 F or better with absolute accuracies of 0.1 F.

The choice of sensing elements depends on the range of temperatures and the linearity requirements. For most laboratory work, platinum or pure nickel wire resistance elements in a three-wire Wien-bridge circuit are quite satisfactory. These units consist of a zig-zag of wire imbedded in plastic or several turns wound around a thin card with a coating to eliminate moisture absorption.

They may be suspended in an air stream, cemented to metal surfaces or held in a wire cage probe for liquid sensing. To obtain high accuracy, every effort must be made to insure that the element is in intimate thermal contact with the material being measured. The size and shape of the element should be chosen to minimize distortion of existing thermal gradients.

The use of thermistors as sensing elements is currently being investigated. The advantage of their increased sensitivity is partially offset by reduced linearity. In addition, insufficient knowledge of their stability and drift for repeatable measurements of 0.01 F or better prevents an unqualified recommendation at this time.

The current through any sensing element must be sufficiently small to prevent errors due to self-heating. If the element is in good thermal contact with the material being measured, a current level of from 1 to 3 ma can usually be tolerated.

D-c bridges are recommended, since they may be nulled to within a few microvolts without phase shift or the quadrature current correction required in a-c bridges.

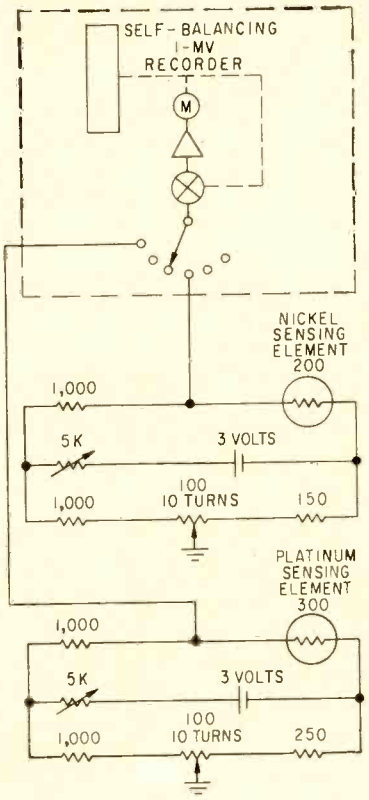


FIG. 1—Simple test circuit provides high accuracy if carefully designed

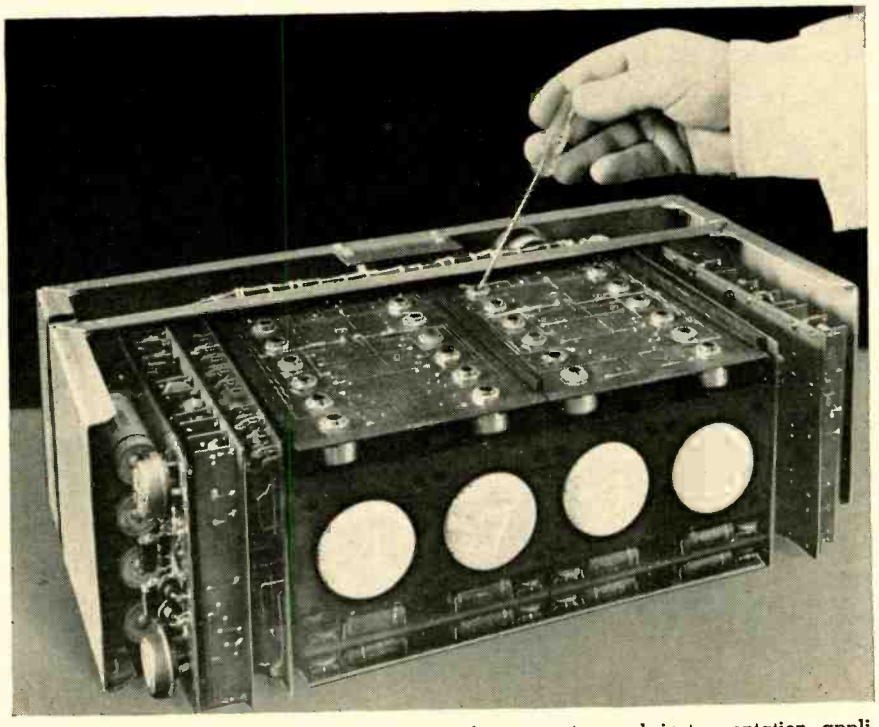
Both the temperature coefficient of the bridge resistors and the thermal emf at all junctions must be carefully considered in the design. These factors can be partially overcome by the placement of the bridge circuit components in a temperature-controlled chassis.

Selecting display or indicating equipment is based on number of sensing elements, required sensitivity and rate of temperature change expected. In many cases, a multipoint strip chart recorder has sufficient speed for common thermal transients. These units are available with a full-scale sensitivity of one millivolt or less. This is sufficient to provide a Fahrenheit span of one or two degrees without additional amplification.

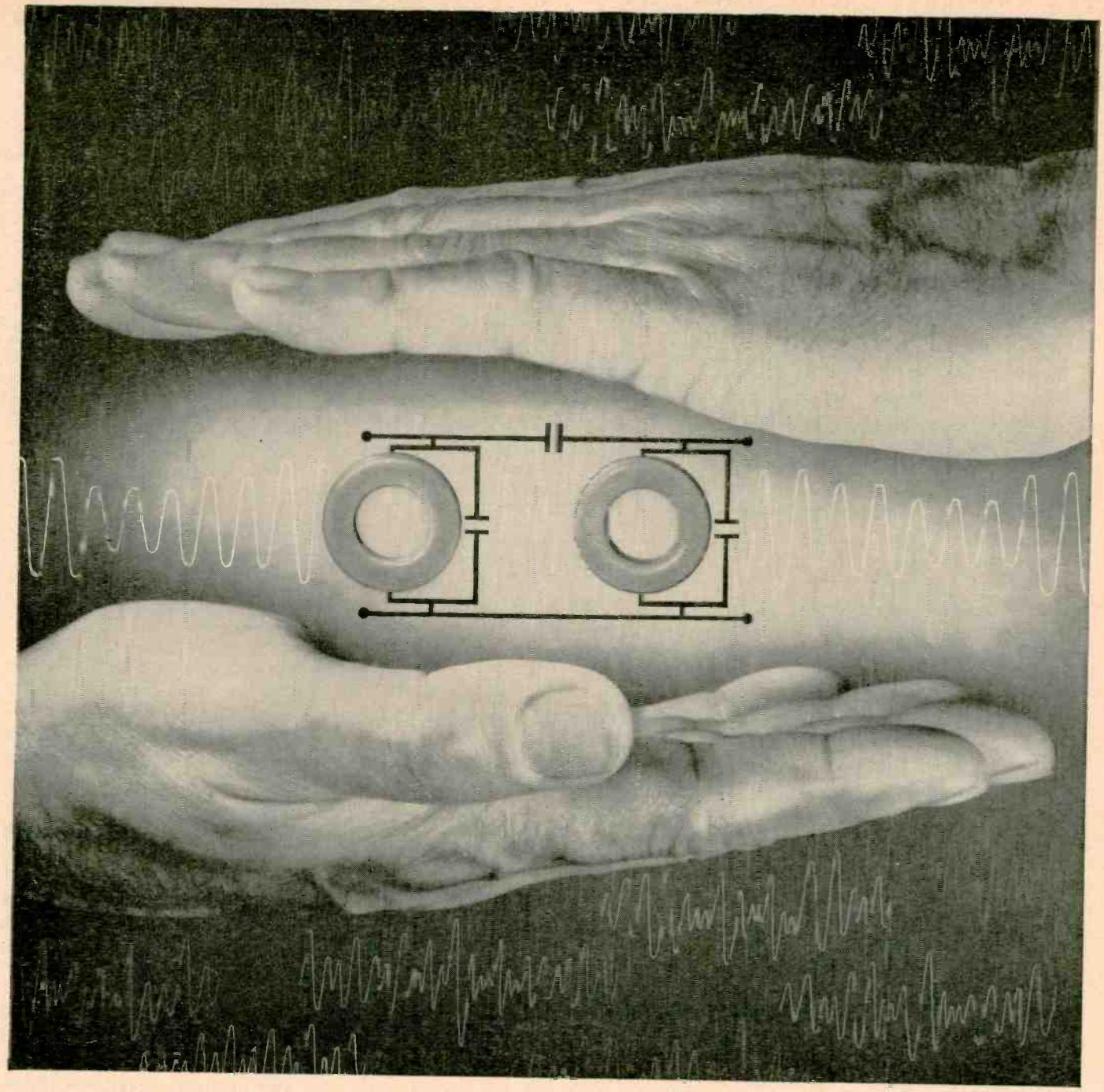
Some magnetic amplifiers or chopper-stabilized vacuum-tube amplifiers may be employed as preamplifiers to obtain greater sensitivities or to allow use of smaller sensing elements or lower bridge currents.

The circuitry currently being used for relative temperature measurement to within 0.01 F is shown in Fig. 1. Absolute calibration to

Digital Display Is All Electronic



Completely electronic digital display device for computer and instrumentation applications is produced by Hoffman Electronics. Numbers are formed by Lissajous pattern on crt's. Readout of two, four or six digits is available



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0.1 F may be achieved with high-quality mercury thermometers available from laboratory supply houses. An increase in absolute accuracies to 0.01 F or better is possible with special equipment.

Francis Associates, Consulting Engineers, is conducting the program. It is supported by the Instrumentation Laboratory of MIT.

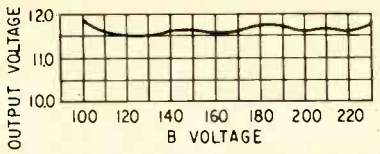

FIG. 3—Output voltage vs supply voltage is shown with a fixed load of 800 ohms

Thyratron Regulates Supply

By W. D. FRYER Electronics Dept., Cornell University, Buffalo, N. Y.

INCREASING use of transistors has heightened interest in regulated low-voltage supplies. A circuit is described that uses a thyratron in a regulator circuit to supply voltages from 12 to 15 volts. The circuit is most useful for short-time regulation against supply voltage and load changes.

The circuit shown in Fig. 1 uses a 2D21, although different thyratrons or mercury-vapor tubes could be used to provide different characteristics. The grid, shown grounded in the schematic, may be connected to the plate through a series protective resistor to assure firing of the thyratron with low B plus.

Output voltage as a function of load current is shown in Fig. 2. The output voltage varied less than one percent over the range of load currents from 6 to 22 milliamperes. Hence, this region is seen as one of exceptionally good performance.

The bend in the curve at lower load currents (higher tube currents) depends upon the detailed volt-ampere characteristics of the tube. This region can be used, however, if maximum regulation is not necessary.

The bend at the higher load currents is caused by the load absorbing all available current (which is the ratio of B plus voltage to series dropping resistor, or about 30 ma

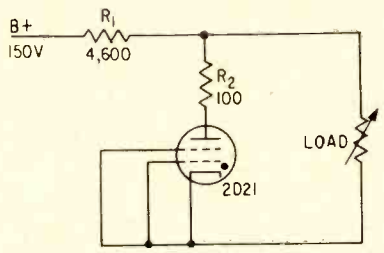

FIG. 1—The 2D21 thyration used in this circuit regulates 12 to 16 volts output over a load range of 6 to 22 ma within one percent

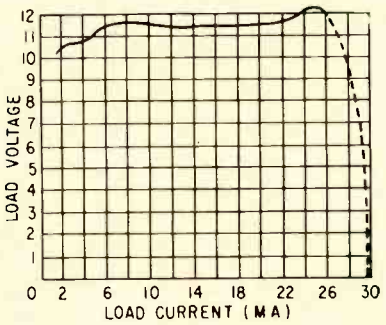

FIG. 2—Load voltage vs load current indicates range over which regulator operates best

in this case), leaving the tube cut off. Since the 2D21 can handle 100 ma continuously (500 ma peak), the circuit is easily modified to extend regulation to higher current values.

The 100-ohm resistor, R_2, tends to compensate for a slight negative-resistance characteristic in the 2D21 volt-ampere curve. If R_2 were omitted, the curve in Fig. 2 would actually show an increase in output voltage as the load current increased. The correct value of R_2 will depend on the tube used. For example, 60 ohms was found suitable for several tubes which were tested.

A typical regulation curve of output voltage vs supply voltage variations is shown in Fig. 3. Except that load resistance is fixed at 800 ohms, all circuit values shown in Fig. 1 apply.

Brief experimentation showed that well-aged tubes do no drift appreciably over a 24-hour period, nor do they show significant voltage changes when subjected to on-off cycling. However, new tubes may show drifts as much as ½ volt during the first hours of operation, and from ½ to perhaps 2 volts in the first 24 hours. Also, different tubes will give different voltages, with a variation of perhaps 2 volts being possible.

For these reasons, the 2D21 at least does not appear particularly useful as an absolute voltage reference, although possibly well-aged tubes may be found moderately satisfactory for such a purpose.

Blocking Oscillator Is Crystal Controlled

By PHILLIP S. BENGSTON
U. S. Naval Ordnance Lab, Silver Spring, Md.

HIGHER original cost and lower reliability are often the price of circuit complexity. These factors were considered in the design of a simple blocking oscillator with crystal control.

The circuit was developed for recording a reference base on magnetic tape in a 10-channel instrumentation system. The recorded signal was to be used both for a timing base and a standard output for obtaining wow and flutter compensation during playback.

The unit, shown in Fig. 1 provides a 3-ma current through a recording-head impedance of about 14,000 ohms at 50 kc. The circuit is an ordinary plate-to-cathode coupled blocking oscillator with the crystal substituted for the capacitor.

The unit oscillates freely without the crystal at a frequency determined by the value of the resistor, the characteristics of the pulse transformer and the distributed wiring and tube capacitances. The free-running frequency is rather unstable and tends to increase with an increase in plate voltage. If the free-running frequency is lower than the crystal frequency by a factor of no more than 40 percent, the oscillator locks to the crystal frequency.

The pulse period is determined

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☐ **malfunction at elevated ambients**

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Stud or bracket mountings
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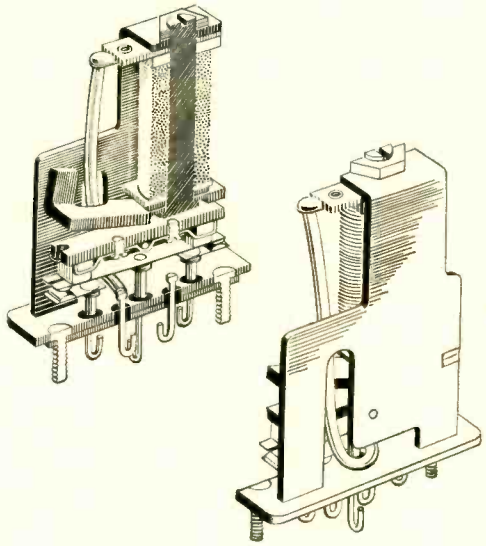
Coils available for ac or dc

TYPICAL RATINGS

Contact ratings (resistive) @ 28 vdc or 115 vac single phase
3 amp @ 125°C ac and dc
5 amp @ 85°C (dc only)
Minimum operating cycles—100,000
Weight—approx.—0.125 lbs.
Shock—50 G's
Vibration—15 G's to 2,000 cps
Temperature range—70°C to +125°C

Applicable specifications—MIL-R-6106C Class A5, A8, B8, minimum current tests applicable; MIL-R-5757B Class A and B

Also available for special requirements such as microamp switching, high vibration and special mountings.



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primarily by the pulse transformer and must be relatively long compared with the usual blocking oscillator. It approaches a half period for the locked crystal frequency.

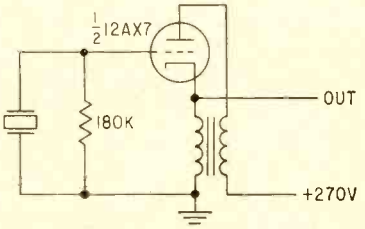


FIG. 1—Output from crystal-controlled blocking oscillator is about 110 volts peak to peak

The component values were determined empirically. Most crystals locked to harmonics of their indicated frequency with other transformers and resistor values.

The output is coupled from the cathode winding of the pulse transformer to the tape recorder head. With the supply voltage shown, the output voltage is about 110 volts peak to peak, sufficient for tape saturation. Output impedance is about 300 ohms.

Dynamic Test for Regulators

By C. L. BENSON Playa Del Rey, Cal

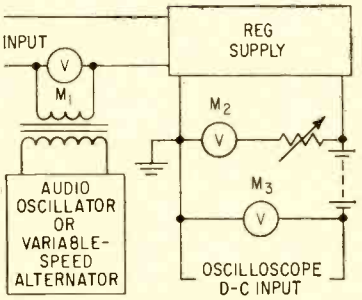
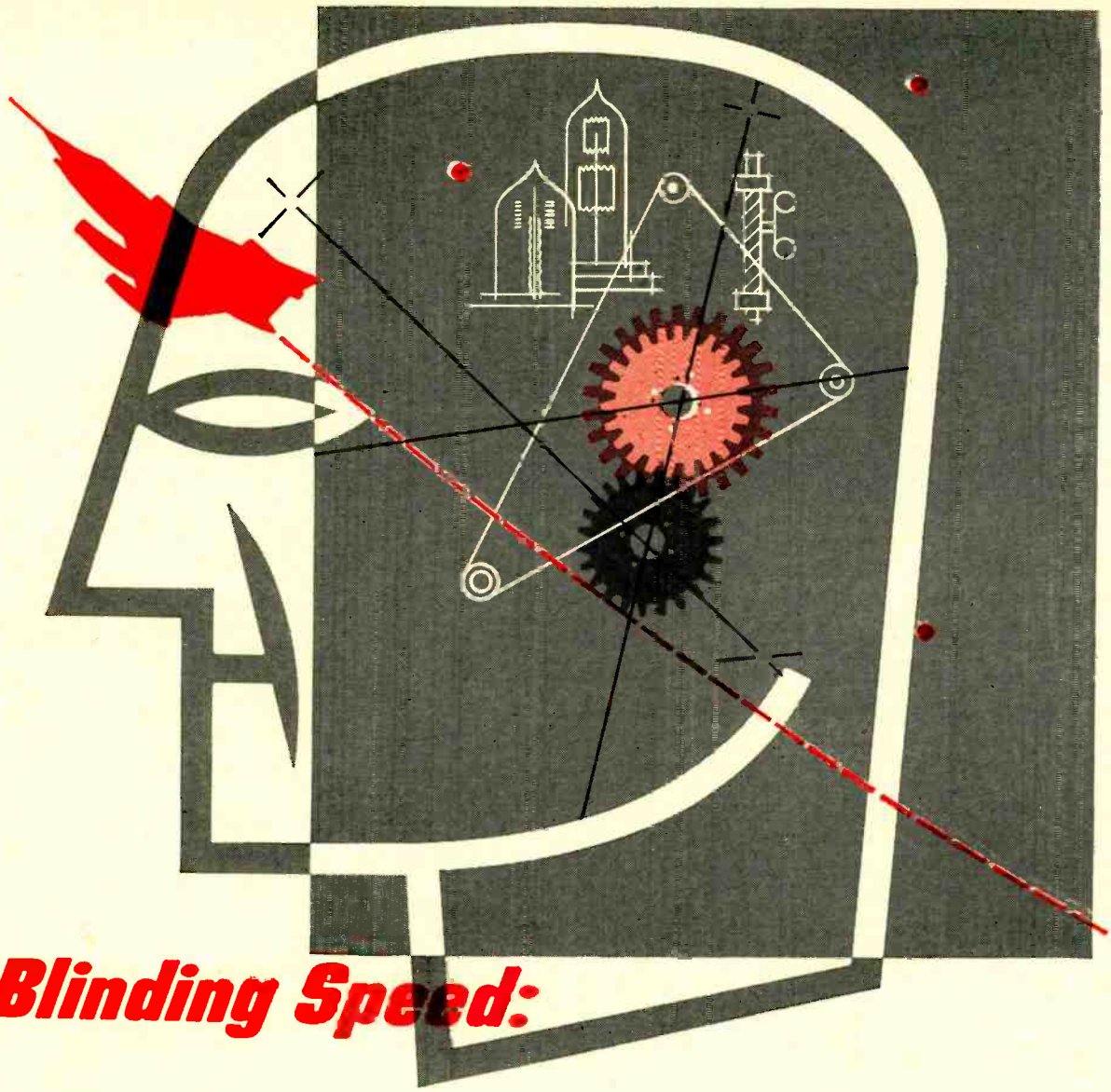


FIG. 1—Audio oscillator modifies input to regulated supply to check regulation and permit dynamic adjustments

DYNAMIC testing of regulated supplies can be done with a simple arrangement requiring few components. This procedure is adaptable to new designs or as a maintenance procedure for existing equipment. In the latter case, the test load resistance and meter M2, shown in Fig. 1, would be replaced with the actual load.

