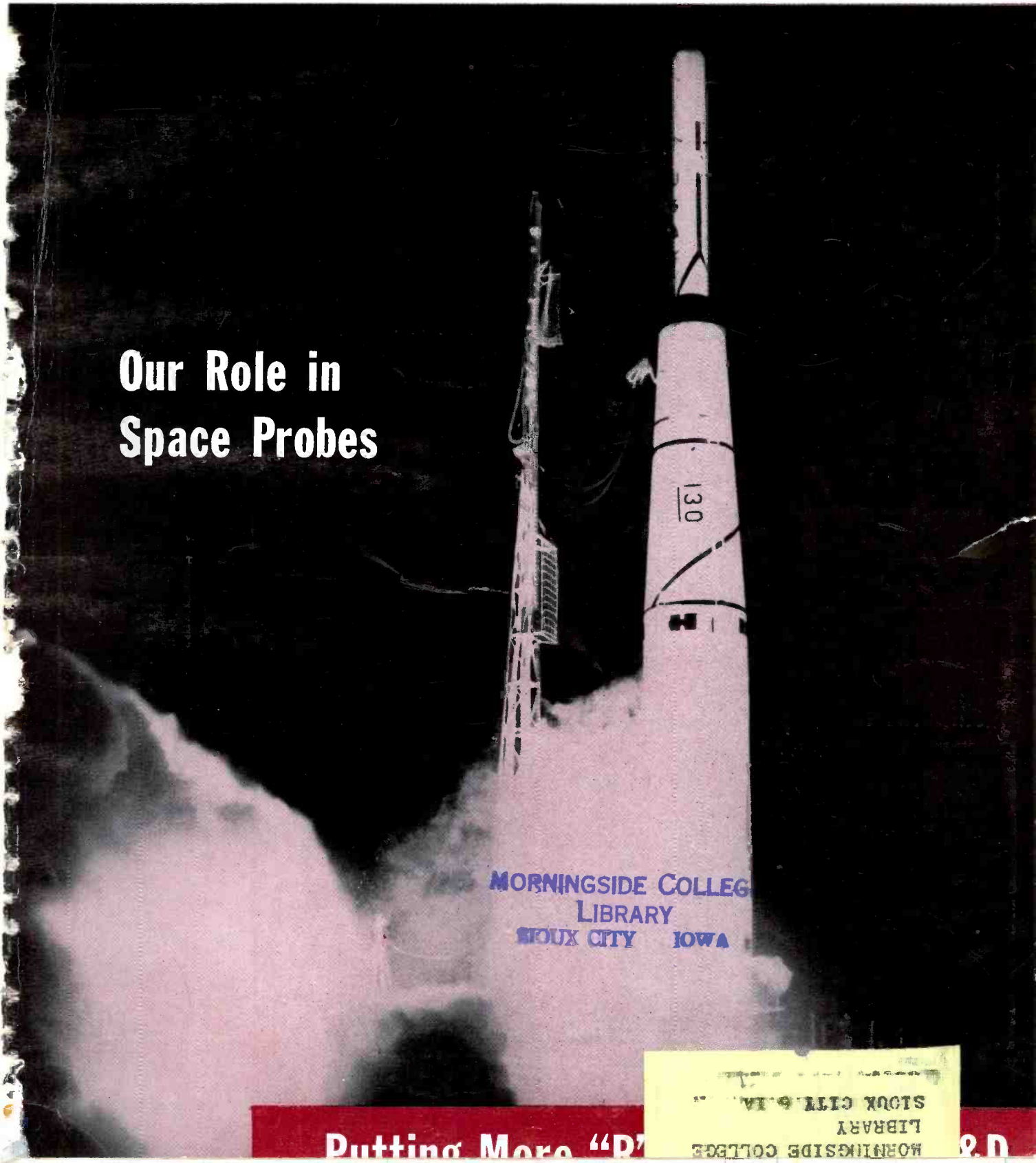
JUNE 19, 1959

electronics

A McGRAW-HILL PUBLICATION VOL. 32, No. 25 PRICE SEVENTY-FIVE CENTS



Putting More "P" ... & D

NEW
MINIATURIZED UNITS
FROM STOCK...

UTC has led the high Q coil and filter fields for over 25 years. Fresh examples of this leadership are represented in the UTC Minifilters and Miniductors described below. Though greatly miniaturized, the designs are conservative and will provide the exceptional reliability associated with all UTC products.

HPM and LPM case (MIL AG)
1 x 1 x 1⅜"
Weight .....2¼ oz.

BPM case (MIL AF)
¾ x ¾ x 1⅛".
Weight .....1 oz.

UTC MINIFILTERS

Hermetically sealed to MIL-T-27A and MIL-F-18327 Specs.

UTC stock interstage filters have been an industry standard for over a decade. The new UTC miniature filters provide almost the same characteristics in an extremely miniaturized package. Attenuation of these minifilters is only slightly less than their larger counterparts, as is operating level. Special minifilters can be supplied for any frequency above the minimum shown for each group. Straight pin terminals are provided for printed or standard circuits.

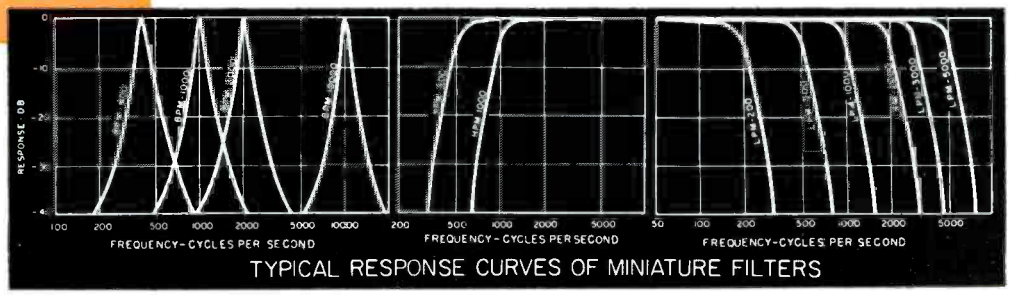
BPM units (band pass) have 2:1 gain. Attenuation is approximately 2 db ± 3% from center frequency, and 35 db per octave as shown. Input 10,000 ohms, output to grid, tapped for 10,000 ohms output to provide flexibility in transistor circuits.

HPM units (high pass) have a loss of less than 6 db at cutoff frequency, and an attenuation of 30 db at .67 cutoff frequency. Input and output 10,000 ohms.

LPM units (low pass) have a loss of less than 6 db at cutoff frequency, and an attenuation of 30 db at 1.5 cutoff frequency. Input and output 10,000 ohms.

STANDARD FILTERS STOCK FREQUENCIES

BPM—400	LPM—200
BPM—1000	LPM—500
BPM—2000	LPM—1000
BPM—10000	LPM—2000
HPM—500	LPM—3000
HPM—1000	LPM—5000

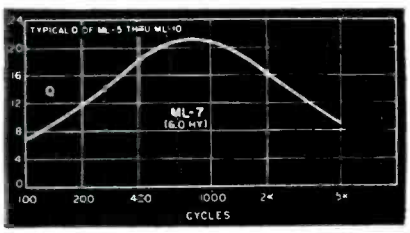


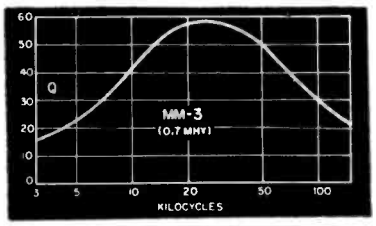
TYPICAL RESPONSE CURVES OF MINIATURE FILTERS

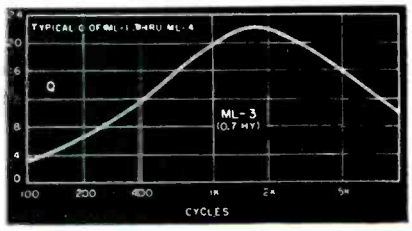
UTC MINIDUCTORS

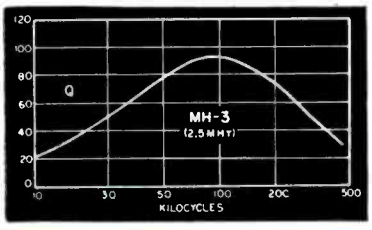
Hermetically sealed to MIL-T-27A Specs., MIL type TF5RX20YY

UTC Miniductors are ideal for transistor and printed circuit applications, providing high Q in miniature form. The ML-1 to 4 units are for medium low frequencies, adjusted to ± 3% at 1 V. 1 KC. The ML-5 thru 10 series are for lower frequencies, adjusted to ± 3% at 1 V. 400 cycles. The MM and MH units are for medium and high frequencies, adjusted to a tolerance of ± 2%. Temperature stability is excellent on all Miniductors, ± 1% from —55° C. to + 100° C. The ML group are in a Hipermalloy shield case . . . The MM and MH coils are symmetrical toroids . . . for high coupling attenuation and low hum pickup. The DCMA MAX. shown is for approximately 5% drop in inductance.









Type No.	Inductance (0 DC)	DC MA Max.
ML-1	.25 Hy.	9
ML-2	.4 Hy.	7
ML-3	.7 Hy.	5
ML-4	1.4 Hy.	3
ML-5	2.5 Hy.	1
ML-6	4.0 Hy.	.7
ML-7	6.0 Hy.	.6
ML-8	10 Hy.	.5
ML-9	25 Hy.	.3
ML-10	60 Hy.	.2
MM-1	3. Mhy.	50
MM-2	5. Mhy.	40
MM-3	8.0 Mhy.	30
MM-4	12.5 Mhy.	25
MH-1	.6 Mhy.	75
MH-2	1.5 Mhy.	37
MH-3	2.5 Mhy.	28
MH-4	6 Mhy.	23

ML CASE
1 3/32 x 1 3/32 x 5/16 high

MM, MH CASE
5/16 Dia. x ¼ high

ACTUAL SIZE

And Special Units to Your Specifications

UNITED TRANSFORMER CORPORATION
150 Varick Street, New York 13, N. Y.
PACIFIC MFG. DIVISION: 4008 W. JEFFERSON BLVD., LOS ANGELES 16, CALIF.
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electronics

JUNE 19, 1959

A McGRAW-HILL PUBLICATION
Vol. 32 No. 25

Issue at a Glance

Business

Engineering

Departments

Your customers will "Count their Blessings" when you give them built-in

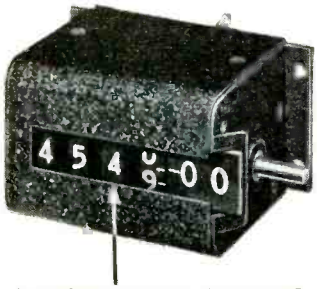
VEEDER-ROOT COUNTERS

They can count on getting all the performance you build into your product, when you build-in Veeder-Root Counters. For then they can:

- Get up-to-the-minute production records
- Get closer production *Count*rol
- See positive proof of your service guarantee
- See when maintenance is coming due
- Avoid costly errors, waste, shortages
- Get extra profits in resale of VR Counters

And what's more, built-in Veeder-Root Counters give you a new merchandising feature that builds up sales. Count on us to show you how. Write.

You always "Know the score" when you count on Veeder-Root!



UNCORRECTED READING

CORRECTED READING

NEW HIGH SPEED, DIRECT-READING COUNTER

can operate continuously at 6,000 rpm. It features a directly geared second wheel which reduces wear . . . also a means of providing an instantaneously corrected direct-reading in case the second wheel is not fully within the window.

Everyone can Count on VR®

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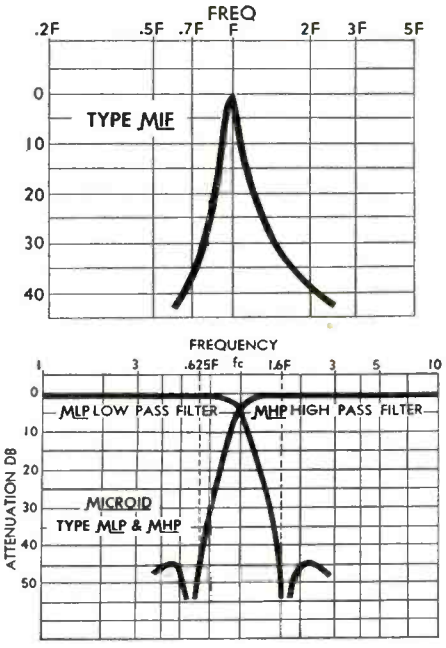
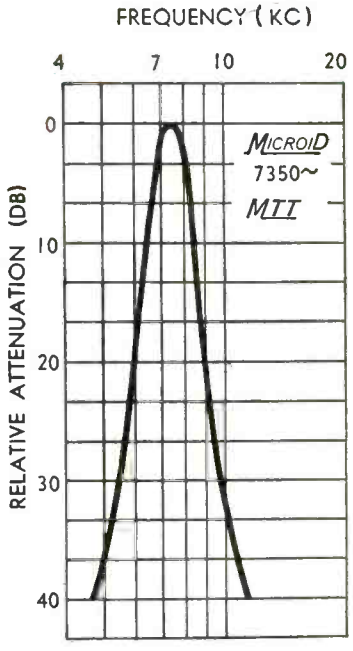
THE SHRINKING MAN'S FILTER

Although worlds apart in purpose, practitioners of the art of head shrinking and Burnell & Co. miniaturization engineers are both expert in reducing to size. For example, Burnell's new microminiature *MICROID* filters are particularly valuable in transistorized circuitry and only a step away from micromodule use. Range of the new Type *MTT* band pass filter is 7.35 kc to 100 kc, band width 15% at 3 db and +60% −40% at 40 db. Size is 1/2"x19/32"x15/16", weight .3 oz. Types *MLP* and *MHP* cover 5 kc to 100 kc with a standard impedance of 10K ohms. These are microminiature counterparts of the popular Burnell TCL and TCH low pass and band pass filters. The band pass filter results when cascading a TCL with TCH filter. Size is 3/4" x 1/2" x 1".

Type *MIF* microminiature interstage filters are designed for a wide variety of applications. Input impedance is 10K ohms, output to grid with a voltage gain of approximately 2:1. The 3 db band width is nominally 8%. Ranging from 7.5 kc to 100 kc, these interstage filters are provided in the same case as Type *MLP*.

Fully encapsulated, the new *MICROID* filters provide less weight, more reliability and exceed MIL specifications. We'll be glad to design and manufacture to your specifications in any quantity. Write for special filter bulletin to help solve your circuit problems.





Burnell & Co., Inc.

PIONEERS IN microminiaturization OF TOROIDS, FILTERS AND RELATED NETWORKS

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PELHAM, N. Y.
PELHAM 8-5000
TELETYPE PELHAM 3633

PACIFIC DIVISION
DEPT. E-21
720 MISSION ST.
SOUTH PASADENA, CAL.
RYAN 1-2841
TELETYPE: PASACAL 7578

electronics

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Member ABP and ABC

SHOPTALK . . . editorial

SPUTNIK REVISITED. On October 4, 1957, Earth got a new moon and the American public got a rude shock. The success of Sputnik I signaled that Soviet science was a force to be reckoned with and that U. S. science and engineering had better look to its laurels.

Now we have spent two years and untold billions to advance our technology and where are we? Our only operational intercontinental missile is a 600-mph air breather, many of our point-defense missiles are ready for the scrap heap with no adequate successor in production. And engineering college enrollments are down about 11 percent for next September.

There are observers who feel that our post-Sputnik whirl was full of sound and fury signifying nothing, that our research and development dollars bought precious little research and developed only more of the same tired old hardware.

Dean Watkins, Palo Alto educator and businessman, is not impressed by much of our R&D effort. He tells why in his article, "More R for Defense R&D?", beginning on p 32.

TROUBLE IN PARADISE. Electronics parts distributors are enjoying their best year but many see trouble on the horizon.

One worry is foreign-made electron tubes, principally Japanese. Right now, some distributors are getting a much higher markup on these items than on comparable domestic products. The situation is potentially dangerous. It's only a matter of time before some distributor, or group of distributors, starts off a price war.

The do-it-yourself tube-checking craze is growing to substantial proportions. And the paths by which tubes get to drugstore and supermarket shelves cause many a raised distributor eyebrow.

Midwestern Editor Harris got onto the trail of these and other stories at the recent Parts Show in Chicago. Some additional digging by Associate Editor Emma in New York helped wrap up the complete package. See p 42.

Coming In Our June 26 Issue . . .

INTEGRATED CIRCUITS. Some of the most exciting developments in our industry are in the field of microminiaturization. They're still young in concept, but apparently integrated semiconductor devices incorporating active and passive elements will someday handle many functions now performed by conventional circuits. Next week, RCA's J. T. Wallmark and S. M. Marcus describe some new devices with incredible packing densities of 10^6 parts per cubic foot.

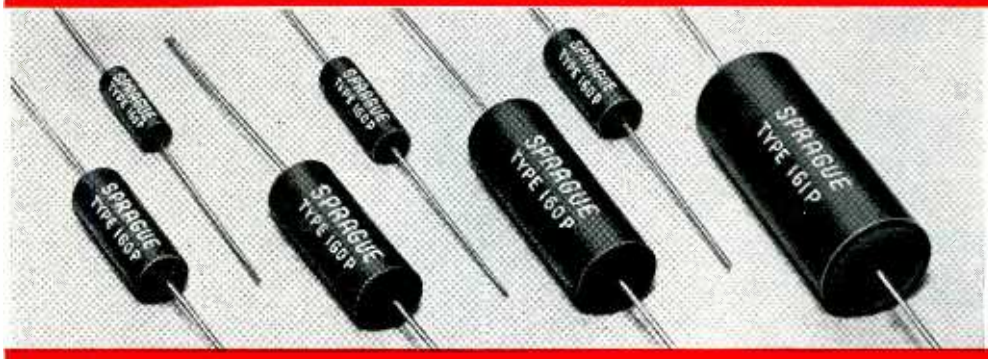
INFRARED VIDICON. Most infrared search equipment employs a single-cell infrared-sensitive detector. This requires a complex arrangement of motors, mirrors and cams to scan a given field of view. To increase sensitivity without increasing the amount of electrons involved many difficult problems must be solved. H. Dubner, J. Schwartz and S. Shapiro of Avion Division of ACF Industries describe techniques which utilize the vidicon principle.

RADIATION MONITOR. Use of radioactive isotopes as tracers in the petroleum industry often involves monitoring the radiation level of flowing liquids or gases over long periods of time. In many instances the environment imposes severe stress on the instrumentation. F. E. Armstrong and E. A. Pavelka of the Bureau of Mines in Bartlesville, Okla., have devised a battery-operated radiation monitor with provision for driving a 1-ma circular chart recorder under the adverse environmental conditions imposed by oil-field research.

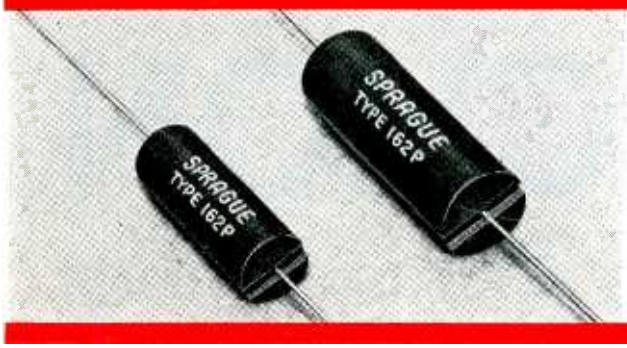
DIFILM® DUAL DIELECTRIC

gives new BLACK BEAUTY® series of small, low-cost capacitors outstanding performance characteristics

- withstand 105C operation with no voltage derating
- moderate capacitance change with temperature
- excellent retrace under temperature cycling
- superior long-term capacitance stability
- very high insulation resistance



NEW!... DIFILM Type 160P fully-molded case and Type 161P pre-molded case capacitors in 5/16" to 1" diameters for general commercial and entertainment electronics.



NEW!... DIFILM Type 162P slotted-base multi-purpose molded case capacitors for auto radios and other severe vibration applications. Slot prevents collection of moisture around leads when capacitor is end-mounted against chassis.

• New DIFILM Black Beauty Capacitors represent a basic advance in paper tubular capacitor design. DIFILM Capacitors combine the proven long life of paper capacitors with the effective moisture protection of plastic capacitors . . . by using a *dual dielectric of both cellulose and polyester film that's superior to all others for small, yet low cost, capacitors.*

• Just check the characteristics listed above. This overall performance is fully protected by HCX®, an exclusive Sprague hydrocarbon material which impregnates the windings, filling all voids and pinholes before it polymerizes. The result is a solid rock-hard capacitor section, further protected by an outer molding of humidity-resistant phenolic. *These capacitors are designed for operating temperatures ranging up to 105°C (221°F) . . . at high humidity levels . . . without voltage derating!*

For complete specifications on DIFILM Black Beauty Capacitors, write for Bulletin 2025 to Technical Literature Section, Sprague Electric Company, 35 Marshall Street, North Adams, Massachusetts.

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THE MARK OF RELIABILITY

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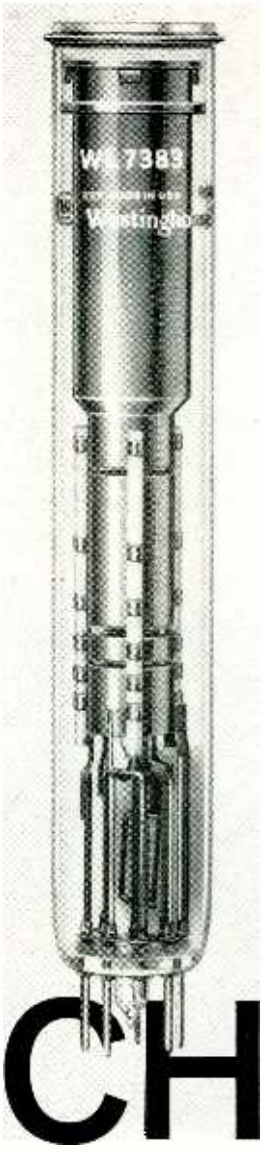
Westinghouse tube engineering...
serving the nation through imagination



THIS IS THE PERMACHON..

a new concept in storage tubes

The Permachon is a new class of tube which will store an image written optically or electrically, and will scan out many copies of that image. Stored resolution is extremely high for the size of target, and is not limited by storage mesh as in conventional storage tubes.

The WL-7383 1″ Permachon stores a resolution of 500 lines per diameter (by shrunken raster method) and eight shades of gray. It will operate in a standard vidicon camera. Optical images of vidicon quality can be stored and over 10,000 copies read out at 30 copies per second.

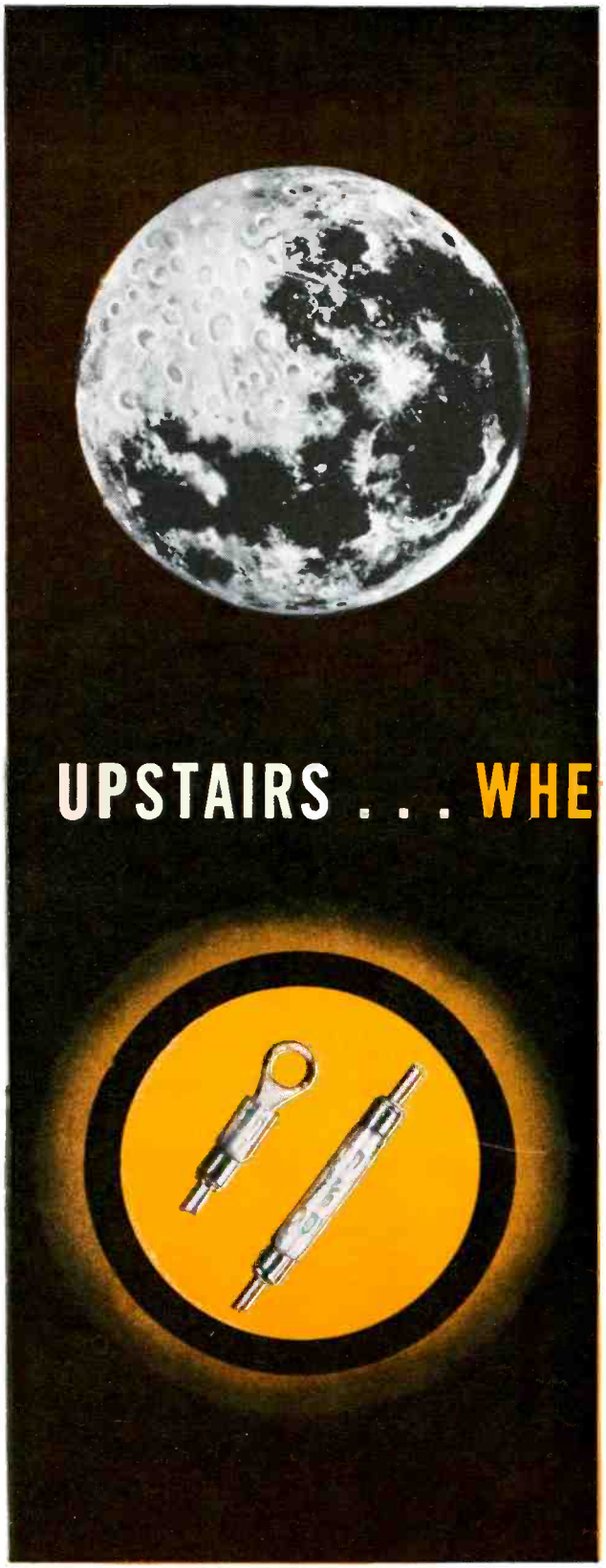
SAMPLE ORDERS INVITED. WRITE FOR DATA.

The WL-7411 3″ Permachon stores an image exceeding the resolution of the image orthicon, and eight shades of gray. It will operate with standard image orthicon components. Storage and readout are comparable to the WL-7383.

YOU CAN BE **SURE**...IF IT'S

Westinghouse

Electronic Tube Division Elmira, N.Y.



PROTECT AGAINST CORONA, HEAT AND ALTITUDE . . .

AMP's new Post Insulated Stratotherm Terminals and Splices are designed for gruelling circuit environments "upstairs." Post Insulated Stratotherm overcomes difficult heat and high altitude problems confronting aircraft and missile engineering . . . combine the outstanding electrical performance of compression crimping with the new insulating qualities of sealed Teflon* sleeves which deter corona effects and moisture entrapment in a wide temperature range.

UPSTAIRS . . . WHEN THE HEAT'S ON

OUTSTANDING FEATURES:

- temperatures as high as 500°F
- fits varying insulation diameters in a wire size range from #22 through #10 AWG
- crimped insulation ring seals termination point against corona and moisture
- high flex and impact strength
- crimp attachment by either A-MP portable power tool or manually operated A-MP hand tool

*Du Pont Trademark

Complete technical data available on request.

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Select here the VOLTMETERS, AMMETERS, Many are

AC

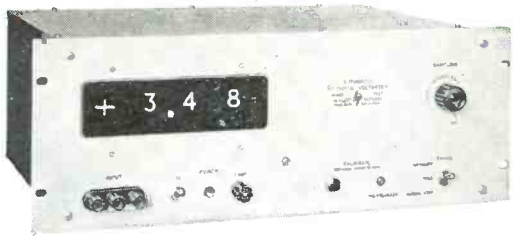
NEW!

hp 403A Transistor ac Voltmeter—1 cps to 1 MC

Battery-operated, weighing less than 5 pounds and small enough to hold in your hand—this new transistor ac voltmeter measures 100 μv to 300 v (max. full scale sensitivity 1 mv) over frequencies 1 cps to 1 MC! Twelve voltage ranges; also reads direct in db from —12 to +2 db. 400 hour battery life equals 6 months of average use; battery voltage may be checked by front panel switch. Noise less than 50 μv. Completely isolated from power line or ground interference. Average reading meter minimizes turnover and waveform errors. Accuracy ±3% to 500 KC, ±5% to 1 MC. Input impedance 2 megohms; generous 600 v overload capacity on higher ranges, 25 v maximum on lower ranges. $250.00.

All of these widely useful -hp- instruments are available in rack-mounted -hp- voltmeter accessories—voltage dividers, coaxial connectors, voltage

DC



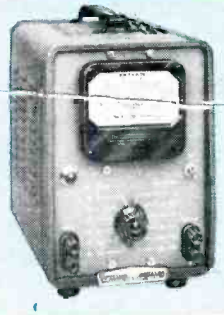
NEW!

hp 405AR Digital Voltmeter
Automatic range, polarity

Here's true "touch-and-read" measuring simplicity. Automatic range, polarity selection; covers 0.001 v to 1,000 v. (Accuracy ±0.2% of reading ± 1 count). New, unique circuitry provides a stability of readings virtually eliminating fatiguing jitter in the last digit. Floating input, multi-electronic code output for use with digital recorders. Uses electronic computing circuits to insure low maintenance, trouble-free operation. Just 7" high! $825.00.

Complete array of ac and dc measuring equipment

versatile, precision
OHMMETERS you need.
multi-purpose!

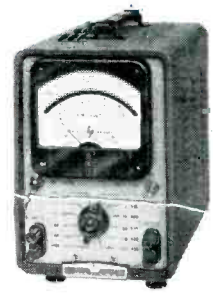


hp 400D
10 cps to 4 MC

Regarded by many as finest ac VTVM ever built. Covers all frequencies 10 cps to 4 MC, extremely sensitive, wide range, accurate within 2% to 1 MC. Measures 0.1 mv to 300 v (max. full scale sensitivity 1 mv), 12 ranges. Direct reading in v, db. 10 megohm input impedance with 15 $\mu\mu$f shunt insures negligible loading to circuits under test. $225.00.

hp 400L
Log VTVM—10 cps to 4 MC

Covering 10 cps to 4 MC, this new hp VTVM features a true logarithmic scale 5" long plus a 12 db linear scale. The log voltage scale plus long scale length provides a voltmeter of maximum readability, with accuracy a constant percentage of the reading. Accuracy is ±2% of reading or ±1% of full scale, whichever is more accurate, to 500 KC, ±5% full range. Range 0.3 mv to 300 v, 12 steps, (max. full scale sensitivity 1 mv). $325.00.



hp 400H
1% accuracy VTVM

Here's extreme accuracy of 1% in a precision VTVM covering 10 cps to 4 MC. Big 5" meter has exact-reading mirror-scale, measures voltages 0.1 mv to 300 v (max. full scale sensitivity 1 mv). 10 megohm resistance with 15 $\mu\mu$f shunt minimizes circuit loading. Amplifier with 56 db feedback insures lasting stability. $325.00.

hp 410B
ac to 700 MC, also dc

Time-tested standard all-purpose voltmeter. Covers 20 cps to 700 MC, full scale readings 1 to 300 v. Input capacity 1.5 $\mu\mu$f, input resistance 10 megohms. Also serves as dc VTVM with 122 megohms input impedance, or ohmmeter for measurements 0.2 ohms to 500 megohms. $245.00.

models! Also, inquire about multipliers and shunt resistors..

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1004A Page Mill Road • Palo Alto, California, U.S.A.
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Field representatives in all principal areas

5489

NEW!
hp 412A Precision
Volt-Ohm-Ammeter

At last a true, precision multi-purpose instrument. Measures dc voltage 100 μv to 1,000 v (max. full scale sensitivity 1 mv), 1% accuracy full scale. Measure currents 1 μa to 1 amp with ±2% accuracy full scale. 13 ranges. As ohmmeter measures 0.02 ohms to 5,000 megohms. Extremely low noise, drift. Recorder output provides 1 v full scale. $350.00.

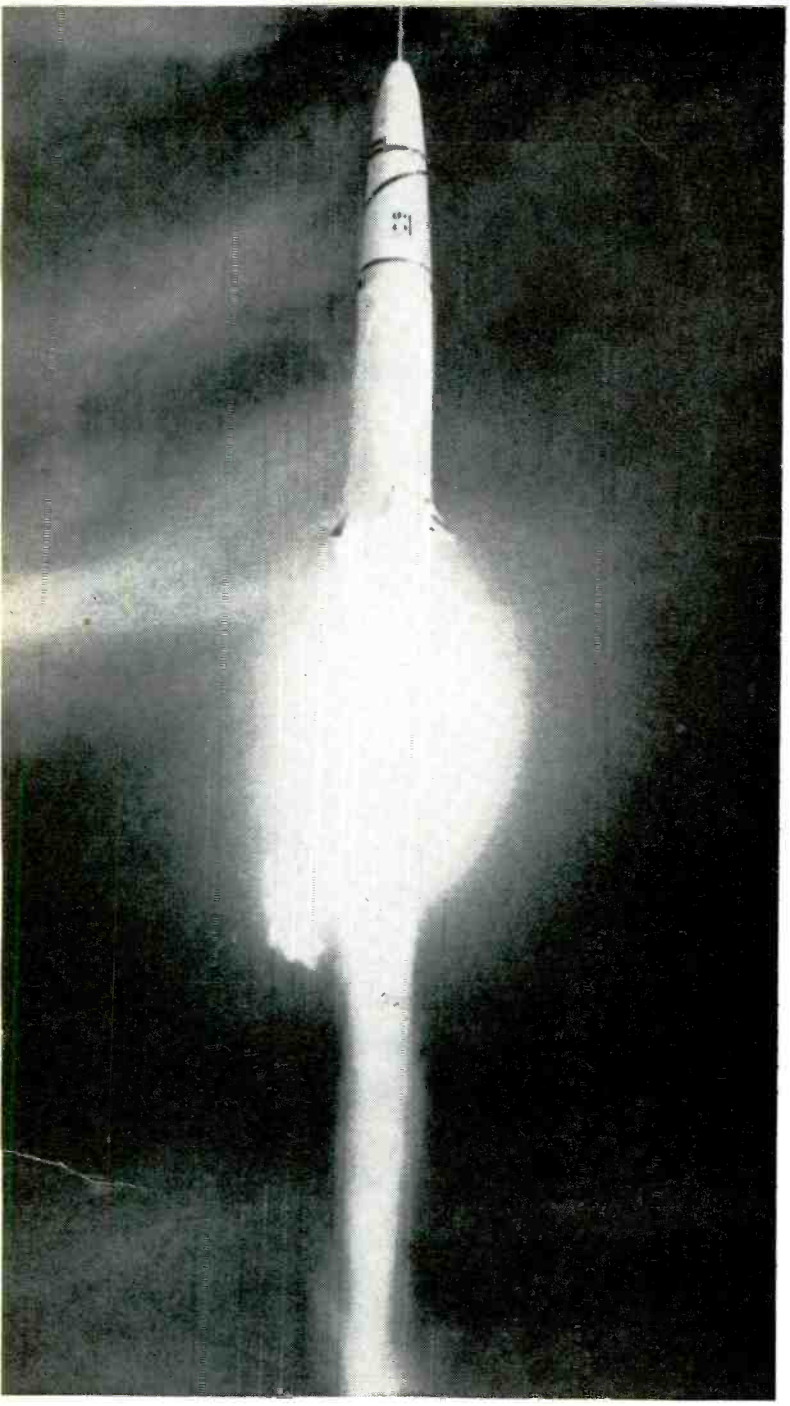
NEW!
hp 425A Microvolt-
Micromicroammeter

New, high sensitivity, high stability instrument reading end scale voltages of 10 μv to 1 v in 11 ranges, or currents of 10 $\mu\mu$a to 3 ma in 18 step, 1-3-10 sequence. Accuracy ±3% on all ranges. Drift less than 2 μv under all conditions; very much less under lab conditions. Input impedance 1 megohm ±3% on all ranges. Also usable as 100 db amplifier with up to 1 v output from signals as small as 10 μv. $500.00.