A 5-watt audio oscillator and a



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117-volt to 6.3 or 10-volt filament transformer will suffice for checking the normal range of regulated supplies in the average laboratory. The oscillator is set to a frequency near the line frequency or is slowly swept to search for points of low regulator response. Shunt regulator tube series resistances and control pentode phasing potentiometers may be adjusted quickly for best performance with a 5-cps difference frequency.

The output of the test circuit employs a differential arrangement to permit the test voltmeter, M3, and the oscilloscope to be used at high sensitivity.

Dissipation Chart for T Attenuators

By **DAVID T. GEISER**
Sprague Electric Co., North Adams, Mass.

KNOWING power dissipation in each leg of a symmetrical T attenuator can save time for designers of such networks.

Power dissipation in each leg depends only on the total attenuation expected and the power input from the generator. While standard formulas permit correct leg resistances to be found easily, the power dissipation in each leg is not so obvious.

The chart in Fig. 1 shows the

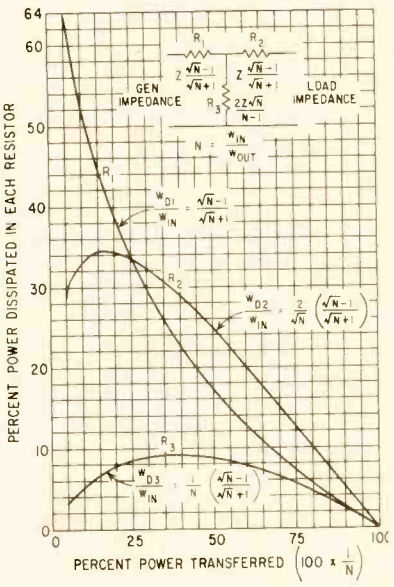

FIG. 1—Percentage of input power lost in each leg of symmetrical T attenuator is shown as a function of the percentage of input power transmitted to the load

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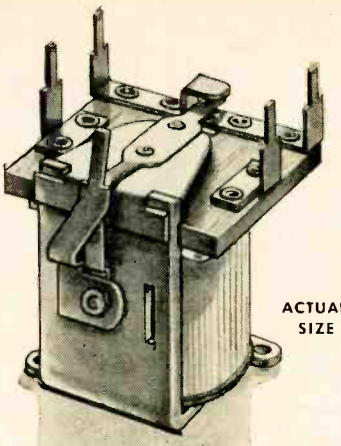

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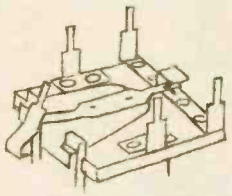
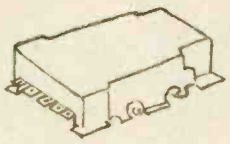
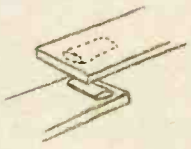


AVAILABLE WITH PRINTED CIRCUIT TERMINALS



ENCLOSED CONTACTS WHERE DESIRABLE



X-BAR CONTACTS INSURE MAXIMUM RELIABILITY

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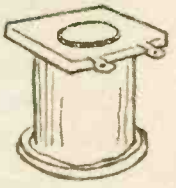

COIL CONSTRUCTION MEETS UNUSUAL CLIMATIC CONDITIONS

CHARACTERISTICS

	MS-40	MS-25
COIL RESISTANCE	TO 10,000 OHMS	TO 15,000 OHMS
MAX. COIL POWER	1 WATT	1.5 WATT
MIN. COIL POWER	.40 WATT (SINGLE POLE)	.025 WATT (SINGLE POLE)
CONTACT RATING	1 AMP. 28V D.C. OR 115V A.C. (NON-INDUCTIVE)	1 AMP. 28V D.C. OR 115V A.C. (NON-INDUCTIVE)

CONTACT FORMS

SINGLE POLE	COMMON MAKE
NO	3 NO & 1 DT
NC	5 NO
DT	

TERMINALS

(A) SOLDER TYPE - ALL VERSIONS

(B) PRINTED CIRCUIT TYPE (SINGLE POLE VERSIONS ONLY)

Consult your local RBM Product Application Engineer or write for Bulletin MS-3

RBM Division

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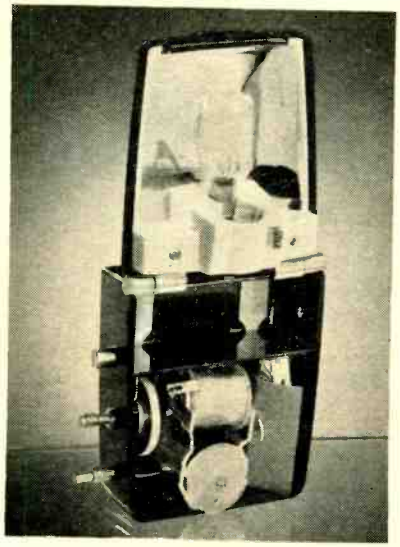
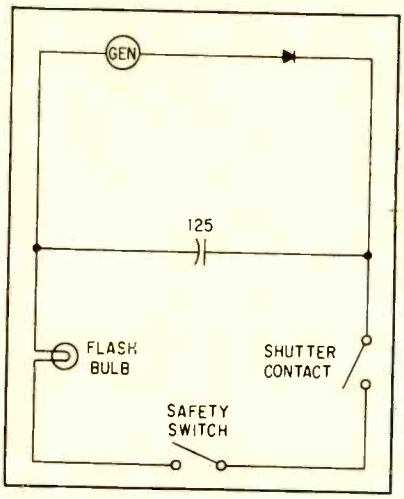
percentage of input power lost in each leg of a T attenuator as a function of the percentage of input power transmitted to the load. This particular approach speeds wattage-rating calculations where only input power and attenuation are known. The curves are independent of the generator and load impedances, though the two are equal in a symmetrical attenuator.

The expressions for calculating the necessary leg resistances are also shown on the body of the chart so that only one sheet is required for reference to design this type attenuator.

Flash Unit Needs No Batteries





High-output self-contained generator charges capacitor sufficiently to fire flash bulb with half turn of knob. High back resistance of diode used in Kodak unit helps retain charge

Code to Voice Communications

DIGITAL codes trigger prerecorded messages in an experimental communications system developed by Hoffman Electronics. Less interference and simpler transmission methods are claimed for the system. The coded signals also require a narrower frequency band than conventional voice transmission.

Many users of radio communications systems are seen as possible customers for the system, including air-to-air, air-to-ground, point-to-point and ship-to-shore. Radio commands in these applications often consist of relatively few stereotyped words and phrases.

The present unit has a vocabulary of 32 words stored on a memory drum. This can be increased many times.

Added flexibility of the system is seen in communicating in different languages. Messages could be recorded in other languages but all triggered by the same transmitted code.

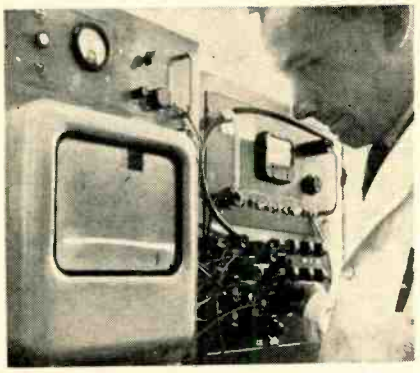
Anticoincidence Plant Detects Weak Radiation

ELECTRONIC circuitry is used to measure weak radioactivity in a plant in Frankfurt/Main, Germany. The anticoincidence plant measures the strength of weak radio active irridiation whose strength is not much greater, and often much less, than the few milliroentgens per hour present in the atmosphere under normal circumstances due to cosmic rays.

Using a screen of lead and iron to hold back the low-energy particles of the cosmic rays, the instrument uses circular shield of counters to isolate the remaining high-energy particles in the cosmic rays from a centrally installed counter.

The circle of screening counters is coupled to an electronic circuit in such a manner that the current pulses emitted by the central counter will only be registered when they do not coincide with current pulses emitted by one or other of the counters in the surrounding screen.

British Work On Flat TV Tube



Adjusting flat screen television picture tube. Depth is only 3.5 in. outside for 12-in. screen

A FLAT, THIN television cathode-ray tube with a depth of about 3½ in. outside, 2 in. inside for a 12 in. screen has been developed by D. Gabor, P. R. Stuart and P. G. Kalman of the University of London. Its features have been tested singly, and partly in combination.

The electron gun in the tube fires a beam vertically downward. In conventional cathode-ray tubes, the beam approaches the screen in a straight line. In the new flat tube, the beam folds over on itself, and runs for most of its length parallel to the picture screen, bending towards it only on the last short section of its trajectory.

At a certain level the beam is thrown against the phosphor screen by an electric field, which travels downward with the speed of the frame scan. The traveling field is produced by the beam itself, which between line scans discharges the conductor and pushes the field to a lower level. Recharging the array after each frame is also performed by the electron beam. It makes use of secondary emission from the array conductors.

Optical Gearing Indicates Shaft Angle

PRECISE SHAFT-angle indicators must overcome problems of friction, inertial loading, vibration, wear and high shaft-speeds. Regardless of how well an angular measuring instrument overcomes these problems, an error in measurement can occur if the dial is not accurately centered. Optical gearing is not affected by these limitations and therefore can give precise shaft-angle measurements.

Photographic Disks

The indicator called an Optisyn by Dynamics Research Corp., Woburn, Mass., is pictorially shown in Fig. 1. Two photographic disks with alternate opaque and clear sectors perform the optical gearing. One disk has one more opaque and transparent sector than the other, resulting in a vernier-type interference pattern. Both disks are mounted concentric to the axis of rotation with one disk fixed to the case and the other mounted on the input shaft. Four lamps, located in quadrature on one side of the disk, align with four photo transistors mounted on the other side. In operation, the lamps transmit light through the interferring disk patterns to the phototransistor.

Optical Gearing

For any given disk orientation a minimum of light will be transmitted in one region around the disk circumference. At 90 deg either side of this region of minimum light, the clear sectors will be half open and at 180 deg the clear sectors will be aligned and completely open for maximum light transmission.

If the shaft is rotated by an amount equal to one sector angle, the dark and light transmission regions rotate 180 deg. The optical light pattern is thus optically geared to the input shaft with a magnification ratio equal to the number of opaque and clear sectors on the rotating disk.

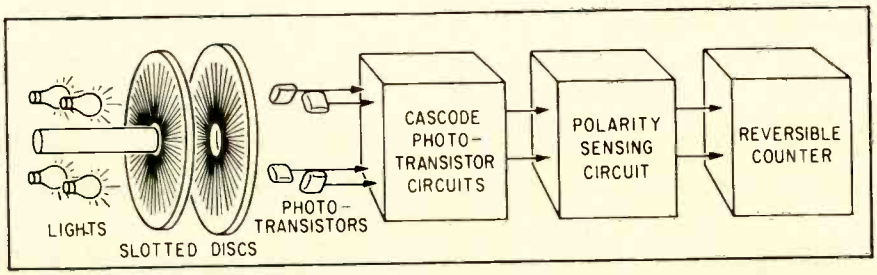


FIG. 1—Optical gearing of slotted disks gives an accurate indication of shaft angle with a minimum of loading

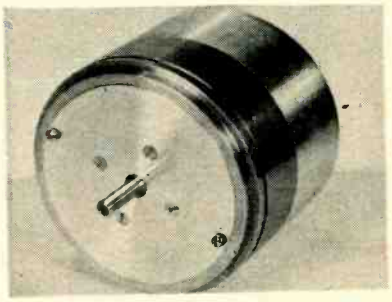


FIG. 2—Output voltage is 6 v to 100 v without amplification

A full rotation of the movable disk gives n (number of dark and light patterns) electrical periods. Each period need only be $1/n$ the accuracy of an electrical period of a synchro for equal accuracy indication.

Any centering error is arithmetically averaged by placing the two photo diodes of each circuit at diametrically opposite points.

Machine Tool Applications

The device may be mounted directly on the lead screw for measuring translational motions and directly on the rotary unit for rotational motions. The unit is totally enclosed for protection against foreign matter. And no slip rings or brushes are present to cause intermittent errors. The lamps and photodiodes are rated for long life.

A shaft position can be teleme-

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Space saving Mylar dielectric gives a rugged, yet miniature, capacitor element.

Thermo-setting epoxy seals the ends and anchors the leads securely.

APPLICATIONS: Instrumentation. Filter networks. Transistor circuitry. Amplifiers. Test equipment. Computers.

SPECIFICATIONS

Insulation Resistance: See curve reproduced below for typical performance.

Lead Pull Test: Steady force of 10 lbs. applied axially for 60 seconds.

Life Test: 250 hours at 85° C and 125% of rated voltage.

Capacity Tolerances to ± 1%.

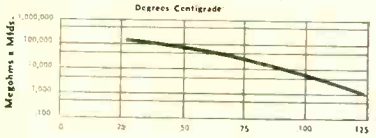
Humidity Resistance: Far exceeds requirements of RETMA Apec. REC — 118 — A.

Temperature Range: Operation at rated voltage from —60° C to +85° C; and to +125°C with 50% derating.

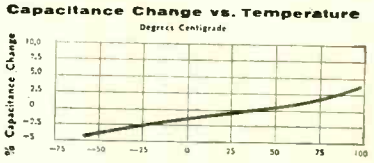
TYPICAL SIZES

Capacity	100 Volts	200 Volts	400 Volts
.001	.156 x ½	.156 x ½	.156 x ⅝
.0047	.156 x ½	.156 x ½	.186 x ⅝
.01	.156 x ½	.171 x ⅝	.250 x ⅝
.047	.234 x ¾	.296 x ¾	.343 x ⅞
.1	.281 x ⅞	.375 x ⅞	.421 x 1
.47	.468 x 1¼	.546 x 1¼	.671 x 1⅝

Insulation Resistance vs. Temperature



Capacitance Change vs. Temperature



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tered by transmitting only two binary wave forms. This reduces both communication capacity of the telemetering system and the number of components which can fail.

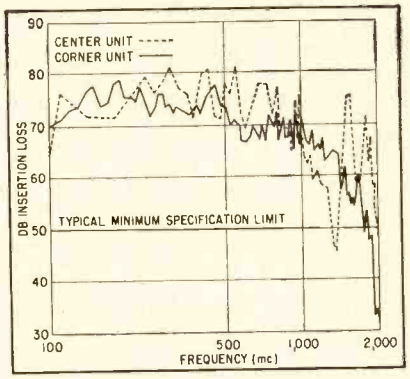
The indicator does not induce a torque nor generate any back emf at high speeds. An output voltage of 6 v to 100 v is available without amplification. The fine-course system of a synchro can be copied by placing a double track on one disk.

Multiple-Unit Feedthrough Capacitors

By J. H. **FOSTER** Erie Resistor Corp, Erie, Pa. **E. M. WILLIAMS** Carnegie Institute of Technology, Pittsburgh, Pa.

A FERRITE-WALL feedthrough capacitor unit has certain advantages over simple tubular capacitors and also over single-tube units with a ferrite washer. The ferrite wall eliminates harmful resonance effects in ceramic tubes and gives a high insertion loss to 1200 mc. Mechanical design of the units makes them relatively inexpensive and compact components. Typical feedthrough-capacitors have twenty circuit connections per square inch of mounted cross-section. Densities of at least twice this number are feasible, but possibly with somewhat less satisfactory cross-talk characteristics.