NEW!
hp 428A
Clip-On Milliammeter

Employs radical new approach to current measurement which eliminates breaking leads, soldering connections or loading of circuit under test. Revolutionary "current sensing" probe clips around wire under test, measures the magnetic field around the lead. Easily measures dc current in presence of strong ac. Covers 0.3 ma to 1 amp in 6 steps; full scale sensitivity 3 ma. Accuracy ±3%, probe inductance less than 0.5 μh. $475.00.

—unique value, traditional -*hp*- dependability



EIMAC CERAMIC-METAL REFLEX KLYSTRONS FOR SEVERE ENVIRONMENT APPLICATIONS

In modern airborne and missile systems, reflex klystrons must be capable of maintaining exceptional frequency stability under conditions of severe shock, vibration and acceleration. Eimac's new ruggedized X- and K-Band reflex klystrons achieve this stability through an advanced system of stacked-ceramic construction and integral brazed 'dual-cavity' design.

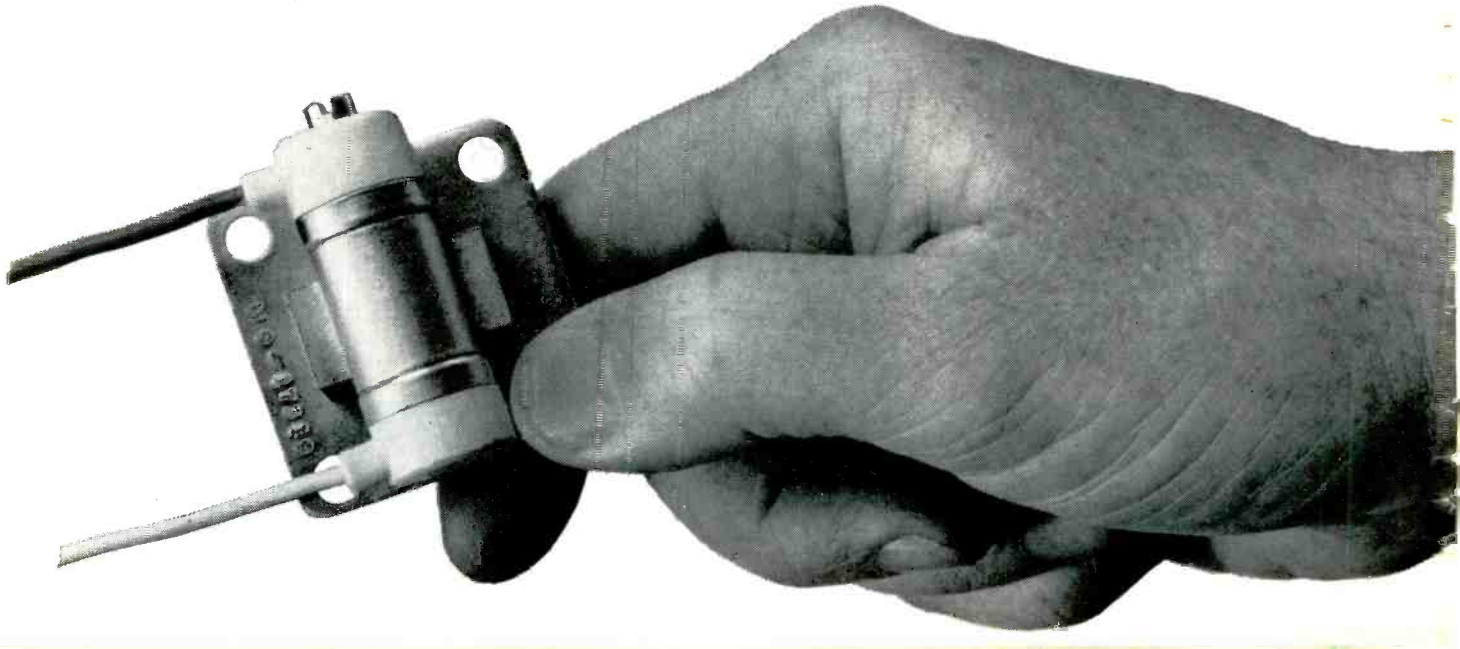
Ceramic construction permits internal electrodes to be supported on rigid concentric cones and allows the entire vacuum assembly to be furnace-brazed into a single rugged structure. The resonant cavity design consists of a fixed-tuned (and hence rugged) inner cavity closely coupled through a ceramic window to a secondary tunable cavity outside the vacuum envelope. The external cavity is tuned by means of a capacitive slug over a minimum range of 700 megacycles per tube.

This advanced design has resulted in a series of four exceptionally stable reflex klystrons covering the 8500 to 11,500 megacycle range at a typical output power level of 75 milliwatts. At vibration levels of 15 to 20G the peak-to-peak deviation of these tubes is less than 50 kilocycles for any vibrating frequency from 20 to 2000 cycles per second, with the force applied in any plane of the tube. The advantage of this low FM noise level in local oscillator service is obvious. Ceramic construction and the superior tube manufacturing techniques it makes possible permit tube or seal temperatures of 250°C without impairment of operation.

For severe environment microwave applications investigate the advantages of Eimac ceramic-metal reflex klystrons.

Eimac

EITEL-McCULLOUGH, INC.
San Carlos, California



ELECTRONICS NEWSLETTER

SUBMARINE DETECTION SYSTEM for Navy planes has been developed by Loral Electronics, Bronx, New York. The system gives the pilot a visual presentation of his position relative to the sub's position. Submarine movement data is obtained by detection devices inside and outside the aircraft and fed to a fully transistorized plotter in the cockpit. Meanwhile, a navigation system feeds the aircraft's track to the plotter, which then shows direction and distance between plane and sub. Loral's contracts for plotters, navigation gear and display systems amount to $32 million. Production contract for an integrated display system for $5 million may be announced soon.

ASH, a snifter detector that reacts to diesel fumes, will enable Navy patrol craft to literally smell out enemy subs. JEZEBEL extra-long-range sonar is another airborne device. ASW planes will also carry radar, low-light-level tv, sonobuoys, infrared and microwave receivers.

LONGEST ONE-HOP SSB TROPO SCATTER communications system, some 600 miles across water from Baffin Island to Greenland, will use up-converter type varactor diode parametric amplifiers for receiver improvement. System under construction for TTY and voice communication is part of DEW-Line extension called DEW-East (ELECTRONICS, p 11, June 5). Tests on Air Force prototype, spanning 640 mi from Lincoln Lab's Millstone Hill, Mass., site to Sauratown Mountain, N. C., showed paramp gave average improvement of 2 db over original design, allowed tuning over 100 mc bandwidth. GE is shooting for December '59 delivery of first production models to Far North.

NAVY'S EAGLE AIR-TO-AIR MISSILE for fleet defense indicates the trend to a greater electronics portion of total missile cost. About 75 percent of Eagle's cost will go for its guidance and a seeker system developed by Sanders Associates, which aims to counteract increasingly effective countermeasures. Bendix Aviation is prime contractor for the third generation missile; its forebears were Lark and Sparrow.

PACKAGED TUNABLE L-BAND MASER SYSTEM has been developed for field use by the military in very-long-range detection. It has been operated over an 850 to 2,000 mc range. Airborne Instruments Laboratory says a tuning range of at least two octaves can be achieved. Low-loss L-band circulator developed for the system by AIL determines usable tuning range. Voltage-gain bandwidth product of 37.5 mc was measured at 1,750 mc, for a temperature of 1.5 K; at 4.2 K, a product of 20 mc was measured. Package is 38 in. wide, 6 ft high. Liquid helium supply can operate 16 to 18 hours. Relay-actuated light warns when refill is needed.

NATO EARLY WARNING RADAR contracts totaling $19.5 million have been awarded to Britain's Marconi Co. and the French Compagnie Generale de Telegraphie sans Fils. The two had announced in October 1957 that they would collaborate in preparing proposals for NATO radar equipment. Besides the supply and installation of gear at all stations in the early warning chain, the two companies will also train personnel and aid in maintenance of the stations. Of the contract total, Marconi gets about $14 million, CSF the rest.

RADAR FOR BMEWS (Ballistic Missile Early Warning System) in the Far North will be inspected and checked out in a full-scale dome-shaped working model of part of a BMEWS installation under construction in Moorestown, N. J. RCA, the weapon systems contractor, says the base of the 15-story high structure will contain high-power transmitting gear and high-speed conputers for calculating speed and direction of approaching ballistic missiles. Six-sided, 140-ft diameter plastic radome will contain an antenna for target tracking.

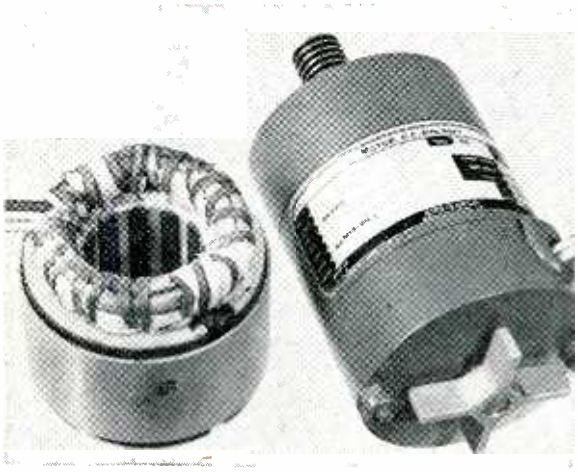
Navy has named Sperry Gyroscope as navigation systems manager for the new 608-class Polaris, with authority to design, draw up specs, integrate, deliver, install and to buy gear from other firms. At the same time, Sylvania received a prime contract for development of communications systems for the Polaris program. Both contracts were called in the "multimillion dollar" category.

TITAN ELECTRONIC SENSOR that detects the presence of liquids, and any change from liquid to gas, will be produced by Bendix Aviation's Pioneer-Central division under contract from Martin-Denver. Unit consists of a light switch with light source, optical prism, solar cell, miniaturized transistor amplifier and a relay. Device is used as a liquid flow control signal for missile ground support equipment.

B-70 INSTRUMENT SYSTEM for in-flight monitoring of high-thrust engines will be manufactured by John Oster Manufacturing Co.'s Avionics division, Racine, Wis., under a subsystem contract from North American Aviation. System is said to provide the pilot with instantaneous and constant visual checks on the performance of all six of the B-70's jet power plants.

F-101B WEAPON SYSTEM SIMULATORS will be built by Melpar Inc. under a $7-million contract just awarded by the Air Force. Prototype has already been shipped to Otis AFB, Mass. The subsidiary of Westinghouse Air Brake will also perform installation and maintenance.

Dow Corning Silicone Dielectrics

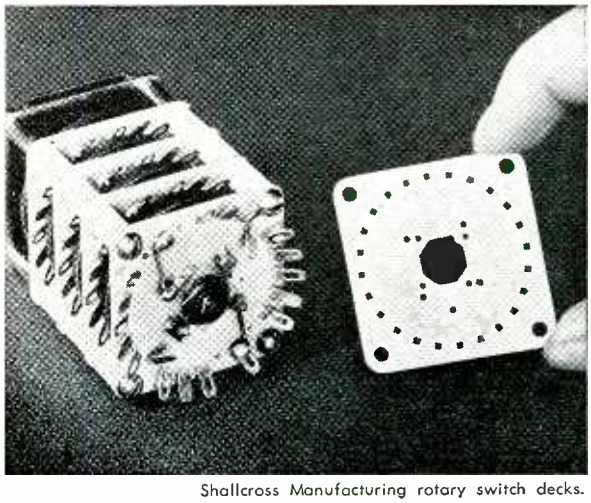


AiResearch miniature motor combines Sylkyd wire and silicone varnish.

REDUCE SIZE, WEIGHT WITH SILICONE INSULATING MATERIALS

Specify Sylkyd® enameled magnet wire to help reduce the size and weight of transformers, servo motors, and other devices by as much as 50%. Equal in diameter to Class A magnet wires, it serves at 180 C . . . withstands the higher temperatures of miniaturization. Impregnated with Dow Corning 997 Varnish, Sylkyd enameled magnet wire and other silicone insulating components are bonded into moisture resistant insulation systems having high dielectric strength, maximum reliability over a wide range of temperatures and environmental conditions. Write for new, illustrated brochure.

CIRCLE 197 READER'S SERVICE CARD



Shallcross Manufacturing rotary switch decks.

SILICONE-GLASS LAMINATES RESIST CONTINUOUS 250 C HEAT

Laminates made of glass cloth bonded with Dow Corning silicone resins provide heat-stable structural and insulating materials . . . withstand soldering heat during assembly of electronic equipment . . . resist continuous exposure to temperatures up to 250 C. Silicone-glass laminates resist moisture, arcing, corona. They are lightweight, strong, rigid . . . supplied in many shapes and forms by leading laminators.

CIRCLE 198 READER'S SERVICE CARD

SILASTIC ENCAPSULATION ABSORBS VIBRATION, SHOCK

Sensitive electronic parts withstand vibration and shock longer when encapsulated with Silastic®, the Dow Corning silicone rubber. That's because Silastic retains all its superior properties on aging. Silastic has low moisture absorption, stays resilient over a wide temperature range . . . is easy to apply. Available in many forms, including molded parts, extrusions, tapes, sheets and pastes.

CIRCLE 199 READER'S SERVICE CARD

Electronic tube encapsulated with Silastic.

WASHINGTON OUTLOOK

THE AIR FORCE plans to clamp new controls on procurement contract pricing in reaction to charges of "overpricing" in recent procurement.

New controls will mean tighter verification by contracting officers of price proposals and cost estimates submitted by contractors. The Air Force is also expected to take a more active role in price negotiations between prime and subcontractors.

The General Accounting Office had charged that "deficiencies" in Air Force contracting have resulted in the "negotiation of unreasonably high prices." In a special report to Congress, GAO cited 14 individual cases with total "over-charges" of $30 million, recommended that the Air Force tighten up control over cost estimates made by contractors.

● **The publicity generated** by GAO's charges has ruled out any chance for Congressional liberalization of the Renegotiation Act. The proposed four-year extension of the law, already passed by the House, does not include the exemption for incentive-type contracts sought by defense producers.

The extension does include a token provision, however, directing the Renegotiation Board to take into account as a factor in determining "excessive" profits the type of procurement contract involved. The House-approved bill also makes it easier for contracts to appeal Renegotiation Board decisions.

There had been talk about a Senate drive to insert the incentive-contract exemption. Now, with all the allegations of overcharging on defense contracts, it's likely that efforts will be made to tack new restrictions on to the law.

President Eisenhower, who recently referred to the "munitions lobby," is peeved by the political pressures which are increasingly brought to bear in military decisions. He's concerned that factors other than purely military considerations are playing a part in the selection of contractors, the scheduling of weapon projects, and the like.

On a similar tack, Congress will shortly begin a probe into the increasing employment of retired senior military officers by defense contractors for executive slots. There are many statutes and Pentagon rules which now restrict the role of such people in the negotiation of military contracts.

But now a House Committee plans to go over the problem, to see whether the restrictions are being observed and whether "conflicts of interest" exist.

All this adds up to a new Washington climate more antagonistic to the interests of military contractors than ever. The upshot will be a resurgence of Congressional efforts to keep closer tabs on defense profits and to push for tighter policing by the Pentagon of all rules governing defense contractor operations.

● **We are far ahead** of the Russians in electronics, says James M. Bridges, director of electronics, Office of the Director of Defense Research and Engineering. "And with continuing work," adds Bridges, "we'll stay in the lead."

He spoke at the Armed Forces Communications and Electronics Association's 1959 convention here recently. More than 130 exhibits and displays were featured at the three-day gathering. Attendance totaled 3,800, almost 1,000 more than last year.

"No man can improve an original invention..."

—William Blake

THERE are many scientists today who would argue this point with Blake.

At Bell Telephone Laboratories, for example, we have seen original inventions improved and re-improved countless times, the better to serve mankind.

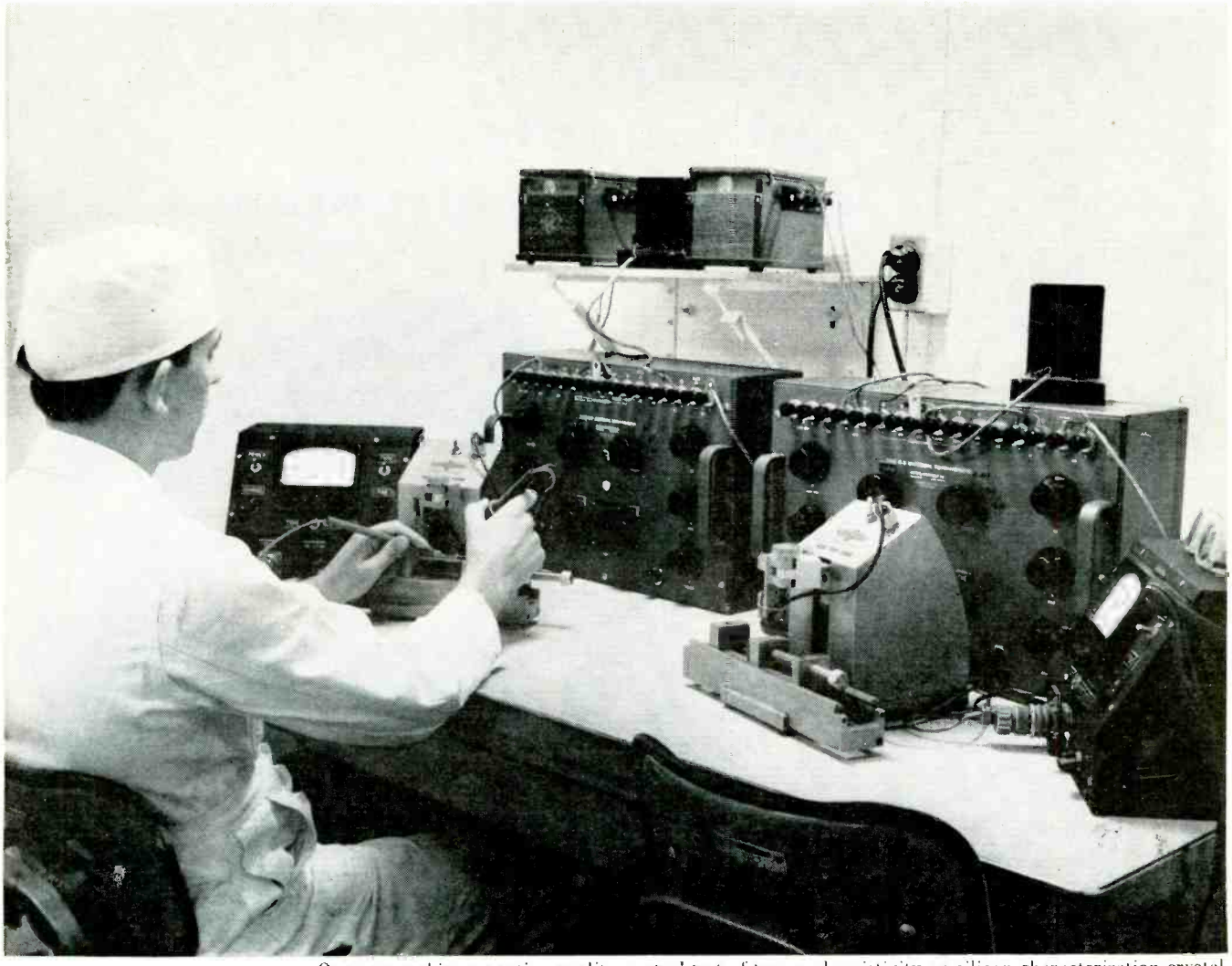
But William Blake went on to say "... nor can an original invention exist without execution organized, delineated and articulated." Here Blake expressed ideas that apply with striking emphasis today. At Bell Laboratories organized effort is constantly aimed at fostering an environment in which inventions can exist and prosper, where they can be expressed either as ideas or in physical form, and where clear understanding of their principles can be achieved.

By helping scientists and engineers to reach for the things they seek, by organizing and coordinating their efforts, Bell Laboratories has made important contributions to the art of communications: proof of the wave nature of the electron, first research in radio astronomy, discovery of the transistor principle, invention of the feedback amplifier. Such ventures into the unknown have twice brought the Nobel Prize to Bell Laboratories scientists, and at the same time have helped create the most efficient and versatile telephone system ever known.

William Blake (1757-1827), a versatile genius, was famous for brilliant, sometimes prophetic, insights which he expressed with provocative beauty in drawing, painting, poetry and prose.

BELL TELEPHONE LABORATORIES

WORLD CENTER OF COMMUNICATIONS RESEARCH AND DEVELOPMENT



Operator making a routine quality control test of type and resistivity on silicon characterization crystal.

Round-the-clock operations at new Du Pont plant assure you of ample supplies of Hyperpure Silicon

Du Pont's new Brevard, N. C., HYPERPURE Silicon plant—with a 70,000 lbs./yr. capacity—is now operating at high production rate to assure you of a prompt supply of high-purity silicon in the form, grade and quantity you need. Du Pont is uniquely qualified to serve you because of its experience as pioneer producer of semiconductor grades of silicon. This experience includes installing the first full-scale commercial silicon plant in the world and frequent expansion of productive facilities since then.

Single crystals of Du Pont HYPERPURE Silicon are now available in a wide range of resistivities, thanks to Du Pont's new research and manufacturing techniques. Each has a specially prepared "spec. sheet."

Here's more news: Du Pont recently completed a $3,000,000 Technical Service Laboratory specifically designed, equipped and staffed to handle customer problems. Here, highly trained Du Pont Technical Specialists are available to discuss any difficulties in crystal growing or manufacture you may encounter.

Du Pont HYPERPURE Silicon is also available in densified cut rods . . . and rods specially designed for float-zone refining in Grades 1, 2 and 3, with carefully controlled purity levels. As an additional service, Du Pont offers doping material at no additional cost.

Free booklet is available upon request. It describes the manufacture, properties and uses of HYPERPURE Silicon. E. I. du Pont de Nemours & Co. (Inc.), Pigments Dept., Silicon Development Group, Wilmington 98, Delaware.

HYPERPURE SILICON

DU PONT
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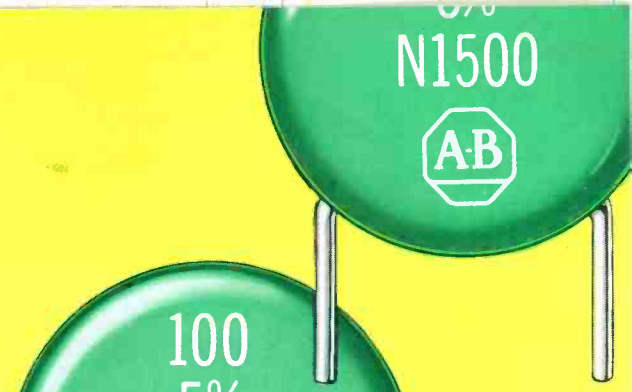
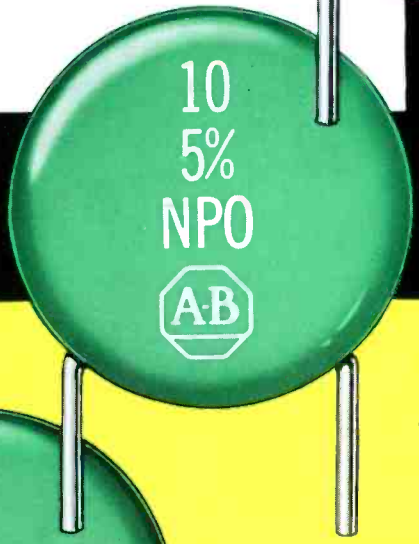
BETTER THINGS FOR BETTER LIVING
. . . THROUGH CHEMISTRY

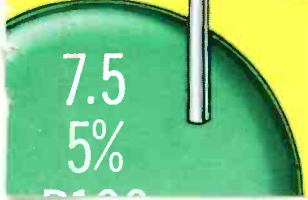
CIRCLE NO. 17 READER SERVICE CARD→

The beauty of this Capacitor is more than skin deep!

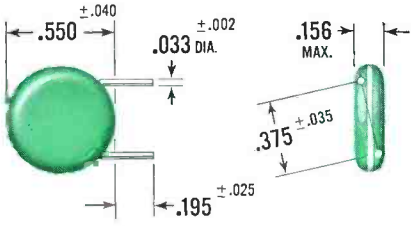


A-B QUALITY





ACTUAL SIZE TYPE A CAPACITORS



Allen-Bradley Type A capacitors are available in the most frequently used types and capacitance values.

General Purpose Type in capacitance values fram 10 mmf to .01 mmf.

Stable Type in capacitance values from 10 mmf to 0.1 mmf.

Temperature Compensating Type in characteristics fram N4700 to P100, and in capacitance values from 10 mmf to 510 mmf.

Type A Capacitor...

One size for all values...

Designed for high speed assembly

Compare the attractive Allen-Bradley Type A ceramic capacitors with all the rest... you'll see instantly why more and more engineers are specifying them and will not accept substitutes —because there aren't any! The exclusive "Auto-Coat" process makes possible—for the first time—a capacitor of real beauty, precise physical uniformity, plus consistent and reliable quality and performance.

The smooth, tough insulating coating and the inherent mechanical uniformity of Type A capacitors permit easy hand or accurate automatic insertion on printed boards. Also, the "Auto-Coat" process prevents rundown on leads—costly wire cleaning and crimping to prevent soldering failures are unnecessary.

For full information on the *superior* physical and electrical properties of A-B Type A capacitors, send for Technical Bulletin 5401.

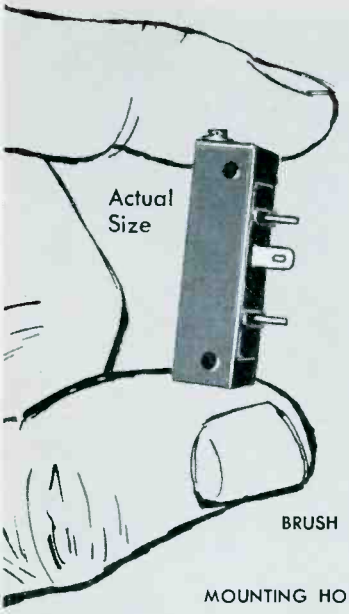
ALLEN-BRADLEY

MEMBER OF EIA

Quality Electronic Components

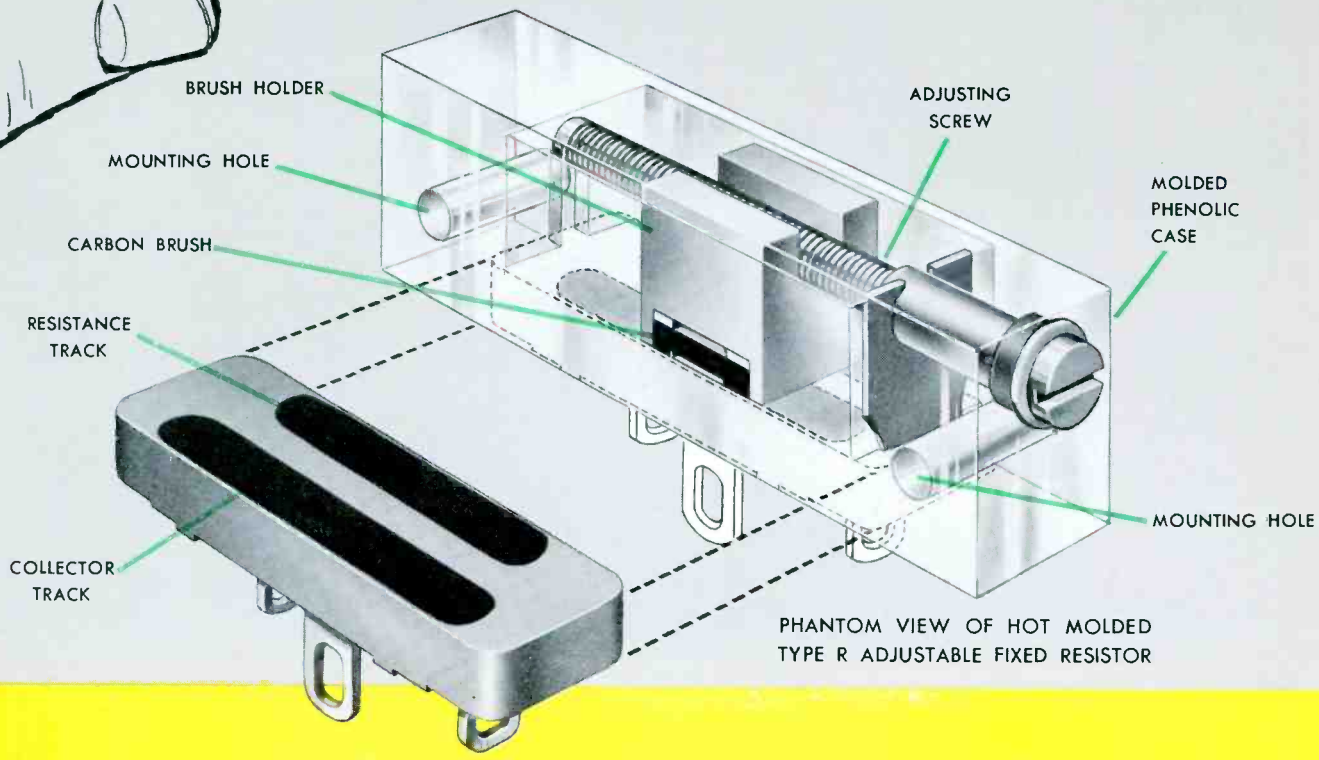
Allen-Bradley Co., 222 W. Greenfield Ave., Milwaukee 4, Wis.
In Canada: Allen-Bradley Canada Ltd., Galt, Ont.

4-59-E



NEW ALLEN-BRADLEY

Adjustable Fixed Resistor



PHANTOM VIEW OF HOT MOLDED TYPE R ADJUSTABLE FIXED RESISTOR

Exclusive hot molded dual track resistance element and carbon brush give unmatched reliability and long life

SPECIFICATIONS

Power Rating: ¼ watt at 70°C ambient

Voltage Rating: 350 volts maximum

Temperature Range: −55°C to 120°C

Resistance Range: total resistance values from 100 ohms to 2.5 megohms ±10% or ±20%

Adjustment: approximately 25 turns

Dimensions: approximately 1¼" x 21/64" x ¼"

Terminals: lug and pin type terminals on 0.1" grid system and are gold plated for ease of soldering.

Here's a new, compact, adjustable fixed resistor—the Type R—with Allen-Bradley's exclusive hot molded resistance element. It's the same type resistance element used in the popular Type J and Type G units . . . which have proved unequaled for reliability and long life. Operation is exceptionally smooth—no abrupt resistance changes occur with adjustment. The molded case of the Type R adjustable fixed resistor is watertight and dust-tight. The mounting for the moving element is self-locking to assure stable setting—and the entire unit can be "potted" after adjusting. The adjustment screw has a "free wheeling" clutch to prevent damage.

Send for complete information on this latest addition to the Allen-Bradley line of *quality* potentiometers.

Allen-Bradley Co., 222 W. Greenfield Ave., Milwaukee 4, Wis.
In Canada: Allen-Bradley Canada Ltd., Galt, Ont.