Insertion loss for two channels of a 24 channel unit is shown in Fig. 1. Electrically, the ferrite-wall unit is equivalent to the circuit in Fig. 2. Insertion loss in each feedthrough channel is considerably increased over the earlier washer-type feedthrough. The larger



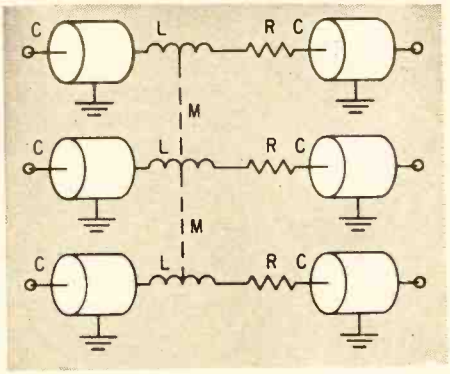
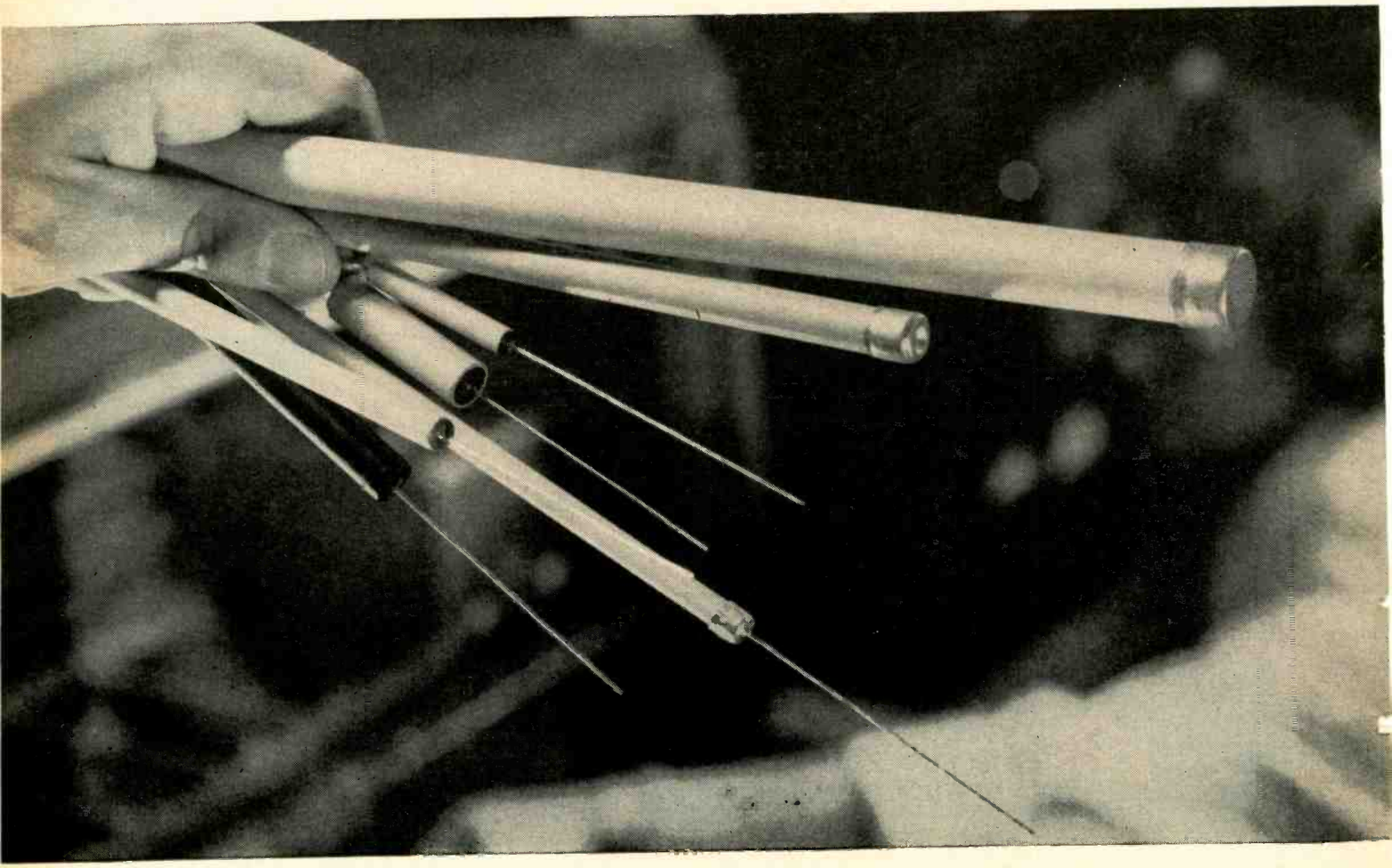
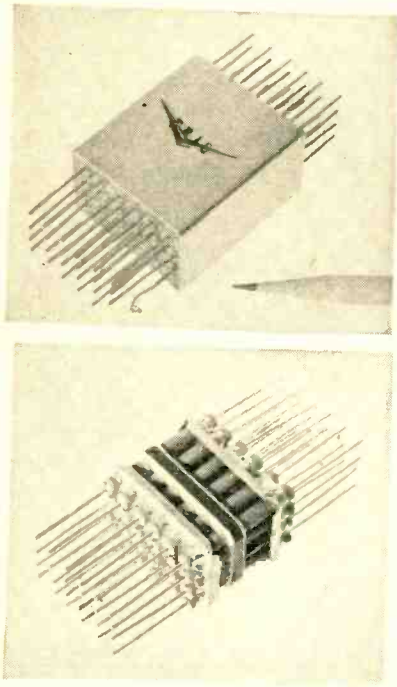


FIG. 1—Insertion loss for two channels of a twenty-four channel unit with a 50 ohm source and load resistance. Characteristics persist over a temperature range of at least —60 to 125 C. Equivalent circuit for multiple unit feedthrough capacitor. Magnetic circuits in the ferrite sheet result in mutual inductance *M* between sections



amount of ferrite material in the magnetic field surrounding the inner conductor increases effective inductance and high frequency losses.



Assembled twenty-four unit feedthrough capacitor (top). Opened case without potting, (bottom) shows ferrite wall and metal ground-plates

Although the unit has advantageous mechanical and electrical properties, it possesses two characteristics which might introduce unfavorable application problems: (1) the possibility of crosstalk between channels from coupling provided by common flux paths in the magnetic material and (2) a diminished insertion loss due to saturation in the magnetic material when d-c is carried by a feedthrough circuit.

Cross Talk

Insertion loss for cross talk channels has been investigated analytically for a ferrite with negligible losses. Appreciably-reduced losses for crosstalk channels appeared at certain critical frequencies. Experimental results with a ferrite designed for use at very high frequencies substantiated this conclusion. It was found, however, that undesirable crosstalk is negligible when a ferrite tailored for low-frequency is used. The latter ferrite material is also less expensive and has better mechanical properties.

The effect of d-c saturation also proved to be unimportant, even for currents in excess of the nominal carrying capacity of the feedthrough conductor. This can be attributed in part to the increased loss which results from a superimposed biassing field.

An interesting potential application for ferrite-wall capacitors is a 'filtered' multiple-circuit cable connector.

The ferrite wall, which serves as a common washer for a group of capacitors, produces a unit with good shock and temperature characteristics. Leakage between circuits is higher than 50 megohms.

Packaging Increases Semiconductor Life

SHELF LIFE of easily oxidized metals and alloys used in the semiconductor industry has been greatly

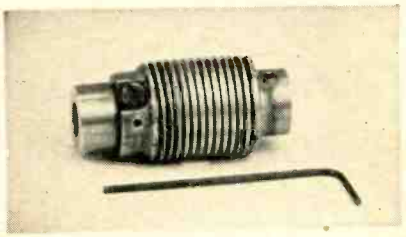
increased by a new packing method. The metals—indium, lead antimony and indium gallium—are packaged in glass containers with an argon atmosphere. A vinyl sealer keeps oxygen out and the argon atmosphere in.

Sealing

Packaging is automatically performed in an hermetically sealed unit. The technique, developed by Accurate Specialties Co., Woodside, N. Y., permits manufacturers of semiconductors to inventory materials which previously had to be reordered time and again in small lots. Less paper work, quantity orders and assured stock should give greater efficiency and savings to semiconductor manufacturers.

Accurate Adjustment of Synchro Shafts

PHASE ADJUSTMENTS between synchro shafts may be difficult to make by the usual method of manually rotating the synchro stator. Accurate adjustments are a particular problem when working space is limited.



Shaft coupling eliminates hand phasing of synchros

A coupling, manufactured by PIC Design Corp., East Rockway, N. Y. overcomes this difficulty.

Continuous Adjustment

It enables continuous angular or phasing adjustments between synchro shafts. The upper screw provides a continuous adjustment of the left hand hub relative to the right hand coupling hub. A smaller socket screw below locks the adjustable hub in its set position. The bellows section of the coupling is conventional.

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There are AlSiMag materials which withstand higher compressive loads than steel . . . with lower coefficients of expansion than any general-use metal. Chemically inert . . . will not rust, oxidize or corrode. Permanently rigid . . . will not deteriorate. Some have unusual abrasion resistance. Some are hard as 9 on Mohs' scale.

No matter what your problem, AlSiMag ceramics may help solve it. And, this source has the machines and experience to produce precision parts in any quantity. Send blueprint with details of operating procedure for complete data on the AlSiMag material best suited for your application.

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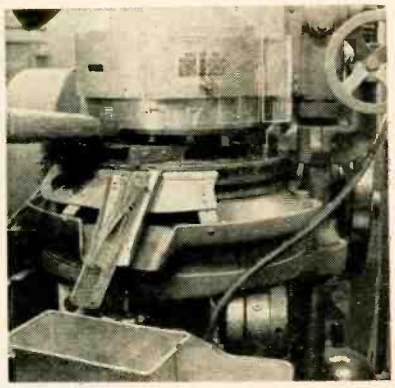
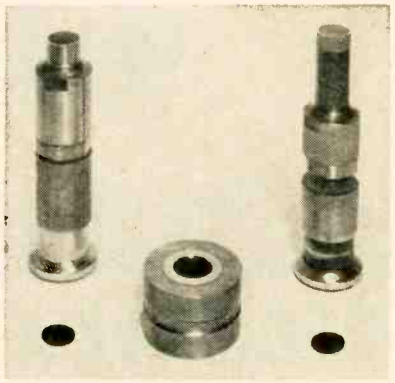
Varistor Production Machinery Avoids Abrasion

By C. C. MARTINDELL Western Electric Co., Allentown, Pa.





Punches used in varistor disk press have rubber inserted in faces. Rubber resiliency ejects fragile disks, which are only 0.020 inch thick

SILICON CARBIDE varistors are made of very abrasive material whose electrical characteristics are variable. Unusual facilities are used to produce these devices at high volume and low cost with a defect level below ½ per cent.

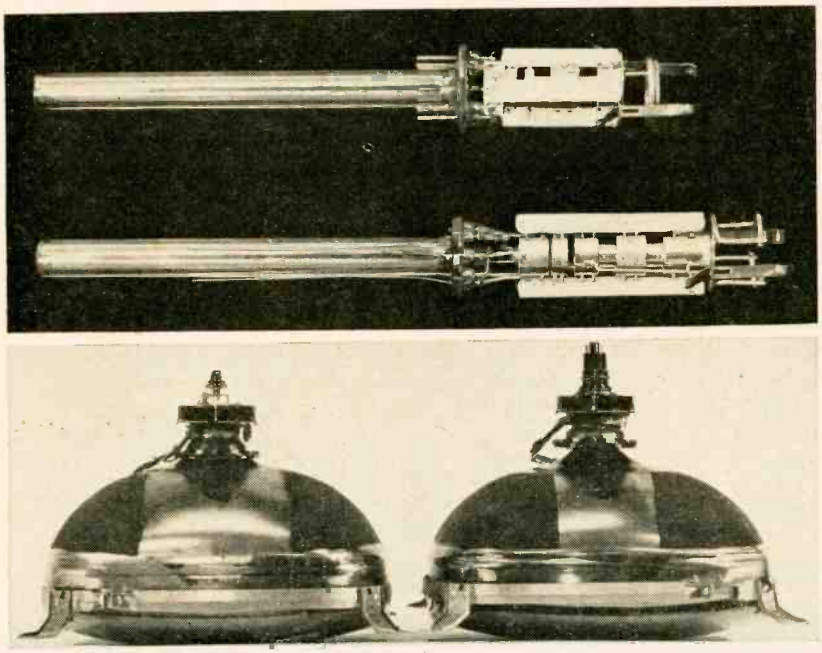
Two new types, differing only in disk thickness, account for over 90 per cent of the 15 million silicon carbide varistors produced annually. As their resistance decreases with increases in impressed voltage, they are used to regulate voice loudness in modern telephone sets.

Acceptance of raw materials is based on prove-in methods since suitable analytical methods are lacking. Sufficient material for a year's production is blended to provide uniformtiy. A sample is processed into varistors for testing. Adjustments in sintering temperatures compensate for variations in electrical characteristics of the material.

In production, English pencil clay and graphite are mixed with water. Silicon carbide is added while heat is applied externally to drive off water as rapidly as possible. When the mixture is too dry for further mixing, it is removed from the mixer, allowed to dry to pressing consistency and pulverized. Working of silicon carbide is minimized since it is believed that sharp corners on the particles contribute to varistor action.

Production machinery is designed or adapted so that abrasion from the silicon carbide is avoided or controlled. Severe wear cannot

DESIGN TRENDS: Tandem Tv Cabinet, Slimmer CRT



Picture tube, chassis and cabinets are radically redesigned in 1959 tv line of Philco Corp., Philadelphia, Pa. Overall depth of picture tube (shown with standard 110-degree tube) is reduced 2 inches. Cathode heater assembly has mica-supported box frame rather than cylindrical structure. Neck, lens and yoke are all more compact. Circuitry is grouped into signal, picture and power supply. Tuner is set at factory and mounted separately. The chassis slides out of the cabinet on rollers for repair. Cabinet depths are: 17-inch portables, 11½ inches; 21-inch console, 13 13/16 inches, and 24-inch console, 14 7/16 inches. Line includes several models with separately-housed picture tubes. Picture tube swivels above stationary chassis and control cabinet in model shown. Another model has tube connected to cabinet by 25-foot flat cable so screen can be moved while cabinet remains in one place

Versatility in Application

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GLASS-TO-METAL SEALS*

Application-tested E-I hermetic terminals feature ruggedized compression construction for complete reliability in severe environments in military and commercial service. The economical E-I standard line offers designers every type terminal from single leads to sub-miniature closures. If your problem involves the use of special seals, E-I will produce custom designs to specifications; or seal components of your own manufacture. Ask E-I engineers for a recommendation on your specific seal application, today!

*Manufactured under Canadian Patent 523,390, United Kingdom Patent 734,583 and Licensed under U.S. Patent 2561520

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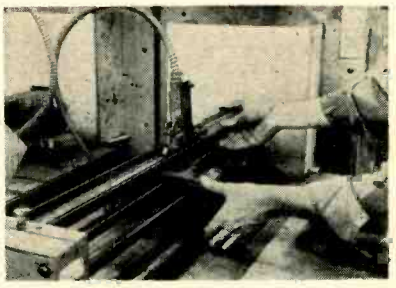
be tolerated in precision operations such as disk pressing.

A commercial tableting press was adapted to make each disk a uniform thickness. Mixed material is fed by a vibrating trough to dies on a rotary table. Rubber disks in the faces of upper and lower punches eject the pressed disks by spring-back of the rubber. Rubber also produces a rough surface which improves the bond of contacts sprayed on after firing.



Disks stacked in ceramic boats pushed into sintering furnace

Each basket holds 4,000 disks in vacuum impregnator

To minimize abrasion, the press punches ride in inexpensive replaceable bushings. Tool edges are sharpened after 90,000 to 100,000 disks are pressed.

Disks are coin-stacked in ceramic boats and fired in a pusher-type furnace with a hydrogen-nitrogen atmosphere. The boats move at a constant speed through 4 temperature zones. Since firing compensates for variations in material, the furnace is accurately controlled.

After firing, copper contacts are sprayed on, the disks are impregnated with silicone oil to seal out moisture, terminals are attached and tests and inspections made. (Contact and terminal steps will be described in a succeeding issue—Ed.)

First test for defects, after impregnation, is made in a test unit also designed to minimize abrasion. The tester is fed from a vibrating

Photocell triggers feed system on disk tester

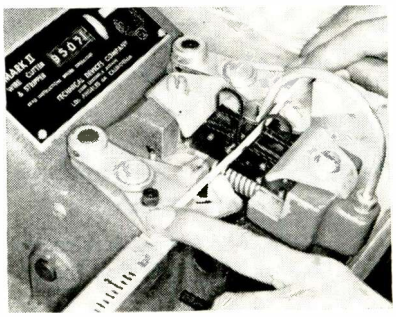
bowl. As most conventional feed mechanisms would be jammed by silicon carbide, a vacuum tube picks up the disks at the end of the bowl track and delivers them to the face of the machine. The disks are stripped from the tube by the face and drop down a chute to the test electrodes. Rubber pins in front of the electrode stop the disks.

Disks are positioned at the end of the bowl track by a photocell. When a disk covers a hole in the track, breaking a light beam, the pickup is made.

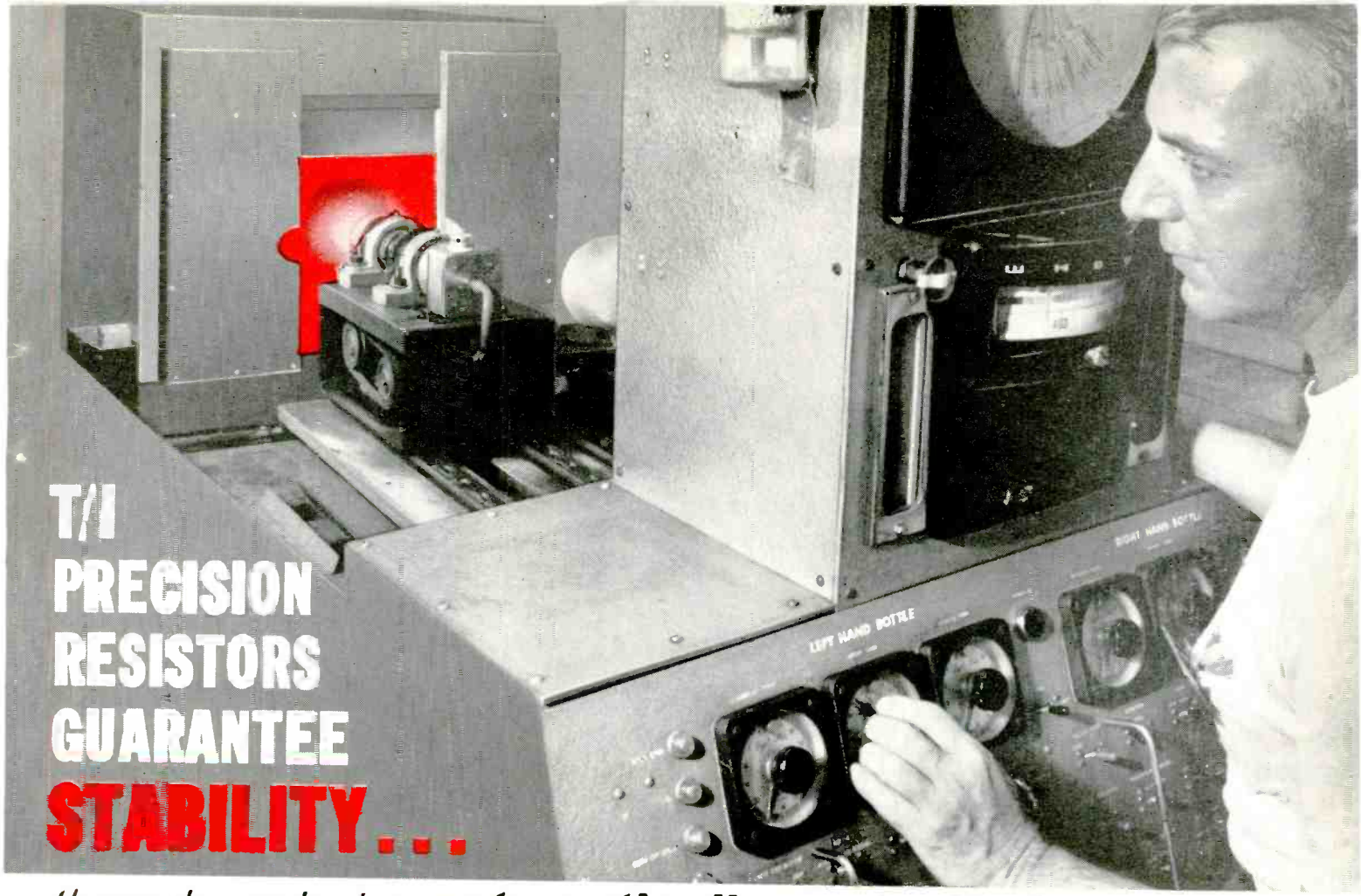
Bench Tools Speed Wire Preparations

WIRE PREPARATION tools which are bench mounted and powered by compressed air for semiautomatic operation have enabled the Pacific Division, Bendix Aviation Corp, N. Hollywood, Calif., to prepare wire faster than by previously used hand methods.