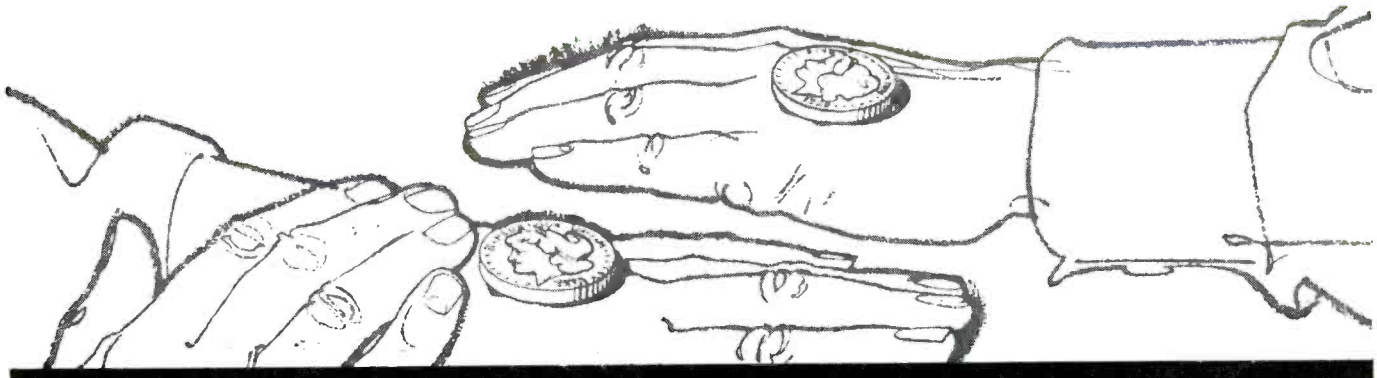
A-B QUALITY

ALLEN-BRADLEY

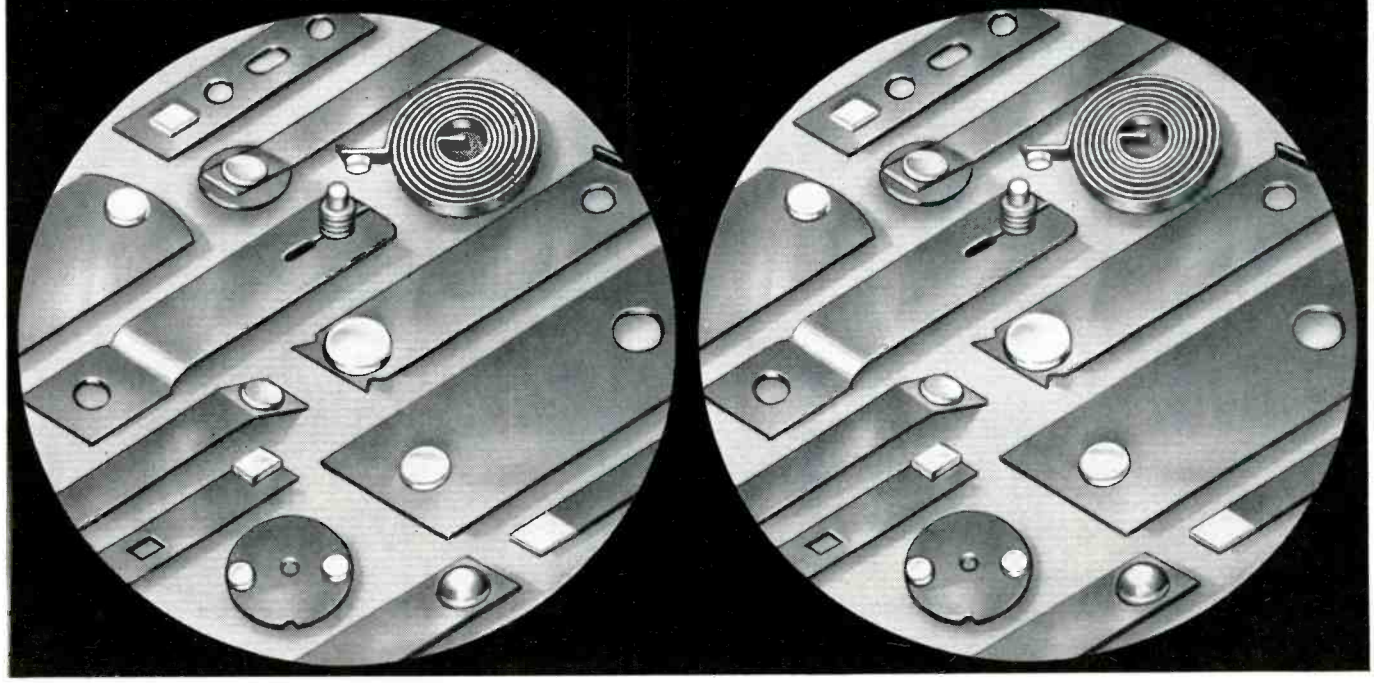
QUALITY

ELECTRONIC COMPONENTS

4-59-E



MATCHED



General Plate Guarantees the Performance You Specify with Matched Truflex® Thermostat Metal and Electrical Contact ASSEMBLIES

Here are advantages that are hard to duplicate. *First* . . . clad electrical contacts in any shape or form. *Next* . . . 60 types of Truflex thermostat metal (resistivity from 15 to 850 ohms per c.m.f.) to meet every requirement.

But most important at General Plate complete units are fabricated according to your specifications. Shipped to you ready for application in your product, these assemblies eliminate your fabricating headaches. Experimental and assembly adjustment costs are crossed from your books. You save money, time, worry and trouble.

Design engineers are invited to make use of General Plate contact and thermostat metal engineering services . . . for materials selection . . . parts design . . . samples. Send us a drawing of one of your bimetal-contact parts and let us show you how General Plate Truflex Thermostat Metal and Electrical Contact assemblies can be put to work for you Write:

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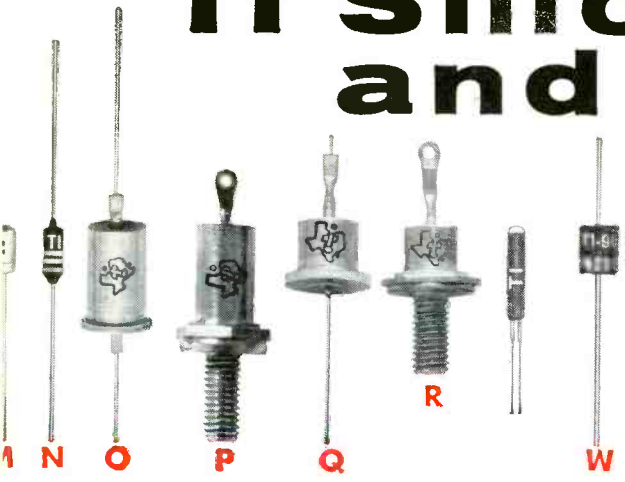
←CIRCLE NO. 18 READER SERVICE CARD

CIRCLE NO. 19 READER SERVICE CARD

or reliable performance . . .

TI Silicon Diodes and Rectifiers



POWER REGULATORS AND DOUBLE ANODE CLIPPERS

Available with either anode or cathode to stud

Type	Case Type	Zener Voltage @25°C	I_z ma	Power Diss @60°C w	Reverse Current I_{Lb} 25°C μa @ −5v	@ −10v	max Z_z @25°C @I_z ohms	Typ Temp Coef %/°C
1N1816	R	13	500	10	25	—	2	0.07
1N1817	R	15	500	10	15	—	2	0.07
1N1818	R	16	500	10	10	—	3	0.07
1N1819	R	18	500	10	10	—	3	0.07
1N1820	R	20	250	10	—	10	3	0.08
1N1821	R	22	250	10	—	10	3	0.08
1N1822	R	24	250	10	—	10	3	0.08
1N1823	R	27	250	10	—	10	3	0.08
1N1824	R	30	250	10	—	10	4	0.08
1N1825	R	33	150	10	—	10	4	0.08
1N1826	R	36	150	10	—	10	5	0.09
1N1827	R	39	150	10	—	10	5	0.09
1N1828	R	43	150	10	—	10	6	0.09
1N1829	R	47	150	10	—	10	7	0.09
1N1830	R	51	150	10	—	10	8	0.10
1N1831	R	56	150	10	—	10	9	0.10
1N1832	R	62	50	10	—	10	12	0.10
1N1833	R	68	50	10	—	10	14	0.10
1N1834	R	75	50	10	—	10	20	0.11
1N1835	R	82	50	10	—	10	22	0.11
1N1836	R	91	50	10	—	10	35	0.12

Suffix A (±5% Tolerance) Suffix C (Double Anode Clipper)

VOLTAGE REGULATOR DIODES

Type	Case Type	Zener Voltage @25°C*	Max Total Power 25°C mw	150°C	Z_z max ohms
1N746†	N	3.3	400	100	28
1N747†	N	3.6	400	100	24
1N748†	N	3.9	400	100	23
1N749†	N	4.3	400	100	22
1N750†	N	4.7	400	100	19
1N751†	N	5.1	400	100	17
1N752†	N	5.6	400	100	11
1N753†	N	6.2	400	100	7
1N754†	N	6.8	400	100	5
1N755†	N	7.5	400	100	6
1N756†	N	8.2	400	100	8
1N757†	N	9.1	400	100	10
1N758†	N	10	400	100	17
1N759†	N	12	400	100	30
650C	M	3.7–4.5	150	40	
651C	M	4.3–5.4	150	40	
652C	M	5.2–6.4	150	40	
653C9	M	6.2–8.0	150	40	
654C9	M	8.5–9.5	150	40	
655C9	M	9.5–10.5	150	40	

*Suffix A (±5% Tolerance)

SILICON RECTIFIERS

Type	Case Type	Mounting	PIV 25°C v	PIV 150°C v	I_o 25°C ma	I_o 150°C ma	Recurrent Peak Current −65°C to +150°C ma	E_b @25°C v@ a	I_{Lb} @ PIV @25°C μa
1N588	O	Axial	1500	1000	25	10	150	10@10ma	50
1N589	O	Axial	1500	1000	50	25	250	8@50ma	50
1N1130	P	Cathode Stud	1500	1000	300	150	1 a	15@ 3	50
1N1131	P	Anode Stud	1500	1000	300	150	1 a	15@ 3	50
1N538	Q	Axial	200	200	750	250	2.5a@25°C	1@ 5	10
1N539	Q	Axial	300	300	750	250	2.5a@25°C	1@ 5	10
1N540	Q	Axial	400	400	750	250	2.5a@25°C	1@ 5	10
1N1095	Q	Axial	500	500	750	250	2.5a@25°C	1@ 5	10
1N1096	Q	Axial	600	600	750	250	2.5a@25°C	1@ 5	10
1N1124	R	Cathode Stud	200	200	3 a	1 a	10a@50°C	1.1@1	10
1N1125	R	Cathode Stud	300	300	3 a	1 a	10a@50°C	1.1@1	10
1N1126	R	Cathode Stud	400	400	3 a	1 a	10a@50°C	1.1@1	10
1N1127	R	Cathode Stud	500	500	3 a	1 a	10a@50°C	1.1@1	10
1N1128	R	Cathode Stud	600	600	3 a	1 a	10a@50°C	1.1@1	10
1N1124R	R	Anode Stud	200	200	3 a	1 a	10a@50°C	1.1@1	10
1N1125R	R	Anode Stud	300	300	3 a	1 a	10a@50°C	1.1@1	10
1N1126R	R	Anode Stud	400	400	3 a	1 a	10a@50°C	1.1@1	10
1N1127R	R	Anode Stud	500	500	3 a	1 a	10a@50°C	1.1@1	10
1N1128R	R	Anode Stud	600	600	3 a	1 a	10a@50°C	1.1@1	10

GENERAL PURPOSE SILICON DIODES

Type	Case Type	PIV	V_z	Min DC Fwd I @25°C ma at 1v	Max I_{Lb} @25°C μa	P @25°C mw	Max at Elevated Temps (150°C) Ambient Temp °C	I_{Lb}† μa	P mw
1N645	N	225	275	400	0.2	600	100	15	
FIN645	N	225	275	400	0.2	600	100	15	
1N646	N	300	360	400	0.2	600	100	15	
1N647	N	400	480	400	0.2	600	100	20	
FIN647	N	400	480	400	0.2	600	100	20	
1N648	N	500	600	400	0.2	600	100	20	
FIN648	N	500	600	400	0.2	600	100	20	
1N649	N	600	720	400	0.2	600	100	25	
FIN649	N	600	720	400	0.2	600	100	25	
600C	M	27	30	3	1 @ −10v	150	100	20@ −10v	40
601C	M	45	50	10	0.025@−10v	150	150	40@ −10v	40
604C	M	4.7	5.5	60	0.1	150	150	40	40
606C	M	6.8	7.5	35	0.1	150	150	40	40
608C	M	10	11	25	0.1	150	150	40	40
610C	M	15	17	20	0.1	150	150	40	40
612C	M	22	25	20	0.1	150	150	40	40
614C	M	33	37	20	0.1	150	150	40	40
616C	M	47	52	10	0.2	150	150	40	40
618C	M	68	75	10	0.2	150	150	40	40
620C	M	100	110	10	0.2	150	150	40	40
622C	M	150	170	7	0.2	150	100	20	40
624C	M	220	250	3	0.2	150	100	20	40

†At PIV except for types 600C and 601C

HIGH CONDUCTANCE SILICON DIODES

Type	Case Type	Min Saturation Volts @ 100μa PIV v	@ 25°C v	Av Rect Fwd I @ 25°C ma	Recurrent Peak Fwd I @ 25°C ma	P @ 25°C mw
1N482	N	30	40	125	400	500
1N482A	N	30	40	200	650	500
1N483	N	60	80	125	400	500
1N483A	N	60	80	200	650	500
1N484	N	125	150	125	400	500
1N484A	N	125	150	200	650	500
1N485	N	175	200	125	400	500
1N485A	N	175	200	200	650	500
1N486	N	225	250	125	400	500
1N486A	N	225	250	200	650	500
1N487	N	300	330	125	400	500
1N487A	N	300	330	200	650	500
1N488	N	380	420	125	400	500
1N488A	N	380	420	200	650	500

SILICON COMPUTER DIODES

Type	Case Type	PIV	V_z	Max T_R @25°C μsec	Max I_{Lb} @ 25°C μa	I_o @ 25°C ma	Min I_b @ 1v ma	Typ Cap @ 25°C f = 1mc VR = −12v μμf	Max I_{Lb} @ PIV @ 100°C μa
1N659	N	50	60	0.3	5	100	6	2.7	25
1N660	N	100	120	0.3	5	100	6	2.7	50
1N661	N	200	240	0.3	10	100	6	2.7	100

PHOTO DEVICE

Type	Bias Voltage v max	Dark Current @ 25°C ±50v max μa	Dark Current @ 100°C ±50v max μa	*Typ Light Current @ 25°C @ ±10v μa	*Typ Sensitivity @ 10v μh/mw/cm²
2N2175	50	0.5	100	200	22.3

*Light current measured in terms of radiation. Radiation = 9 mw/cm² in a frequency bandwidth of .7 micron.

SILICON RECTIFIERS — ECONOMY PACKAGE

Type	Case Type	PIV	I_o ma 25°C	I_o ma 100°C	Recurrent Peak Current @ 25°C a	Dynamic Forward Voltage Drop @ 100°C v @ ma	Dynamic Reverse Current @ 100°C ma @ v
2N2069	W	200	750	500	6	0.6 @ 500	0.2 @ 200
2N2070	W	400	750	500	6	0.6 @ 500	0.2 @ 400
2N2071	W	600	750	500	6	0.6 @ 500	0.2 @ 600

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More Groups Combine Forces

MERGER ANNOUNCEMENT by Lockheed Aircraft and Stavid Engineering, Plainfield, N. J., reveals the two firms will join forces by early this summer.

A Lockheed official says his firm, which specializes in aircraft and missiles, is ideally suited for combination with Stavid, which specializes in military electronics.

Spokesmen for both firms anticipate the merger will improve their position in competing for contracts. Acquisition of Stavid by Lockheed will be on the basis of 2½ shares of Lockheed stock for each share of Stavid. Preliminary approvals have been granted, subject to legal and stockholder endorsements.

The aircraft and missile firm, currently employing some 56,500 persons, had 1958 sales of $962,697,000, one-third of which was in missiles and space vehicles. Its total assets at year's end were $508,479,000 and net worth $136,643,000.

Stavid, employing about 1,000 people, recorded sales of $11,277,000 last year, a fourfold increase since 1953.

• **Hewlett-Packard Co.,** Palo Alto, Calif., has acquired the **Palo Alto Engineering Co.** by a stock transfer. Under terms of the acquisition, PAECO becomes a wholly-owned subsidiary of the instrument manufacturing firm. Palo Alto Engineering, which makes high-quality transformers, has an annual sales volume of over $1.5 million. Sales growth since 1951, when the company was founded, has averaged about 30 percent a year.

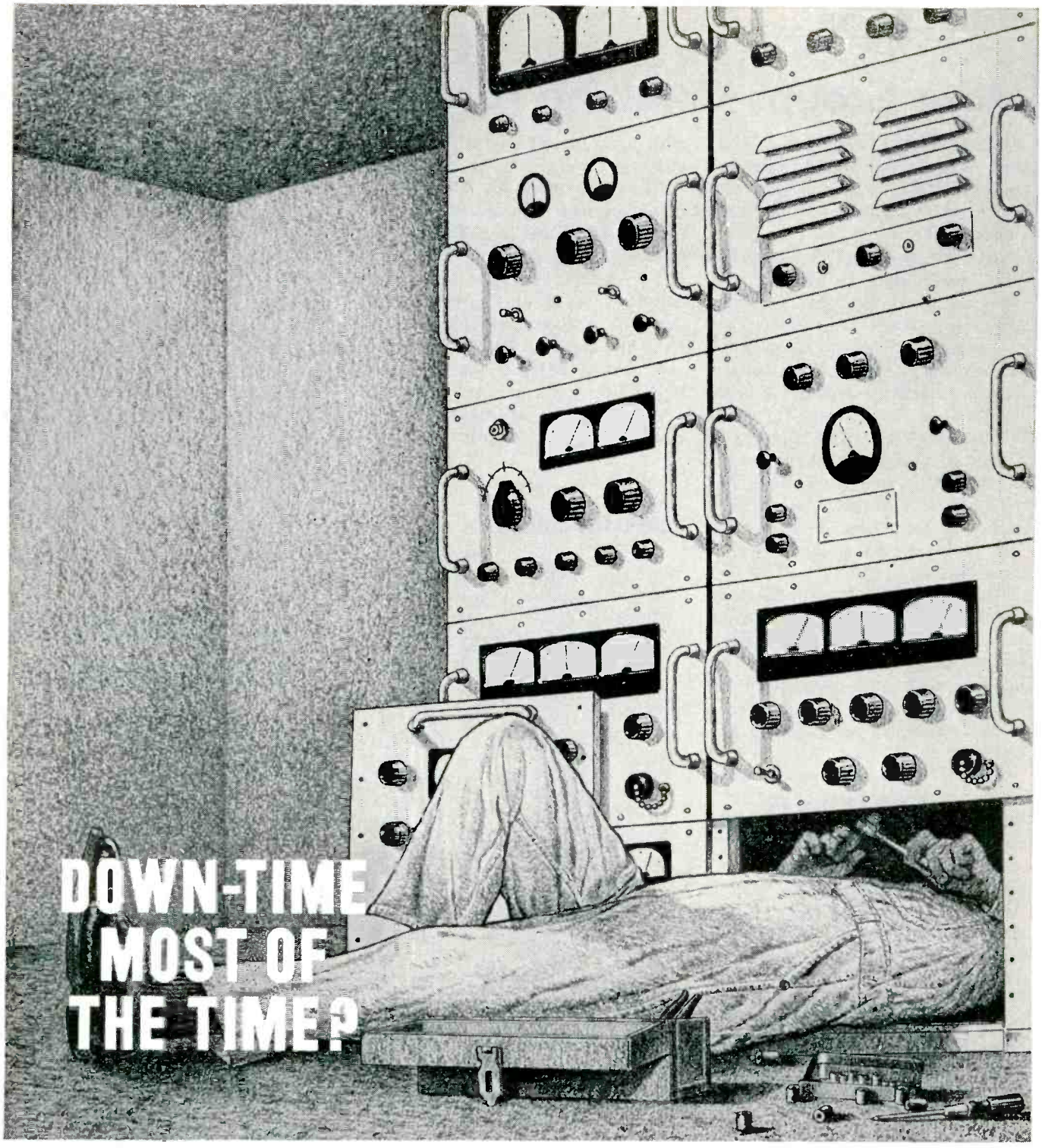
• **Elsin Electronics Corp.,** Syosset, N. Y., and **Specialty Engineering & Electronics Co.,** Brooklyn, N. Y., have approved merger plans and will adopt the name of Specialty Electronics Development Corp. Merger will be effected through an exchange of stock, Elsin shareholders to receive one new share for each two now held, and for the partners of the second firm to receive a block of stock.

Elsin, founded in 1904, now manufactures microwave components, radar test equipment and telemetering gear. The new concern reports over $3 million in backlog orders plus several government projects which will utilize the combined facilities of the two firms. SE&E's product line prior to the merger centered around automatic weather station equipment and dosimetry gear.

OVER THE COUNTER

1958 BIDS LOW	HIGH	COMMON STOCKS	WEEK ENDING May 29 BID	June 5 BID	ASKED
3¾	20½	Acoustica Assocs	28½	28½	33½
1⅝	3	Advance Industries	2¾	2⅝	3¼
3⅛	6⅝	Aerovox	9¾	9⅝	10¾
5½	15	Appl'd Sci Princet	9½	8½	10¼
1⅛	8⅞	Avien, A	10¾	11¼	13⅜
6¾	24	Baird-Atomic	30½	28	32½
9¾	13⅜	Burndy	17½	17½	19⅜
6¾	9	Cohu Electronics	8½	8⅛	8⅞
11	22½	Collins Radio	33	34	37
32½	49	Cook Electric	44	43½	50⅜
4	7	Craig Systems	10¼	10½	11¾
17⅝	25⅜	Eastern Industries	17⅛	15½	18⅛
1¾	8⅜	Elco Corp	8	7⅝	9⅛
10½	21	Electro Instr	26½	26½	28⅞
34	49	Electronic Assocs	41	43	48¼
5	11	Electronic Res'rch	18	17½	19⅜
8½	12¾	Electronic Spec Co	15⅛	16	17¾
15¼	49½	Epsco, Inc	36	37	40⅞
5½	9⅜	Erie Resistor	10	9⅝	10⅞
10	17½	Fischer & Porter	14⅜	14⅛	14¾
5½	10½	G-L Electronics	11¼	11½	13⅛
12	27	Giannini Controls	29	27¼	30⅞
...	...	Haydu Elec Prod	4¼	3½	5¼
30	39½	Hewlett-Packard	43½	43	49
23¼	48	High Voltage Eng	61	56½	63½
1¾	3	Hycon Mfg	3¼	3⅜	3⅞
1⅛	5⅛	Industro Trans'tor	5¾	5¾	6⅝
...	...	Internat'l Rec'f'r	27½	27¼	30⅜
...	...	Interstate Engin'g	20¼	21¾	24⅛
1½	4¾	Jerrold	5½	5⅜	5⅞
21	30	D. S. Kennedy	30	28	34⅝
3¾	29	Lab For El'tronics	32	31½	35⅛
19¼	28	Leeds & Northrup	32¼	32	34⅞
2	3⅛	Leetronics	3⅜	3¼	4
5	18¾	Ling Electronics	26¼	26¼	30½
3¼	8¼	Magnetic Amplifiers	9	9¾	10¼
2⅞	4½	Magnetics, Inc.	5¾	5⅛	6⅛
4⅝	12	W. L. Maxson	13¼	12¾	14⅜
10⅝	29	Microwave Assocs	22	23	25⅛
5¼	11¾	Midwestern Instr	11	11	12⅞
1⅛	7	Monogram Precis'n	10¾	11⅛	11¾
3½	7¼	Narda Microwave	11¼	11	12⅝
...	...	Narda Ultrasonics	11¾	11	12⅞
9¾	16	National Company	28½	26¾	31⅛
14¼	56	Nuclear Chicago	35	37½	42
4½	7⅜	Pacific Mercury, A	12	11½	13⅛
10⅛	27½	Packard-Bell	42½	41¾	45⅜
4¼	9⅜	Panellit, Inc	7	6⅞	7⅞
21	53¾	Perkin-Elmer	54	51½	57½
11⅜	19½	Radiation, A	20¾	19¼	22
2⅛	7⅜	Reeves Soundcraft	7	7⅝	8¼
13	32½	Sanders Associates	31½	31½	35⅜
...	...	Silicon Transistor	11¼	12½	13⅞
7	12	SoundScriber	17	16¼	18¾
22⅜	40	Sprague Electric	48¾	47½	53¼
26	35	Taylor Instruments	34½	33	37½
5½	15	Technical Operat'ns	13	11	17¼
5½	15¾	Telechrome Mfg	19½	18½	22
3¼	7¾	Telecomputing	13⅛	12½	13¾
1⅛	2¾	Tel-Instrument	2¾	2¾	3⅜
8¾	16¼	Topp Industries	14	14	16
3¾	10¾	Tracerlab	11	10⅞	12
1⅛	3⅜	Universal Trans'tor	1¼	⅞	1½
14¼	40	Varian Associates	32	30½	35⅜

The above "bid" and "asked" prices prepared by the NATIONAL ASSOCIATION OF SECURITIES DEALERS, INC., do not represent actual transactions. They are a guide to the range within which these securities could have been sold (the "BID" price) or bought (the "ASKED" price) during preceding week.



Grant Slides have been the pattern for all slide designs. While Grant is flattered, it is important to point out to designers and engineers that Grant research, design and sales engineering have been and are the factors that place the nation's leading industrial manufacturers on our list of customers.
If you require imaginative assistance in determining the proper slide for your equipment — or, if you'd simply like to discuss the possibilities for slides in your units, Grant sales engineers are at your service — as they have been ever since the first industrial slide (a Grant slide!) was marketed.

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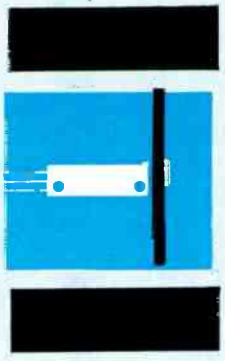
As many as 17 of these compact units can be mounted in a space of just one cubic inch. Designed for printed circuits and modular assemblies, Trimpot Model 220 measures less than 3/16" x 5/16" x 1". Power rating is 1 watt and maximum operating temperature is 175°C. This Potentiometer meets or exceeds Mil-Specs for humidity, salt spray, fungus, sand and dust, as well as acceleration, vibration and shock. Self-locking 15-turn shaft insures sharp, stable settings...exclusive Silverweld* fused-bond termination and ceramic mandrel provide extreme temperature stability. The Model 220 is available in a wide variety of resistance ranges and a choice of two terminal types—gold-plated Copperweld wire or insulated stranded leads.

Stocked by leading electronic distributors across the nation, these units are ready for immediate delivery. **Write for complete technical data and list of stocking distributors.** AVAILABLE AS PANEL MOUNT UNIT (illustrated at right) with same specifications. *Trademark



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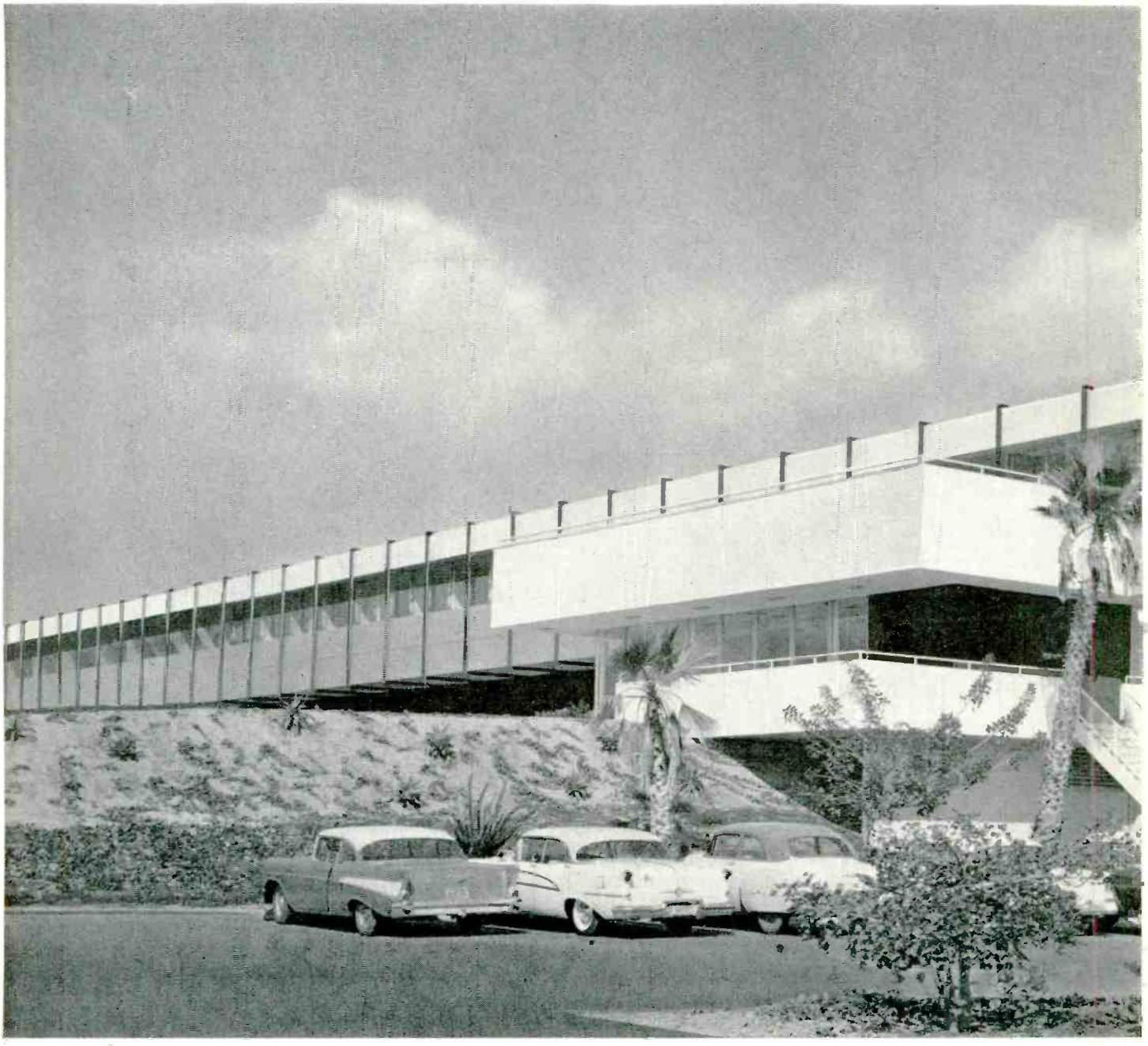

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The Semiconductor Division of Hughes Products has one goal: to give you the best performing semiconductors—both today and tomorrow. Here's how we are doing this:

1. *Start with a better manufacturing facility*—The new Hughes multi-million dollar semiconductor plant has 300,000 square feet of space. Hughes has installed over $3 million worth of mechanized manufacturing equipment which will provide you with more uniform semiconductors . . . at a lower cost.

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These factors enable Hughes to bring you a number of products which make a significant improvement in the state of the art. To date these include: a complete line of silicon and germanium

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SEMICONDUCTORS

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In addition, the Semiconductor Division is active in related fields... thermal relays and cast silicon domes. Many other startling devices are now in advanced state of development at the Semiconductor Laboratory.

You can obtain information *concerning any of the Hughes semiconductors from the Hughes field offices in* ***Boston*** *(phone WO 2-4824),* ***Newark*** *(phone MA 3-3520),* ***San Francisco*** *(phone DA 6-7780),* ***Syracuse*** *(phone GR 1-0163),* ***Philadelphia*** *(phone MO 4-8365),* ***Chicago*** *(phone NA 2-0283), and* ***Los Angeles*** *(phone OR 8-6125). Or write Hughes Products, Marketing Dept., Semiconductor Division, Newport Beach, Calif. In addition to Hughes sales offices, distributors are located in all major cities. For export write: Hughes International, Culver City, Calif.*

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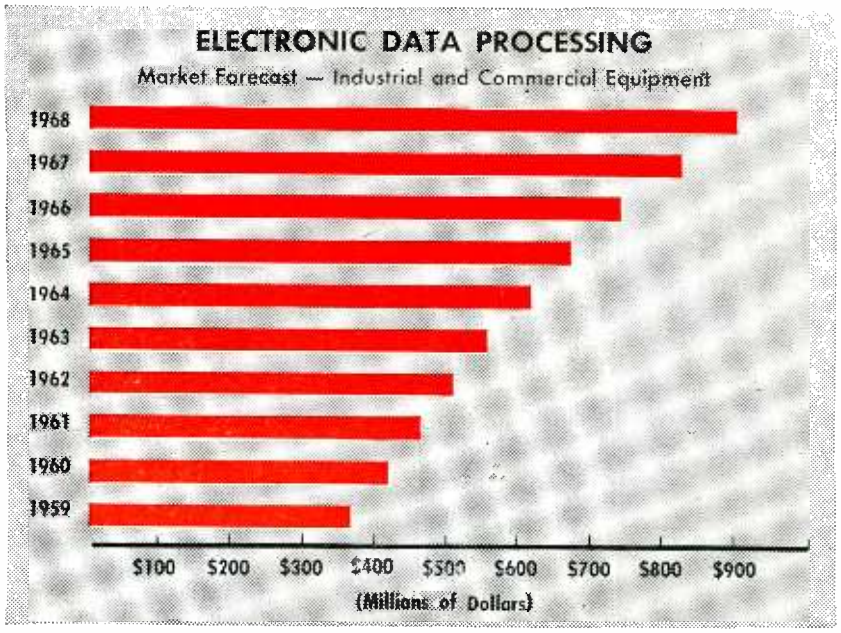


Tomorrow's Computer Sales

THREE HUNDRED and sixty million dollars worth of electronic data-processing equipment will be sold to industrial-commercial users this year; by 1968 annual sales will rise to $910 million.

That's the prediction of Frank W. Mansfield, Sylvania's director of market research.

Total forecast for the ten-year 1959-1968 period adds up to about $6 billion. It includes $4 billion of digital computers, plus $2 billion of electronic mechanisms to increase computer capacity.

The expected $4 billion digital computer sales break down to 995 large computers with a value of $1,790 millions, 7,795 medium computers ($1,170 millions) and 43,500 small computers ($1,088 millions). Average prices used in calculating value are: large—$1,800,000, medium—$150,000, small—$25,000.

Some 51,600 U. S. firms with more than 100 employees are the sole support of the industrial-commercial computer market, says Mansfield. Remaining number of firms, about 2.7 million, are too small.

Each of 43,500 firms with 100 to 500 employees is considered a prospect for one small computer. It is expected that one medium computer will be bought by each of 7,795 firms with more than 500 employees. Large computer market consists of 305 of the nation's largest firms, each of whom is regarded as a prospect for one or more large computers.

By 1968 this market will be 100 percent saturated. But sales are expected to continue at a level of $800 million to $900 million per year with replacement business providing the new sales drive. On average, computers are expected to be obsoleted by new equipment in seven years.

Electronic data-processing equipment sales to the Department of Defense are expected to account for an additional $1,550 millions between 1959 and 1968. Mansfield estimates DOD sales at roughly equivalent to 25 percent of industrial-commercial sales in each year of the period. Special-type computers for the government are not included in the estimates.