Time studies were made at Bendix of two machines designed by Technical Devices Co., Los Angeles, Calif. A wire cutter and stripper turned out 100 wires in 0.1 hour compared with a hand rate of 100 wires in 0.39 hours. A pigtailing tool was operated at 100 wires



Operator holds shielded cable in stripping position. Cutting head is open



T/I PRECISION RESISTORS GUARANTEE STABILITY . . .

through exclusive **automatically controlled processes**

Consistent TI resistor stability and performance for ***every run***, such as the carbon depositing operation shown above, are assured by exclusive ***TI automatically controlled processes.***

For your resistor applications that demand stability, TI precision carbon film resistors provide three full lines — hermetically sealed, molded, and mil-line.

Low negative temperature coefficient of resistance (0.03—0.05%/°C) provides reliable performance under full load with linear derating from 70° to 150°C.

For your next resistor application, select from one of the following encapsulations:

TEST	AVERAGE PERFORMANCE OF TI RESISTORS* HERMETICALLY SEALED	MOLDED	MIL-LINE
Temperature Cycling per Mil-R-10509B (4.6.3)	+0.05 to −0.15%	+0.05 to −0.15%	0 to −0.15%
Low Temperature Exposure per Mil-R-10509B (4.6.4)	Less than ±0.10%	Less than ±0.10%	Less than ±0.10%
Short Time Overload per Mil-R-10509B (4.6.5)	0 to ±0.15%	Less than ±0.10%	Less than ±0.10%
Effect of Soldering per Mil-R-10509B (4.6.8)	Less than ±0.05%	Less than ±0.05%	Less than ±0.10%
Shelf Life, change per year	Less than ±0.10%	Less than ±0.10%	Less than ±0.10%
Insulation Resistance per Mil-R-10509B (4.6.7)	Greater than 1,000,000 Megohms	Greater than 100,000 Megohms	Greater than 100,000 Megohms
Voltage Coefficient	Less than 0.002%/Volt	Less than 0.002%/Volt	Less than 0.002%/Volt

* Unless otherwise noted, data is % change in total resistance

HERMETICALLY SEALED: for highest reliability . . . solder sealed in a vitrified ceramic case for utmost protection . . . ⅛ to 2-watt ratings.

MOLDED: encased in a tough, molded jacket for protection against mechanical damage and moisture . . . ⅛ to 2-watt ratings.

MIL-LINE: new design provides full load performance at 70°C, derates linearly to 0 at 150°C . . . light weight . . . small size . . . exclusive TI multi-coat synthetic protection . . . ⅛ to 2-watt ratings.

ALL LINES EXCEED APPLICABLE MILITARY SPECIFICATIONS.

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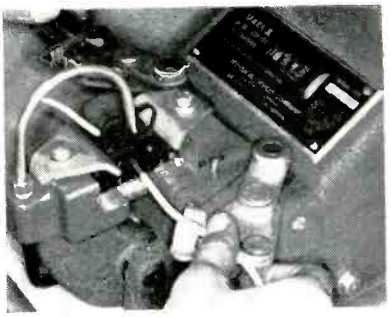
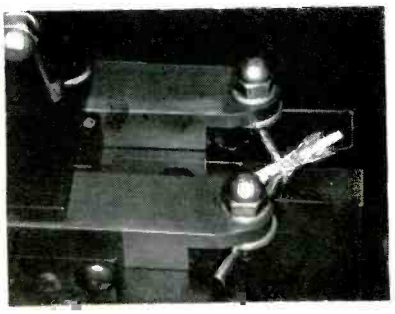


Air pressure moves gripping jaws outward as insulation slides off braid

Holding jaws of pigtailer bulge braided conductor

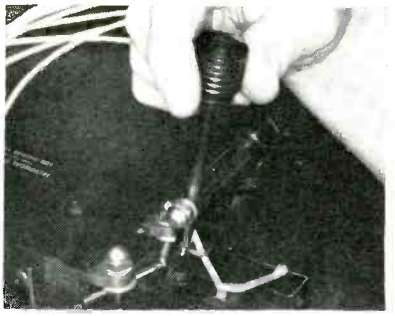


Prongs push braid up so portion of inner wire is bared

in 0.24 hour as against 1.4 hours by hand.

Operation of the cutting and stripping machine is controlled by a floor-mounted foot valve. The operator lays the wire in the gripping jaws and open cutting head. Cut and strip lengths are adjusted by a clamp screw on a scale. Adjustment for various wire gages and coaxial cable are made by changing cutting and stripping heads, which are supplied as easily changed cartridges.

The pigtailer removes braided inner conductors from the ends of small coaxial cable and shielded wire. The braid is left undamaged, ready for grounding. The wire is lowered into holding jaws after outer insulation has been stripped. Lower jaws grip the unstripped part of the cable while upper jaws push down on the braid. The braid

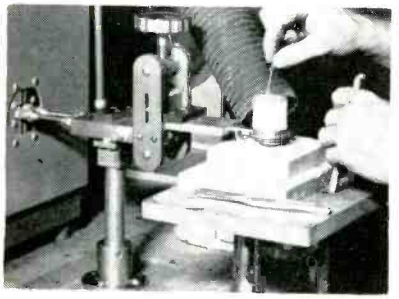


Hook has pulled inner wire free from braid, leaving pigtail

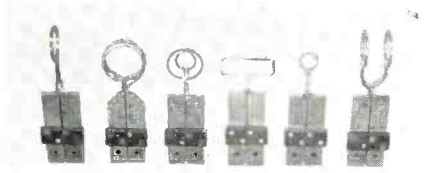
is bulged so that prongs can push it toward the wire end. This allows a hook to grasp the inner wire and pull it free from the braid. The inner wire may then be stripped.

Interchangeable H-F Heating Coil Mounts

TERMINAL which holds interchangeable work coil blocks allows coils to be changed without altering connections to high-frequency induction heater. The terminals are made by L. C. Miller Co., Los Angeles, Calif., to fit any heater.



Pedestal supports terminal at heater without mounting blocks. A solenoid housing is being silver brazed

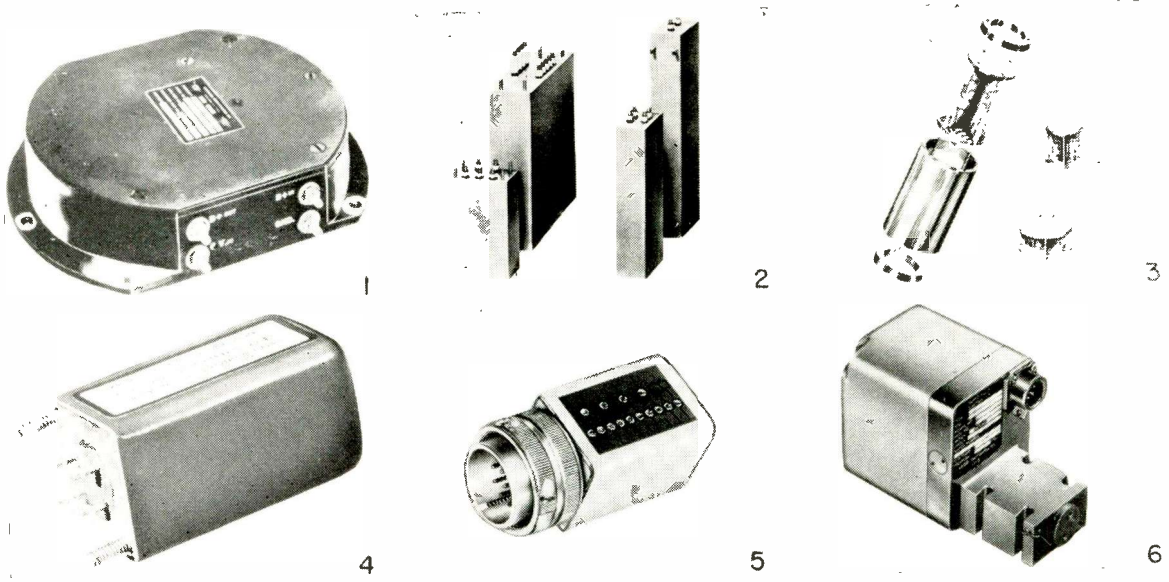


Standard coil blocks slip in and out of terminal, allowing many coil shapes to be used on same setup

The terminal consists of a screw clamp to hold the coil blocks and a water-cooled mount. The mount goes directly onto heaters equipped with mounting blocks or bars. A pedestal will support the terminal's weight if it is to be used with a heater lacking mounting blocks.

NEW PRODUCTS

Missile Components Soar



(1) Simmonds Acrocessories, Inc., radio beacons. (2) ERA Electric Corp., transformers. (3) Arthur Ansley Mfg. Co., missile module. (4) Plas-Kem Electronics Corp., decade amplifier. (5) Electro-Mechanical Specialties Co., miniature relays. (6) Lear, Inc., servo valves

GUIDED MISSILES have clearly moved forward as a mainstay of our defense. More than half the total cost of a missile today is for electronic or allied equipment. The components shown should benefit missile designers.

Simmonds Acrocessories, Inc., 105 White Plains Road, Tarrytown, N. Y., (200) is making radio beacons for missile and drone recovery. Power can be supplied from the missile batteries, or the beacon can be furnished with internal batteries or an internally mounted transistorized power supply.

Slim-Tran electronic transformers are being manufactured by **ERA Electric Corp.**, 67 E. Centre St., Nutley, N. J., (201). They are ideally suited for guided missile and other applications where space and weight reduction coupled with severe ambient conditions are requirements.

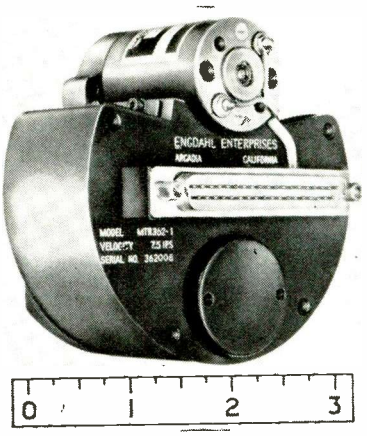
Arthur Ansley Mfg. Co., New Hope, Pa., (202) has announced the Missile Module, a new interlocking printed circuit structure for electronic equipment subject to extreme shock and vibration, such as encountered in missiles and rockets.

Model 12-D miniature hermetically sealed decade amplifier is available from **Plas-Kem Electronics Corp.**, 100 W. Alameda Ave., Burbank, Calif., (203). It will provide a solution to difficult gain problems in instrumentation, and in aircraft and missile checkout systems.

Electro-Mechanical Specialties Co., Inc., 1016 N. Highland Ave., Los Angeles 38, Calif., (204) has developed the E420D, a miniature 4 pdt, 20 ampere relay. It is designed to meet the stringent requirements for airborne and missile applications.

Now in production at **Lear, Inc.**, Elyria, Ohio, (205) are the series 5214 electro-hydraulic servo valves designed for use in control or guidance systems of missiles or aircraft. Models are available for operation at supply pressures to 3,000 psi, flows to one gpm, fluid temperatures from —65 to 180 F and ambient temperatures from —65 to 250 F.

For more information use READER SERVICE Card

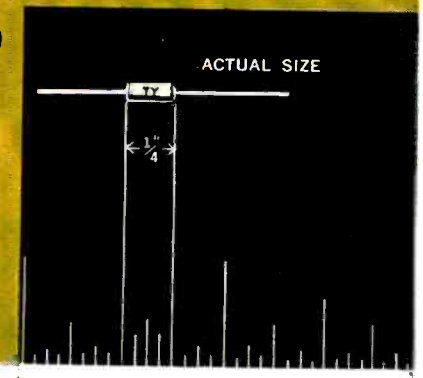


Tape Recorder up to 13 channels

ENGDAHL ENTERPRISES, 226 San Antonio Rd., Arcadia, Calif. This miniature tape recorder simultaneously records data (1 to 13 in-line channels) from tests conducted under severe environmental and extremely limited space conditions. A permanent record of the tests is obtained which can be completely analyzed at a later time. Due to the extreme ruggedness of the recorder, the tape will survive high impacts at the termination of the tests without loss of the record. The recorder features a precision in-line recording head, precision ball bear-

Solitan

the truly dry tantalum capacitor!



NEW SOLID-STATE ELECTROLYTE CAPACITORS BY CORNELL-DUBILIER • SOLITAN capacitors are specifically designed for transistor application in computer and military circuits. Solid electrolyte tantalum assures extreme resistance to shock and vibration, wider useful temperature characteristics, stability of capacitance in spite of aging or temperature variations, freedom from corrosion or leakage. Cornell-Dubilier has SOLITAN tantalum capacitors in production quantities. Write for 4-pg. Bulletin No. 537 to Dept. 000, Cornell-Dubilier Electric Corp., South Plainfield, N.J.

SOLITAN

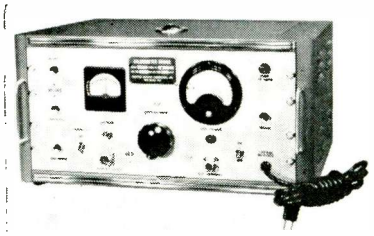
Specifications and Features

- Ratings up to 6.0 mfd. at 35 volts DC Working, or 60.0 mfd. at 6 volts
- Wider useful temperature characteristics within range of −80°C to +85°C
- Freedom from corrosion and leakage
- Extremely small size
- Remarkable stability of capacitance with time and temperature
- Metal cased, hermetically sealed

Consistently *Dependable*

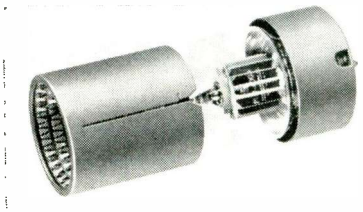
CORNELL-DUBILIER CAPACITORS

ings supporting all revolving parts, adjustable motor speed and tape tension, and moulded rubber pressure roller and drive wheels. Recording time is 120 sec at 7½ ips. **Circle 206 on Reader Service Card.**



Calorimeter Bridge direct reading

ELECTRO IMPULSE LABORATORY, 208 River St., Red Bank, N. J., announces a new direct reading calorimeter bridge for use with any water load. It measures 10 kw full scale. Water flow is 4 gallons per minute. Accuracy of a-c wattmeter is 1 percent. The instrument contains an a-c standard load, a balancing thermopile, a galvanometer, a variac and an a-c wattmeter. The balancing thermopile consists of two thermopiles in series connected in such manner that the emf developed by the external calorimetric load balances the emf developed by the internal a-c standard load. **Circle 207 on Reader Service Card.**



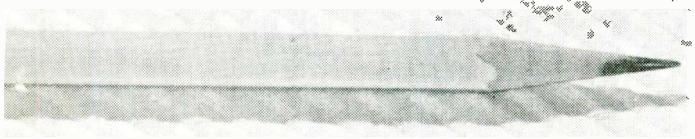
Retaining Shields for large tubes

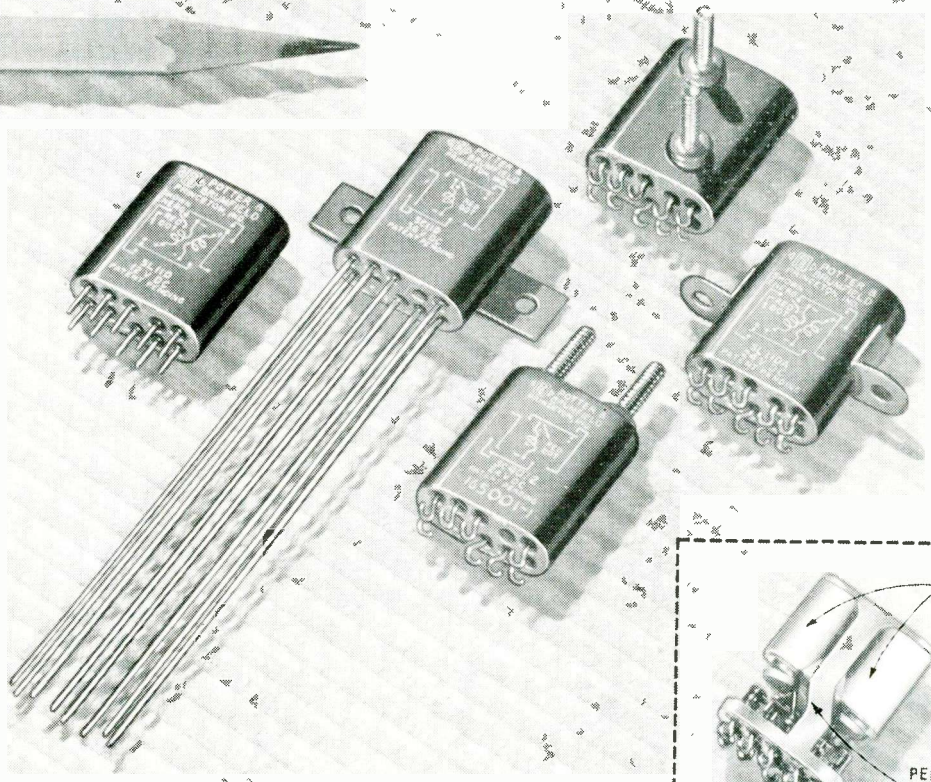
INTERNATIONAL ELECTRONIC RESEARCH CORP., 145 W. Magnolia Blvd., Burbank, Calif. The new power size tube shields afford bulb temperature reduction through the use of an inner liner of multiple spring finger contacts which grasp the hot tube bulb regardless of variations in changes of bulb envelope contours and irregularities. These contacts conduct the heat

P&B MICRO-MINIATURE RELAYS LEAD IN

performance

SHOCK: 100g* VIBRATION: 30g to 2000 cps*



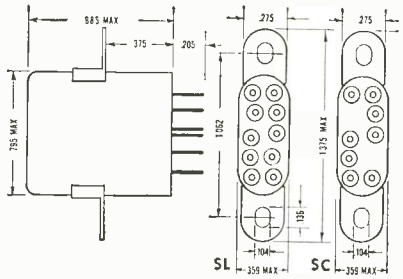


*NO CONTACT OPENING

New P&B crystal-case size relays, the SC and the SL (magnetic latching), show amazing shock and vibration capabilities. They absorb shocks of 100g and vibrations 30g to 2000 cps. without contact openings!