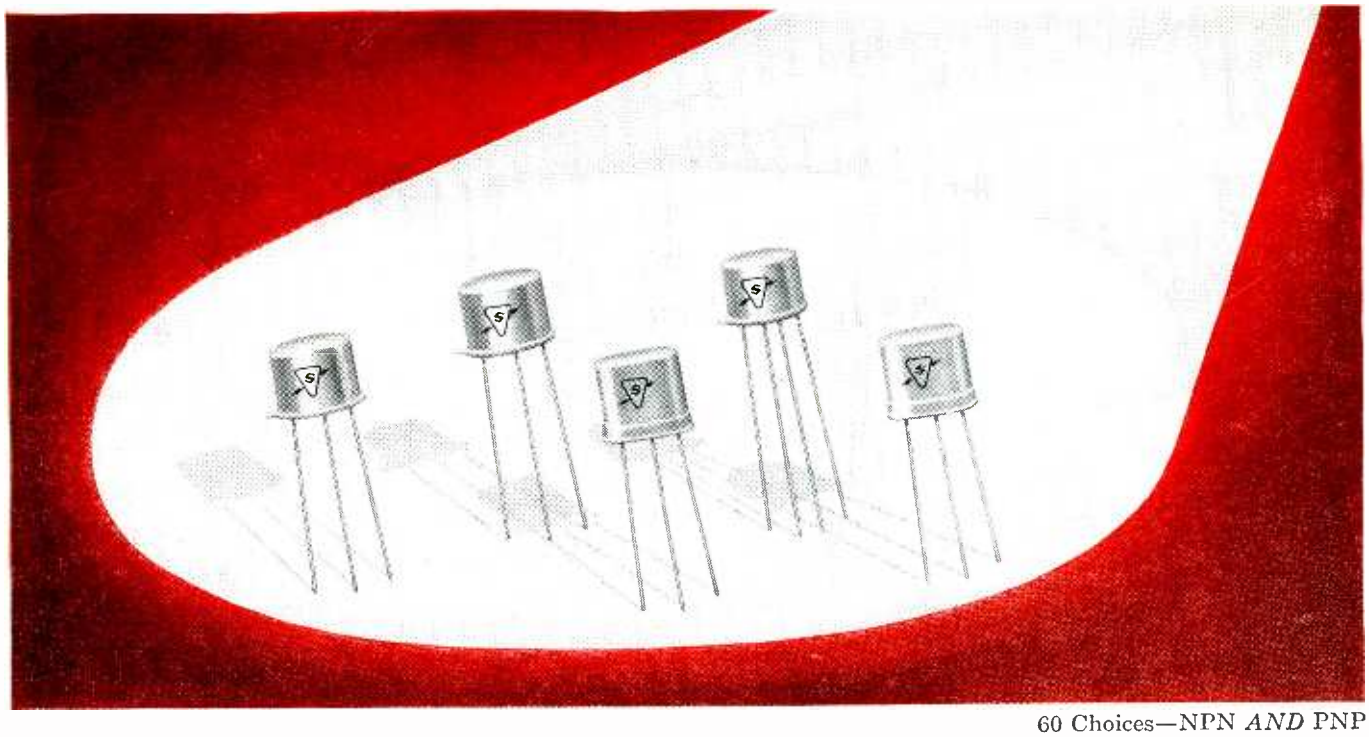
FIGURES OF THE WEEK

LATEST WEEKLY PRODUCTION FIGURES

(Source: EIA)	May 29, 1959	May 1, 1959	Change From One Year Ago
Television sets	109,239	92,157	+68.2%
Radio sets (ex. auto)	250,224	255,218	+69.6%
Auto sets	122,227	117,422	+183.6%

STOCK PRICE AVERAGES

(Standard & Poor's)	June 3, 1959	May 6, 1959	Change From One Year Ago
Electronics mfrs.	91.11	101.57	+72.5%
Radio & tv mfrs.	113.28	112.68	+137.0%
Broadcasters	100.88	104.32	+58.8%



60 Choices—NPN *AND* PNP

Sylvania Entertainment Transistors

...star performers for every role

For any consumer product application—portable radio, toys, organs, intercoms, shortwave radio, auto radio, Hi-Fi—there's a Sylvania entertainment type to fill the bill

Sylvania's broad entertainment transistor line is one of the most complete in the industry. It offers the creative design engineer a full range of types from one source to meet his most selective needs. Twenty new types have been added, bringing the total number to over 60 top-quality types including PNP, NPN, PNP (Drift), Medium Power and Low Power transistors. The entire line incorporates hermetic seal construction for maximum protection against humidity and other environmental conditions that can affect performance.

These Sylvania quality transistors are available now in production quantities to meet your new product manufacturing schedules—and at prices competitive with any comparable types in the industry.

Call your Sylvania representative now for a full rundown on the Sylvania entertainment line—or contact the factory directly at the address below.

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GENERAL SYSTEM

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Semiconductor Division
100 Sylvan Rd., Woburn, Mass.

POPULAR SYLVANIA ENTERTAINMENT TRANSISTORS

PNP

Type	Description
2N34	GP Audio
2N109	GP Audio
2N217	GP Audio
2N405	GP Audio
2N406	GP Audio
2N407	GP Audio
2N408	GP Audio
2N409	HF, IF Amp
2N410	HF, IF Amp
2N411	HF, IF Conv
2N412	HF, IF Conv
2N591	Med Power, Audio
Syl 1430	Ent
Syl 1536	Ent
Syl 1537	Ent
Syl 1549	Ent
Syl 1604	Ent
Syl 1608	Ent
Syl 1621	Ent

NPN

Type	Description
2N35	GP Audio
2N94	RF Amp
2N193	HF Osc
2N194	HF Conv
2N194A	HF Conv
2N211	HF Osc
2N212	HF Conv
2N213	GP Audio
2N213A	GP Audio
2N214	Matched Pair
2N214 (single)	GP Audio
2N216	HF IF Amp
2N228	GP Audio
2N229	GP Audio
2N233	HF RF Amp
2N233A	HF RF Amp
2N515	HF RF-IF Amp
2N516	HF RF-IF Amp
2N517	HF RF-IF Amp
2N1058	HF Mixer
2N1059	GP Audio
2N1101	GP Audio
2N1102	GP Audio
Syl 1279	Ent
Syl 1310	HF Conv
Syl 1311	HF Conv
Syl 1312	HF Conv
Syl 1313	RF Amp
Syl 1329	Ent
Syl 1524	Ent
Syl 1538	Ent
Syl 1539	Ent
Syl 1547	Ent
Syl 1583	Ent

(Drift) PNP

Type	Description
2N247	HF RF
2N370	HF RF
2N371	HF RF
2N372	HF RF
2N373	HF IF
2N374	HF Conv
2N544	HF RF
Syl 1475	Ent
Syl 1509	Ent

Tomorrow's dialing will be out of this world

Global telephone calls via satellites brought nearer by a new ITT electron tube

From the nation-wide resources of ITT Laboratories has come the ultimate development in a unique electronic amplifying device called the *traveling wave tube*.

A four-foot version pioneered by ITT for the Armed Forces can transmit as many as 100,000 telephone messages *simultaneously!*

Telephone Exchanges in the Sky

Now a miniaturized type is to be produced by ITT Components Division—small enough for satellites, where its amazing message capacity could be utilized to relay *thousands* of dial telephone calls to points around the globe.

ITT traveling wave tubes of many sizes are already in use in major areas of telecommunications, and in radar, missile guidance, electronic countermeasures, microwave radio, and television.

Pioneers in Electron Tubes

ITT Components Division, backed by experience almost as old as the electron tube industry itself, also manufactures *Iatron*® tubes that can display information, store it for days, erase it at will; photo multiplier tubes that convert light into an electrical signal and amplify it millions of times; image converter tubes for infrared applications, and tubes that give sharp eyes to our radar warning systems.

Other ITT tubes include types for industrial power, rectification, and radio-TV broadcast transmission.

In the free world today, nine ITT System companies are developing and building electron tubes for hundreds of essential and sophisticated tasks—in laboratories, industry, global communications, and national defense. For information, write ITT Components Division, Clifton, New Jersey.

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. . . the largest American-owned world-wide electronic and telecommunication enterprise, with 101 research and manufacturing units, 14 operating companies and 130,000 employees.

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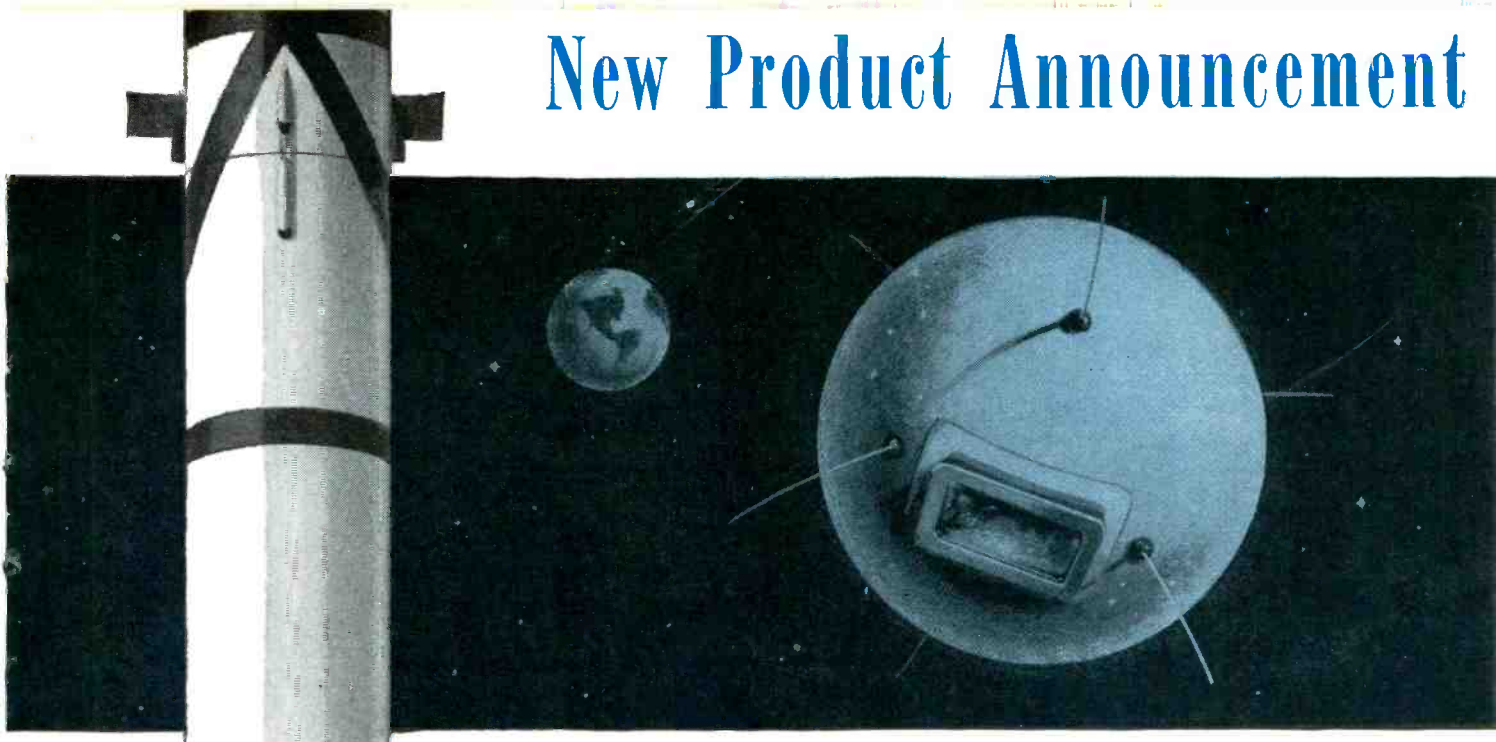
New Product Announcement



STEMCO TYPE MX* THERMOSTATS

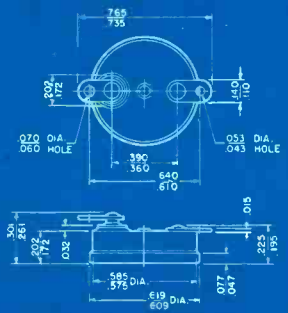
especially designed for missile, avionic and electronic applications

New Stemco Type MX Thermostats are miniature snap-acting units designed to *open* on a temperature rise. Being compact, lightweight units able to withstand high G's under wide ambient temperature ranges, Type MX thermostats are ideal for missile, avionic and other electronic applications where close temperature control is mandatory.

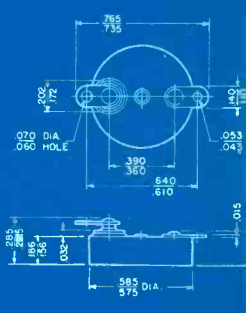
Basic design flexibility of the Stemco Type MX Series means the units can be supplied from regular production runs in a wide variety of models, both semi-enclosed or hermetically sealed. Ceramic or metal bases for semi-enclosed units, round enclosures or CR-7 crystal cans for hermetically sealed units. Several types of terminal arrangements, mounting provisions, brackets, etc., are available.

Stemco Type MX thermostats give you performance . . . small cubage . . . rugged reliability . . . *at a production price.*

* 2° to 6°F differentials available



TYPE MX *Hermetically Sealed* — Electrically independent bimetal disc. Rated at 2 amps at 115 VAC and 28 VDC, based on 250,000 operations.

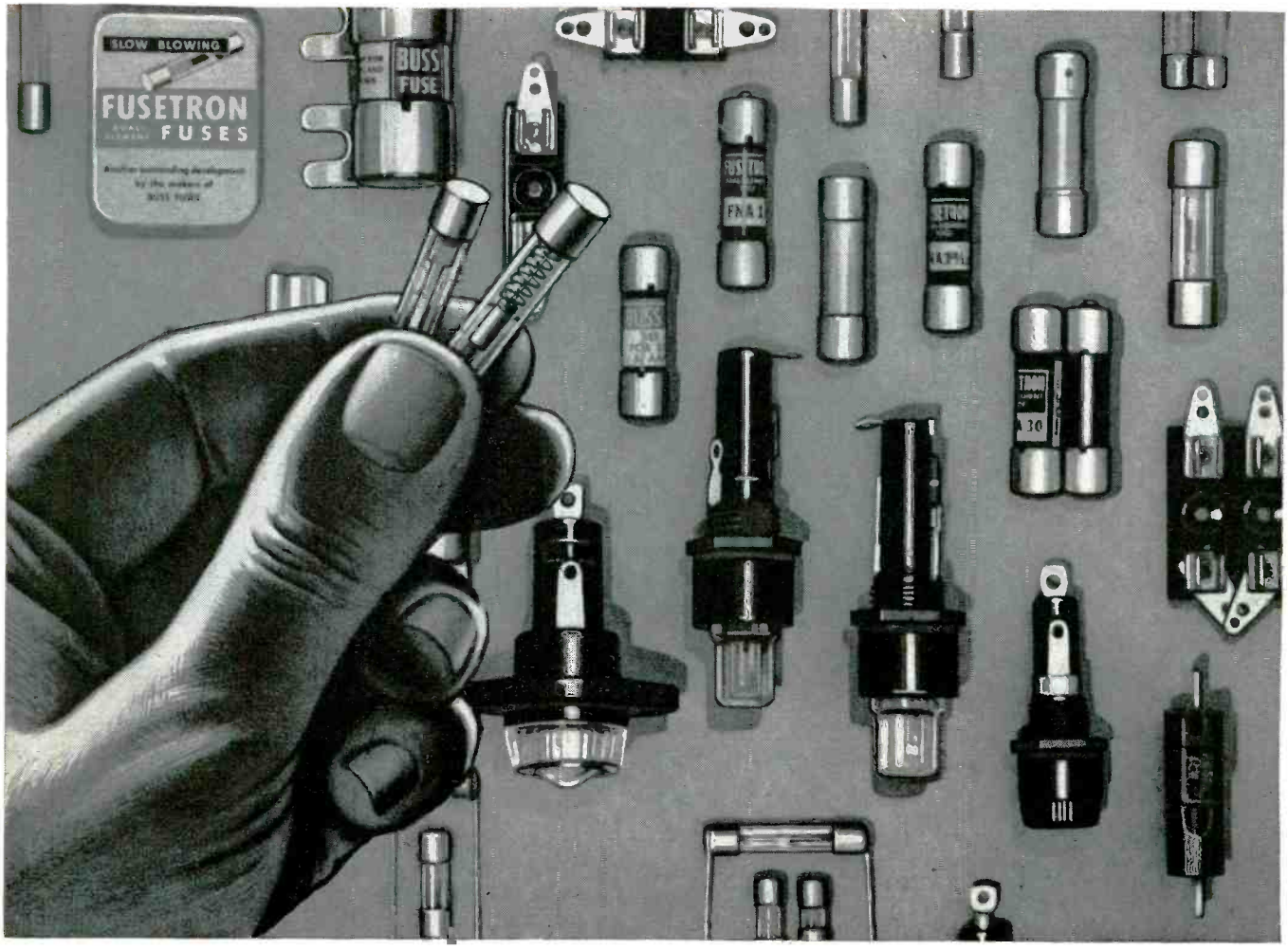


TYPE MX *Semi-Enclosed* — Metal base shown; also ceramic base types. Bulletin 6100 for data on hermetically sealed and semi-enclosed types.

AA.7258

STEVENS *manufacturing company, inc.*
Mansfield, Ohio

® STEMCO THERMOSTATS



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there's a safe and dependable BUSS or FUSETRON Fuse!

BUSS fuse engineers have consistently pioneered the development of new fuses to keep pace with the demands of the Electronic Industry. Today, the complete line includes:

Single-element fuses for circuits where quick-blowing is needed;—or single-element fuses for normal circuit protection;—or dual-element, slow-blowing fuses for circuits where harmless current surges occur;—or indicating fuses for circuits where signals must be given when fuses open. Fuses range in sizes from 1/500 amperes up—and there's a companion line of fuse clips, blocks and holders.

Dependable protection under all service conditions.

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If you have a special protection problem.

The world's largest fuse research laboratory, plus the experience gained by solving all types of electrical protection problems is on call to you at all times. Our engineers, work with yours and can most probably save you time and trouble.

For more information, write for BUSS bulletin SFB.

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BUSS fuses are made to protect - not to blow, needlessly.
BUSS makes a complete line of fuses for home, farm, commercial, electronic, electrical, automotive and industrial use.

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NOW AVAILABLE IN TRANSITRON'S NEW PACKAGE

SILICON CONTROLLED RECTIFIER

handling 10KW power

TYPE	MINIMUM PEAK REVERSE VOLTAGE (Volts)	MINIMUM FORWARD BREAKDOWN VOLTAGE (Volts)	MAXIMUM AVERAGE FORWARD CURRENT (amps) at T case = 100°C	MAXIMUM AVERAGE FORWARD CURRENT (amps) at T case = 25°C
TCR 102	100	100	10	20
TCR 202	200	200	10	20
TCR 302	300	300	10	20
TCR 402	400	400	10	20

Maximum Storage Temperature Range — 65°C to +150°C
Maximum Operating Temperature Range — 65°C to +125°C
Send for Bulletin TE 1356

Transitron's Silicon Controlled Rectifier is a PNPN high power bistable controlled switching device. It is analogous to a thyratron or ignitron, with far smaller triggering requirements and microsecond switching. The low forward voltage drop permits high current ratings and provides high efficiency with low cooling requirements. The PNPN design permits higher voltage ratings and lower saturation resistance than power transistors. This permits the smallest packaging for high power control yet made possible.

Ratings currently available extend to 10 amperes at 100°C case temperature and up to 400 volts forward and inverse ratings. *Operation at 125°C is now permissible with derating.* Full ratings are possible at 35°C ambient with a 5″ square heat sink. The peak control power is typically 1/200,000 of the output power!

Transitron's Silicon Controlled Rectifier has been designed into a new package for more rugged, convenient, and practical application. The 11/16″ hex base and the general outline coincide with EIA standards for the 20-ampere rectifier.

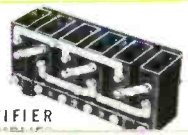
OTHER TRANSITRON SILICON PRODUCTS FOR HIGH POWER USE

6 AMP

50 AMP

85 WATT POWER TRANSISTORS

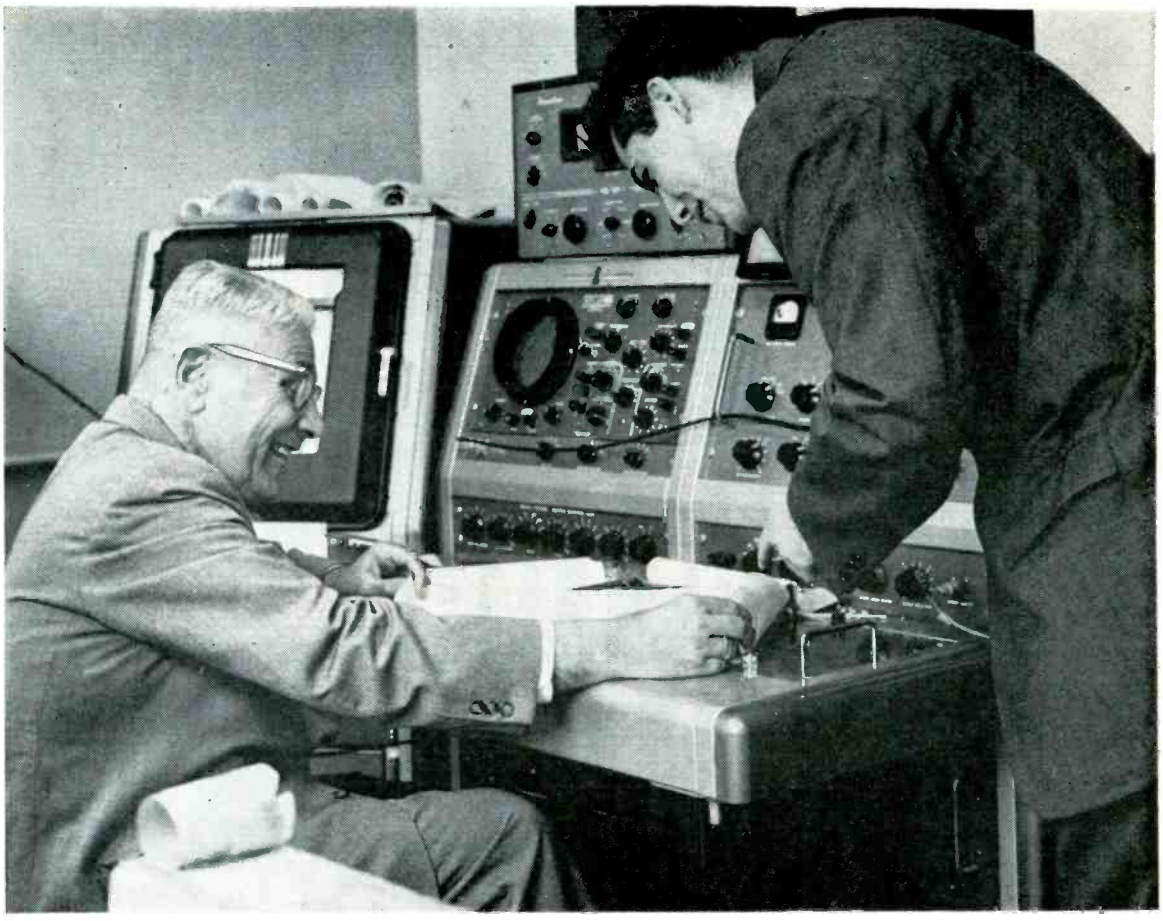
HIGH VOLTAGE ASSEMBLIES



RECTIFIER

Transitron

electronic corporatio



NYU physics professor Hartmut P. Kallman and a graduate student use an electron paramagnetic resonance spectrometer to detect and measure the concentration of unpaired electrons in inorganic phosphors

More R for Defense R&D?

Yes, declares a university lab director and business executive who urges renewed support of academic research by Defense Department

By **DEAN A. WATKINS**, Director, Electron Devices Lab, Stanford U.; President, Watkins-Johnson Co., Palo Alto, Calif.

IN ITS ZEAL to impress Congress and the general public with its efficiency, the Defense Department has been spending most of its budgeted research and development funds on systems development; only a small fraction of these funds has been spent on research in support of defense technology, carried on primarily at universities. This leaves untapped a large reservoir of academic brainpower.

There has been some feeling that the Defense Department, spurred by the launching of Sputnik I, has steadily increased its support of research at university graduate schools and laboratories. This has not turned out to be the case. In fact, there has been less money available for this purpose since Sputnik I as development of missiles and satellites was accelerated.

As one observer puts it, there should be within present Defense Department R&D funds, a greater emphasis on the R and less on the D, whereas the trend has been in the opposite direction.

That the defense establishment is aware of the need became evident last April when the late Deputy Defense Secretary, Donald A. Quarles, submitted a fiscal 1960 budget request to the House Committee on Appropriations which calls for higher research spending.

Even if this latest Defense De-

ABOUT THE AUTHOR

DEAN A. WATKINS speaks from his background as director of the Electron Devices Laboratory of Stanford University and president of the Watkins-Johnson Co., Palo Alto, Calif., which is concerned with applied research, development and manufacture of microwave electronic devices. Inventor of the Helitron tube for instant radar tuning over a wide range of microwave frequencies, he is nationally recognized as a microwave tube specialist.

partment budget request is granted and more money is directed towards university research, this sum will still be insignificant. It will hardly be enough to remedy the harm done in recent years to our long-term defense effort by insufficient research support. The cost of too much D and too little R has been a loss of new science and technology for the weapons of a decade hence.

Inadequate Support

It is also doubtful that Defense Department funds now spent on university research will go very far towards reversing the effects of insufficient funds on the graduate schools of our universities, where this research is carried on.

Despite the post-Sputnik hue and cry for more training in science and technology, universities have not been adequately supported to do the kind of teaching and research jobs they should.

In fact, the reduction in Defense Department support of university research has had the effect of reducing the number of graduate students in physical science and advanced engineering that institutions can turn out—this at a time when graduate enrollment in science and technology should be expanded.

This is bad business, for the Defense companies must bid higher for the services of fewer competent research scientists. The cost is passed along to the DOD in cost-plus-fixed-fee contract charges.

Neglecting Knowledge

A matter of far greater importance than costs is the fact that we are also neglecting the advancement of knowledge through research, which makes real advances in defense capability possible.

Electronics is one of the important areas of defense technology where this R&D imbalance will lead to future difficulties.

Take, for example, the supporting research in electron devices, a field which includes transistors, traveling-wave tubes, solid-state devices, parametric amplifiers and masers, and their underlying technology.

Defense Department spending

(Continued on p 39)

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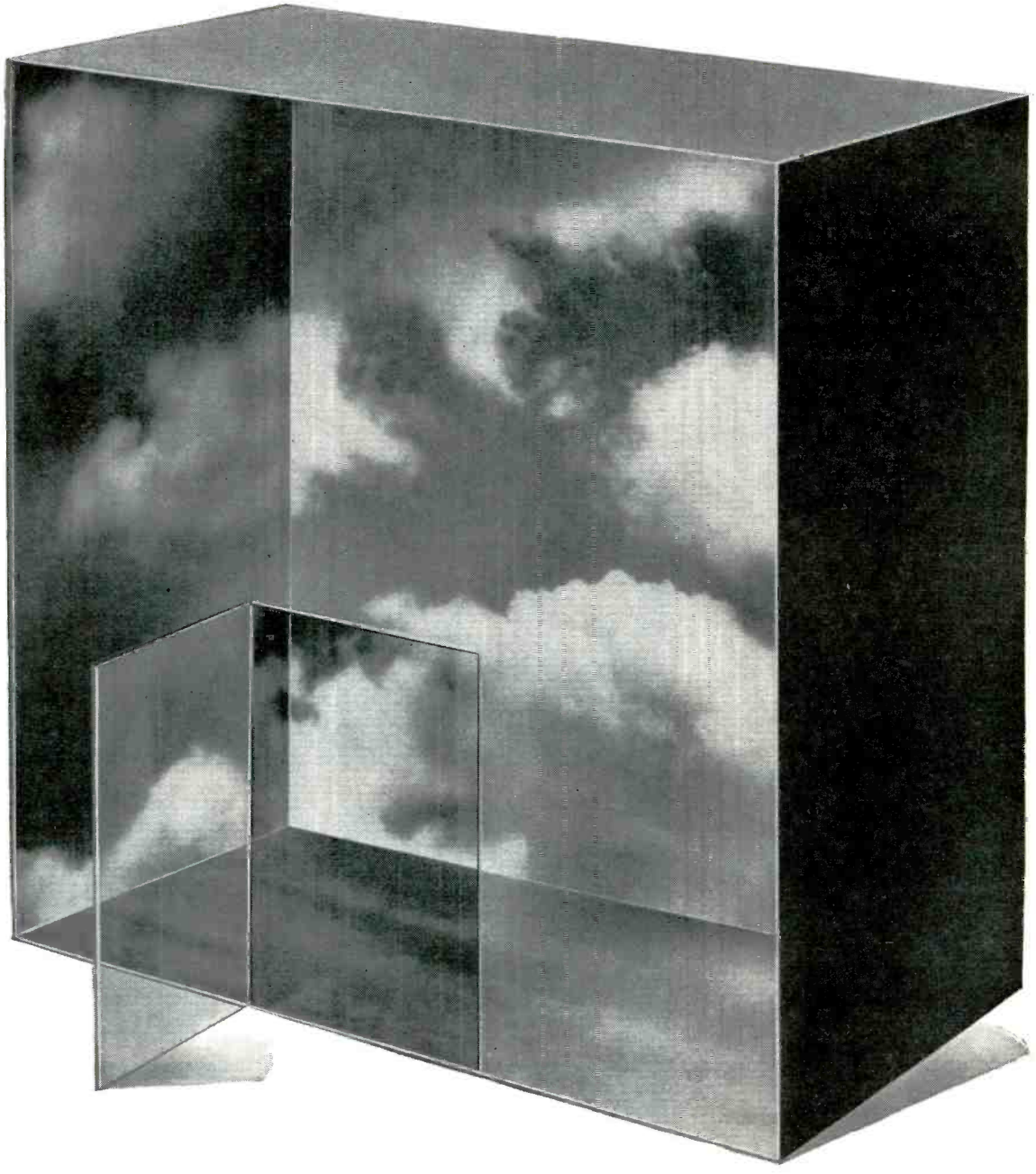

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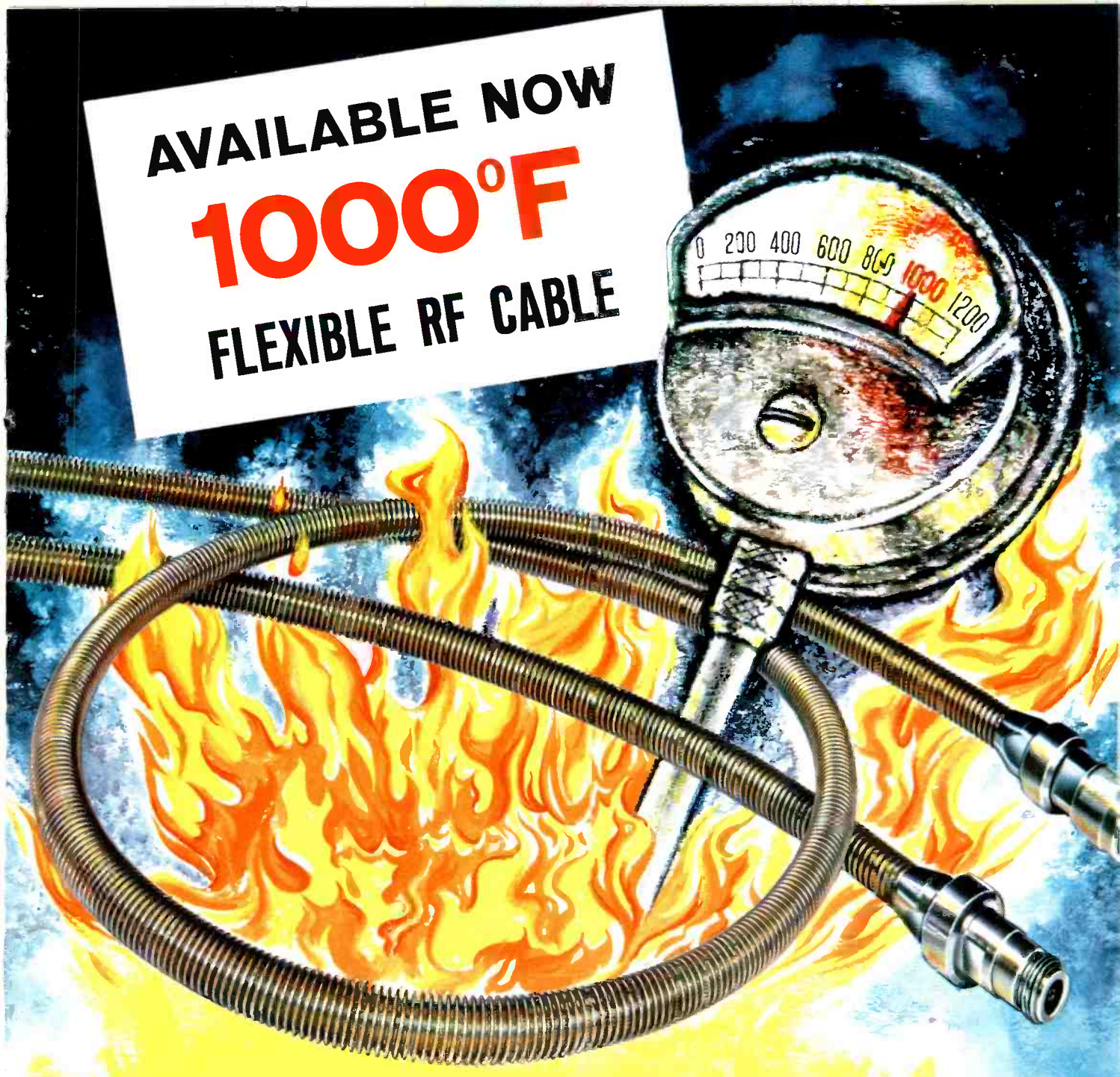

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Altitude Insensitive—Moisture Resistant
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Capacitance: 30.0 μμf/ft.
Velocity of Propagation: 69.0%
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Maximum Operating Voltage: 1000 VRMS
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Connectors, 2½ ounces each

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NAME _____ TITLE _____

COMPANY _____

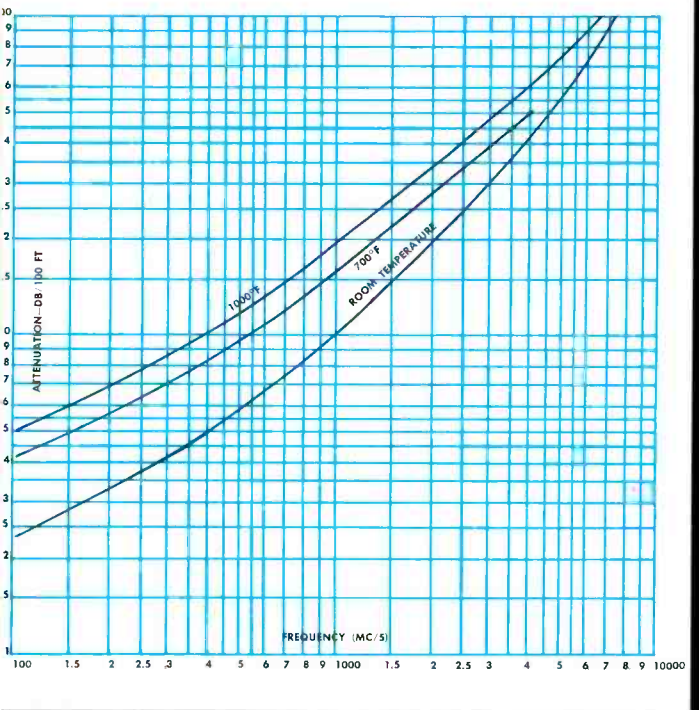
1000°F FLEXIBLE RF CABLE

PHYSICAL CHARACTERISTICS

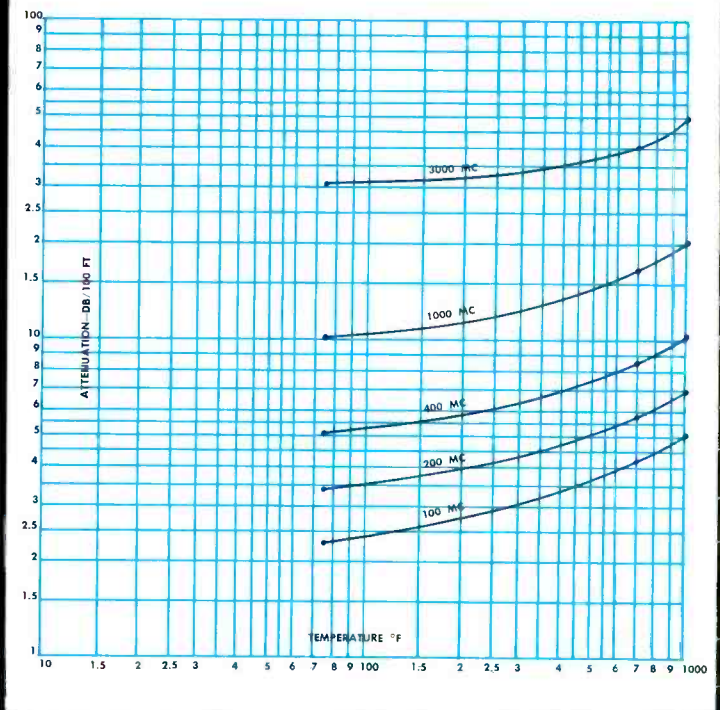
DESCRIPTION	CONSTRUCTION DETAILS
Inner Conductor	Stranded coated oxygen-free, high-conductivity copper wire.
Cable Core	Modified semi-solid silica.
Outer Conductor	Single braid, AWG size 32 coated oxygen-free, high-conductivity copper wire.
Jacket	Flexible special metal alloy. Nominal overall diameter: .525".