A highly efficient magnetic structure utilizing a permanent magnet makes possible at least twice the contact pressure found in DPDT relays of comparable size. One watt of power for three milliseconds operates either relay. Transfer time is unusually fast —0.5 milliseconds maximum.

For more information, contact your P&B sales engineer, or write Potter & Brumfield, Princeton, Indiana.



SL—dual coil latching relay. Operates on a 1 watt, 3 ms. pulse at nominal voltage. Permanent magnet latch locks the armature in either position.

SC—non-latching relay with series-connected dual coils. Operates on approximately 1 watt at nominal voltage. Coils must remain energized to hold the armature in the operate position.

SC and SL Series Engineering Data

GENERAL:

Insulation Resistance: 10,000 megohms, min.
Breakdown Voltage: 1,000 V. RMS.
Shock: 100g.
Vibration: 30g 55 to 2000 cps.; 0.195" max. excursions from 10-55 cps.
Temperature Range: —65° C. to + 125° C.
Weight: 15 grams without mounting bracket.
Operate Time: 3 MS. max. with 550 ohm coil @ 24 V. DC. (SL: 630 ohm coil at 24 V. DC).
Transfer Time: 0.5 MS max.
Terminals: (1) Plug-in for microminiature receptacle of printed circuit board.
(2) Hook end solder for 2 #24 AWG wires.
(3) 3" flexible leads.
Enclosure: Hermetically sealed.

CONTACTS:

Arrangement: 2 Form C.
Material: Gold flashed palladium.
Load: 2 amps @ 28 V. DC, resistive; 1 amp @ 115 V. 60 cycles AC, resistive.
Pressure: SC—16 grams min.; SL—20 grams min.

COIL:

Power: Approx. 1.0 watt at Nominal Voltage.
Resistance: SL—40 to 1400 ohms; SC—35 to 1250 ohms.
Duty: Continuous.

MOUNTINGS:

Bracket, stud and plug-in.

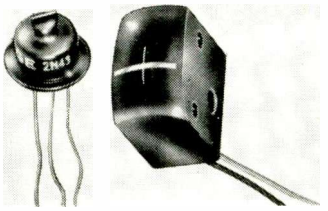
P&B STANDARD RELAYS ARE AVAILABLE AT YOUR LOCAL ELECTRONIC PARTS DISTRIBUTOR

POTTER & BRUMFIELD INC.

PRINCETON, INDIANA • SUBSIDIARY OF AMERICAN MACHINE & FOUNDRY COMPANY

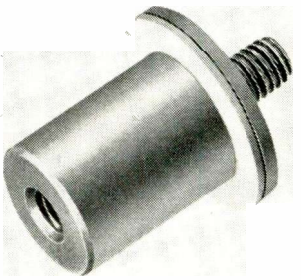
CIRCLE 76 READERS SERVICE CARD

uniformly away and eliminate dead air space and hot spot problems. The IERC method protects and retains these large tubes in shock and vibration environments and also furnishes excellent electrostatic shielding. Circle 208 on Reader Service Card.



D-C Erase Head small in size

MICHIGAN MAGNETICS, INC., Vermontville, Mich., announce production of a new d-c erase head providing 50 db erasure with 5.5 ma of current through the coil. The head is currently manufactured in a 20 mil track width configuration. A mating play-back record head will be announced shortly. Pictured is the new head alongside an ordinary transistor for size- comparison purposes. Circle 209 on Reader Service Card.



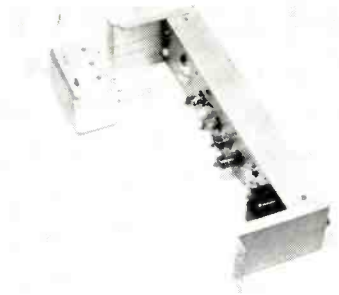
Insulator Mount for semiconductors

THERMO MATERIALS, INC., 4040 Campbell Ave., Menlo Park, Calif. New stud-type copper-and-ceramic insulator mounts for diode, rectifiers and transistors have been announced. Rated up to 4,000 v, they are designed for high altitude operation and to allow highly efficient heat transfer to the chassis or ground. In overall thermal drop the new mounts are rated better than 1 C per watt. Physically the

mounts consist of a copper alloy cylindrical heat sink, copper alloy flange and ceramic insulator brazed together into a unit. This one piece construction simplifies installation. Circle 210 on Reader Service Card.

D-C Power Supply transistorized

Universal Electronics Co., 1720 Twenty-Second St., Santa Monica, Calif., has announced a twin transistorized d-c power supply, Unireg model TQ-36, with each output rated at +36 v, 0-1 ampere. Extremely good regulation of 0.1 percent for line or load is afforded by the Zener diode reference, which also reduces drift. Absolute protection against short-circuits is provided. Output impedance is 0.01 ohm, d-c; typical transient response is 50 μsec; ripple is less than 3 mv. Long-term stability is rated at 0.05 v for an eight-hour period. Circle 211 on Reader Service Card.



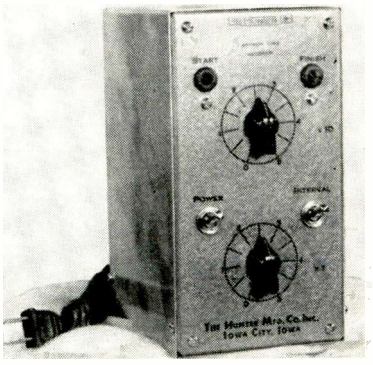
Packaged Amplifier for flexibility

George A. Philbrick Researches, Inc., 230 Congress St., Boston, Mass., has designed the model UPA-2 utility packaged amplifier. It can drive a 12,000 ohm load to 100 v in either direction, and will tolerate large values of cable capacitance. Being an operational amplifier, the user can select the de-

sired operation, and within limits, the performance level appropriate to the application. Applications include analog computing measurement and control, continuous data reduction, and feedback operations of many kinds. Circle 212 on Reader Service Card.

Flexible Cable high flex life

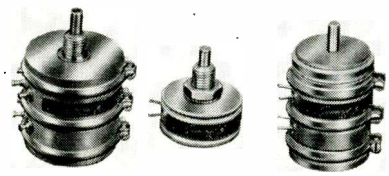
ORGANIC DEVELOPMENT CORP., 10052 Larson Ave., Garden Grove, Calif., announces an ultra flexible cable called Spectra-Flex. A flex life of 50,000,000 cycles is not uncommon. It is at present manufactured in any number of conductors. The extended length of cables goes up to 40 to 1 of their folded thickness. Larger ratios than this are quite practical, merely involving a different diameter of spiral. Circle 213 on Reader Service Card.



Interval Timer simplified unit

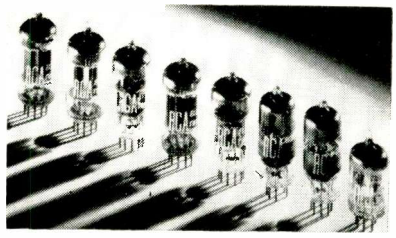
HUNTER MFG. CO., 108 N. Linn St., Iowa City, Iowa, introduces the model 115 interval timer. Two dials on the front panel provide controlled time intervals up to 55 sec. Multiple pole, double-throw start and finish relays are provided to permit remote control of several circuits or sequence operation with

other timers. Unit measures 4 in. by 8 in. by 7¼ in. Circle 214 on Reader Service Card.



Potentiometers gold anodyzed

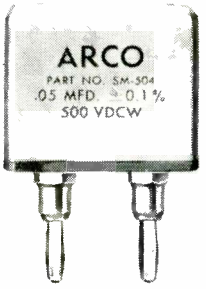
General Scientific Corp., 1509 First St., San Fernando, Calif., has developed a full line of gold anodyzed, all metal, single turn pots. Offered in diameters from ⅞ in. to 3 in., the units feature one piece external clamp rings to join each cup securely, and to permit each cup to be accurately phased either before or after installation. Features include low temperature coefficient wires; high resolution; low noise level; dielectric strength 1,000 v rms 60 cps; ambient temperature range — 55 C to + 125 C. Circle 215 on Reader Service Card.



Industrial Tubes for transceivers

Radio Corp. of America, Harrison, N. J. Eight new industrial tubes for two-way mobile radio systems operating from 12-v storage batteries are announced. To insure dependable performance when storage batteries are charging and discharging, the heaters of these tubes are designed to withstand an intermittent heater-cycling test of 2,000 cycles minimum at high heater voltage. Designed to operate over a heater voltage range of 12 to 15 v, the tubes are subjected during manufacture to rigid controls and tests for heater-cathode leakage, in-

terelectrode leakage, elevated heater-voltage life performance, as well as intermittent short-circuits. Circle 216 on Reader Service Card.



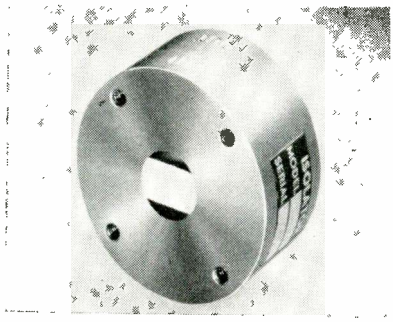
Standard Capacitor compact unit

Arco, 64 White St., New York 13, N. Y. A new line of capacitor standards are compact and readily combined to duplicate the function of decades. The banana plug terminals are detachable. Their removal leaves a threaded 6-32 bushing for easy attachment of terminals of another design. All standards are individually calibrated at 1 kc and 24 C with an accuracy of ± 0.1 percent + 0.5 $\mu\mu$f. Long term stability is ± 0.05 percent + 0.1 $\mu\mu$f. Circle 217 on Reader Service Card.

Bridge Calibrator in three models

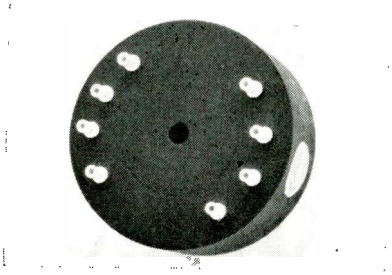
Bytrex Corp., 294 Centre St., Newton 58, Mass. A precision mv per v standard for convenient calibration and maintenance of strain gage systems provides a series of bridge outputs from 0.00 mv/v to 4.80 mv/v in eight increments.

Nominal outputs are guaranteed of 0.25 percent over a temperature range of 0.40 C. Overall size of the unit is 7 in. by 4 in. by 3 in. Three standard models are available for bridge resistances of 120 ohms, 350 ohms, and 500 ohms. Price is $165 each. Circle 218 on Reader Service Card.



Ferrite Isolator for 9.0-10.0 kmc

RAYTHEON MFG. CO., Waltham 54, Mass. Model IXL10 microwave ferrite isolator is designed for the frequency range of 9.0-10.0 kmc. The unit weighs 6 oz, and its length is 1.04 in. with the input and output flanges rotated by 45 deg. Minimum isolation is 22 db over the 9-10 kmc band; maximum insertion loss is 0.4 db. Maximum vswr over the range is 1.25. Circle 219 on Reader Service Card.



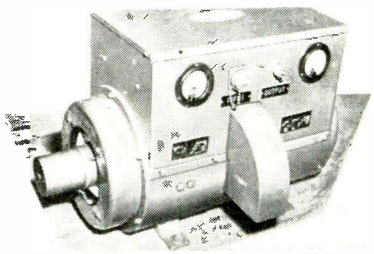
Transformers toroidal type

POLYPHASE INSTRUMENT CO., East Fourth Street, Bridgeport, Montgomery Co., Pa., has available a standard line of toroidal transformers for d-c to d-c or a-c transistorized converter applications. Dual purpose transformers for switching power transistors and supplying various output voltages are available for compact single transformer

applications. These transformers are available with power ratings up to 120 w, input voltages of 6, 12 and 24 v d-c, and output voltages to 600 v. Circle 220 on Reader Service Card.

Power Supplies transistorized

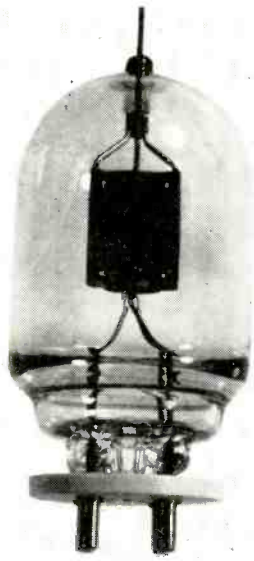
Southwestern Industrial Electronics Co., 2831 Post Oak Road, Houston 19, Texas. TPC-5 power supplies can be furnished for any desired output between 1 and 25 v d-c. Rated output current is 350 ma and regulation over the entire input voltage and output current ranges is 1 percent. The 120 v a-c input is reduced through a specially designed transformer, rectified in a bridge circuit and filtered. A portion of the output voltage is compared to a Zener diode reference voltage, amplified in a transistor circuit, and applied to the input to maintain a constant output voltage. Circle 221 on Reader Service Card.



Motor Generator d-c to 400 cps

Kato Engineering Co., 1415 First Ave., Mankato, Minn., has developed a small motor-generator set for possible use in conjunction with

military and CAA development programs. Generator portion produces an exact frequency of 400 cps. It is single phase and rated at 1,100 w. Generator is self-regulated with voltage change kept within 5 percent from no load to full load. The d-c motor is mounted on the same shaft, within the same frame as the alternator and is equipped with a speed governor which maintains constant speed despite load variations. Circle 222 on Reader Service Card.



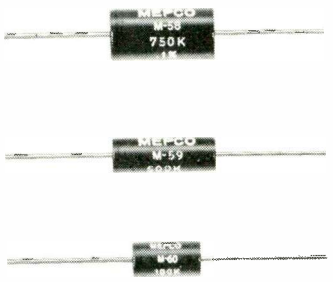
Half-Wave Rectifier ruggedized version

Vacuum Tube Products Co., Inc., 2020 Short St., Oceanside, Calif., announces a new ruggedized version of the 705A, half-wave, high vacuum rectifier. Major applications include airborne radar, electrostatic precipitators and h-v power supplies. Radiating fins and improved mechanical design permit its use in systems where a reliable tube with the ability to withstand adverse conditions of shock and vibration is required. Circle 223 on Reader Service Card.

Static Time Delay highly reliable

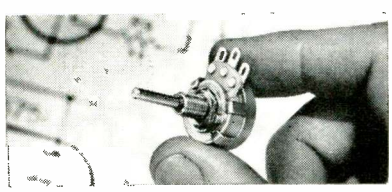
Electronic Specialty Co., 5121 San Fernando Road, Los Angeles 39, Calif., announces type T-275-1 static time delay. The void created by the high environmental requirements imposed by super-

sonic aircraft and missiles can be filled by this device employing no moving parts. Time delays up to 90 seconds can be manufactured to hold to tolerance of ±5 percent over all environmental conditions. Circle 224 on Reader Service Card.



Wirewound Resistors miniature units

MEPCO, INC., 35 Abbett Ave., Morristown, N. J., announces three new miniature precision encapsulated wirewound resistors—the M58, M59 and M60. They are produced in MIL styles 9444 AFRT 10, 11 and 12, in a power range of $\frac{1}{8}$ to $\frac{1}{3}$ w at 125 C. Operating range is −65 to 145 C with a temperature coefficient of 0.003 percent per deg. C. All units are aged at high temperature to insure a stability of 0.03 percent or better, and are tested at three times rated load prior to shipment. The units are also available in types MR58, MR59 and MR60, which are tested under Mepco's high reliability specification MF4. Circle 225 on Reader Service Card.



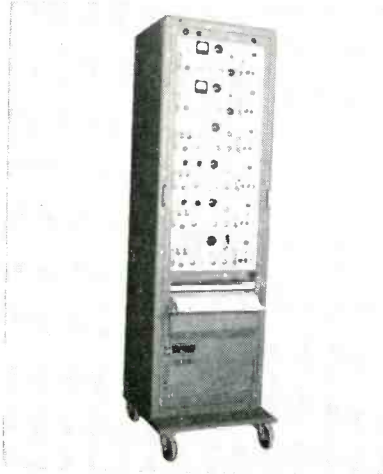
Wirewound Control miniature device

P. R. MALLORY & CO. INC., Indianapolis 6, Ind., has developed a new wire wound control only $\frac{3}{4}$ in. in diameter. Designed ambient temperature range is 200 C and up. At 145 C ambient, the control is rated at 5 w dissipation. It is available in linear resistance tapers from

10 to 10,000 ohms. Standard tolerance is ±5 percent. Circle 226 on Reader Service Card.

Relay Tester and power supply

MARINE VIEW ELECTRONICS, INC., 28 Main St., White Plains, N. Y. Model MPS-1 relay tester and power supply features continuously variable d-c supply from 0 to 25 v. Maximum current available is 1 ampere. It has regulation and hum level of laboratory standards. The unit gives visual indication of contact performance for up to 6 pdt relays. There are provisions for current reversal and current monitoring. Circle 227 on Reader Service Card.

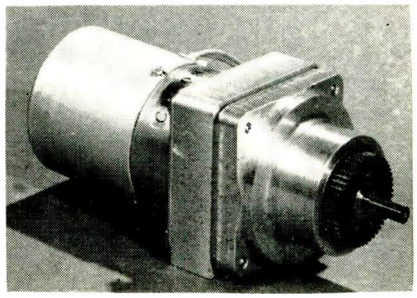


Six-Channel System in single cabinet

SANBORN CO., 175 Wyman St., Waltham 54, Mass. A new space-saving packaging method is now used for 6-channel 150 series direct-writing oscillographic recording systems.

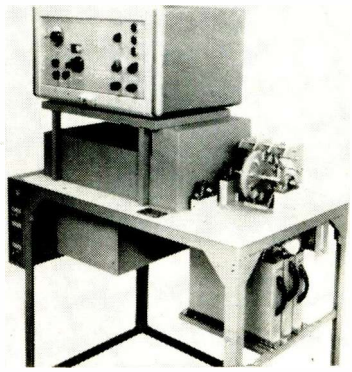
The six driver amplifier-power supply units, which accept the interchangeable plug-in preamplifiers,

occupy 42 in. of panel space above the recorder assembly. Overall dimensions of the vertical, mobile cabinet are 78 in. high by 22 in. wide by 25 in. deep. Circle 228 on Reader Service Card.



Power Drive constant speed

M. Ten Bosch, Inc., Pleasantville, New York, announces a constant speed power drive designed for computer and control system applications. Company says 16 in.-oz. of torque can be obtained at a constant speed of 1,000 rpm. Tolerance on speed is in the order of ± 0.1 percent with an input voltage variation of ± 20 percent and an input speed of 1,100 rpm ± 15 percent. A typical unit, type 041-9902, measures 4¼ in. by 2 in. by 2 in. and weighs in the order of 1 lb. This unit utilizes a timing motor requiring 28 v d-c at 3 w. Circle 229 on Reader Service Card.



Capacitance Bridge automatic unit

Industrial Instruments, Inc., 89 Commerce Road, Essex County, N. J., has available a high-speed, 1 mc automatic capacitance limit bridge to meet all government and

commercial testing specifications. It can be used as a simple indicator with green light indicating test capacitor within tolerance. Red and amber lights indicate high or low, out of tolerance units. Units are available with semi or fully automatic component feeding and sorting mechanisms. Circle 230 on Reader Service Card.

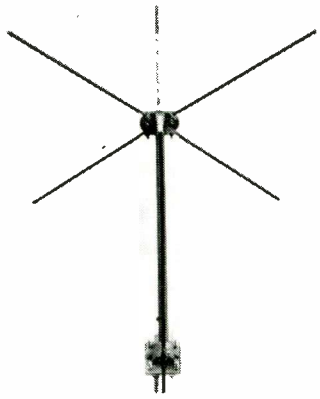
Isolation Amplifier has many uses

QUAN-TECH LABORATORIES, Morristown, N.J. Model 202 differential or isolation amplifier is ideal for use with an oscilloscope or voltmeter in measuring a-c voltages whose reference is not at ground potential, such as in servo systems and motors, magnetic amplifiers, a-c bridges, and those circuits employing floating power supplies. It is useful also where large amounts of ripple are present on the reference. Because it is also a differential, or bridging amplifier, it can be used for a balanced output. Circle 231 on Reader Service Card.

Waveguide Filters low-pass type

MICROPHASE CORP., Box 1166, Greenwich, Conn., has introduced a new line of r-f waveguide filters featuring very sharp cutoffs and low insertion loss in the passbands. The unit illustrated is of the low-pass type cutting off at 5 kmc, carefully matched to achieve a maximum loss

of only 0.75 db in the passband, with a minimum attenuation of 60 db from 1.08 f_c out to 12 kmc. Circle 232 on Reader Service Card.



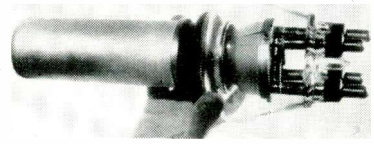
Antenna with heaters

SCALA RADIO CO., 2814 19th St., San Francisco, Calif. This heated ground plane antenna was developed at the request and with the cooperation of utility companies who must have communication under the most extreme weather conditions. The antenna is available with stainless steel elements and Tensilog castings. It is also available with aluminum or 10-18 steel machine tube. The heaters are waterproof and slide fit inside the elements with approximately 0.010 in. clearance. Low voltage (24 v) heaters are used because it allows the use of heavier heating wire that will withstand heavy vibration. Circle 233 on Reader Service Card.

Ohmmeter 2-percent accurate

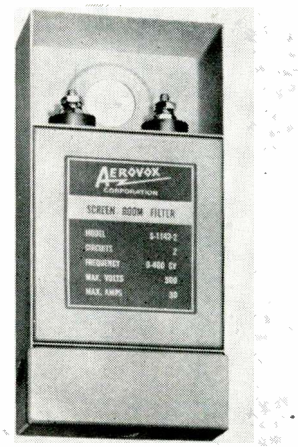
ELECTRONIC APPLICATIONS, 194 Richmond Hill Ave., Stamford, Conn. Model 321 direct-reading ohmmeter is usable safely in all transistor circuitry. It features ab-

solute minimum of loading (under 30 mv to 300 ohms); extreme wide range—10 milliohms to 10 megohms in 8 ranges; easy to read scales, no scale changing; and compact size—8½ in. by 6 in. by 4½ in. **Circle 234 on Reader Service Card.**



Industrial Triode water cooled

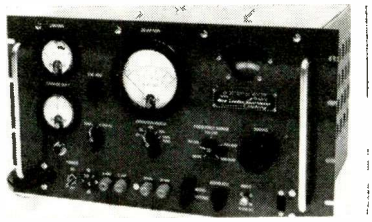
INTERNATIONAL TELEPHONE & TELEGRAPH CORP., 67 Broad St., New York 4, N. Y. Type F-7206 water cooled industrial triode is designed for use as an r-f amplifier and oscillator in Class C operation. It features a thoriated tungsten filament of mesh construction and continuous high temperature gettering and is ideally suited for low plate voltage operation. Maximum ratings are: plate voltage, 10 kv; plate current, 8 amperes; grid bias, 1,500 v; grid current, 0.6 ampere. **Circle 235 on Reader Service Card.**



Screen Room Filter wide range offered

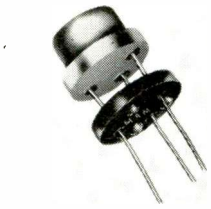
AEROVOX CORP., New Bedford, Mass., offers a complete selection of high attenuation screen room filters in single, double and triple section units to comply with the rigid specifications of advanced type screen room designs. Buyers may choose from a range of attenuation

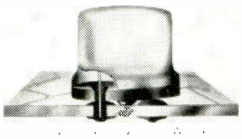
patterns from 14 kc to 10,000 mc. Each screen room filter is hermetically sealed and terminals at both ends are shielded. Easy mounting arrangements are incorporated. Circle 236 on Reader Service Card.



Modulation Monitor for telemetry

New London Instrument Co., 82 Union St., New London, Conn. Model 257B modulation monitor is capable of measuring total deviation of the carrier of f-m transmitters when modulated by multiple subcarrier oscillators. Frequency range is 20-100 mc and deviation measurements can be made from 0-1,000 kc. The a-f range is flat within ± 1.0 db from 50 cps to 200 kc. Circle 237 on Reader Service Card.

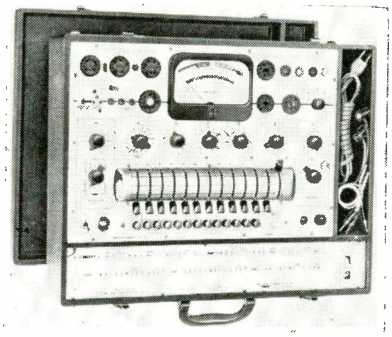




Mounting Pad for transistors

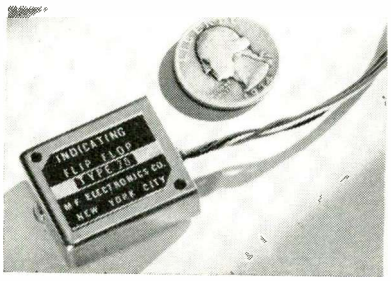
Milton Ross Metals Co., Davisville Rd., Southampton, Pa., announces Transipad, a new device which simplifies installation and permits a more reliable mounting for transistors on p-c boards. It is a glass filled diallyl phthalate wafer with three holes and three hemispherical feet. Leads pass through the holes to the circuit board solder connections, and the transistor

rests directly on the Transipad. The hemispherical feet raise the Transipad off the board, allowing flow clearance for the solder fillets and permitting air to circulate between circuit board and Transipad. Circle 238 on Reader Service Card.



Test Set
comprehensive unit

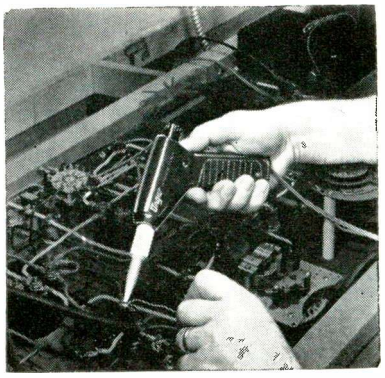
Precision Apparatus Co., Inc., 70-31 84th St., Glendale, L.I., N.Y. Model 10-60 Electronamic tube and transistor checker provides comprehensive tube, transistor, crystal diode and tv picure tube testing facilities for industrial and communications applications as well as for service/maintenance and technical education. Other features include: picture tube beam current test, ultrasensitive gas test, and functional testing of voltage regulator tubes. Circle 239 on Reader Service Card.



Flip-Flop
has indicator lamp

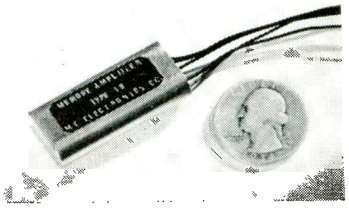
MF Electronics Co., 122 E. 25th St., New York 10, N. Y. Type 20 indicating flip-flop is designed to operate as a combined binary counter and indicator at speeds up to 20 kc. Operation is stabilized in ambient temperatures from −25 to +50 C. Due to its low current

drain it is particularly suitable for use in portable equipment, where it may be used for events per unit time indicators, predetermined counters, and summation counters. Circle 240 on Reader Service Card.



Soldering Iron
pistol shape

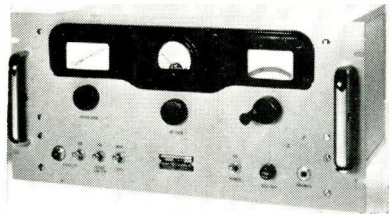
UNGAR ELECTRIC TOOLS, INC., 4141 Redwood Ave., Los Angeles 66, Calif. Model 260 soldered pistol features a comfortable hand fitted grip, together with light weight and perfect balance for fatigue-free soldering. It comes equipped with a long lasting 2½ in. Tellurium copper chisel tip. Adjustment knob permits 180 deg turn of the tip. Positive tip positioning and extra long reach combine to provide professional type on-target soldering. The unit has a full 6 feet of extra-flexible, extra light weight cord. The soldering pistol with tip is priced at $4.50. Circle 241 on Reader Service Card.



Memory Amplifier
sealed unit

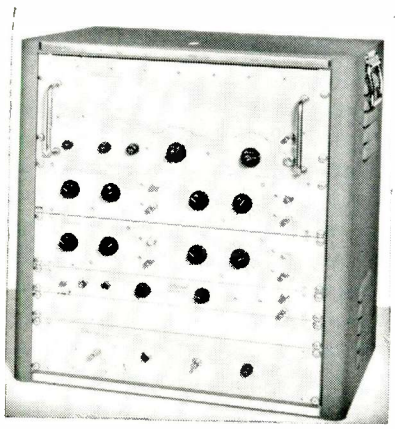
MF ELECTRONICS CO., 122 E. 25th St., New York 10, N. Y. Type 19 memory amplifier is a latching type amplifier with ability to control power into a load. It takes two input pulses between which power is alternatively applied or removed from the load. It includes four

subminiature transistors and a density of 100,000 parts per cu ft is achieved. The device can be connected for relatively long periods of time in the OFF condition yet draws no more than 1.5 ma. A bulletin giving complete electrical and mechanical data is available. Circle 242 on Reader Service Card.



Receiver for communications

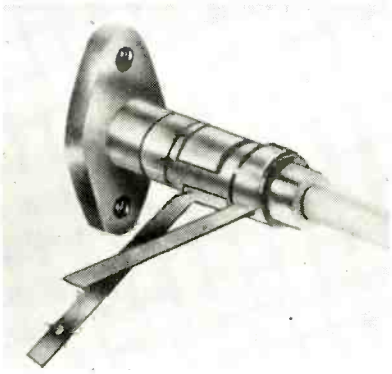
NEMS-CLARKE Co., 919 Jesup-Blair Drive, Silver Spring, Md. Type 2201 communications receiver operates in the 105-155 mc range. It is designed primarily for commercial airport communications use, employs a double conversion superhet circuit with automatic noise limiter, avc, and squelch circuit. Circle 243 on Reader Service Card.



Pulse Generator has varied uses

RUTHERFORD ELECTRONICS Co., 8944 Lindblade St., Culver City, Calif. Model B3-3 double pulse generator provides two pulses of identical amplitude and polarity from a single pulse forming unit. The instrument may be used as a double pulse generator with both pulses timed with respect to a sync pulse or with the second pulse

timed with respect to the first or as a single pulse generator. Single pulses can be generated at rates up to 1 mc and pulse pairs can be generated at rates up to 500 kc. Each pulse width is variable from 0.08 μsec to 10,000 μsec and the pulse delays are variable up to 10,000 μsec. The repetition of the internal oscillator is from 10 cps to 1 mc or the instrument may be triggered externally. Circle 244 on Reader Service Card.



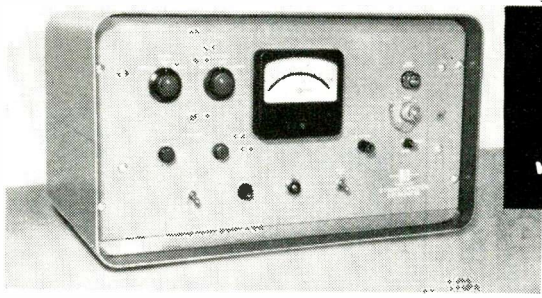
Miniature Trimmers completely sealed

JFD Electronics Corp., 6101 Sixteenth Ave., Brooklyn 4, N. Y., announces new miniature piston capacitors with permanently sealed interior construction. This prevents any formation of moisture inside the unit as well as increasing its insulation resistance and dielectric strength. The seal also maintains a constant pressure within the capacitor. This pressure, together with the closed and glass cylinder, protects against corona and voltage breakdown at high altitudes. Sealcaps are available in panel mount and printed circuit mount types. Circle 245 on Reader Service Card.

Coil Forms ribbed ceramic

Waters Mfg., Inc., Wayland, Mass., announces a new line comprising ribbed ceramic coil forms for rugged construction. Ceramic conforms to JAN-I-10, grade 15 or better, silicone impregnated. Ribbing permits coil leads to be brought under windings to lugs—no loose leads. New permanent ten-

Curtiss-Wright *ultra-sensitive* DYNAMIC CAPACITOR ELECTROMETER



Reads as low as 10^{-15} AMPS with 10^{12} ohms resistor

- 10—100—1000 mv scales
- 10^{-5} to 10^{-14} amps full scale
- Less than 1 mv drift per day
- Accuracy ± 2%
- Input resistance 10^{15} ohms
- Short response time

The Curtiss-Wright Dynamic Capacitor Electrometer is both a highly sensitive millivoltmeter and a micro-microammeter. It can be used to read low potentials originating in high impedance sources, insulation resistance, grid currents, static charges, etc., and as a null detector. In physics and chemistry, it provides measurement of pH ion currents in mass spectrometry. Its low drift permits reliable detection of radioactivity for health physics and reactor control. For complete information, write: Electronic Equipment Sales Dept.

MODEL NA100
Price $1,075
FOB Carlstadt, N. J.

ELECTRONICS DIVISION
CURTISS-WRIGHT
CORPORATION • CARLSTADT, N. J.

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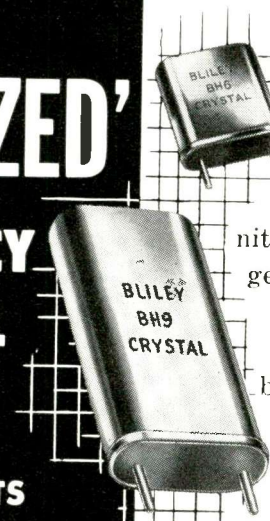
'RUGGEDIZED' FREQUENCY CONTROL



NEW
CRYSTAL UNITS MEET VIBRATION UP TO 2000 cps AT 5G. AND 100G. SHOCK IN RANGE 4kc TO 125mc

This new series of Bliley crystals units answers a definite need for "ruggedized" frequency control in the field of airborne and missile-borne equipment. These units meet or exceed the electrical and mechanical requirements of MIL-C-3098B. Request Bulletin #512.

Bliley CRYSTALS

BLILEY ELECTRIC CO.
UNION STATION BUILDING
ERIE, PENNSYLVANIA

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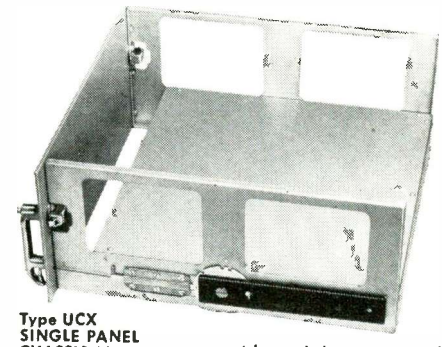
RIGID MOUNTING for YOUR COMPONENTS

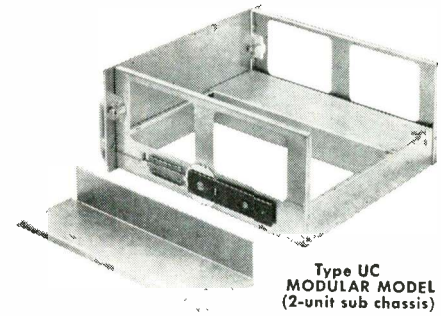
UNIVERSAL CHASSIS

Available in two types: full chassis plate or modular sub chassis.



Type UCX SINGLE PANEL CHASSIS PLATE MODEL—with push-button panel lock, trigger 'Detent' tilt control and 'Chassis-Trak' tilt-lock section.

Flat chassis plate is readily punched or drilled, permits fore-and-aft or cross-mounting of assemblies, provides unrestricted front panel mounting area.



Type UC MODULAR MODEL (2-unit sub chassis)

This series permits fore-and-aft mounting, superior cooling of assemblies.

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WESTERN DEVICES, INC.
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*For Inquiries on 'Chassis-Trak' East of Rockies: Chassis-Trak Corp., 525 S. Webster Ave., Indianapolis

CIRCLE 103 READERS SERVICE CARD

sion device is designed into the construction—no loose parts. Design of form permits coil forms to be stacked or bushings added to each end for double tuned coils. Circle 246 on Reader Service Card.

Oscilloscope
d-c to 15 mc

TEKTRONIX, INC., Portland, Oregon, Type 533 is a d-c to 15-mc oscilloscope with the company's plug-in feature. It has 22 calibrated direct-reading sweep rates from 0.1 μsec/cm to 5 sec/cm, with sweep magnifications of 2, 5, 10, 20, 50, and 100 times. Full sweep range is 0.02μsec/cm to 15 sec/cm. Triggering is preset for operating convenience, but can be controlled manually when desired. Amplitude calibrator has 18 fixed steps from 0.2 mv to 100 v peak to peak. Square-wave frequency is about 1 kc. Price, without plug-in units, is $1,050. Circle 247 on Reader Service Card.

Power Transistor
germanium h-v type

MOTOROLA INC., 4545 W. Augusta Blvd., Chicago 51, Ill. Model 2N618 transistor has maximum ratings of collector to base voltage of 80 v; collector current of 3 amperes; collector dissipation at 25 C mounting base temperature 45 w, at 80 C mounting base temperature 10 w. Grounded emitter current gain is specified as a minimum of 60 and a maximum of 140 at 25 C mounting base temperature. Circle 248 on Reader Service Card.