FLEXING CHARACTERISTICS

Cable can be bent on a 10X mandrel (bend diameter=10X diameter of cable). Cable dielectric shows no deterioration after 30,000 cycles of bending over 10X mandrel in accordance with specification MIL-C-915.



ATTENUATION VS. FREQUENCY AT ROOM TEMPERATURE, 700°F and 1000°F



ATTENUATION VS. TEMPERATURE AT VARIOUS FREQUENCIES

(See Other Side)

AMPHENOL

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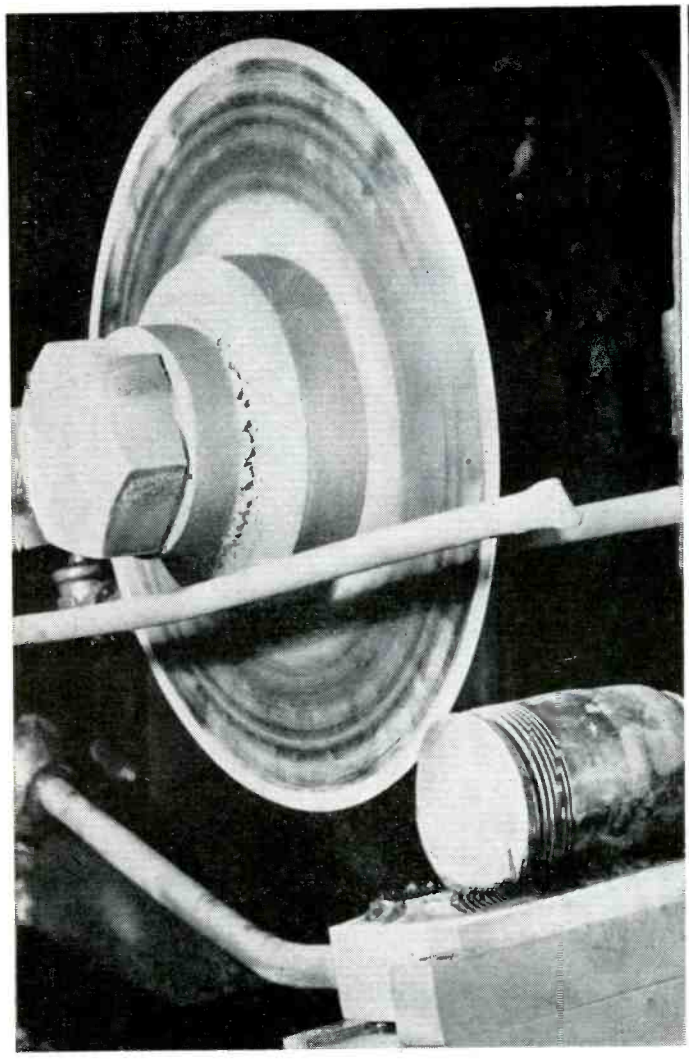

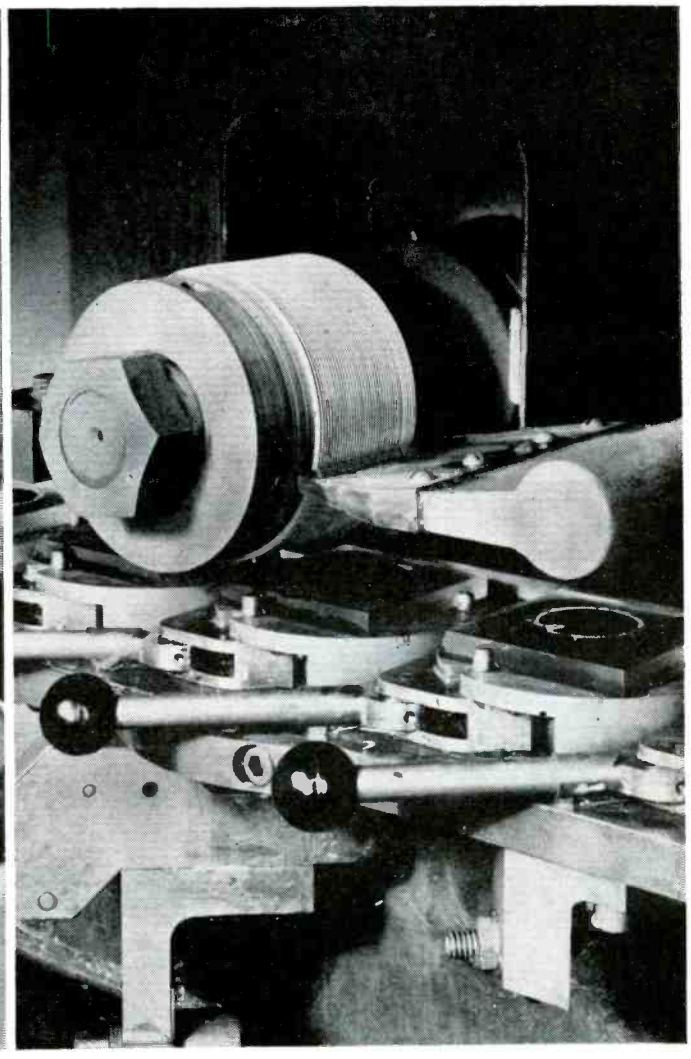

Slicing and dicing operations are both performed by Norton diamond cut-off wheels. An ingot of pure silicon, cemented to a ceramic block is sliced by a single wheel. In dicing, wafers are also mounted on ceramic blocks. Ganged wheels first cut in one direction; then the blocks supporting the wafers are turned 90° for the second cut. The tiny diced pellets, used in diodes, are about 1/32" square by .020" thick. (Photos courtesy of Hughes Aircraft Company).

*Slice, dice — **and save** — electronics materials with Norton diamond wheels*

To be suitable for diodes, transistors and other electronics parts, such materials as silicon and germanium must be practically 100% pure. That makes them rare materials — and costly.

They are even more costly when you waste any of them in grinding operations. This risk is unnecessary. You can avoid it when the diamond cut-off wheels you use are Norton — engineered to your exact requirements.

These Norton diamond wheels always cut fast, free and straight. Their extreme thinness and non-chipping action avoids wasting valuable material. And their dimensions are constantly uniform as specified — especially important when wheels are set up for gang dicing.

Remember: Norton was first to introduce all three types of diamond wheels — resinoid, metal and vitrified bonded . . . does all its own checking and sizing of diamonds . . . certifies the diamond content . . . duplicates wheel specifications with consistent accuracy . . . brings you a complete line, covering every application.

See your Abrasive Engineer or Norton Distributor for prompt service and additional facts. Or write to NORTON COMPANY, General Offices, Worcester 6, Massachusetts. Plants and distributors around the world.

Diamond-hard, yet paper-thin. Miking of this Norton diamond cut-off wheel shows an extreme thinness of .004" — a typical result of Norton leadership in developing diamond wheels "tailor-made" to every application for finest results.

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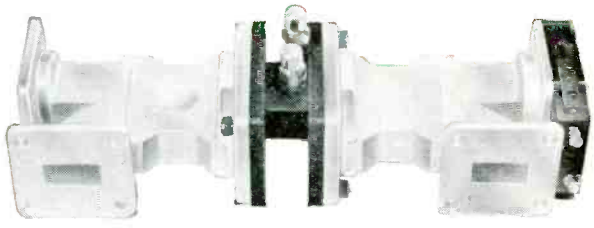
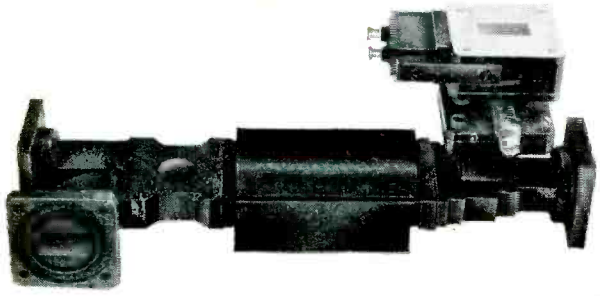
BALANCED DUPLEXER: DUAL PRE-TR, DIODE PROTECTOR, SHUTTER



BALANCED DUPLEXER: DUAL TR, SHUTTER



FERRITE DUPLEXER: DIODE PROTECTOR, SHUTTER

New Microwave Associates Ku Band duplexers give you guaranteed crystal protection - for life - at full rated power and elevated temperatures.

For the first time, Ku Band users are enjoying crystal protection never before attained in this band!

New, highly successful gas tube and ferrite devices of proven design but previously produced for L, S & X bands, are now in actual production for Ku Band . . . and available for immediate delivery.

These new duplexers developed by Microwave's Switching Devices Laboratory under the direction of Dr. Lawrence Gould are guaranteed to solve premature crystal burnout problems. One of these systems will bring you optimum duplexer performance and reliability. All three use the MA-760 shutter for standby receiver protection.

If you work with the Ku Band, you owe it to yourself to see how these latest developments from Microwave will bring you new concepts in receiver performance and crystal protection. Write or call our application engineering department.

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Frequency Experts Eye Space

Private industry, government agencies push research toward ruggedizing atomic clocks

PREOCCUPATION with the space age's impact on frequency control keynoted the three-day 13th annual symposium on frequency control, sponsored recently by the U. S. Army Signal Research and Development Laboratory, at Asbury Park, N. J.

Research is being pushed by government agencies and private industry toward ruggedizing atomic clocks, such as the ammonia beam maser and cesium beam frequency standard (Atomichron), for service in satellites, missiles and space vehicles.

Present state of the art has produced developmental models of such ruggedized clocks with stability and reproducibility of 1 part in 10^{9} or 10^{10}. Frequency control specialists are shooting for precisions of 1 part in 10^{12}.

Offer Proposals

Progress in space technology and the growing availability of satellites for experiments have encouraged a number of proposals for using super-precise clocks in space to prove or disprove certain relativistic concepts about our universe.

One of these is the theory that the laws of physics and physical constants observed in a laboratory are not independent of the position, time and velocity of the laboratory in which the constants are measured.

It has been suggested, for instance, that the gravitational constant decreases inversely as the age of the universe. This would result in a gravitational clock, such as the planetary system, running more slowly as time goes on when compared with an atomic clock.

Similarly, motion of the earth relative to distant matter in the universe is thought to have enough interaction to cause an annual periodic variation in the period of an earth satellite of the order of a part in 10^{8} per year.

For similar reasons, intercomparison of two different atomic clocks might reveal an annual variation of 1 part in 10^{10}. Definitive experiments are being planned.

Another proposal involving satellites calls for placing an atomic clock in orbit around the earth for the purpose of instantaneous synchronization of frequency and time of earth clocks on a world-wide basis.

What's Needed

Precise frequency control was also pointed out as being a severe requirement for communication with space probes reaching the outer fringes of the solar system and beyond.

Within the next two decades, it may be possible to send such probes considerably beyond the planet Pluto. For communicating at such ranges the receiving system on earth must have the utmost sensitivity. To accomplish this, the bandwidth must be significantly reduced.

To reduce the bandwidth by a factor of 10^{4} will require oscillators with an average frequency stability of 10^{-12} per day.

More R for Defense R&D?

(Continued from p 33)

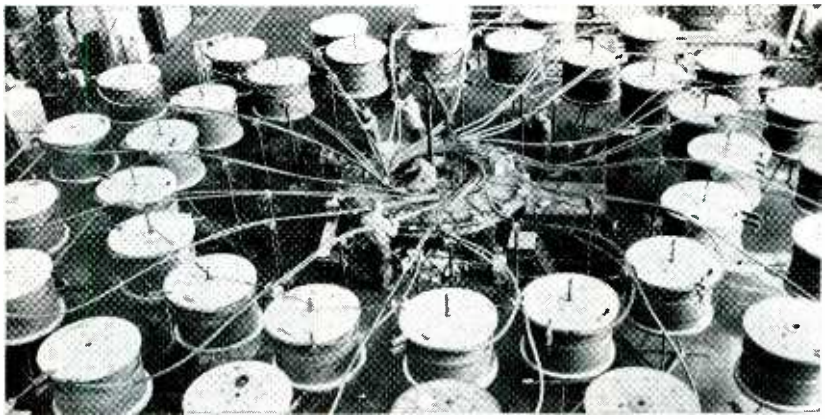
for applied research in these categories actually went down in the year after Sputnik I. Dollar figures to support this statement are contained in classified reports. But until this year's budget request for fiscal 1960, the trend had been to even less money for supporting research.

This situation is most serious when one considers that characteristics of electronic systems—performance, power consumption, size and weight—are all pretty much determined by the electron devices they use.

We may very well be able to get a man into space with our present technology, but we must not discount the future to achieve present goals, especially when the needed research can be carried on for such a small percentage of the defense R&D budget.

At the present time, less than five percent of Defense Department R&D money goes for basic research. It is likely that the total spent on supporting or applied research in defense technology is not much, if any, greater. It should be apparent that a slight shift of emphasis will buy a large amount of insurance for the future.

Coil For Mach 20 Wind Tunnel



Induction coil being wound (center) is part of electrical power supply system built by GE for driving air through Army's Tullahoma wind tunnel at speeds of Mach 20. Finished copper coil will contain about six miles of cable, weigh 60 tons, stand five ft high, and take one million amps of current

4400° F in Three Minutes

NEW

Production Tantalum Sintering Furnace

- ***Large 6″ I.D. x 10″ Heating Element***
- ***Automatic Protective Devices***
- ***Operates at 10^{-5} mm Hg or with Inert Gas***

Connect water, power, air and drains to the NRC Model 2915 and you're in business. That's just the first convenience you'll experience when you use this new refractory-free resistance furnace to produce tantalum capacitors.

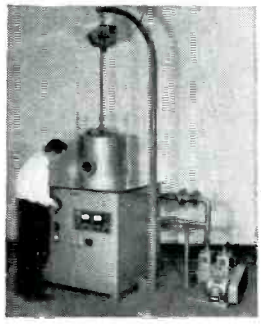
Loading, unloading, and cleaning are quick and easy. With one finger you can raise the spring-loaded stainless steel cover and lift out the top heat shield assembly. For cleaning, the heating element and other shield assemblies can be removed in less than 30 minutes. Every square inch of the stainless furnace chamber is accessible. Graphic control panel simplifies operation.

The three-phase cylindrical heating element offers long, trouble-free life because of its rugged construction, three point support, and ample spacing from heat shields.

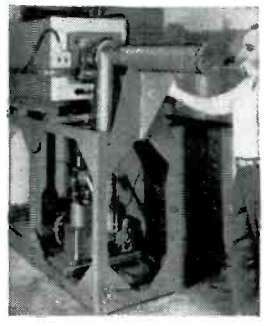
This furnace will help you make more money. Large capacity, rapid heating and cooling, and high speed evacuation increase productivity. Double glass sight port, interlocked, fail-safe pumping system and power supply protect work and heating element against excess pressure and temperature. Special circuit prevents air-releasing before work is sufficiently cool. *Send for more information today!*

SEMICONDUCTOR PRODUCTION EQUIPMENT

Low-cost standard furnace for growing single crystals of silicon, germanium, and intermetallic compounds with reliability. Grows a 150 gram crystal in about 3 hours.



Belljar and tank vacuum metallizers, diameters 12″ to 66″, for depositing thin films to precisely controlled thicknesses of fram one molecule to several mils.



Two-zone 5″ diameter muffle vacuum heat treating furnace. For annealing semiconductors and electronic parts.

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. . . in complementary push-pull circuits

These new NPN transistors in the complementary push-pull circuit eliminate input and output transformers with many resulting advantages:

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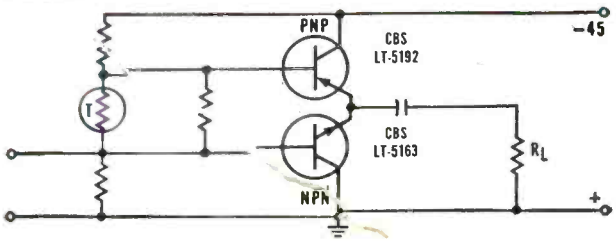
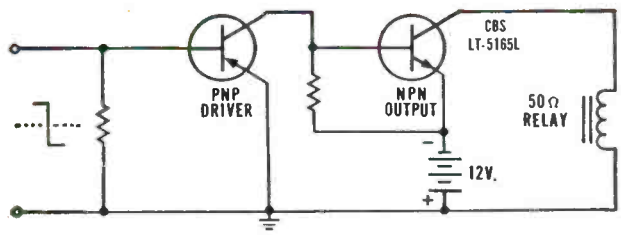
. . . in complementary cascade circuits

CBS NPN power transistors are also intended for single-ended cascade output circuits, and three types are designed for use with inductive loads such as output transformers, motors and relays. The simplified direct-coupled circuits permit economies through elimination of components.



COMPLEMENTARY CLASS B AMPLIFIER



DIRECT-COUPLED COMPLEMENTARY CONTROL AMPLIFIER

FIRST COMPREHENSIVE LINE OF NPN POWER TRANSISTORS

Type	Max. W Diss. (25°C Ambient*)	Max. V_{CBO}	Max. V_{CES}	Min. h_{FE} (I_C = 0.5A)	Max. Thermal Res. °C/W	Similar PNP Types
FOR RESISTIVE-LOAD CIRCUITS						
2N326	20	35	35†	30	3	2N325
LT-5165	20	35	30#	30	3	LT-5191
LT-5163	20	60	45#	30	3	LT-5192
LT-5164	20	80	60#	30	3	LT-5193
FOR INDUCTIVE-LOAD CIRCUITS						
LT-5165L	20	35	30ϕ	30	3	LT-5191L
LT-5163L	20	60	45ϕ	30	3	LT-5192L
LT-5164L	20	80	60ϕ	30	3	LT-5193L

All seven types have: Max. collector current, 3 amps; storage temperature, −65 to +85°C; avg. cutoff frequency, 150 kc. *Adequate heat sink required. †I_{CES} = 1 ma. max. #I_{CES} = 10 ma. ϕI_{CES} = 300 ma.

New design economies in complementary push-pull and cascade circuits are made possible by these CBS NPN power transistors. They feature high voltages . . . up to 80 volts. Their proven reliability (they meet the MIL-19500A specification) is what you might expect from specialists in reliable NPN switching and PNP power transistors. Check the typical circuits and abbreviated data for this versatile and comprehensive line. Write for complete technical Bulletin E-332 . . . and, if you wish, for Bulletin E-348 on CBS PNP power transistors for complementary circuits.

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CBS ELECTRONICS, Semiconductor Operations
A Division of Columbia Broadcasting System, Inc.

There's much to see and hear at a parts show, especially when . . .

Distributors Air Complaints

Inventories, pricings, markups spell stormy weather—even though sales look good, say distributors at Electric Parts Show

CHICAGO—TUBES SOLD by U. S. manufacturers for the export market are reportedly winding up in the hands of domestic users. Also winding up in domestic hands, according to reports, is the ten-percent profit saved because export tube buyers do not pay excise taxes.

This is just one of several gripes being aired by electronic parts distributors, and in particular those attending the Electronic Parts Distributors Show.

Complaints on Pricing

Manufacturers and distributors report this week that sales are up over the spring of 1958.

This bright prospect is alloyed, however, by a number of grumbles on present industry practices. One of the most frequently voiced complaints concerns the spread between low prices charged to original equipment manufacturers and higher amounts demanded of distributors for the same components.

In defending price differentials, which sometimes runs as high as 20 percent, one manufacturer told ELECTRONICS: "It costs us more to sell and promote in the distributor field. The original equipment market is a smoother, easier sales area although profit margins are smaller. At any rate, this practice eventually reflects to the good of the distributor because the equipment manufacturer can sell more items which then serve to boost the replacement market."

Strong protests were also directed against the number of foreign tubes being imported into the U. S. market. This situation is allegedly complicated by the practice of some distributors who purchase tubes at export prices and divert them to domestic markets. The user pays the same for both tubes, but the seller is the one who pockets the difference.

Foreign Competition

Objections to foreign-made tubes were directed particularly at those of Japanese manufacture. One commentator said the Japanese tubes decrease employment in the American tube industry.

Current list prices on Japanese tubes are comparable to prices of

U. S. tubes. Net prices to distributors are lower. Fears are expressed that this state of affairs is ideally suited to the precipitation of price wars, with the tubes as ammunition.

Retailers Censured

A common complaint among distributors is that the over-the-counter prices are excessive. One distributor estimates that some over-the-counter establishments sell at better than twice the amount they pay.

One improvement strongly sought by distributors centers around demands to manufacturers to set up more efficient supply lines. Distributors feel they are excessively burdened by unnecessary inventory requirements. A trade custom still in practice is for distributors to buy a year's stock at a clip to get special financial concessions from the manufacturer. This and other "loading practices" ties up capital for long periods.

Deliveries Speeded

Many manufacturers are coming up with automatic inventory controls and accelerated delivery programs to help overcome the distributors' difficulty.

Under these systems, a business machine punch card is contained in each tube carton. The card indicates tube type and quantity. The dealer, rather than writing a purchase order when he needs more stock, simply mails the accumulated cards to the manufacturer. The manufacturer in turn uses the cards to accelerate order processing, speed up delivery, and issue shipping data.

Flexible prices of tv picture tubes seem likely to remain part of the distributor's problems for some time to come. This market is old enough now for seasonal drops to be anticipated. To offset these volume fluctuations, manufacturers of picture tubes give periodic discounts which average about 15 percent but range from 10 to 25 percent.

One major manufacturer adds a 4-percent incentive discount for carload lot orders. Another, who gives all comers a 12½-percent discount, adds on a 1-percent allowance for promotion purposes, plus 3½ percent more for carload lots or 2½ percent more for truckload shipments of picture tubes.

Flying brains need

clear heads

...and keeping them "thinking" clearly is the job of the Hughes Field Engineer. Invariably you'll find him in the company of top armed services and aircraft manufacturer's personnel. As in the photo at far left, his laboratory is in the field, evaluating a highly advanced Hughes Electronic Weapons System.

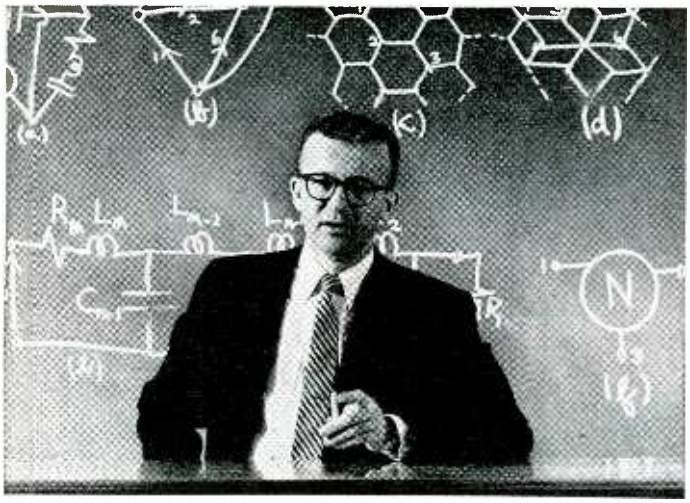
Drawing on a firm base of training in the total system, he judges and evaluates its performance. One of his key jobs is suggesting basic modifications. Simultaneously, he maintains close liaison with Hughes manufacturing groups to insure the highest standards of reliability.

The Hughes Field Engineer is typical of engineers and scientists throughout the Hughes organization. Here, the individual is given every opportunity to work out his ideas, to add measurably to his professional stature.

At Hughes Ground Systems Division, for example, engineers and scientists are now exploiting a major breakthrough—3-D radar. This new development is acknowledged as the most significant progress step since radar itself was discovered.

At Hughes Products, advanced work is being done on a variety of automatic control systems, microwave tubes and new semiconductor devices.

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



NETWORK SYNTHESIS *is one of the many areas of study at Hughes Research and Development Laboratories. This work includes lumped and distributive parameter systems, both passive and active.*

TESTING THE TESTERS—*At Hughes Advanced Electronics Manufacturing Division, test equipment designed and built for Hughes Weapons Systems is often as sophisticated as the systems themselves!*

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

Communications	Environmental Engineering
Industrial Systems	Logical Design
Electron Tubes	Radar Circuit Design
Field Engineering	Material & Component Eng.
Semiconductors	Systems Analysis
Test Equipment Eng.	Systems Management

Write in confidence, to Mr. John Case, Hughes General Offices, Bldg. 6-D6, Culver City, California.

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

British Show New Transistors

Units displayed at recent exhibition point up advanced h-f and fast-switching applications

LONDON—TRANSISTOR manufacturers in Britain are producing this year at an estimated rate of more than 20 million units. Although this is far from approaching the 80 million transistors U. S. companies are expected to turn out, the British are pushing hard on improving their techniques.

At the stands at last month's International Transistor Exhibition in London were alloy-germanium transistors with dissipations up to 20 watts and lower power models with cutoff frequencies up to 20 mc. Recently introduced diffused base transistors ranged up to several hundred mc.

New on the British market also were alloy transistors of both npn and pnp types for computers. Switching times of 10 millimicroseconds were reported.

Simulates Behavior

Improved temperature ratings are available, such as the Mullard OC 200 silicon alloy junction types with junction temperature range from —50 to 150 C. Mullard is using electrical network analogs to simulate transistor behavior. Variable resistors are set in the various thermal coefficients, while other analogs determine geometric and surface effects on transistor performance.

The Royal Radar Establishment showed a high-speed shift register operating from 70 millimicrosecond pulses at a five mc repetition rate. A novel beat frequency oscillator exploits the transistor switching properties.

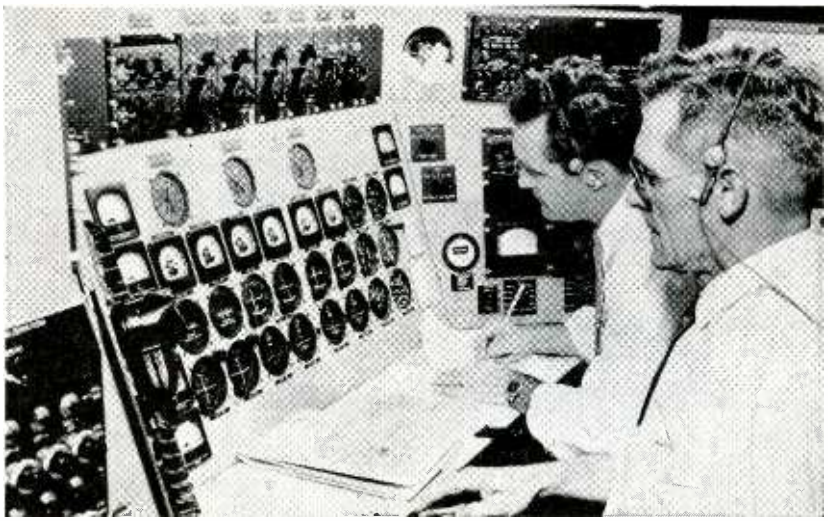
Two oscillators, one fixed and one variable, are used. The variable frequency source supplies a square wave current to a balanced two-transistor switching circuit. This circuit switches the fixed oscillator sine wave output to the respective emitters of a pair of common base amplifier stages.

The wanted audio signal appears across an output resistor in the collector circuit. With this system, and with no buffer stages between the oscillators, pull-in does not occur until the beat frequency is less than 0.1 cps.

Armstrong Whitworth Aircraft Co. exhibited a transistorized analog-digital converter operating at a 50,000 per second conversion rate.

Ferranti Ltd. showed its new 560 lb fully transistorized Sirius desk computer costing $45,000. Input and output may be in form of punched or magnetic tape.

Test New Air Nav-Aids



Federal Aviation Agency technicians check out new direction-finding gear made by Topp Industries to work into VOR (vhf omnirange) system. Topp gear reduces angular tolerance of VOR measurement to half a degree; present systems vary as much as 5.4 deg

NEW PROGRAM

Raytheon enters new weapons systems program and offers advancement opportunities for both Junior and Senior electronics engineers with experience in the following fields:

- Microwave engineers—component and antenna design
- Communications systems
- Guidance systems
- Computer systems
- Radar systems
- Inertial reference systems
- Feed-back control
- Auto-pilot
- Ground support
- Electronic packaging engineers
- Radar systems engineers (project management)
- Electromechanical engineer for missile control and auto-pilot design (project management)
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Pulse Communications

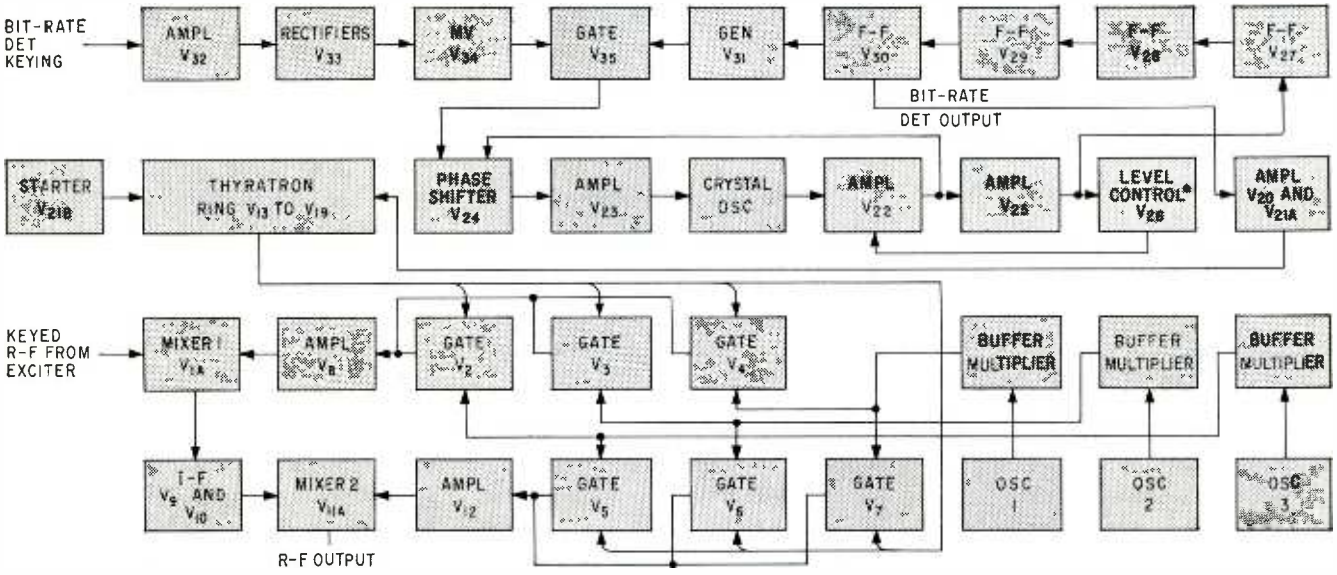


FIG. 4—Transmitter frequency translator. Bit-rate detector consists of all blocks in the upper-two rows, except the thyratron block

Figure 2 shows the frequency-shifting relationships in a system developed for ionospheric-scatter circuits above 30 mc. Frequency-shifting relationships are the same for the receiver and transmitter.

The frequency-translation circuits of the transmitter successively shift transmitter frequency through seven frequencies. The portion of each frequency swing that is introduced by the frequency-translation circuits is 0.8 kc. Keying of the transmitter by the space-mark information contributes the other portion.

For example, the frequency-translation circuits set up the transmitter so that during time-interval t_1 the transmitter frequency is either that shown at point a or at point b depending on whether the transmitter is keyed by a space or a mark. Space-mark frequencies are 6-kc apart.

As the receiver frequency is also shifted, during time t_2 the receiver is sensitive only to either of the frequencies corresponding to points c and d. During time t_0 the receiver is again sensitive to these frequencies, but it cannot pick up anything radiated at time t_2 because the total time interval of a cycle, t_2 to t_0, is long enough for multipath transmission to die out.

The transmitter and receiver (Fig. 3) each contain a near-identical section called a frequency translator. Each translator produces a small frequency shift that is in step with keying information.

At the transmitter, space-mark keying information drives a frequency-shift exciter and a bit-rate detector. The detector samples the keying input to determine its basic repetition, or bit rate and produces a stepping pulse coincident with the end of each bit. Each keying pulse advances the frequency translator to the next frequency in its sequence by pulsing a thyratron ring. The ring shifts the translator through seven frequencies (Fig. 2) and then returns the translator to its original frequency.

The frequency translator of the receiver reverses the frequency shift produced in the transmitter. Thus the specific frequency that is to be received during each interval is translated to the frequency to which the receiver is tuned. All other frequencies that are picked up at the receiver antenna are rejected. The keying information which originates the receiver frequency shift comes from the receiver keying output.

To minimize fading effects, two receivers are used in a dual-diversity setup.

In its passage through the transmitter frequency-translation system (Fig. 4), the keyed-carrier frequency passes through two frequency shifts. The first shift converts the carrier frequency from the exciter to an intermediate frequency where the carrier frequency is filtered out. The second shift reconverts the i-f to the carrier frequency, plus or minus a discrete number of frequency-shift units. The i-f used is approximately 5 mc and is the difference between the carrier frequency and the 1st-mixer injection frequency, which is 5 mc below the carrier frequency. Thus, a plus-frequency shift unit added at this point results in an i-f that is 5 mc minus the unit.

In the second mixer the carrier frequency is restored by adding the i-f and the second mixer injection frequency. At this point another frequency-shift unit is added, producing the original carrier frequency plus or minus the difference between the frequency-shift unit subtracted in the first mixer and the

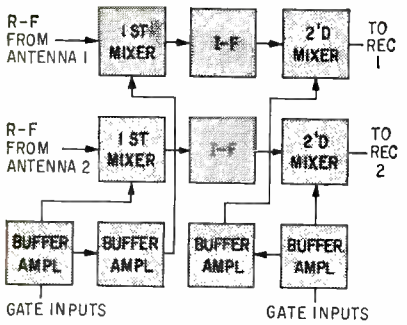


FIG. 5—These blocks compose portion of receiver frequency translator that differs from transmitter frequency translator

frequency-shift unit added in the second mixer. Each frequency-shift unit is 0.8 kc. and there are seven frequency shifts.

The reverse, though identical, procedure takes place at the receiver. That is, if 800 cps are added to the carrier frequency at the transmitter it must be subtracted at the receiver. In the receiver's first mixer (Fig. 5) the frequency-shifted carrier is converted to 5 mc minus the frequency-shift unit added in the second mixer at the transmitter. The original carrier frequency is restored in the second mixer by adding the frequency-shift unit that was subtracted in the first mixer at the transmitter. Thus the receiver-mixer output emerges as the received signal minus the difference which was added at the transmitter. Output frequency is the same as the frequency of the keyed transmitter exciter.

Translation Oscillators

Three crystal oscillators supply the three different injection frequencies that add or subtract in the mixers. Combinations of the injection frequencies supply the frequency-shift units.

Oscillator No. 2 generates a frequency which is one frequency-shift unit (about 0.8 kc) higher than oscillator No. 1. Oscillator No. 3 oscillates at three frequency-shift units above oscillator No. 1.

First Mixer and Gates

The keyed-carrier signal from the transmitter exciter is fed to the cathode of tube V_{1A}, the first mixer in Fig. 4 and 6. The second half of the tube acts as a clamp to maintain the injection-frequency signal at a constant level.

Two sets of three diodes, V_2 to V_4 and V_5 to V_7, constitute the gating system for the first and second mixers. Each diode input is fed continuously by one of the three oscillators. Each diode gate normally has a negative voltage on its plate and is thus doubled until enabled by a pulse from a thyratron ring. Each gate is neutralized so that it cannot pass a signal by its plate capacitance when disabled. At the proper instant, the thyratron ring applies a positive voltage to the plates of two of the gates causing them to conduct. The enabled gates pass the injection frequencies to tubes V_8 and V_{12}. Tubes V_8 and V_{12} are isolation-buffer amplifiers which pass the injection frequencies to the grids of the mixers.

The output tank of the first mixer is tuned to about 5 mc, the difference between the incoming carrier and the injection frequency applied to the first mixer. Tubes V_9 and V_{10} are i-f amplifiers which feed the first-mixer signal to the second mixer.

Second Mixer and Gates

Gates of the second mixer operate in the same manner as the first-mixer gates, although not in the same order. The second mixer operates in the same manner as the first mixer, except that second-mixer output is the sum of the i-f and the injection frequencies.

The i-f is fed to the cathode of tube V_{11A}. Tube V_{11B} operates as a clamp to maintain the injection signal at a constant peak level. When any particular gate is enabled, an injection signal passes to tube V_{12} which is an isolation-buffer amplifier. The signal then goes to the grid of V_{11A} where it is injected and mixed with the 5-mc i-f. The tank circuit of the second mixer is tuned to the carrier frequency.

Thyratron Ring

Tubes V_{13} to V_{19} constitute the thyratron ring—Fig. 7. This ring triggers the gates of the first and second mixers at the proper speed and in the proper sequence so the gates pass the various injection frequencies to the mixers.

The input signal from the bit-rate detector enters the first of two dual triodes, V_{20} and V_{21}. The first three triode sections function as pulse-shapers, and the fourth triode, V_{21B}, is an automatic starter for

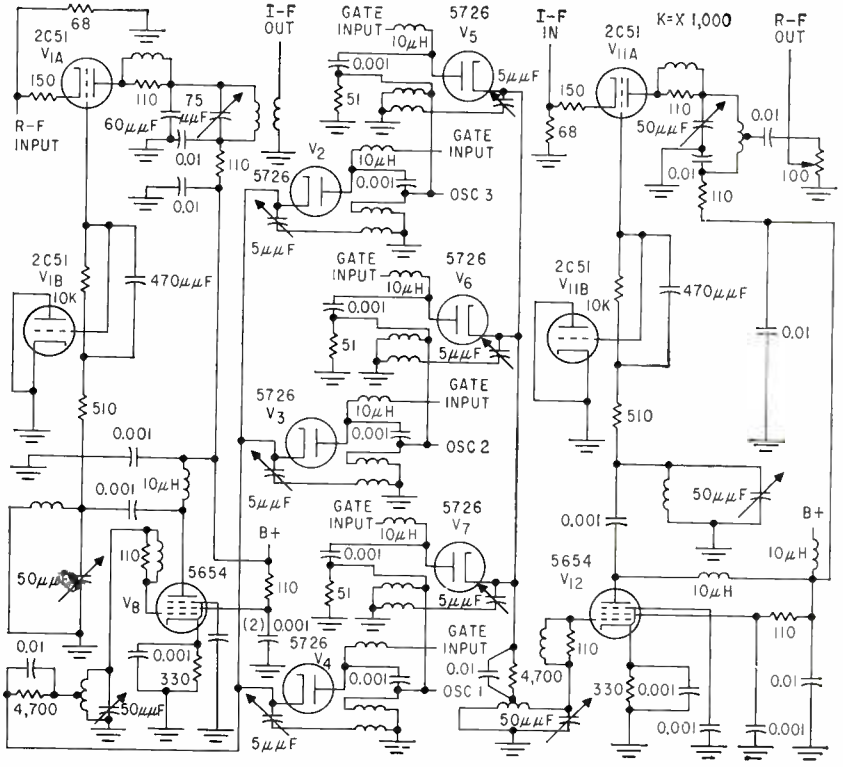
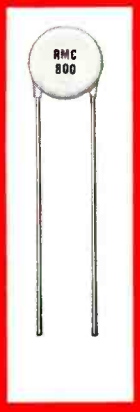


FIG. 6—First mixer, gates and second mixer of transmitter. Output of first mixer passes through two i-f amplifiers, which are not shown, before entering the second mixer

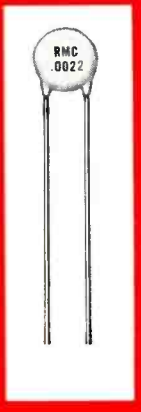
Check RMC for your needs in ceramic capacitors

RMC DISCAPS



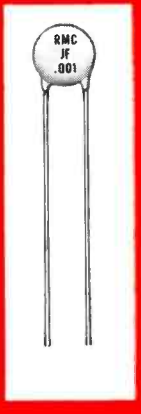
Type JL

RMC Type JL DISCAPS are engineered for applications requiring a minimum of capacity change as temperature varies between −60°C and +110°C. Over this wide range the capacity change of type JL DISCAPS is only ±7.5% of capacity at 25°C. Standard working voltage is 1000 V.D.C.



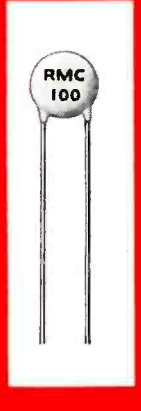
Type B

Designed for by-passing, coupling or filtering applications, Type B DISCAPS meet and exceed all E.I.A. RS198 specifications for Z5U ceramic capacitors. Type B DISCAPS are manufactured in capacities between .00015 MFD and .04 MFD and are rated at 1000 working volts.



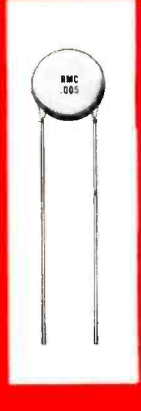
Type JF

Type JF DISCAPS exhibit a frequency stability characteristic that is superior to similar types. These DISCAPS show a change of only ±7.5% over the range between +10°C and +85°C. These DISCAPS extend the available capacity range of the E.I.A. Z5F ceramic capacitor between +10°C and +85°C and meet all Y5S specifications between −30°C and +85°C.



Type C

Specifications of E.I.A. RS198 are met or exceeded by these temperature compensating DISCAPS. Smaller sizes are well suited to designs where space is at a premium. Type C DISCAPS are rated at 1000 working volts providing a higher safety factor.



Type SM

Where space is at a premium, Type SM DISCAPS can be specified with complete assurance of the quality, dependability, and electrical performance built in all RMC DISCAPS. SM DISCAPS show minimum capacity change between +10°C and +65°C.

FIN-LOCK DISCAPS

Designed for holes from .040 to .052 "Fin-Lock" DISCAPS are automatically stapped in holes over .052 by the shoulder design of the leads. "Fin-Lock" leads permit either automatic or hand assembly. "Fin-Lock" leads are available on all DISCAPS of standard voltages, ratings and spacings at no increase in price.

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MEETINGS AHEAD

June 24-26: Nuclear Instrumentation Symposium, ISA, Idaho Falls, Ida.

June 24-27: Medical Electronics, International Conf., UNESCO, CIOMS, PGME of IRE, Rockefeller Inst., UNESCO House, Paris, France.

June 29-July 1: Military Electronics, National Convention, PGMIL of IRE, Sheraton-Park Hotel, Wash., D. C.

July 1-5: Television Convention, International, British Institution of Radio Engineers, Univ. of Cambridge, England.

Aug. 17: Ultrasonics, National Symposium, PGUE of IRE, Stanford Univ., Palo Alto, Calif.

Aug. 18-21: Western Electronics Show and Convention, WESCON, Cow Palace, San Francisco.

Aug. 23-Sept. 5: British National Radio & Tv Exhibition, British Radio Industry Council, Earls Court, London.

Aug. 31-Sept. 1: Elemental and Compound Semiconductors, Tech. Conf., AIME, Statler Hotel, Boston.

Sept. 14-16: Quantum Electronics, Resonance Phenomenon, Office of Naval Research, Shawanga Lodge, Bloomingburg, N. Y.

Sept. 15-17: Electronic Exposition, Twin Cities Electronic Wholesalers Assoc., Municipal Auditorium, Minneapolis.

Sept. 17-18: Nuclear Radiation Effects in Semiconductors, Working Group on Semiconductor Devices, USAS-RDL, Western Union Auditorium, New York City.

Sept. 21-25: Instrument-Automation Conf. & Exhibit, ISA, International Amphitheater, Chicago.

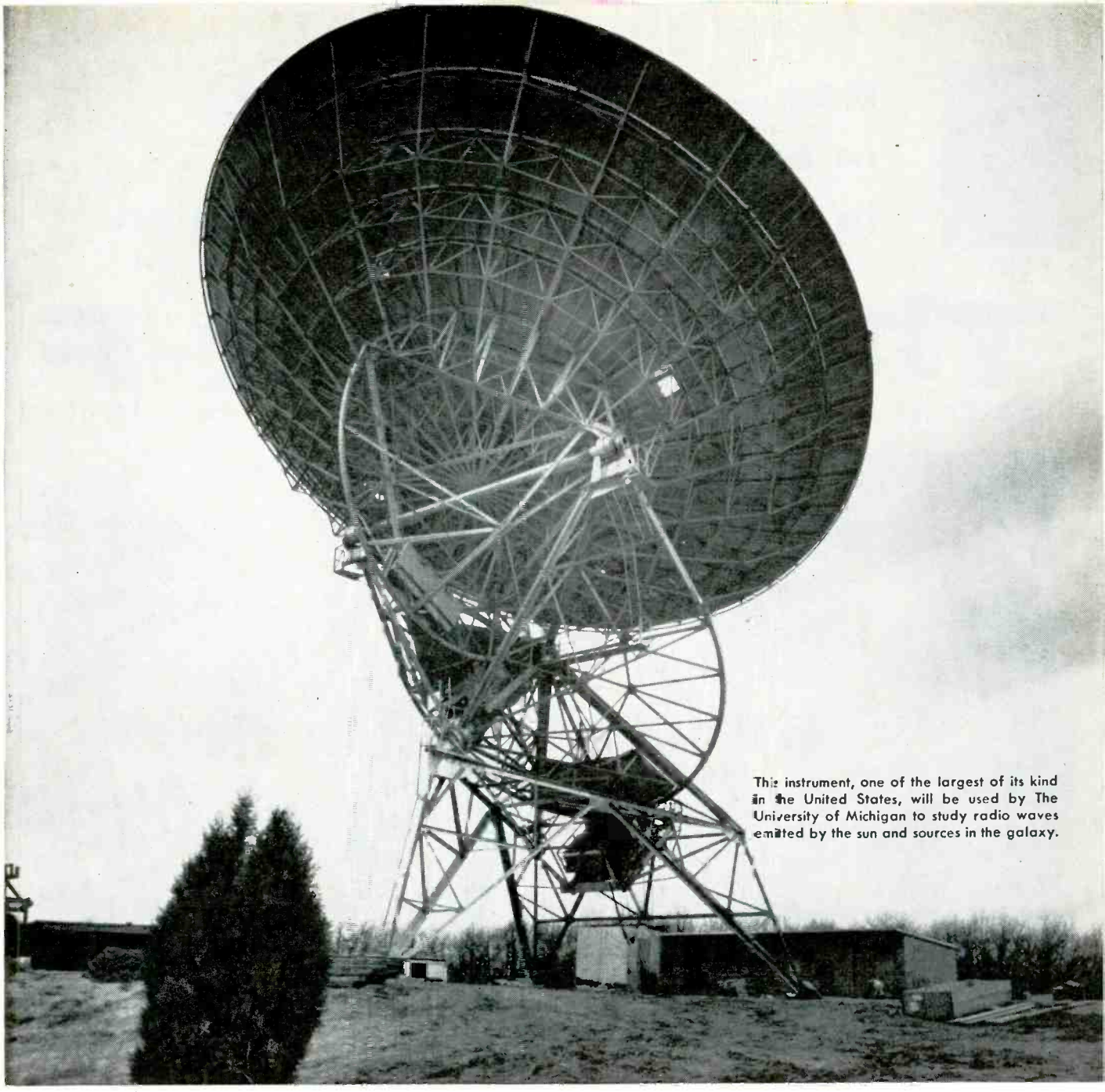
Sept. 23-25: Non-Linear Magnetics and Magnetic Amplifiers, AIEE, ISA, PGIE of IRE, Shoreham Hotel, Wash., D. C.

Sept. 23-25: Residual Gases in Electron Tubes and Related High-Vacuum Systems, International Symposium, Italian Society of Physics, Como, Italy.

Oct. 12-15: National Electronics Conference, IRE, AIEE, EIA, SMPTE, Sherman Hotel, Chicago.

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

There's more news in ON the MARKET, PLANTS and PEOPLE and other departments beginning on p 90.



This instrument, one of the largest of its kind in the United States, will be used by The University of Michigan to study radio waves emitted by the sun and sources in the galaxy.

New BLAW-KNOX 85-foot diameter Radio Telescope

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Equatorial Mount—The telescope is mounted with its polar axis parallel to the earth's axis. The reflector moves from the eastern and western horizons about the polar axis; and rotates about the declination axis from the north celestial pole, through zenith, to the southern horizon.

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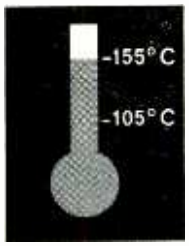

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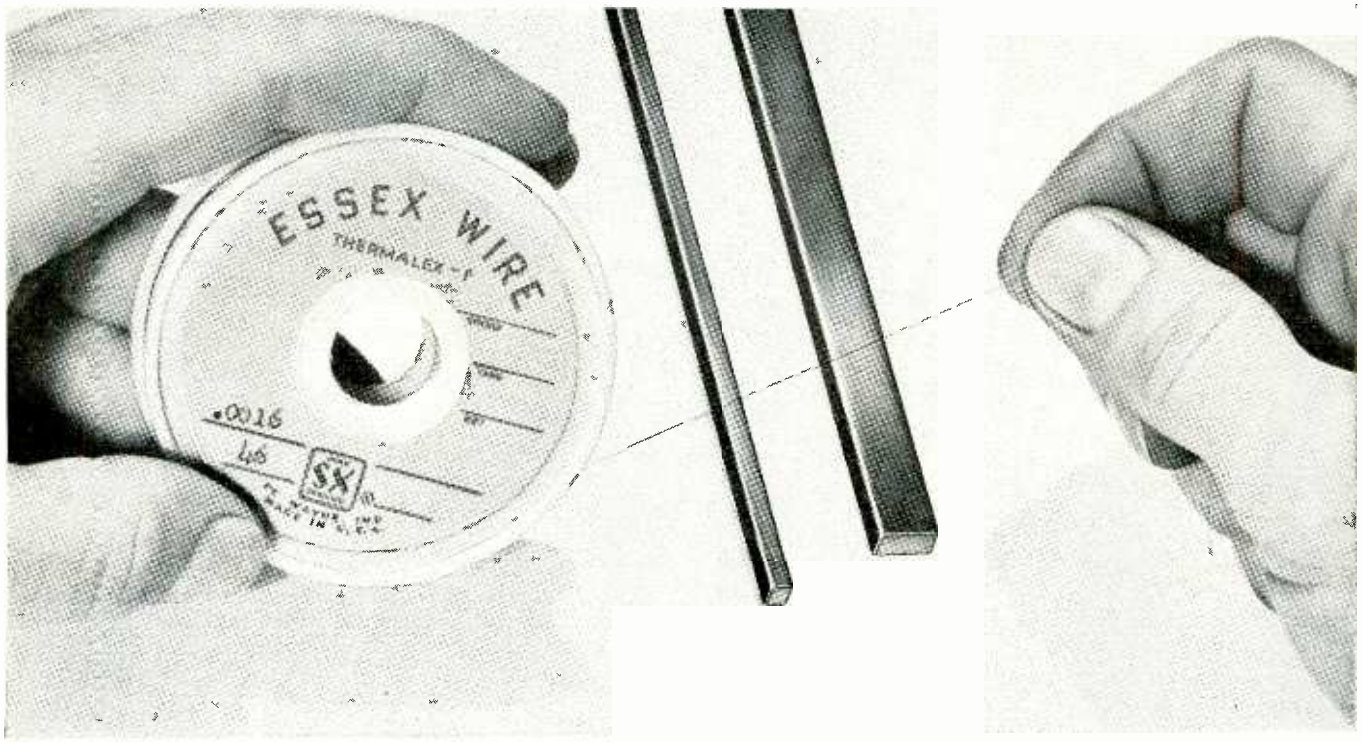

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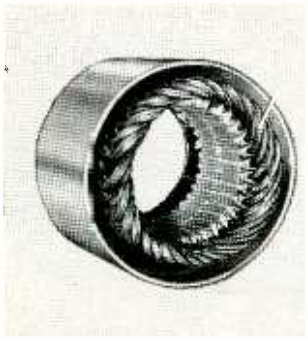

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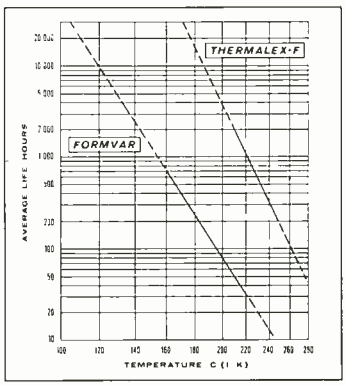
Thermalex-F is not a special wire but has properties required for a general purpose application and can be used through the 105 C-155 C temperature range... Class A applications as well as Class F... eliminating the need for buying more than one type of magnet wire.



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Latest in the Clare line of Mercury-wetted Contact Relays, world famous for their billions of operations*, is Type HG6F, a six-in-line flat-pack relay. This striking new design provides the most reliable, durable, maintenance-free relays ever made anywhere, *plus these savings.*

Compact CLARE TYPE HG6F Relay ready for mounting. Overal dimensions: 3.640"x3.125"x" .046"

SAVES SPACE–

Unique packaging affords up to 50% savings in space over cylindrical multi-element mercury-wetted contact relays.

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Six switches per coil saves operating power.

SAVES COST–

Switch cost as much as 26% below cost of same number of switches in cylindrical packages.

*Mercury-wetted contact relays on test have completed over 8 billion operations with a contact-load of 250 volt-amperes, and are still going strong.

MECHANICAL FEATURES

Flat, rectangular package makes most efficient use of chassis space.

Printed circuit mounting eliminates customary internal wiring except for coil leads.

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No shelf deterioration; requires no maintenance.

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Tamper proof.

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Nominal operating time: 1 watt input, 11 milliseconds; 2 watts input, 7 milliseconds; 4 watts input, 5 milliseconds.

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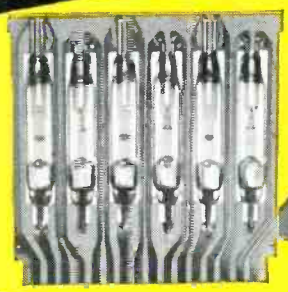
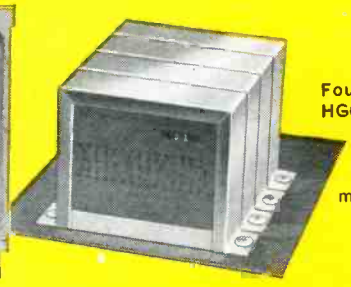


Arrangement of six-in-line mercury-wetted contact switches on printed circuit panel.



Four CLARE Type HG6F relays mount in a space 50% less than cylindrical multi-element assemblies.

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CLARE RELAYS

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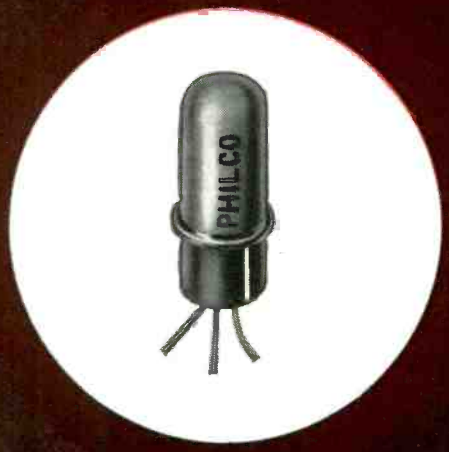

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Type 2N496 is specifically engineered for high speed switching circuits. The frequency at which beta equals unity (f_t) is typically 18 mc. It gives the designer the advantages of low saturation resistance and low voltage operation, at high junction temperatures.

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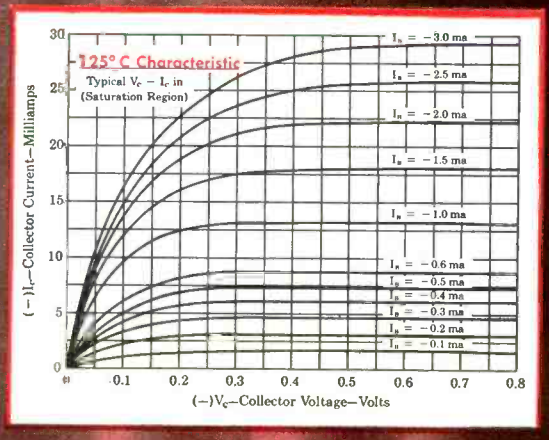
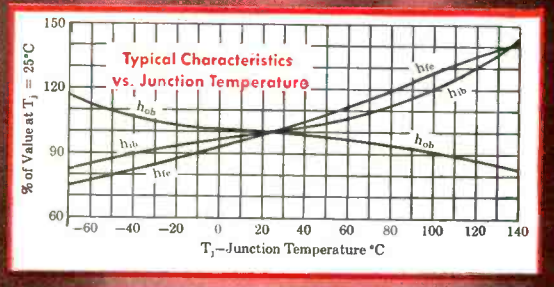
Complete information will be supplied upon request. Write Lansdale Tube Company, Division of Philco Corporation, Lansdale, Pa., Dept. E-659.

**Trade Mark Philco Corp. for Surface Alloy Transistor*





CHARACTERISTICS OF TYPES 2N495 and 2N496

CHARACTERISTIC	CONDITION	TYPICAL VALUE	
		2N495	2N496
Current Amplification Factor, h_{fe}	$V_{CE} = -6$ v, $I_E = 1$ ma	20	
Current Amplification Factor, h_{FE}	$V_{CE} = -0.5$ v, $I_C = -15$ ma		16
Output Capacitance, C_{ob}	$V_{CB} = -6$ v, $I_E = 1$ ma	7 $\mu\mu$f	7 $\mu\mu$f
Maximum Frequency of Oscillation, f_{os} max.	$V_{CB} = -6$ v, $I_E = 1$ ma	21 mc	
Frequency for Beta = 1, f_t*	$V_{CE} = -6$ v, $I_E = 1$ ma, $f = 4$ mc		18 mc
Cutoff Current, I_{CBO} or I_{EBO}	V_{CB} or $V_{EB} = -10$ v	.001 μa	.001 μa

Maximum Power Dissipation—150 mw

Maximum Collector Voltage 2N495—25 V
2N496—10 V

*f_t (the frequency at which beta is unity) is typically 85% of the alpha cutoff frequency.

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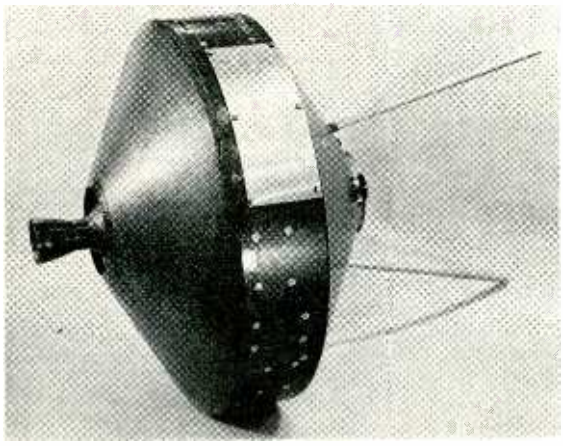
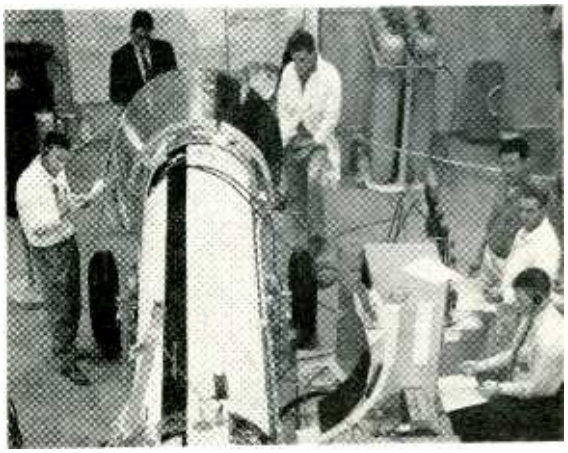


Pioneer lunar probe vehicle. Retro rocket to place the vehicle in lunar orbit protrudes from shell. Antenna is at rear



Ground testing portion of missile to check proper operation of second, third and fourth stages

Circuits for Space Probes

They measure magnetic fields, sense radiation level and transmit tv pictures back to earth. Circuit design allows use of vehicle as space station relay for long-distance vhf communications

By R. R. BENNETT, G. J. GLEGHORN, L. A. HOFFMAN, M. G. McLEOD and Y. SHIBUYA,
Space Technology Labs., Inc., Los Angeles, Calif.

ON OCTOBER 11, 1958, the United States launched the first space probe using the Pioneer vehicle. This highly-instrumented vehicle travelled over 70,000 miles from the earth before it returned to destruction in the earth's atmosphere. Portions of the electronic circuits that composed the fourth or payload stage will be covered in this article.

MISSILE — The first stage was a conventional Thor IRBM missile generating 150,000 lbs of thrust. The normally-used guidance system was removed to save weight. The second stage was a special vehicle which had been successfully flown previously, and had a thrust of 7,500 lbs.

Control about the pitch and yaw axes was provided by gimballing the engine (thrust chamber) with hydraulic servos. The pitch and yaw channels were identical except for the addition of a gyro torquing signal used to program the missile in pitch.

Roll control was provided by a set of helium jets located about the periphery of the missile. The jets used the main propulsion system helium supply. The roll jet helium supply was controlled by solenoid-operated valves. The jets operated in pairs and provided 7.5 lbs of thrust each.

Certain critical second stage airframe, control, and propulsion functions were telemetered by a three-band f-m/p-m system that radiated 2 w of r-f. Pulse-amplitude modulation was employed on one subcarrier to multiplex a number of information channels.

An electronic commutator capable of time-division multiplexing 14 channels of information, inserting a reference level between information pulses and supplying a synchronizing pulse to identify each frame was used.

The Pioneer's third stage used a solid-propellant rocket motor. The fourth stage was to be used as

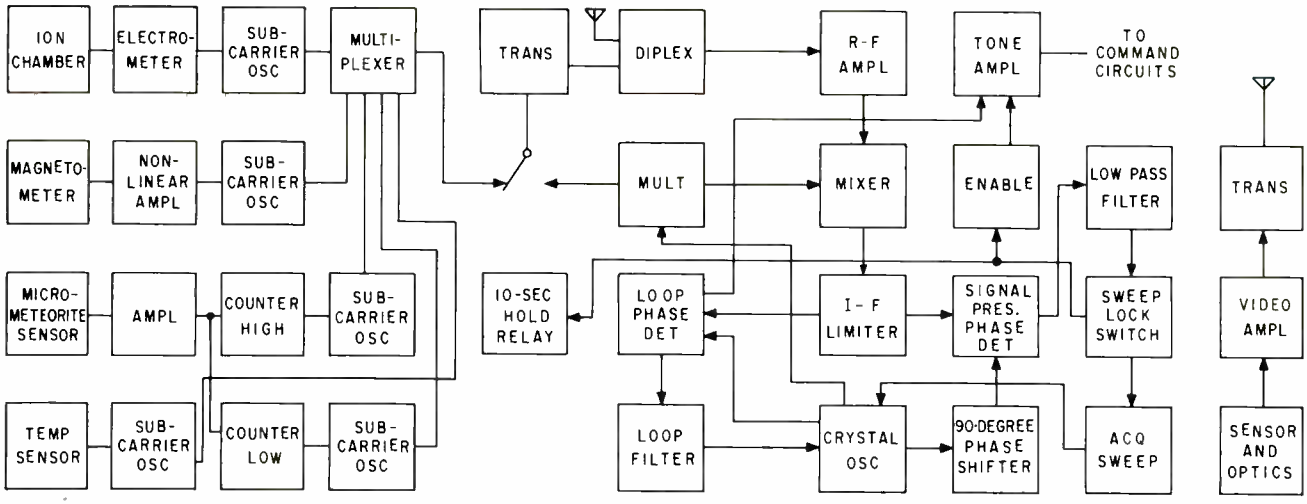


FIG. 1—Four sensing devices are multiplexed for transmission as f-m/p-m signal. Transmitter can be switched for use as Doppler transponder and as receiver-transmitter repeater system

a retro rocket. It's solid-propellant motor was mounted within the payload. The retro rocket was intended to be fired when the payload approached lunar orbit and guide the payload toward the moon.

PAYLOAD—The total weight of the payload was 83 lb of which 34 lb was in electronic components. Power was obtained from a combination of mercury cells and silver-zinc hydroxide batteries. A honeycomb structure made of epoxy-fiberglass housed the electronic components. The exterior of the shell was coated with a special blue paint pattern with proportion of the coated to the uncoated portion of the shell providing temperature control within the vehicle.

A block diagram of the payload is shown in Fig. 1. The telemeter was an f-m/p-m system. Five frequency-modulated subcarrier oscillators operated in the five lowest bands normally associated with frequency-division telemetering; 400, 560, 730, 960 and 1,300 cps. The subcarrier oscillator outputs are resistively summed and amplified to become the complex modulation for the transistorized crystal-controlled transmitter. Each tone phase-modulates the r-f carrier approximately 0.3 radian to form a frequency spectrum where a few percent of the total r-f power is carried in each of the five sets of symmetrical sideband pairs about the carrier. This low degree of modulation insures that a major portion of the total power always remains in the carrier so that a locked condition can be maintained in the microlock receiving system used at ground tracking and receiving stations.

The five subcarrier channels were employed to transmit ion density, two levels of micrometeorite particle impacts, magnetic field strength and compartment temperature.