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Literature of

MATERIALS

Rosin Flux. Division Lead Co., 7742 W. 61st Place, Summit, Ill. A recent bulletin announces Divco No. 600, an improved noncorrosive, plasticized, rosin soldering flux developed specifically for printed circuit manufacture. **Circle 249 on Reader Service Card.**

COMPONENTS

Coils. Poughkeepsie Coil Co., Inc., 24 Charlotte St., Binghamton, N. Y. A four page folder discusses the company's capacity and facilities for production of quality coils for electrical, solenoid and relay applications. **Circle 250 on Reader Service Card.**

Mercury Switch. Micro Switch, a division of Minneapolis-Honeywell Regulator Co., Freeport, Ill. Data sheet 144 describes a new nylon-enclosed mercury switch, fabricated of materials which are highly resistant to the effects of water, oil, alkalis and acids. **Circle 251 on Reader Service Card.**

Meter Mounting. Lord Mfg. Co., 1635 W. 12th St., Erie, Pa. A four-page product bulletin describes in detail a low-cost, bonded rubber meter mounting for protecting sensitive instruments against shock and vibration. **Circle 252 on Reader Service Card.**

Slip Ring Assemblies. Slip Ring Co. of America, 3612 W. Jefferson Blvd., Los Angeles 16, Calif., pictures over 50 slip rings, brushes, commutators and drums in their new brochure. The nine methods of manufacturing the units are disclosed along with the different materials and end uses of the product. **Circle 253 on Reader Service Card.**

Snap-Acting Switches. Unimax Switch Division, The W. L. Maxson Corp., Ives Road, Wallingford, Conn. A 28-page illustrated catalog contains complete information on a wide variety of precision snap-

the Week

acting switches. **Circle 254 on Reader Service Card.**

Transformers. Transformers Inc., 200 Stage Road, Vestal, N. Y. A well illustrated booklet describes the company's facilities for the manufacture of high-precision transformers, other components and special test equipment. **Circle 255 on Reader Service Card.**

Tube Shields. The Staver Co., Inc., 41-51 N. Saxon Ave., Bay Shore, N. Y. A six-page folder details the company's tube shielding and tube guard products for miniature and subminiature electron tubes. **Circle 256 on Reader Service Card.**

Vibration Pickups. Consolidated Electrodynamics Corp., 300 N. Sierra Madre Villa, Pasadena, Calif. Bulletin 1596 covers a line of horizontal, vertical, and omnidirectional models of vibration pickups. Applications and construction are discussed. **Circle 257 on Reader Service Card.**

EQUIPMENT

Coupling System. Consolidated Electrodynamics Corp., 300 N. Sierra Madre Villa, Pasadena, Calif. Bulletin CEC-1517D fully describes a compact, low-cost system for measurement of vibrational amplitudes in the 8- to 800-cps range. **Circle 258 on Reader Service Card.**

Double Pulse Generator. Electro-Pulse, Inc., 11861 Teale St., Culver City, Calif. Complete specifications and large instrument photos constitute a new 3-page booklet on model 3460A megacycle double pulse generator. **Circle 259 on Reader Service Card.**

Galvanometer. Consolidated Electrodynamics Corp., 300 N. Sierra Madre Villa, Pasadena, Calif. Bulletin 1528A contains an illustrated description, specifications and applications for the series 7-300 galvanometers. A price list is in-

cluded. Circle 260 on Reader Service Card.

Ground Power Systems. Varo Mfg. Co., 2201 Walnut St., Garland, Texas, has compiled a brochure dealing with five models of 400 cycle motor-clutch-generator sets with power outputs of 1.5 to 15 kva. **Circle 261 on Reader Service Card.**

House Organ. Polytechnic Research & Development Co., Inc., 202 Tillary St., Brooklyn, N. Y. Volume 5, No. 4 of PRD Reports discusses the frequency resolution obtainable from a noise-jittered harmonic generation system. **Circle 262 on Reader Service Card.**

I-F Amplifiers. Lel, Inc., 380 Oak St., Copiague, L. I., N. Y. Miniature, subminiature and transistorized i-f amplifiers for radar and guided missile applications are illustrated and described in a new catalog. A price list is included. **Circle 263 on Reader Service Card.**

Instruments. Computer Measurements Corp., 5528 Vineland Ave., North Hollywood, Calif., announces a series of applications notes and data sheets on the use of counting, timing, and frequency measuring instruments. **Circle 264 on Reader Service Card.**

Phase Sequence Indicator. Master Specialties Co., 956 E. 108th St., Los Angeles 59, Calif. New literature is now available on request for the pocket size phase sequence indicator. Illustrations and specifications are given. **Circle 265 on Reader Service Card.**

Pulse Height Analyzer. Eldorado Electronics, 2821 Tenth St., Berkeley, Calif. A four-page bulletin notes the features and applications of the model PA-400 multichannel pulse height analyzer. **Circle 266 on Reader Service Card.**

Relay Analyzer. Schmeling Electronics, 20 First St., Keyport, N. J. A single-sheet bulletin illustrates and describes the model 140 universal relay analyzer which quantitatively checks relay operation un-

der actual contact current. **Circle 267 on Reader Service Card.**

Servo Actuator. Lear, 110 Ionia Ave., N.W., Grand Rapids 2, Mich. Product data sheet 111-7 contains description, features and engineering data on the series 1383 servo actuator. **Circle 268 on Reader Service Card.**

Temperature Controls. United Electric Controls Co., 79 School St., Watertown 72, Mass. Condensed catalog 400 describes a wide variety of both local mounted and remote bulb temperature controls. It contains over 160 standard types and models. **Circle 269 on Reader Service Card.**

Test Chambers. American Research Corp., Farmington, Conn. Bulletin SD-58 illustrates and describes sand and dust test chambers which feature automatic dust density control. **Circle 270 on Reader Service Card.**

FACILITIES

Accelerometer Manual. Endevco Corp., 161 E. California St., Pasadena, Calif. Methods and accuracies of crystal accelerometer calibration are featured in a 25-page manual complete with actual photos and graphs. **Circle 271 on Reader Service Card.**

Designing/Fabricating. The Tele-Tronics Co., 180 So. Main St., Ambler, Pa., has released a brochure describing the company services for designing and/or fabricating custom-built electrical-electronic and mechanical equipment. It is illustrated to show the diversity of equipment that has been built with the manufacturing facilities available. **Circle 272 on Reader Service Card.**

Temperature and Pressure Measurement. Trans-Sonics, Inc., Burlington, Mass. A 20-page glossary of terms used in temperature and pressure measurement is now available. The pocket size booklet is completely illustrated with drawings and graphs. **Circle 273 on Reader Service Card.**

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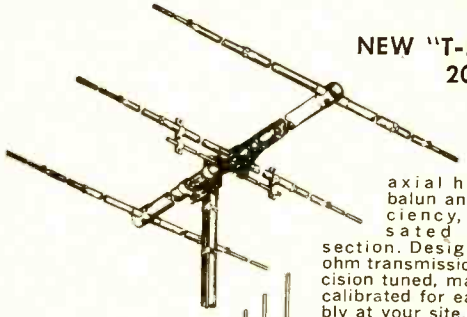

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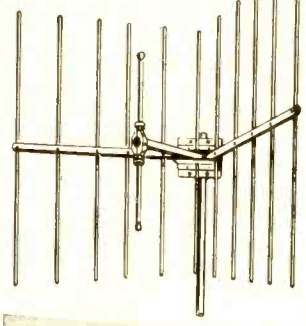

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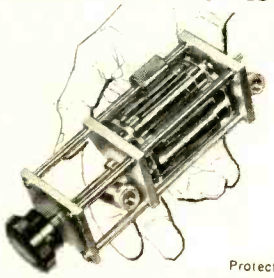
TURRET ATTENUATORS
with simple "PULL-TURN-PUSH" operation, small and rugged.



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ATTENUATOR PADS

Available in any conceivable combination of male and female Type C and Type N connectors. Maximum length of 3" for any attenuation value.

GENERAL SPECIFICATIONS
VSWR: Less than 1.2 to 3000 mc.
Characteristic Impedance: 50 ohms.
Attenuation Value: Any value from 0 db to 60 db including fractional values.
Accuracy: ±0.5 db; values above 50 db have rated accuracy of attenuation through 1000 mc only.
Power Rating: 1.0 watt sine wave.

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Small-stable-50 or 70 ohms

½-Watt: 50 ohms impedance, TNC or BNC connectors, dc to 1000 mc, VSWR less than 1.2.

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CIRCLE 118 READERS SERVICE CARD

IBM Opens 'Campus' Facility

"Industrial Campus" is an apt description for IBM's new 210-acre facility at San Jose, Calif. Designed as the exclusive site for engineering and production of the company's new RAMAC (Random Access Method of Accounting and Control), the seven-building complex has the appearance of a university, and reflects its planners' aims: an efficient production plant and a pleasant place to work.

Beside RAMAC, two other machines—the 604 and 607—are produced here. Also, reconditioning of punch card equipment and certain types of electronic computers operated in the Western States, formerly done on the East Coast, is now handled at San Jose.

Seven coordinated buildings provide the "campus" effect. Largest structure, the manufacturing building, has a 40-ft mobile aluminum sculpture hydro-gyro as a facing landmark (picture). The building has 200,000 sq ft of floor space. Receiving, quality control, and final testing are housed here. Latest material flow and assembly line practices are utilized.

"Campus" describes the new site for another reason: IBM's accent on education. Second largest building is the education unit, used for instruction of local employees, customers, and sales and service personnel from all over the world. Curriculum includes lectures and laboratory sessions on disassembly, trouble shooting, and repair of IBM equipment.

The Research Lab, established in 1952 at San Jose, now occupies the third largest building, with 43,000 sq ft. The Engineering Building faces the manufacturing plant and contains 40,000 sq ft for Component and Product Engineering labs.

Other buildings, equally well integrated into the whole, are the boiler plant with a heating capacity of 70 million BTU per hour, and the cafeteria which feeds 1400 persons an hour.

Gavin A. Cullen, general manager of the San Jose center, believes both RAMAC and its plant "will make San Jose synonymous with electronic data processing—just as Schenectady is known for electrical industry."

More than two thirds of the 2700 IBM employees in the San Jose area work at the "campus", which was dedicated May 27.

Reassign Ward At Varian

Curtis E. Ward is named manager of small tube product development at Varian Associates, Palo Alto, Calif. In his new position, he will direct the development of new tube types as well as performing product improvement work on types originating in research and development, supplying important information to production.

Ward formerly was a research and development project manager in Varian's tube division, heading up a team of engineers in the development of new tube types.

Shallcross In North Carolina

After more than 30 years in Collingdale, Pa., the Shallcross Mfg. Co. has moved its entire operation to North Carolina. New 41,000 sq ft plant is in Selma, N. C.—28 miles south of Raleigh. The one story plant houses expanded office, engineering and manufacturing facilities. Separate departments will be maintained for the production of Shallcross precision resistors, rotary switches, instruments and attenuators.

Borck Joins Empire Devices

Appointment of Alan Borck as chief engineer of Empire Devices, Inc., Amsterdam, N. Y., is announced. Prior to joining Empire, he was chief magnetics engineer of Emerson Radio and Phonograph's government electronics division.

G-C Electronics Names Sales Mgr

New sales manager at G-C Electronics Mfg. Co., a division of G-C Textron Inc., Rockford, Ill., is Don Jonson (picture). He takes charge

GUIDANCE and TELEMETRY

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Because of Bendix-Pacific's seasoned engineering background in both missile electronics and telemetry, this Division has been selected as a major subcontractor to develop and supply both an advanced missile guidance system and the complete telemetering system for the Talos Missile Program. Bendix Products Division, Missile Section, is the prime contractor for Talos.

The Bendix-Pacific guidance system, originally conceived by the Applied Physics Laboratory of The Johns Hopkins University, is recognized as a distinct forward step in the state of the art . . . while the telemetering equipment represents the first t[illegible]sistorized system in quantity production.

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of all marketing and promotion of the complete line of carbon resistors and thermistors.

Jonson comes to G-C Electronics from the electronic division of the Elgin National Watch Co. where he was administrative assistant to the director of sales.

Glover Becomes RCA V-P

ELECTION of Alan M. Glover (picture) as vice president, RCA semiconductor and materials division, Somerville, N. J., is announced. He has been general manager of the new division since its formation last March, and prior to that was general manager of the semiconductor division.

General Radio Receives Award

MARTIN HIRSCHORN, president of the National Noise Abatement Council, recently presented the Council's Certificate of Award to the General Radio Co., Cambridge, Mass., during ceremonies at council headquarters in New York City.

The award was given to the Cambridge firm "For providing pioneering service in the development and distribution of superior quality technical literature on sound measurement and noise abatement. It has cooperated extensively with

various committees to establish standards for acoustical measurement and instrumentation."

Power Sources Names Exec V-P

STANLEY N. GOLEMBE has been appointed executive vice president at Power Sources, Inc., Burlington, Mass. Before joining Power Sources he was with Laboratory for Electronics as manager of manufacturing and prior to that as chief contract administrator and project engineer.

Stevenson Takes New Post

DESIGN of the Navy's Polaris ballistic missile, being developed by Lockheed Missile Systems division in Sunnyvale, Calif., will be directed by William A. Stevenson. He moves to Lockheed from Convair, where he was chief engineer of advanced missile projects.

NDA Hires Kellogg

NEW consulting engineer at Nuclear Development Corp. of America, White Plains, N. Y., is Donald S. Kellogg (picture).

Prior to accepting the NDA post, Kellogg had served for four years with General Precision Laboratory, where he was chief engineer. Earlier

service includes one year with Simmonds Aerocessories, Inc., where he was director of development engineering, and 14 years as project engineer, and chief engineer of the W. L. Maxson Corp.

IRC Promotes Medlock

RECENT appointment of E. P. Medlock, Jr. (picture), to plant manager of IRC's subsidiary, Circuit Instruments Inc., St. Petersburg, Fla., is announced. He was previously chief engineer.

Prior to joining IRC, Medlock was associated with the Brown Instrument Division of Minneapolis-Honeywell as sales engineer.

Set Up New Firm

A NEW electronics firm, Farinon Electric Co., has been established in Redwood City, Calif., to design and manufacture narrow-band multichannel radio equipment for communication services. William B. Farinon has resigned his position with Lenkurt Electric Co., in San Carlos, to direct the activities of the new company.

George Berry To NYT Electronics

NEW design engineer on the staff of NYT Electronics, Inc., Burbank, Calif., is George M. Berry. He was previously chief engineer of National Electronics Corp., North Hollywood, Calif. Prior to that he

was a design engineer for Packard-Bell Electronics Corp., Bendix Aviation and Triad Transformer Corp.

Plant Briefs

Carmer Industries, Inc., extruders of Kel-F, Nylon and Teflon, has doubled its plant facilities in Kenilworth, N. J.

Pacific Magnetic Corp. has moved into a newly remodeled 14,000 sq ft plant in Riverside County at Electronic Center, Romoland, Calif.

News of Reps

DAYSTROM Transicoil, Worcester, Pa., appoints **Peterson Co.** as its servo and synchro sales rep in Colorado, Utah, Wyoming, Idaho, Montana and western Nebraska; **Avionics Liaison Inc.**, in Washington and Oregon.

Paul F. Wiley Co. will represent Kintronic Division of Chicago Aerial Industries, Inc. for its line of wirewound potentiometers in the southern California, Arizona and southern Nevada area.

Fischer & Porter Co., Hatboro, Pa., names **Martig's Inc.** as rep for all of Oregon and the counties of Cowlitz, Skamania, Clark, and Klickitat in Washington.

Sale of relays, solenoids and hermetic seals of the Phillips Control Corp., Joliet, Ill., will be handled in Florida by the **Benz Sales Co.**

Burroughs Corp., Electronic Tube Div., Plainfield, N. J., appoints the following reps:

Arnold Barnes, for Texas, Oklahoma, Louisiana and Arkansas.

Brooks, Feeger and Morrow, for New Mexico; Arizona; Colorado; Utah; Clark County, Nevada; Laramie County, Wyoming.

Instrument Dynamics, for the New England states.

J. A. Reagen Co., for New York state.

R. M. C. Associates, for metropolitan New York and New Jersey.

NEW BOOKS

Electronic Components Handbook

By Keith Henney and Craig Walsh.

McGraw-Hill Book Co., Inc., New York, 1958, 250 p, $10.00.

Many books try to show design engineers how to design any kind of circuit imaginable. No book in the past has told him what components or piece parts will successfully convert these design ideas into physical hardware. "Electronic Components Handbook" is the first book to bring this much needed information into the hands of the design engineer.

Scope—Information on piece parts exist in many places in small amounts and as such is of little use to the industry. This book is one of a planned series that will gather into a set of volumes the presently known information specifications, ranges, uses, failure rates and reliability of the most commonly used piece parts. This first volume covers the basic piece parts discussion on resistors, capacitors, relays and switches as well as introductory chapters on reliability and its importance, and the role of component parts.

The coverage on resistors, capacitors and switches is excellent. Practically all the known types of piece parts in these categories are discussed. Included are applicable military specifications, reliability factors, failure data and the reaction of these piece parts to a variety of environments.

Relays—The discussion on relays is not as complete. This may be due to the rapidly changing specifications and characteristics of products in this field. In general relay characteristics, both physical and electrical, have been dictated by telephone and telegraph usage. In recent years electronics in the computer and missile fields has placed tremendous demands on relay manufacturers. New products and characteristics are in evidence daily. The text on relays is sufficient to acquaint the engineer with the pertinent terminology, specifications,

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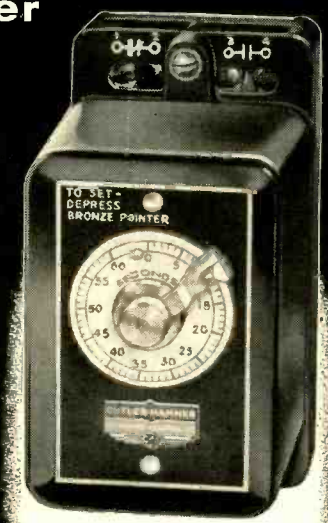

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types and available characteristics.

This book as the first of the series should be of as much help to the engineer as the familiar tube manual. A suggestion to the publisher is that this book series might be published in loose-leaf form as the tube manuals are. This will prevent the material from becoming obsolete through some annual reader service similar to the tube manual service.

The book as is, is worth reading and having since it does bring together in one volume the pertinent military specifications, environmental characteristics, types available and failure data of the most commonly used electronic piece parts. —Anthony J. Finocchi, *Reliability Manager, Federal Telecommunications Lab., Nutley, N. J.*

Rectifying Semi-Conductor Contacts

By H. K. Henisch

Oxford University Press, New York, 1957, 372 p, $11.20.