MAGNETOMETER—Typical of the circuits is the magnetometer used to measure the earth's magnetic

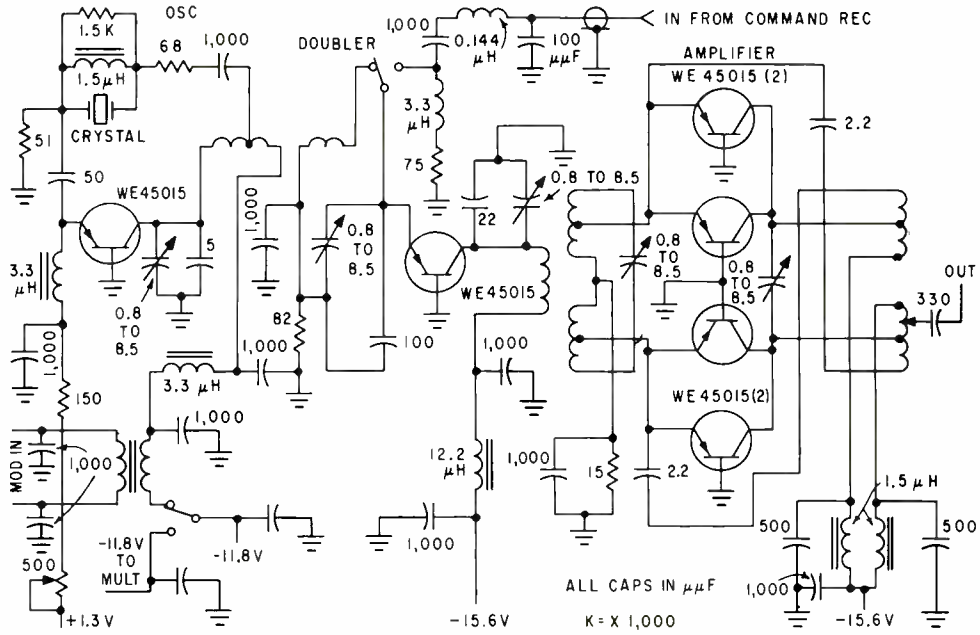


FIG. 2—Pioneer's all-transistor transmitter uses a push-pull parallel output stage. It will accept inputs from either the telemeter system or signals from the command receiver

field at great distances. It consists of 30,000 turns of fine wire wrapped around a ferromagnetic core. This core is mounted against the inner circumference of the payload. As the payload spins about its axis at 2 cps, the output of the magnetometer coil consists of a sine wave with a frequency equal to the payload spin rate and an amplitude proportional to that component of the earth's magnetic field vector perpendicular to the spin axis. The magnetometer is in effect a simple a-c generator in which the magnetic field strength in space takes the place of the field windings and the coil fastened to the spinning payload is the armature.

The output of the magnetometer is amplified by a nonlinear amplifier that provides gain and compresses a large input range to a small output range to make wide-range magnetic field measurements possible.

The output of the nonlinear amplifier is fed to an f-m subcarrier oscillator to produce a signal frequency modulated at the spin rate. The frequency deviation is proportional to the amplitude of the amplifier output which in turn is a function of the magnetic field strength. This subcarrier output is mixed with the other subcarriers of the telemeter system and the resultant signal is used to phase modulate the transmitter.

The transmitter may be coupled to the receiver to form a phase-coherent transponder system to provide measurements of Doppler velocity and position from earth tracking stations. The receiver also furnishes output commands to operate certain payload equipment sequences. Unless interrogated for command or Doppler purposes, the system continuously transmits telemetry data.

The electrical schematic of the transmitter is shown in Fig. 2. The output stage uses four transistors in a push-pull parallel combination. The transmitter has an output of 400 mw with a frequency stability of 2 parts in 10^7 per deg C, an efficiency of 53 percent and weighs 10 oz.

RECEIVER—The receiver uses 62 transistors, has a gain of 20 db and a noise figure of 8 db. The i-f bandwidth is centered about 6 mc and is determined by a crystal-lattice filter that is 10 kc wide at the 6 db point.

The receiver sweeps in frequency until phase lock is accomplished. The sweep circuit uses a voltage-variable semiconductor capacitor effectively shunting the crystal of a crystal-controlled oscillator. The receiver has a sensitivity of −130 dbm, consumes less than 270 mw and weighs 5.7 lb including batteries for a life of 120 hours.

MISSILE TESTING AND CHECKOUT—After the various subsystems were installed in the missile, exhaustive checks were performed to check proper operation of the equipment as a missile system. The propulsion system was exercised by pressurizing gas fed through the ground console. All systems were operated in as realistic a time scale as possible.

GROUND STATIONS—To track the Pioneer and receive the telemetry signals, a network of ground

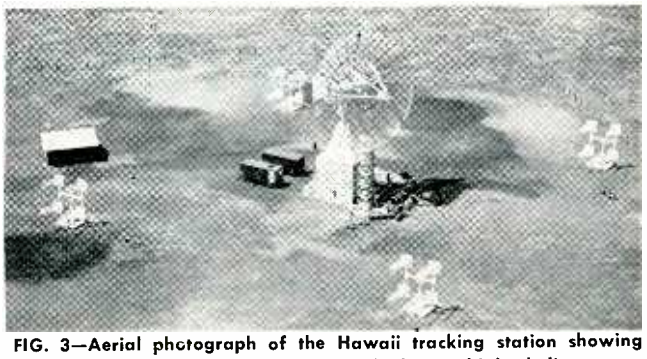


FIG. 3—Aerial photograph of the Hawaii tracking station showing the parabolic receiving antenna and the multiple helix arrays arranged as an interferometer system

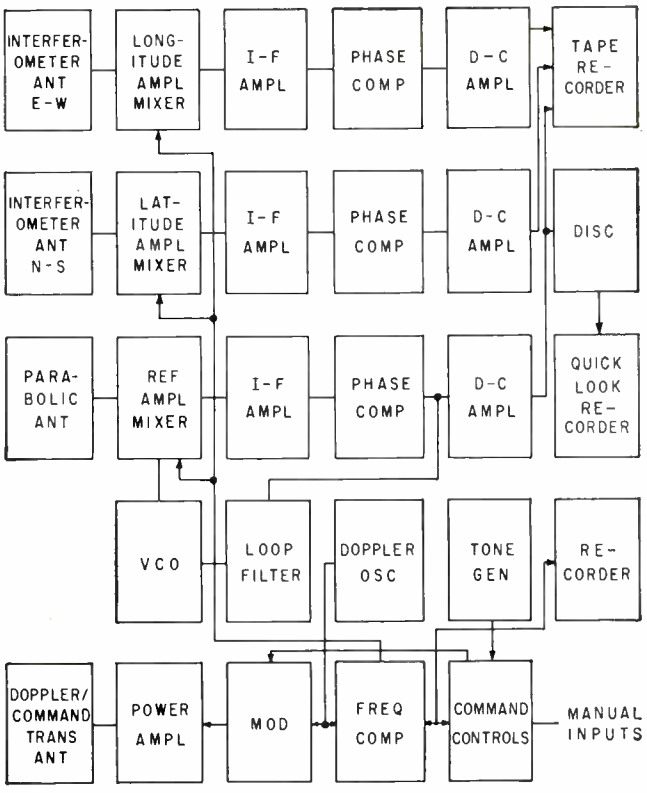


FIG. 4—Main elements of the Hawaii tracking station showing the microlock receiving system and the command transmitter

stations was established. Two of these, at Cape Canaveral and Hawaii, included provisions for sending commands to the payload. Figure 3 is an aerial view of the Hawaiian station showing the 60-ft parabola and multiple-helix arrays. The latter are used in an interferometer arrangement. The block diagram of the Hawaii station including the microlock receivers and command transmitter is shown in Fig. 4.

Because the Pioneer contained a receiver-transmitter repeater system, it was possible to communicate through the payload from one ground station to another.

On October 12, 1958, a vhf relay was accomplished between Florida and England and between Hawaii and Florida. This portion of the experiment highlights the use of satellites for intercontinental communications.

Switching VHF Power

Silicon power rectifier diodes, placed in a coaxial cable, switch r-f power from one circuit to another. Configuration, designed for vhf antenna systems in fast aircraft, can be used in many applications and at lower frequencies

By ROY H. MATTSON and S. H. LIU, Electrical Engineering Department, Iowa State College, Ames, Iowa

NEED FOR SWITCHING radio frequency power in coaxial cable systems arose first in the aircraft antenna field. Although this article presents the solution to the antenna switching problem, the results are applicable to a large number of problems and a much wider frequency range, especially to lower frequencies. To avoid generalities the specific results of the antenna switching project will be used.

Antennas used for vhf communications on high-speed aircraft cannot be constructed with omnidirectional radiation patterns. Therefore, two antennas are located on the aircraft to give better coverage. But in the region where energy from both antennas is received, interference nulls occur that interrupt communications. To avoid this problem, a switching system has been constructed to transfer the amplitude modulated r-f carrier from one antenna to the other.

Silicon Switch

Switching is accomplished in a simple and straightforward manner using silicon power rectifier diodes placed in coaxial cables as illustrated in Fig. 1.

Figure 2A shows a sketch of a silicon power rectifier diode, and Fig. 2B represents the distribution of conduction carriers inside of this diode when it is reverse biased. Figure 2C represents the distribution of conduction carriers inside of the diode when it is forward biased. Because of the abundance of injected carriers in the intrinsic region, an a-c signal sees a low impedance through the diode.

The graph, Fig. 3, shows how the magnitude of the impedance of a silicon power rectifier diode varies as a function of frequency for various biasing conditions. Note when the diode is forward-biased to 50 ma, the impedance is less than five ohms, and when the diode is reverse-biased to 50 v, the magnitude of the impedance of these diodes is greater than 130 ohms up to 500 mc.

To be complete, Fig. 4 shows how the phase angle of the impedance of these diodes varies as a function of frequency and bias condition.

Thus, these diodes can be operated as switches at all frequencies from 100 to 500 mc. In this particular application, the frequency range of interest was 225 to 400 mc. The diodes should operate even better at lower frequencies down to around 100 kc.

In the antenna application, the peak r-f power is 10 watts, which corresponds to an rms current of about 450 ma. The silicon power rectifier diodes are rated at 600 ma continuous current with surge current ratings of about an ampere.

When the diode is forward biased to 20 or 30 ma with a direct current, it carries an alternating current of 450-ma rms or 600-ma peak. The current flows in the reverse direction for such a short time at these frequencies that the injected carriers are not swept out of the intrinsic region and the diode remains forward biased. Thus the carrier-storage effect aids system

Table 1—Antenna Switch Data

Freq (mc)	VSWR	Power Loss (db)
200	1.2	1
250	1.1	1
300	1.1	1
350	1.1	1.2
400	1.2	1.2
450	1.3	1.3
500	1.4	1.2

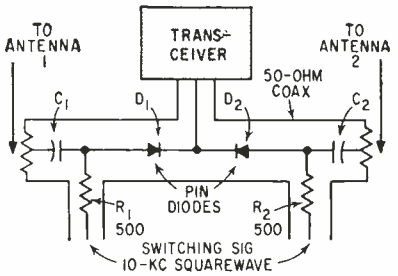


FIG. 1—Antenna switching system, using Sarkes Tarzian M-600 silicon diodes in coaxial cables

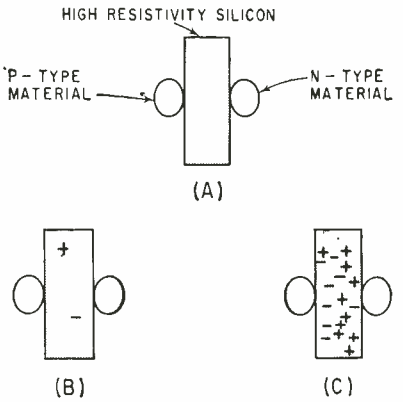


FIG. 2—Sketch of *pin* diode (A) shows distribution of conduction carriers when reversed-biased (B) and when forward-biased (C)

With Silicon Diodes

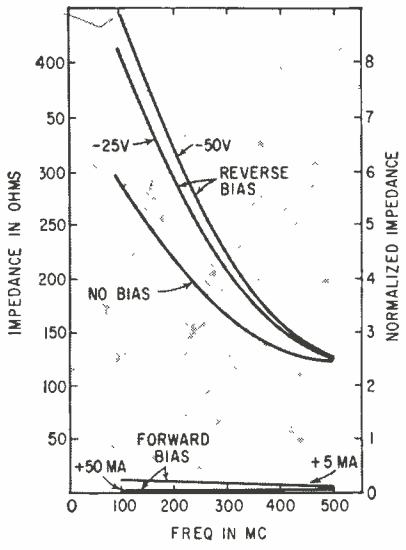


FIG. 3—Impedance of a *pin* diode plotted as a function of frequency for varying bias conditions

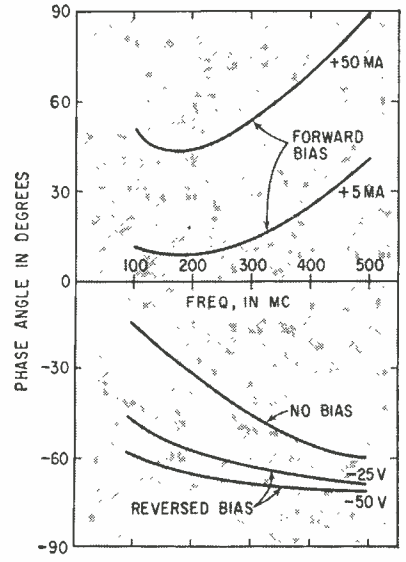


FIG. 4—Phase angle of the impedance of a *pin* diode plotted against frequency for various bias conditions

operation.

However, as the frequency is decreased, this problem becomes more pronounced, and for this particular diode and these power levels, nonlinearity of the diode becomes noticeable at about 100 kc. This imposes a low-frequency limit. With care and proper choice of a diode, the low-frequency limit can be dropped to a few kilocycles.

Figure 5 shows how the diodes are positioned inside a coaxial tee connector with a spring loaded plug for making contact to the diode. The diodes are placed close to the point of separation of power, since the impedance in a coaxial line is a function of the length of the line as well as the load. By placing the switch less than a fifteenth of a wavelength from the tee, it is impossible for a high impedance switch to be reflected as a low impedance at the switching point.

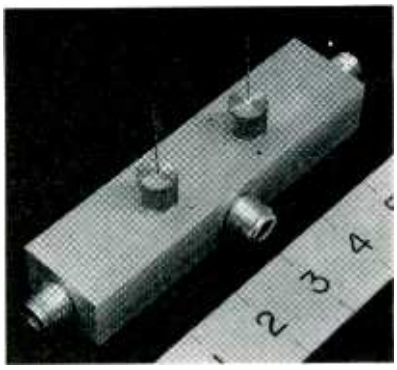
Diode Bias

Figure 1 shows how the diodes are biased. The filter capacitors keep the switching frequency from reaching the antennas and the 500-ohm resistors keep the r-f power in the coaxial line feeding the antenna. There is a low frequency short from the center coaxial conductor to ground inside the transceiver thereby allowing a return path for the 10-kc square wave.

If diode D_1 is forward biased, D_2 is reverse-biased and power goes to antenna 1. When the square wave reverses, D_1 bias reverses, D_2 becomes forward-biased and the power goes to antenna 2. This same operation occurs during reception.

Table I shows results obtained using Sarkes Tarzian M-600 *pin* silicon diodes, with one diode forward biased, the other reverse biased and 50-ohm loads used in place of antennas.

Much of the mismatch and some of the power loss are attributable to the relatively crude filtering em-



Model of diode switch was developed by the Communications Laboratory of the McDonnell Aircraft Corp.

ployed. The system was operated over a temperature range from −60 C to 100 C with no change in operation.

The diode could be used to switch any one of a number of transmitters to a single antenna in some prearranged fashion when the transmitted information is intended for a particular individual.

By using this type of diode switch, controllable shorts and opens can be introduced into a system as variable circuit elements, and can be used as tuning elements. This leads to a number of specific arrangements for particular applications.

The authors are indebted to the McDonnell Aircraft Corporation under whose auspices this work was done; and to the Electrical Engineering Department and Engineering Experiment Station of Iowa College for use of their facilities.

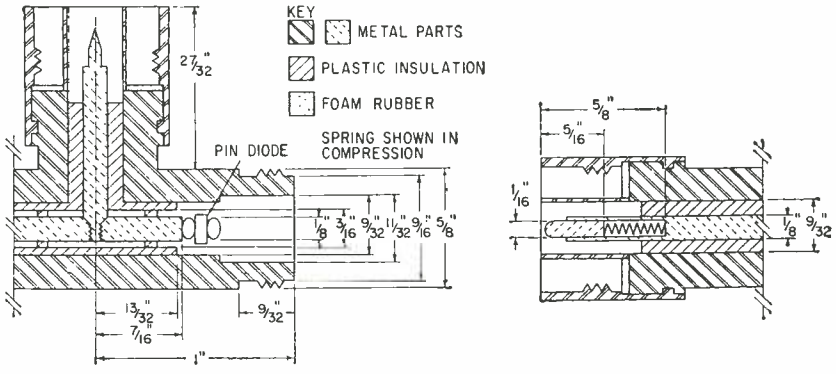


FIG. 5—Mechanical arrangement of diode, showing details of the semiconductor switch. The diodes are positioned inside a coaxial tee connector with a spring-loaded plug for making contact to the diode

Using Isotopes to

Radiological vacuum gages permit measuring extremely low pressures for checking industrial and scientific laboratory equipment and in high-altitude research. This instrument is extremely compact and provides a digital output that can be used for storage or telemetering

By G. FREDERICK VANDERSCHMIDT,
Physicist, Applied Physics Dept., National Research Corporation, Cambridge, Mass.

BY MODIFYING CURRENT from a density-sensitive radiological transducer, the instrument to be described can measure pressures between sea level and 300,000 feet above sea level. Compactness and low-power requirements of this instrument have made it well suited for balloons and rockets to lift it to such heights. Differing from previous radiological pressure gages[1, 2, 3], its output is a digital signal which can be used for storage or telemetering more conveniently than an analog signal.

Radiological Transducer

The pressure-sensing transducer of the instrument is a small cylindrical tube with a radioactive foil fastened around the inside of the tube, as illustrated in Fig. 1. The foil contains a thin layer of titanium in which tritium, the radioactive isotope of hydrogen, is absorbed. Tritium, which is in concentrations up to 400 millicuries, supplies intense low-energy beta radiation to ionize the gas in the chamber. Because only low-energy beta particles are produced by the source, the instrument can be handled with negligible hazard.

Pressure Sensing

To start transducer operation, a charging voltage is briefly applied between the wall of the chamber and the central electrode that runs through an insulating seal at the end of the tube and lies along the tube's axis. Electrons and negatively charged ions are attracted to the positively-charged wall and

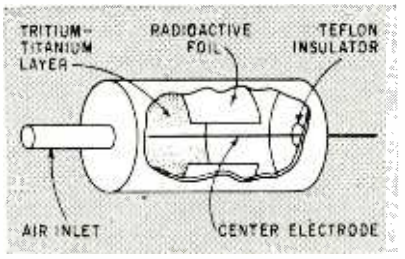


FIG. 1—Although radiation is not detectable outside the radiological transducer, its external surface bears a warning symbol

positive ions to the negatively charged central electrode. When the electrons and ions reach the surface, they neutralize the charge there and the voltage across the chamber falls.

If the density of air in the chamber is high, many ions are formed and the chamber voltage falls rapidly. If there is little air in the chamber, the chamber voltage will retain its value almost indefinitely. The rate of voltage decay is thus proportional to the air density.

When the chamber has discharged to a predetermined voltage,

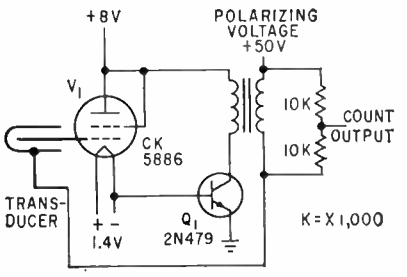


FIG. 2—Transformer is an audio type with large step-up ratio. Polarizing voltage supplies less than a μamp

a sensing circuit generates an output signal pulse and another circuit simultaneously recharges the chamber to its original voltage.

With a fixed amount of radioactive material the discharge time is given by $T = C\Delta V/ap_0$, where T is in sec, C is the chamber capacitance in farads, ΔV is the voltage drop of the chamber, p_0 is the chamber air pressure in mm Hg at 0 C, and constant a relates the ionization current produced in the chamber to p_0. For the chamber in Fig. 1, which contains a tritium-titanium source of 400 millicuries, a is about 10^{-9} amps/mm Hg.

Recharging Time

Recharging time is generally short compared to discharge time T and the repetition frequency of the signal pulse is nearly equal to $1/T$. Therefore, frequency is directly proportional to normalized pressure.

Ionization is sensitive to the density of the gas in the tube rather than its pressure; as indicated above, the pressure must be normalized to 0 C. Air entering the chamber rapidly attains the temperature of the chamber walls, which generally is different from the outside-air temperature. Knowing the temperature of the chamber wall, the density information provided by the chamber can be used to calculate the chamber pressure, which equals the pressure of the outside air.

Charging and Signaling

Initially, the transducer wall is held at a constant d-c polarizing

Measure Low Pressures

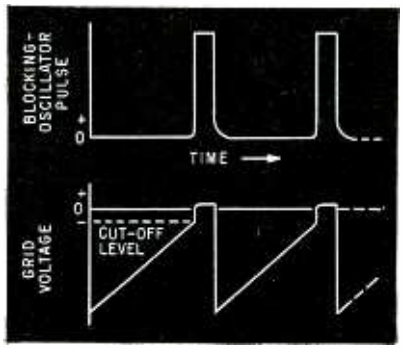


FIG. 3—Blocking-oscillator pulses and grid voltage are shown on a common time scale

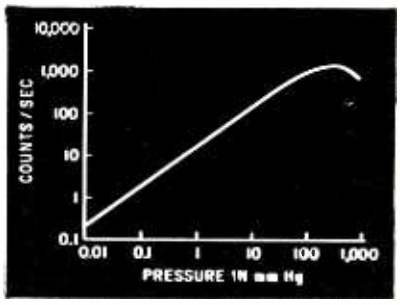
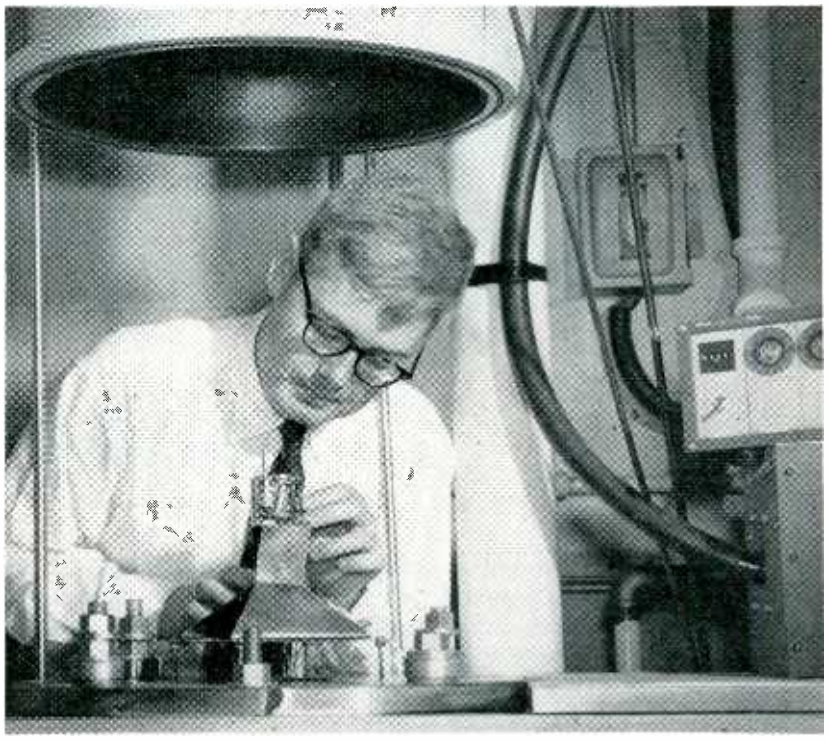


FIG. 4—Reversal of near-atmospheric pressures is due to ion recombinations



Scientist installs a radiological pressure gage in a high-altitude simulation chamber. During test the counter at the right will indicate the pressure

voltage of 15 to 100 v to collect all ions that are formed, and the central electrode is charged to a voltage that is sufficiently negative to cut off electrometer tube V_1 (Fig. 2). When the voltage across the chamber becomes low enough to permit current to flow through V_1, blocking oscillator Q_1 applies a positive pulse to the transducer wall. This pulse is transmitted through the capacitance of the transducer tube to the grid of V_1, switching on the grid current. This current recharges the chamber and when the oscillator pulse ends, the grid of the electrometer tube is left at a negative voltage that is nearly equal to the height of the oscillator pulse.

Output pulses from the oscillator go to a telemeter transmitter. A receiver on the ground picks up the information and drives a pulse counter, whose count rate indicates pressure.

Pulse Shapes

Initially, the center electrode of the transducer is at a high negative voltage and V_1 is cut off, as illustrated in Fig. 3. With the decay of the charge, the center electrode voltage climbs to the cut-off level and V_1 begins to conduct. Current through the base of transistor Q_1 triggers a blocking-oscillator pulse whose peak amplitude is approximately 30 v. Grid current flows in V_1, but grid voltage rises only slightly above ground potential. When the blocking-oscillator pulse ends, so does grid current. The potential of the center electrode drops to a negative value that almost equals the peak amplitude of the blocking-oscillator pulse.

Performance

Figure 4 shows the output pulse repetition rate as a function of pressure. Assuming that pulse repetition rates of less than about one per sec are not useful, the instrument has a maximum useful altitude of about 250,000 ft (0.05 mm Hg). By using a larger chamber, the maximum altitude can be increased to 300,000 ft (0.001 mm Hg).

The finite energy (18 kv max) of particles from the tritium source places a lower limit of around 50,000 ft (300 ohm Hg) on the altitudes at which useful information can be obtained. A smaller chamber would permit useful pressure measurements down to sea level.

Output pulses are about 10 v, 100 μsec long and approximate rectangles.

Compensation

The temperature coefficient of the transistor circuit in Fig. 2 compensates for the pressure-density correction. Over the temperature range of about 0 C to 40 C, instrument output is constant to within a few percent at constant pressure. At constant temperature under laboratory conditions, the reproducibility of instrument output is 1 percent.

Total power drain is less than 40 mw. The instrument can withstand accelerations of 100 g, its weight is 3 oz and its size only 2 x 2 x 1 in.

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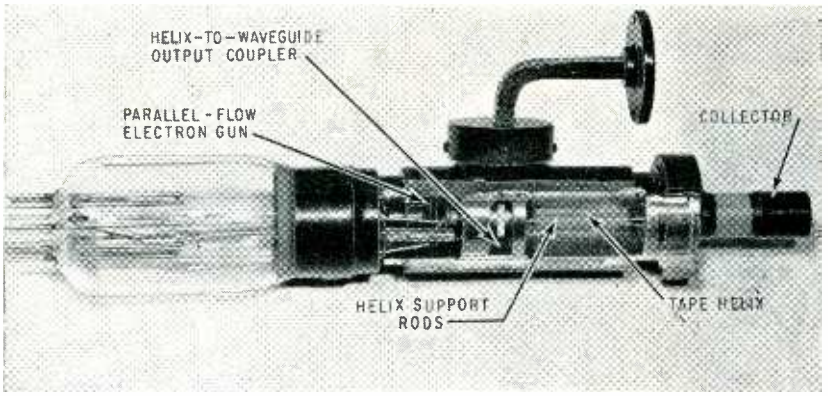

Cut-away section exposes electron gun, r-f output coupler and helix of millimeter oscillator

Voltage Tunable

LACK of satisfactory generators of coherent r-f has in the past retarded use of the millimeter-wave region of the electromagnetic spectrum. Until recently, harmonic generators were the only power sources for millimeter waves.

This article describes the characteristics and performance of two experimental backward-wave oscillator tubes designed to explore the possibilities of obtaining voltage-tunable oscillations over wide frequency ranges in the millimeter region. One of the tubes oscillates between 29 and 49 kmc and the other between 48 and 74 kmc. Frequency is varied by a single voltage adjustment.

Design

Both tubes use a tape-helix backward-wave circuit, through the center of which a solid electron beam from a parallel-flow gun is focused by a uniform axial magnetic field. The r-f outputs are from standard waveguides.

The electron guns use an impregnated tungsten matrix cathode that produces an average current density of 1 amp per sq cm. With a confining axial magnetic field, the guns produce a parallel electron beam that flows through the helix and is collected in the hollow copper collector cylinder.

A helix wound from rectangular cross section tape is used as the slow-wave structure. Electrically, the tape helix offers high backward-wave impedance over an octave frequency range; this simplifies coupling between the r-f output and the helix over this frequency range. Moreover, the helix presents a comparatively large cross-sectional area over which the r-f field can interact with the electron beam.

Mechanically, the helix is a good circuit to use because conventional grid-winding techniques can be used to keep the parts within the close dimensional tolerances required in structures for such extremely high frequencies.

Helices are made of tungsten tape 0.002-in. thick by 0.006-in. wide for the lower-frequency tube and 0.002-in. thick by 0.0045-in. wide for the higher-frequency tube. The mean diameters of the helices in the two tubes are 0.0315 in. and 0.021 in., respectively.

The tape helix circuit is supported mechanically by three round quartz rods spaced equally around its outside diameter. Rods are held in contact with the helix by a fine nickel wire spiraling around their entire length.

Electromagnetic waves which are excited in the tape helix by interaction with the electron beam are radiated from an antenna at the gun end of the helix into a thin section of waveguide. The waveguide is tapered up to standard waveguide size to permit the output connections for the tubes to be standard RG 97/U and RG 98/U waveguides and flanges. The output waveguide is sealed vacuum-tight with an experimental gasket-type mica window[1]. Transfer of power from helix to waveguide has been found experimentally to be efficient over the entire frequency range of the tubes.

Oscillation Frequency

Frequency of the two experimental backward-wave oscillator tubes is varied by changing the helix potential.

Figure 1 shows the tuning curves for the two tubes, with the frequency of oscillation plotted as a function of helix voltage. As voltage is varied from 650 to 3,200 v, the oscillation frequency of the lower-frequency tube tunes from 29 to 49 kmc; for the other tube, voltage variation from 750 v to

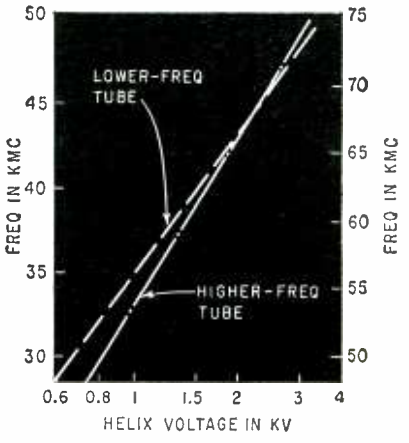

FIG. 1—Helix voltages control operating frequencies of oscillators

Experimental backward-wave oscillator tubes for millimeter-wave generation can be tuned over wide frequency range by single voltage adjustment. Tubes utilize helix slow-wave structure wound with rectangular cross-section tape. Two designs described cover 29 to 49 kmc and 48 to 74 kmc

By **D. J. BLATTNER** and **F. STERZER,** RCA Electron Tube division, Princeton, N. J.

Millimeter-Wave Oscillators

3,100 v tunes the oscillation frequency from 48 to 74 kmc.

The output power to be expected from these experimental tubes was calculated for beam currents of 3 ma for the 29 to 49 kmc tube and 2 ma for the 48 to 74 kmc tube. The curves in Fig. 2 show that the power output of the former should increase from 5 mw at 30 kmc to 13 mw at 50 kmc and the calculated power output of the latter should rise from 1.2 mw at 50 kmc to 2.6 mw at 74 kmc.

Power output, measured with a commercial bolometer, was several milliwatts for the lower-frequency tube and about 1 mw for the higher-frequency tube. Although the power was not monotonic over the band, output was observed to be continuous. Accurate power measurements

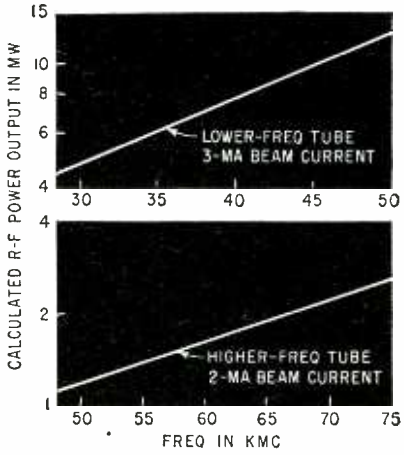

FIG. 2—Power outputs of oscillators vary with operating frequencies

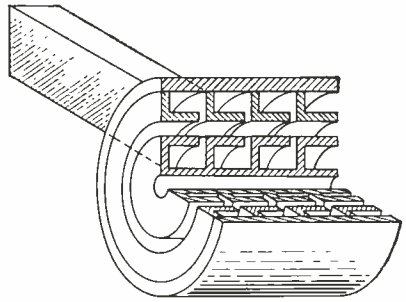

FIG. 3—Proposed coiled ridge waveguide structures for higher power output

at millimeter wavelengths are extremely difficult, however, and commercially available bolometers, which tend to indicate less than true power, are useful only to indicate relative power values.

Higher r-f power output necessitates a larger circuit structure to pass more current and dissipate more heat.

One proposed structure is the coiled ridged waveguide shown in Fig. 3. The electromagnetic wave traveling through the coiled waveguide interacts with a hollow cylindrical electron beam flowing through cuts in the broad surface of the guide.

Ridging the waveguide permits the frequency range of such a structure to be made relatively wide, although not so broadband as the helix circuit.

Raising Frequency

As the calculated and measured performance of these tubes were in fair agreement, it is reasonable to attempt to extend their design to higher frequencies.

An extrapolation of the present design to a backward-wave tube, which would operate in the frequency range between 90 kmc and 150 kmc, results in a tube that would have a 0.6-in. long helix made of 0.001 by 0.0022-in. molybdenum tape wound at 218 turns per in. on a 0.0105 in. inside diameter. The simplicity of design makes this structure mechanically feasible.