In the author's words, "This book is intended mainly for physicists who require a specialized knowledge of semiconductor contacts and related surface phenomena. The introductory chapters are included so as to make the volume self-contained for the reader not previously engaged in research on solid-state physics".

The book covers almost exclusively and very thoroughly the behavior of old-art (pretransistor) diodes made of Se, CuO, TiO_2, CuS, as well as point contacts on Ge and Si. The book also gives a rather complete survey of various theories proposed by Mott, Schottky and others in an attempt to explain the highly complicated characteristics of the old-art diodes by theories and models. This report is a useful compendium with much boiling-down of the vast old-art literature so that the book is not unduly bulky.

For the reviewer's taste, there is not enough reference to transistor results and to contacts as applied to transistors. I believe, myself, that many of the old-art diodes will eventually be understood through

experimentation on transistor structures and test devices (*pnpn*, field-effect testers and surface experiments). Unfortunately, the author has excluded this approach by stating that "a comprehensive treatment of the *pn* junction is outside the scope of this book". Similarly, the author has refrained from an excursion into the closely related field of electrolytic capacitors (e.g. Ta_2O_5) which are really reverse-biased diodes also. Presumably, he did this to avoid writing an encyclopedia; however, a few more cross references would have been helpful.

What remains then is a useful, complete and penetrating survey of the old-art diodes and of theories applying directly to them.

The book begins with three introductory chapters on electrical properties, historical notes and mechanisms of charge transport. There are then five chapters on electronic equilibrium in solids; four on bulk properties of important semiconductors; four on structure and voltage-current characteristics of plate rectifiers; five on point contact rectifiers; three on capacitive effects; eight on unipolar rectification theories at metal-semiconductor contacts; three on injecting contacts; five on special topics of theory, including ionic effects and high frequency; and seven on the attempt to reconcile the theories with experiment.—R. M. Ryder, *Bell Telephone Laboratories, Murray Hill, N. J.*

Elements of Magnetic Tape Recording

By N. M. Haynes.

Prentice-Hall, Inc., Englewood Cliffs, N. J., 1957, 392 p, $7.95.

This logical compilation of much of the existing technology on the subject provides a welcome addition to the rather meager hard-cover literature concerning magnetic tape recording. Although there is little unique or original here, much of the information has heretofore been confined to articles in periodicals.

The work is divided into four main sections, the first being de-

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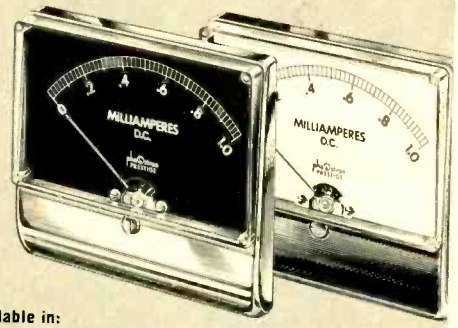

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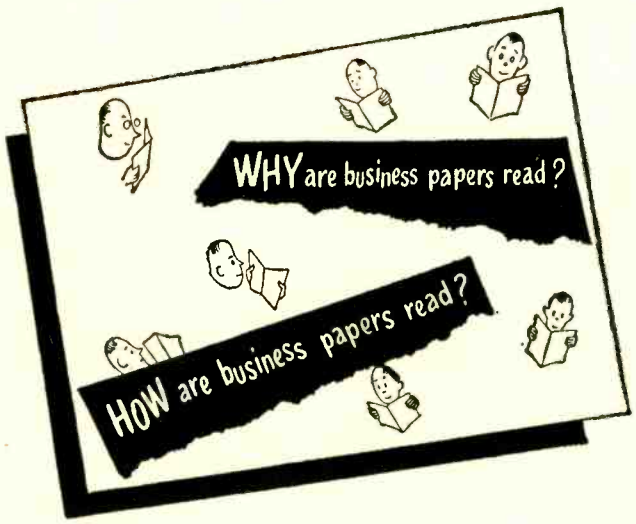

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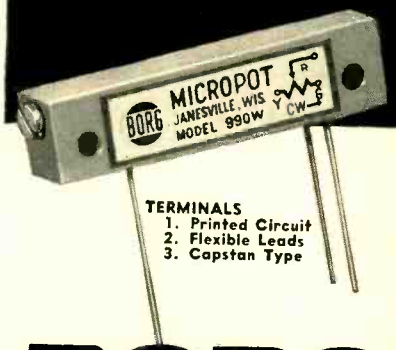

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voted to the fundamentals of magnetic theory and the second to the specific theoretical considerations of magnetic recording. Part three discusses the mechanical aspects of recording equipment and the concluding section covers circuitry. The primary consideration throughout the book is audio, with only slight coverage given to other applications such as computers, instrumentation or video recording.

Perhaps the most serious shortcoming of the book is the author's apparent indecision as to the make-up of his audience. Written primarily at technician level, the text frequently digresses into discussions which might fit better into the Sunday supplements. If the intention was to broaden the potential market for the book, the result is a work which is neither fish nor fowl.

Despite these lapses, the book does provide much information which is not otherwise available in this form. There is still a great need for a definitive work on magnetic recording, but until that book comes along, the present one will help to fill the void.—DONALD C. HOEFLER.

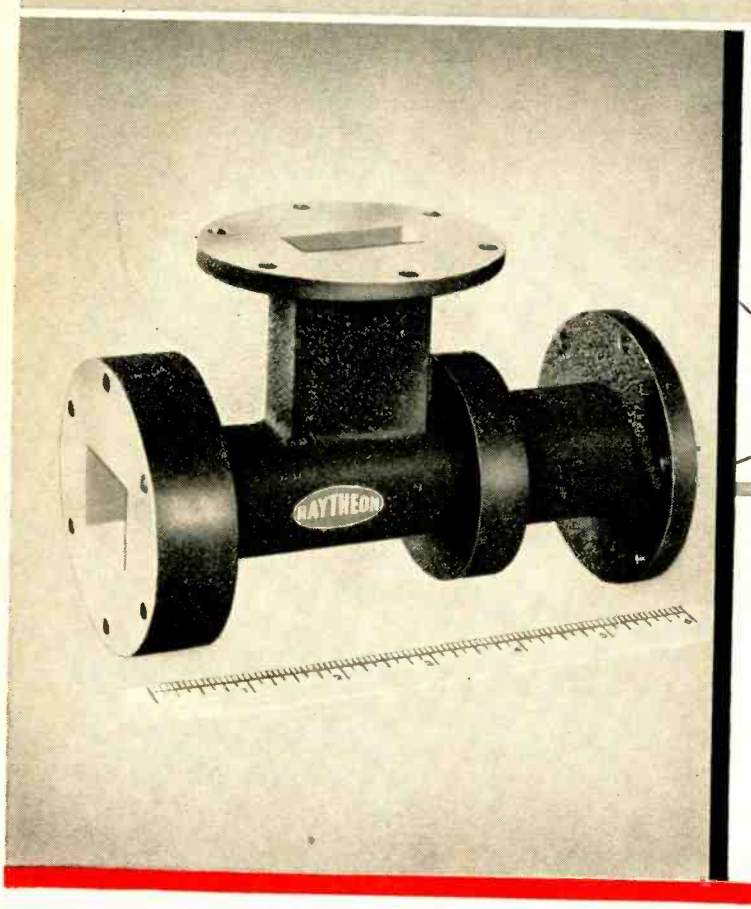
THUMBNAIL REVIEWS

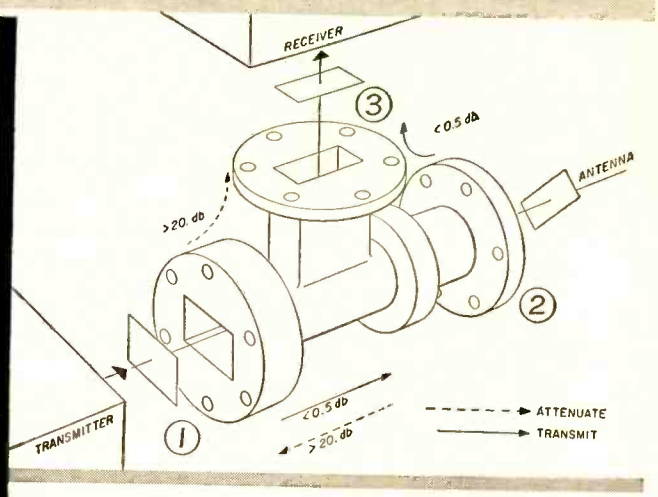
Technical Report Writing. By James W. Souther, John Wiley & Sons, Inc., New York, 1957, 70 p, $2.95. Fundamentals of technical writing, treated from a design approach emphasizing method and centering on the writing process, intended for both undergraduates and practicing engineers.

Prazisionsmessungen von Kapazitaten, Induktivitaten under Zeitkonstaten. By Erich Blechschmidt, Friedrich Viewig & Sohn, Braunschweig, Germany, 1957. Bridge techniques for precision measurements of capacitors, inductors and fine constants.

How to Read Schematic Diagrams. By David Mark, John F. Rider Publisher, Inc., New York, 1957, 160 p, $3.50 (paper). Intended for high-school students and beginning technicians, this book explains basic theory, symbolism, technical notations and organiaztion of schematics in pictorial-diagram form.

Recent Raytheon achievements in Microwave





THE MICROWAVE CIRCULATOR. Typical of recent Raytheon developments in advanced microwave equipment and components is the microwave ferrite circulator recently developed by Raytheon's Special Microwave Device Group. **HOW IT WORKS:** in the diagram above, transmitted signals enter arm (1) vertically polarized. They are then rotated 45° from the vertical in a ferrite Faraday rotator with a longitudinal field applied by a small cylindrical permanent magnet. They flow out of the circulator at the antenna arm (2) which is set at the same 45° angle. Received signals fed into the antenna arm are rotated an additional 45° by the ferrite Faraday rotator and can only leave through the receiver arm (3).

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MARINE EQUIPMENT—submarine, ship and airborne sonar, depth sounders, direction finders, radars.

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COMMENT

Symbols

Our article "Solid State Thyratron Switches Kilowatts" (Mar. 28, p 52) describes the operation and application of the silicon controlled rectifier. The sketches submitted with this article were redrawn for publication.

The symbol used by ELECTRONICS to represent the controlled rectifier

differs from the symbol commonly used for controlled rectifiers with *p* gate terminals

or with *n* gate terminal.

The ELECTRONICS symbol is apparently derived from transistor symbology and, in fact, appears to fit the IRE standard for a *pnp* transistor symbol (with the position of the emitter changed to the opposite side of the horizontal line).

In deriving the controlled rectifier symbols we desired a close identification with the standard rectifier symbol, since the operation and application of the device is more closely related to a rectifier than to a transistor. At the same time, an attempt was made to conform to the new IRE standard symbols to as great a degree as possible. For this reason a 60-degree arrow at right angles to the center line is used, rather than a 30-degree arrow at an angle to the center line, which, according to IRE symbology, would represent an emitter contact.

The gate lead symbol does not strictly conform to IRE standards, but was chosen to maintain simplicity without the possibility of conflicting with present or potential semiconductor devices. Strict conformity with IRE symbols

would call for an additional slanting line without an external connection to denote a transistion between p and n regions. The gate lead on presently available devices is shown on the cathode side of the rectifier symbol, representing an ohmic contact to the center n region and control between this region and the cathode (center sketch). Future devices will incorporate a gate lead contact on the n region and will be represented symbolically as in the bottom sketch, which depicts control between gate and anode.

R. P. Frenzel
F. W. Gutzwiller

General Electric
Syracuse, N. Y.

We'd be most interested to know what other readers think about these particular symbols.

Phase Shift

I was quite pleased to see my brief paper "Phase-Shift Curves" (May 9, p 86). However, I am afraid that quite a few people will be making disparaging comments about it unless you print a correction to the magnitude response in Fig. 1C. . . .

R. H. Engelmann
University of Cincinnati
Cincinnati, O.

Author Engelmann caught a draftsman's error. Straightline approximation G_b in his Fig. 1C begins as a positive value on our drawing, drops to zero db at ω_{c1}/α_1 to converge with line G_e. G_b should have started at zero, gone negative to cross G_e at $\omega_{c1}/\sqrt{\alpha_1}$ and continued horizontally from ω_{c1}/α_1.

Russian Ships

Has it occurred to anyone that those Russian fishing ships in the Grand Banks might be part of the International Geophysical Year oceanography activities?

Roger N. Englander
Rye, N. Y.

If they were IGY vessels, it seems that our IGY people would've already said so. They haven't.

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Circuit Development Group Leader Ralph Wolcott (left) considers future changes in computer output unit for bombing—navigational systems.

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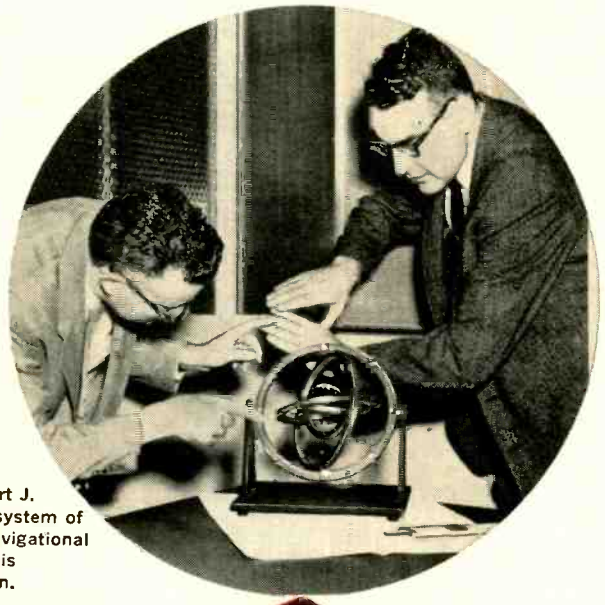

roject Engineer Robert J. antwell (left) uses a system of mbals to describe navigational roblems in the analysis a new system design.

Staff Engineer William Howard (center) reviews gearing accuracy requirements of test equipment with electronic circuit designers.

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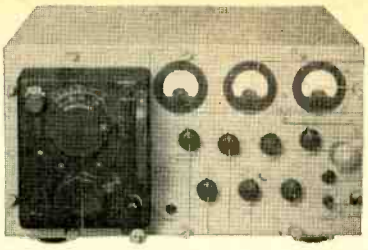

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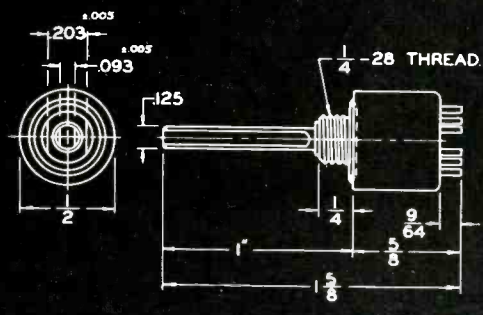

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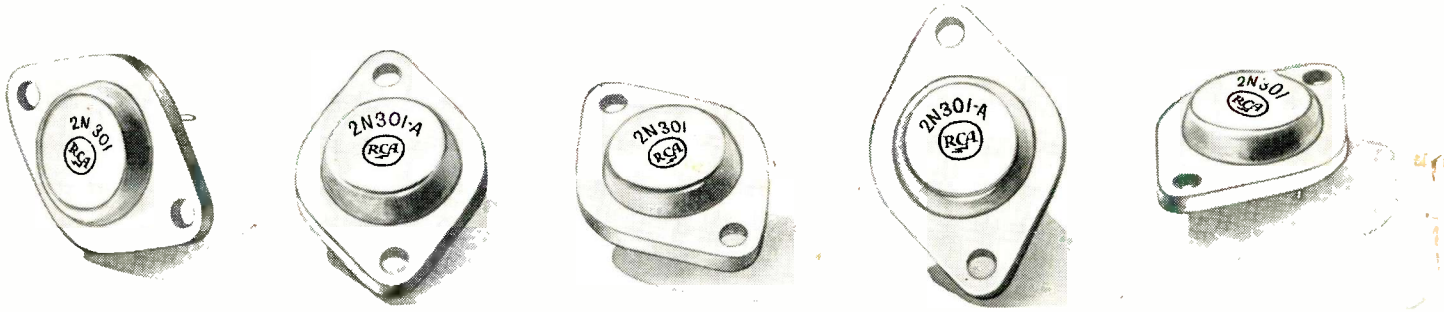

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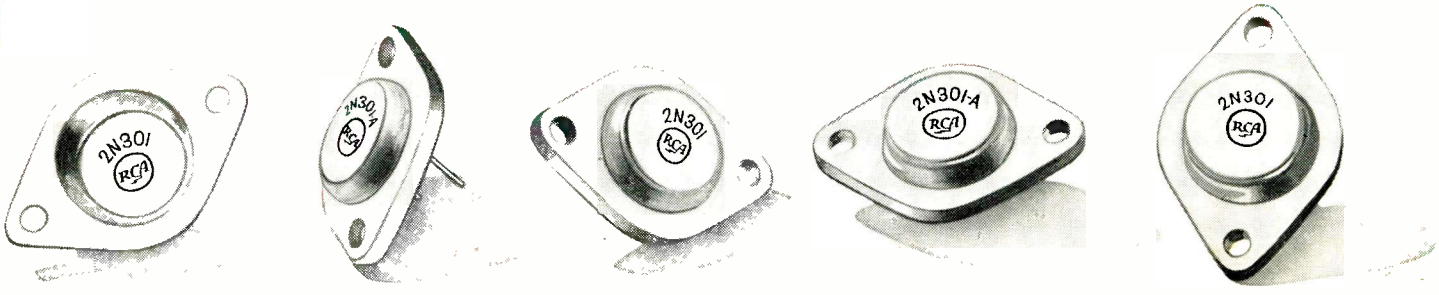

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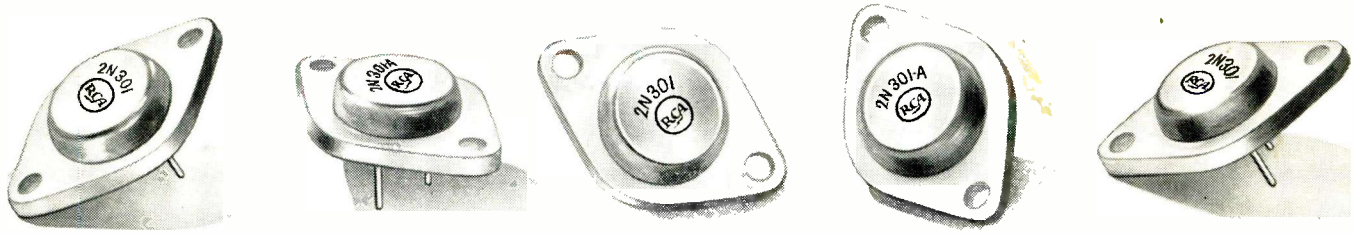

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