The tube should oscillate at frequencies from 90 to 150 kmc as the helix voltage is varied from 600 v to 3,300 v. Starting current is calculated to be 0.5 to 1.9 ma over the frequency range. For a current density of 5 amp per sq cm, which is not impractical with impregnated cathodes, the collector current is 2.8 ma and the expected power output is of the order of 1 mw.

Although theory predicts certain power outputs, obtaining them over the entire operating range of an actual tube is another matter. A great deal of further developmental work must still be done to provide reliable performance and uniformity.

Much of the work described in this article was sponsored by Wright Air Development Center under Contract AF33(600)-29244.

REFERENCE

(1) F. Sterzer, Simple High-Temperature Vacuum Tight Mica Window, *Rev. Sci Instr.* 28, p 208, 1957.

Distributed Amplifiers

By ROGER T. STEVENS,
Senior Engineer, Electronics Systems, Inc., Boston, Mass.

DISTRIBUTED AMPLIFIERS consist of a chain of tubes connected between sections of a pair of lumped-constant artificial delay lines. Since output signals from all tubes are added, gains are also added rather than multiplied. Bandwidth of conventional amplifiers is limited because the tube type has a specified gain-bandwidth product and gain must be greater than one. In distributed amplifiers, fractional gains in each tube add to produce overall stage gains greater than one while isolating stage capacitances thus giving wider bandwidth. Characteristics of typical commercially available distributed amplifiers are given in Table I.

TV AMPLIFIERS—These amplifiers provide high gain concentrated over all or part of the tv band. Transformer coupling permits matching delay line impedances of several hundred ohms to conventional 52- or 72-ohm coaxial cable. Limited bandwidth and high delay line impedance reduce tubes per stage. Improved noise figure results since it is determined by equal contribution of all tubes in the first stage. These amplifiers usually feature a rising frequency versus gain curve to compensate loss of long coaxial cable.

LABORATORY AMPLIFIERS — These amplifiers are designed for nearly linear phase shift, good matching and wide frequency response. Inputs and outputs are essentially direct-coupled to the input and output delay lines. Thus, input and output impedances are not usually compatible with existing coaxial cables. More tubes per stage are used than in tv distributed amplifiers; therefore, the noise figure is generally poorer and overall gain is somewhat less. Laboratory amplifiers are suitable, however, for general amplification of r-f or small pulses.

PULSE AMPLIFIERS—Pulse amplifiers are generally biased at cut-off to permit swinging the tubes throughout their entire grid base.[1] Often they use element voltages which would result in overdissipation if they conducted for extended periods, severely limiting duty cycles.

PREAMPLIFIERS—Distributed preamplifiers use a special broadband triode input stage to give an exceptionally good noise figure. Also bandpass filter sections are used in their delay lines rather than the low-pass filters used in all other distributed amplifiers.

REFERENCE

(1) S. K. Meads, How to Design Pulsed Distributed Amplifiers. ELECTRONICS, p 56, Mar. 20, 1959.

Table I—Characteristics of Typical Commercially

Manufacturer	Model	Frequency Response[a]	Rise Time (μsec)	Noise Fig (db)
Entron, Inc.	RA-1B	45 mc to 105 mc		
	RA-1C	51 mc to 89 mc		
Haller, Raymond and Brown, Inc.	510	50 mc to 100 mc		6
	515	50 mc to 150 mc		6
	530	50 mc to 300 mc		8
	530NS	50 mc to 300 mc		8
	1530	150 mc to 300 mc		6
	2550NK	250 mc to 500 mc		8
Hewlett-Packard Co.	460AR	3 kc to 140 mc	0.0026	10
	460BR	3 kc to 140 mc	0.0026	6
Instruments For Industry	M-400	200 kc to 300 mc	0.0016	
	M-500A	200 kc to 220 mc	0.0025	
	M-510	200 kc to 220 mc	0.0025	
	M-530	10 kc to 300 mc	0.0016	
Jerrold Electronics Corp.	ABC-522	10 mc to 230 mc		10 to 12
	LSA-795	7 mc to 95 mc		8
RS Electronics Corp.	2210	100 kc to 220 mc		6
	2220	100 kc to 220 mc		
	2230	100 kc to 220 mc		
Spencer-Kennedy Laboratory, Inc.	202D	1 kc to 210 mc	0.0026	9
	206	600 cps to 320 mc	0.002	10[b] and 15[c]
	211	15 mc to 100 mc		8.8
	212C	54 mc to 216 mc		
	214B	200 cps to 90 mc	0.006	

(a) to 3-db points (b) at 50 mc (c) at 300 mc

For Wideband Applications

Available Distributed Amplifiers

Gain (db)	Max. Out. (rms v)	Impedance (ohms)	Type and No. of Tubes	Application	Remarks
41	45	75	6AH6 (12)	Tv distribution	Has 18-db gain control
42	27	75	6AH6 (12)	Tv distribution	Includes tilt to compensate for cable losses and a 12-db gain control
32		50	GL6299 (2) 5702 (6)	Preamplifier	Has low-noise input stage
20		50	GL6299 (2) 5702 (6)	Preamplifier	Has low-noise input stage
14		50	GL6299 (2) 5702 (6)	Preamplifier	Has low-noise input stage
40		50	GL6299 (6) 5702 (18)	Preamplifier	Has low-noise input stage
20		[illegible]	GL6299 (2) 5702 (6)	Preamplifier	Has low-noise input stage
27		50	GL6299 (4) 5702 (12)	Preamplifier	Has low-noise input stage
20	4	200	6AK5 (12)	Laboratory amplifier	Has gaussian high-frequency roll off. Useful output to 200 mc
15	8 see remarks	200	6AK5 (12)	Pulse amplifier	Has high-frequency roll off similar to 460AR. Pulse position permits 125-v peak outputs into open circuit with duty cycle less than 0.1
10	95	In: 50 Out: 90		Laboratory amplifier	Output is 100-w c-w. With special power supply, 5-kw peak output pulse may be obtained
12	22	In: 90 Out: 185		Laboratory amplifier	Up to 240-v pulse obtainable with special supply [All applicable for tv also]
16	12	In: 90 Out: 185		Laboratory amplifier	
18	3.5	In: 135 Out: 150		Laboratory amplifier	
20	0.032	75	6CY5 (12)	Tv distribution	
32	0.45	75	6CY5 (6) 12BY7 (6)	Tv distribution	Has 4-db gain control and built-in voltmeter
20		In: 200 Out: 93		Preamplifier	
20		93		Laboratory amplifier	
18		93		Power amplifier	Output is one watt
20	4	200	6AK5 (12)	Laboratory amplifier	
18	6 see remarks	In: 180 Out: 200	5654 (16)	Laboratory amplifier	Pulse mode—30-v peak neg output; high-level mode—50-v peak neg output with 2% max. duty cycle. Also, has 10-db gain control. Adapters for various frequency response curves are available
33	3	75	6AK5 (12)	Tv distribution	Tilt to correct cable losses
20	2.1	72 or 52	6AK5 (12)	Tv distribution	
30	see remarks	In: 180 Out: 5K[d]	6AH6 (14)	Pulse amplifier	Output is 65 v at 0.3 duty cycle with no grid current; 125 v at 0.1 duty cycle with grid current.

(d) or greater with 8 $\mu\mu$f in parallel; with termination removed, impedance is 500 ohms in parallel with a maximum of 5 $\mu\mu$f

Frequency Shifts Improve

New technique overcomes multipath problems in long-range pulse transmission. Transmitter and receiver simultaneously shift frequency so that receiver is sensitive only to the transmission arriving by the shortest path

By **J. L. HOLLIS,** President, Rixon Electronics, Silver Spring, Maryland

RECEPTION OF SHORT PULSES over long radio paths is often hampered by the transmitted signal taking several paths to reach the receiver. If the lengths of these paths differ enough, the receiver may produce an output pulse that begins with the start of the first arriving signal pulse and ends with the decay of the last arriving signal pulse. Thus the output pulse is lengthened by the difference in transmission time between the shortest and the longest paths. If this time difference is appreciable compared to the duration of the transmitted pulse, disastrous time distortion results.

Figure 1A illustrates a simple case of two-path propagation which is common at high frequencies. The longer path involves an earth reflection near the path's midpoint and two ionospheric reflections.

Figure 1B shows a simple example of a two-path transmission above 30 mc which involves F-layer reflection and ground scatter. This problem has been most significant in ionospheric scatter circuits where the scatter mode is the most direct route between the two terminals. For certain maximum useable frequency (muf) conditions, strong F-layer reflections produce high-intensity signals at the surface of the earth many miles beyond the intended receiving terminal. These strong signals are reflected backward by surface irregularities on the earth. Thus transmission conditions can cause separately transmitted signals to appear simultaneously at the receiver.

A frequency-translation system solves the problem of multipath transmissions by synchronously changing pulse-transmitting and receiving frequencies so that the receiver is sensitive to only the signal energy arriving by the shortest transmission path. After pulse energy is received, gates shift the receiver and transmitter frequencies. The receiver is shifted to a frequency which makes the receiver insensitive to the freqency that had been transmitted and the transmitter frequency is shifted to the new operating frequency at the same time.

A frequency is abandoned long enough for the last pulse that was transmitted at this frequency to disappear. The number of frequencies required is thus one more than the time difference between the longest and shortest path divided by the signalling element duration.

For example, in the h-f case where time differences of 10 to 12 millisec are common, three frequencies are required to transmit 3-millisec pulse elements. For ionospheric-scatter circuits above 30 mc where delays of 40 millisec are common, seven or eight frequencies are required.

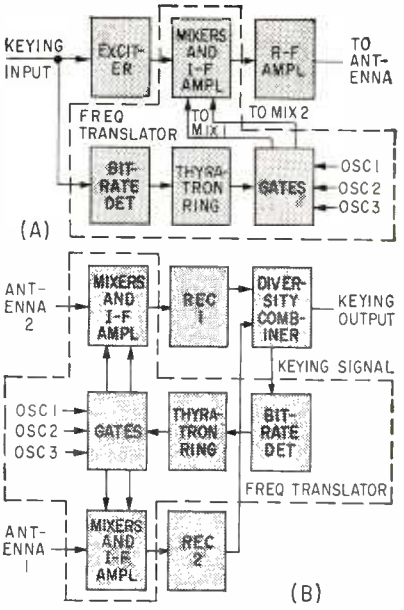

FIG. 3—Section enclosed by the broken lines is the frequency translator of the transmitter (A) or the receiver (B)

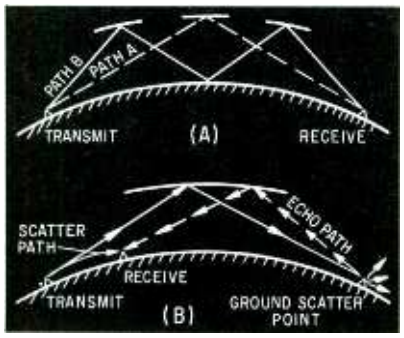

FIG. 1—Path B (A) is the longer of the two paths. Direct-scatter path (B) is much shorter than the indirect paths

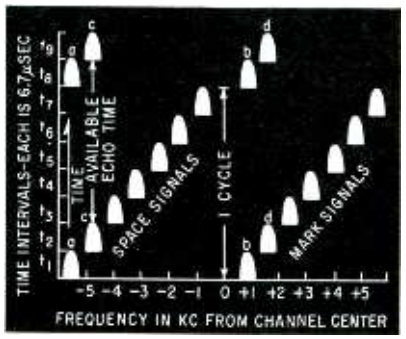

FIG. 2—At any time *t*, channel frequency is shifted either right or left of center, depending on keying information

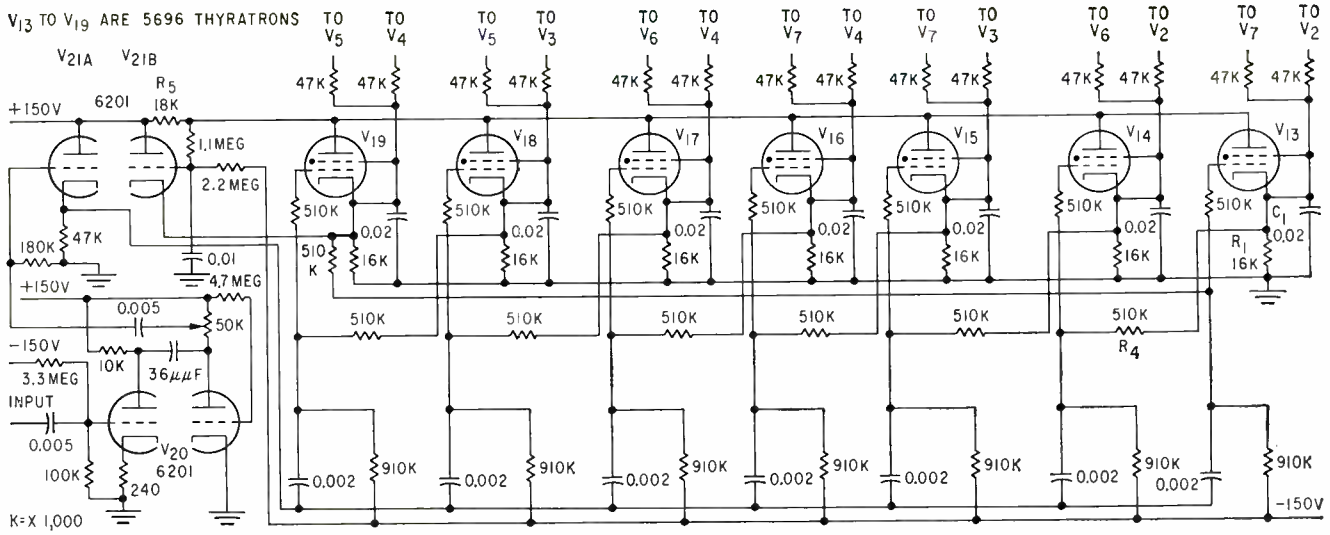

FIG. 7—The bit-rate detector supplies the input to V_{20}, which is an input amplifier of the thyratron ring comprising tubes V_{13} to V_{19}

the first thyratron.

Assume that the first thyratron, V_{13}, is ignited and conducting. As current flows, a voltage builds up across the cathode circuit of R_1 and C_1. This voltage is fed through the 47,000-ohm resistors to the plates of two diode gates. The gates open, passing injection frequencies to the mixers.

At the same time, this voltage is passed through resistor R_4 to the grid of the next thyratron, V_{14}. This voltage is not sufficient to trigger the thyratron, but when added to a positive pulse from the bit-rate detector it is sufficient. When the next positive pulse arrives at all thyratron grids only tube V_{14} ignites. When this happens, enough current is drawn through the common plate resistor, R_5, to lower the voltage enough to extinguish the first thyratron.

The triggering process continues through seven frequency shifts and repeats itself until the equipment is turned off.

When the equipment is first turned on no thyratron is primed for firing, as was thyratron V_{14} in the above example. Tube V_{21B} is used as an automatic starter. When plate voltage is first applied, the grid of V_{21B} is positive and enough current flows in the cathode circuit to prime the first thyratron, V_{13}. The next pulse from the bit-rate detector ignites the first thyratron and as soon as current flows in the thyratron plate resistor, the resultant voltage drop swings the grid of V_{21B} negative and cuts off V_{21B}.

Bit-Rate Detector

The bit-rate detector, Fig. 4, is effectively a locked oscillator which controls the operation of the thyratron ring in exact synchronization with the mark-space pulses from the information signal.

Crystal oscillator frequency is 1,200 cps. Tube V_{23} is a feedback amplifier which affords the 360-deg phase shift necessary for oscillation.

Tube V_{24} is a double-triode phase shifter which changes oscillator frequency when gate V_{35} changes the voltage it applies to tube V_{24}.

After being amplified in tube V_{22}, the oscillator signal goes to tube V_{25}. Operating level is automatically controlled by tube V_{26}, a rectifier-clamp stage. The amplified signal goes to tube V_{27}, a one-shot multivibrator used as a pulse shaper. The next three stages, tubes V_{28}, V_{29}, and V_{30}, are flip-flops which divide their input frequencies by two. Thus signal frequency is 150 cps at the square-wave output of tube V_{30}. Tube V_{30} provides the signal which, after clipping and amplifying, triggers the thyratron ring.

Tube V_{30} also applies a square-wave signal to an integration circuit which produces an isosceles saw-tooth wave at the plate of tube V_{31}.

Keying signals enter the bit-rate detector at tube V_{32}, a phase-splitter. After differentiation, the signal appears at the plates of dual-diode V_{33} as a series of pulses representing the keying-signal reversals. These pulses are rectified by tube V_{33} and applied to tube V_{34}. Tube V_{34} is a one-shot multivibrator which delays the pulses.

The delayed pulses are applied in push-pull to tube V_{35}, where they are opposite in polarity and equal in amplitude. Tube V_{35}, a double diode, is used as a dual-gate and is normally nonconducting. The pulses, however, switch tube V_{35} on for the duration of the pulses.

Phase-Difference Detection

Tubes V_{31} and V_{35} act as a phase-difference detector. If the instant of diode conductance occurs at the zero point of the isosceles wave that comes from V_{31}, no change in the output of V_{35} takes place. But if the crystal frequency should drift slightly, the diodes conduct at a time when the isosceles wave is at a point other than zero. This conduction-time shift charges or discharges an integrating capacitor, depending on whether the isosceles wave is lagging or leading the keying signal. Thus a positive or negative voltage appears at one grid of tube V_{24}, bringing about an unbalanced condition. The degree of unbalance determines the degree of phase shift introduced in the crystal oscillator circuit. Phase shift causes the crystal to change frequency in the proper direction so as to synchronize exactly with the keying input signal.

Thermoelectric Properties

Important semiconductors are evaluated for thermoelectric performance. Figures of merit, presented for each material, place bismuth telluride and lead telluride at top of list: Ten well-known semiconductors are presented in convenient table that shows comparative characteristics

By D. A. WRIGHT, Research Laboratories, The General Electric Co., Ltd., Wembley, England

THERMOELECTRIC PERFORMANCE of a semiconductor can be discussed in terms of the figure of merit $z = \alpha^2\sigma/\lambda$, which serves as a criterion for both refrigeration and generation. Here σ is the electrical conductivity, λ is the thermal conductivity and α the Seebeck coefficient, which is also referred to as the thermoelectric power.

Semiconductor theory shows that electrical conductivity, thermal conductivity and the Seebeck coefficient are interrelated, and that the best thermoelectric performance from any material is obtained if the doping level is adjusted to give a thermoelectric power of approximately 200μv/deg C at the temperature at which the material is to be operated.

MERIT FORMULA—Provided the doping level is adjusted in this way, theory shows that for a wide range of semiconductors the figure of merit, z, is proportional to $(\mu/\lambda_o)\ (m^*/m)^{3/2}T^{3/2}$.

Here μ is the mobility, m^* is the density of states effective mass, λ_o is the lattice component of the thermal conductivity, and T is the absolute temperature.

The total thermal conductivity λ is made up of the lattice component λ_o and the electronic component λ_e which is proportional to σT. The values of μ and m^* involved are for electrons in n-type material, and for holes in p-type material.

It is not possible to dope a semiconductor to achieve a Seebeck coefficient as high as 200μv/deg C if the energy gap, E_g, is too small or the temperature is too high. In bismuth telluride, Bi_2Te_3, the energy gap at room temperature is 0.13 ev, and a thermoelectric power of 200μv/deg C can be obtained at temperatures up to 200 C. The table gives values of E_g for a variety of semiconductors.

In column 9 of the table, the values of $(\mu/\lambda_o)\ (m^*/m)^{3/2}$ are based on the values for μ, m^* and λ_o shown in the previous columns. In each case the upper figures refer to electrons and the lower to holes. These values indicate the relative merits of the semiconductors at a fixed temperature. The figures for germanium, silicon and the compounds between group III and group V elements are much lower than for bismuth telluride or lead telluride.

TEMPERATURE—Mobility varies with temperature according to the law $\mu \propto T^{-x}$. Values of χ are given in column 5.

Since the figure of merit z is proportional to $(\mu/\lambda_o)\ (m^*/m)^{3/2}T^{3/2}$, the variation of the figure of merit, z, with temperature is dependent on the values of χ. Thus if χ were equal to 1.5, the quantity $\mu T^{3/2}$ would be independent of temperature; m^* does not vary appreciably with temperature, so that the temperature variation of z would depend entirely on that of λ_o. For most materials near and above room temperature $\lambda_o \propto 1/T$.

Thus, as temperature varies, the changes in the relative values of z comparing the different semiconductors depend mainly on the value of χ. For example as temperature rises, z for lead telluride falls relative to the value for bismuth telluride, because of the larger value of χ for lead telluride.

THERMAL CONDUCTIVITY—The value of λ_o for a semiconductor can be lowered by substituting for one of its constituents another element from the same column of the periodic table. The values of $\lambda_{o\,min}$ in column 10 represent the minimum values of λ_o for the different semiconductors which can be achieved by this substitution.

For bismuth telluride a value of 0.01 w/cm/deg C is achieved by forming the compound $BiSbTe_3$, that is, replacing half the bismuth by antimony. In lead telluride a similar effect is obtained by replacing half the tellurium by selenium.

The mobility at the composition giving the minimum value of the lattice component, λ_o, is shown in column 11 under μ_{min}, and the corresponding value of $(\mu/\lambda_o)\ (m^*/m)^{3/2}$ is shown in the last column of the Table.

# of Semiconductors

Table I—Comparison of Well-Known Semiconductors

Semiconductor	Melting Point deg C	E_g ev	μ cm²/v/sec	χ $\mu \propto T^{-\chi}$	$\frac{m^*}{m}$	$\mu\left(\frac{m^*}{m}\right)^{3/2}$	λ_o w/cm/deg C	$\frac{\mu}{\lambda_o}\left(\frac{m^*}{m}\right)^{3/2}$	$\lambda_{o\,min}$ w/cm/deg C	μ_{min} cm²/v/sec	Max $\frac{\mu}{\lambda_o}\left(\frac{m^*}{m}\right)^{3/2}$
Bi_2Te_3	575	0.13	1,250 550	1.7 1.9	0.45 0.6	350 260	0.015	22,000 17,200	0.01	1,250 600	35,000 26,000
PbTe	901	0.27	2,000 500	2.5 2.5	0.3 —	300 —	0.023	13,000 —	0.01	1,300 —	20,000 —
Ge	936	0.65	3,600 1,900	1.7 2.3	0.5 0.35	\$1,260 410	0.61	1,970 640	0.03	400 —	4,700 —
Si		1.1	1,200 500	2.5 2.3	1.08 0.6	1,350 230	1.13	1,200 200			
InAs	940	0.45	30,000 200	1.6 2.0	0.06 0.3	440 33	0.3	1,300 100			
InSb	525	0.2	77,000 1,200	1.7 2.1	0.01 0.18	620 92	0.15	4,100 600	0.02 0.03	20,000 600 8,000	8,000 2,000 6,000
GaSb	720	0.7	4,000 850	— —	0.2 0.3	360 150	0.27	1,350 500	0.04	1,000 2,000	4,000 1,500
GaAs	1,240	1.3	5,000 200	— —	0.01 ≈0.3	40 ≈10	≈0.5	≈100 ≈100	0.03	400 8,000	1,800 2,000
InAs	940	0.45	30,000 200	1.6 2.0	0.06 0.3	440 33	0.3	1,300 100	0.05	200 8,000	1,000 2,500
InP	1,070	1.2	4,000 100	2.0 —	0.08 —	90 —	≈0.5	≈180 —		100	500
1	2	3	4	5	6	7	8	9	10	11	12

Note: For each semiconductor, the upper figure in a column refers to electrons, the lower to holes. The values quoted refer to 300 k. The figures in the last three columns opposite Bi_2Te_3 refer to $BiSbTe_3$, having the minimum value of λ_o. The corresponding figures opposite PbTe refer to Pb_2TeSe.

FORMING SOLID SOLUTIONS—In columns 9 and 10 of the table, the brackets are intended to indicate the effect of forming solid solutions between the different semiconductors. Thus, with germanium and silicon a value of the lattice component, λ_o, as low as 0.03 can be obtained for the composition 70 percent Ge, 30 percent Si. However, the mobility is also lowered, so that the figure in column 12 is not much improved compared with that in column 9. The figures for the solid solutions between group III and group V compounds are intended as intelligent guesses at the minimum value of λ_o at room temperature which could be obtained in solid solutions, if in fact such solutions could be formed in these systems. In some cases (InAs-InP, GaAs-GaP, and InSb-GaSb) this is known to be possible. Solid solutions have not, however, been studied in detail, so that there is so far no definite evidence to confirm these figures. The values estimated for $\lambda_{o\,min}$ and μ_{min} lead to the figures in column 12 considerably lower than those for bismuth and lead telluride.

COMPARISON OF MATERIALS—This survey shows that the thermoelectric properties of bismuth telluride and lead telluride, and compounds derived from them by substitution, are superior to those of the other well-known semiconductors listed in the table. This applies both for the individual compounds and for solid solutions and alloys formed between them. So far there is not enough reliable information about other materials now under active investigation, and it is premature to try to list their properties. It is hoped that compounds will be discovered which are superior even to bismuth telluride.

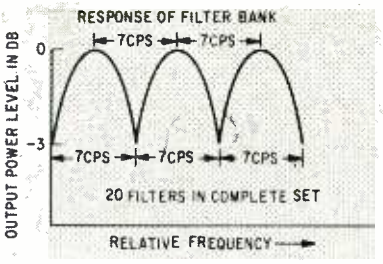

FIG. 1—Frequency response of a narrow-band filter bank

Checking a 40-kc filter bank (on bench at left) with counter accurate to 0.1 cps

Circuit Design Using

NARROW-BAND FILTER BANKS can be used in telemetry, for noise reduction in radar systems, for Doppler radar and model control. The spectrum analyzing or combing effect of such banks is illustrated in Fig. 1.

Advantages of the basic elements used here are several. The ferrite material is cheap and readily available, circuits are simple, insertion loss can be held to 6 db and complete filter banks are relatively small and mechanically simple.

Resonant Frequency

A filter element is shown in Fig. 2. A tube of nickel zinc ferrite (Ferroxcube IV D) is supported at its center by three screws equally spaced around a brass ring. The ring is split to keep it from being a shorted turn. The primary is a single turn on the printed circuit board and the secondary slips over the end of the phenolic tube.

The ferrite tube can vibrate longitudinally or torsionally, depending on its magnetic polarization. Sending a large current through a wire strung through the center of the tube will produce a circumferential polarization. The alternating field from the input coil will now induce torsional vibration.

In Fig. 3, H is the static biasing field and $h \sin \omega t$ is the alternating axial field. The maximum resultant field $H_{max\ res}$ will be at a small angle to the axis and have a value $(H^2 + h^2)^{1/2}$. The maximum stress will be in the direction of this resultant field. The total spiral stress acts as a couple on the ferrite tube, causing torsional vibration.

The resonant frequency is $f_r = 1/2\ v\ s(E/\rho)^{1/2}$ where ρ = density, s = length of the ferrite tube and E = rigidity modulus for torsional vibration, Young's modulus for longitudinal.

Air pockets in the ferrite cause density variations which affect the operating frequency. Even samples taken from the same batch show this effect so exact frequencies can not be calculated.

A longitudinal filter is almost twice as long as a torsional one at the same frequency. Being easier to support, the shorter torsional unit is preferred for mechanical stability. Since IV D material is comparatively soft magnetically, the self-biasing needed in the torsional mode may lead to long term instability. But the flux lines in the ferrite are closed and such instability has not been noticed over periods up to a year.

For maximum electromechanical coupling the magnetostrictive constant λ must be maximum. λ varies with intensity of magnetization and

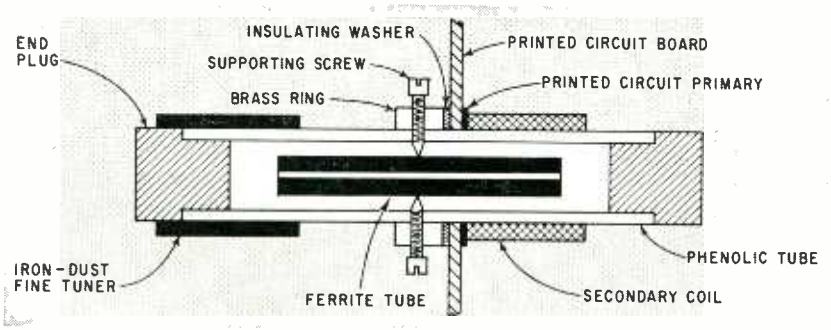

FIG. 2—Construction details of a torsional mode magnetostriction filter element

Designers of telemetry equipment, Doppler radar and computers are finding that magnetostrictive filters compare favorably with the crystal type, offer significant cost reduction. Ferrites used in torsional mode are basic elements of these narrow-band filter banks

By **A. P. THIELE,** Cossor Radar and Electronics Ltd., Harlow, Essex, England.

Magnetostrictive Filters

is maximum at 0.6 saturation intensity; this value coincides with the remanent flux density produced when the resonator is polarized.

The frequency response of an element is shown in Fig. 4. A bucking coil, series connected in phase opposition with a filter output, masks the antiresonant effect.

Torsional Resonators

The dimensions of a resonator for 40-kc center frequency are: length 38 mm, o-d 5.6 mm, i-d 1.5 mm. The ferrite tubes were polarized by passing up to 200 amps through a wire strung through the center of the tube. The current was obtained from an ignitron magnetizer. While the current was much more than required for saturation the setup gave repeatable results. The bucking coil is a conventional transformer similar to filter elements but with a nonmagnetostrictive slug of grade III B ferrite. The slug is adjusted for the desired output. In some cases phase control may also be needed.

Filter characteristics as a function of input current are shown in Fig. 5. The changes at high input are caused by magnetomechanical hysteresis. The linear region is between 0.01 ma and about 2 ma.

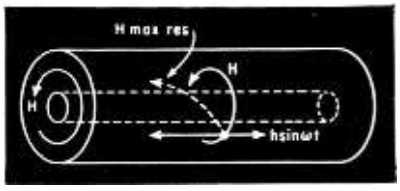

FIG. 3—Method of inducing torsional vibrations

Coarse tuning of the resonators is accomplished by grinding to decrease length. For fine tuning of about 4 cps, an adjustable iron-dust tube is placed over the support tube.

Output impedance at resonance is about 1,000 ohms. Care must be taken that the output impedance is not damped by the input circuit.

A simple way of mounting the filter support tubes is through holes in an insulated board. A printed-circuit board 4 by 7.5 in. was used to handle the large number of connections, with single-turn primaries printed on one side and connecting points for outputs on the other. The arrangement was three rows of seven elements: 20 filters and one bucking coil.

Table I—Performance of Filter Bank

Number of Filters	20
Center Frequency	41,770 cps
Bandwidth	7 ± 0.25 cps
Insertion Loss	6 db
Input	2 ma max
Output	23 mv max
Temp Coef.	2.8 cps per deg C at 41 kc
Outputs	matched better than 0.1 db
Size	2½ by 1¾ by 8½ in.
Weight	2 lb

The natural bandwidths of the filters vary by about ±1 cps and can be increased by a suitable resistor across the output. These equalizing resistors are mounted on the same board.

The primaries were laid out carefully to obtain equal coupling to the filters and the printed wiring was doubled back to obtain a noninductive lead. Layout of the filters placed frequency adjacent units as far apart as possible to minimize any interaction that might occur because of the high mechanical Q of the resonators.

Target bandwidth for each filter was 7 cps and output levels were to be equal. Bandwidths were controlled with load resistors; levels by moving the output coil away from the center. Although these two adjustments are not entirely orthogonal, they were completed without great difficulty. A schematic

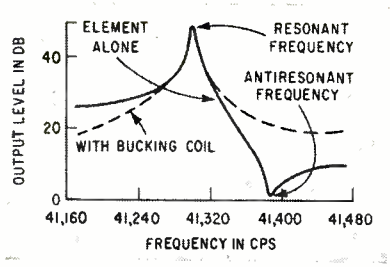

FIG. 4—Frequency response of typical element, with and without bucking coil

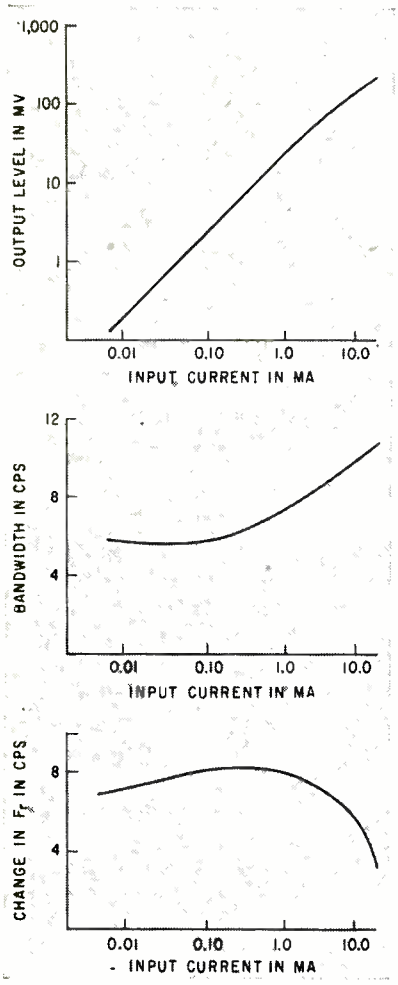

FIG. 5—Characteristics of element versus input current

diagram of a typical filter bank without load resistors is shown in Fig. 6.

Performance

Characteristics of the complete bank are shown in Table I. There was no detectable change over a one-year period in resonant frequency, bandwidth or output. Interaction between frequency adjacent elements was about 1 db at a level 15 db below the main response. This interaction can be further reduced by magnetic screening.

These filters were developed mainly for use in banks where large numbers of filters are required. The initial application required they be narrow band and have single tuned circuit response. Further developments will include using two or more units to form band-pass filters. If two elements are used, the output coils can be connected in antiphase. The off-resonance from each filter will cancel, thus lowering the level of the skirts. (Fig. 4.)

The temperature coefficient in Table I is for Ferroxcube IV D material. Ferroxcube VII B has a temperature coefficient about 1/10 of IV D. A filter bank made with VII B material showed only a 0.02 percent frequency change from 0 to 50 C. Ordinary quartz crystals would show almost the same change but specially cut units could be twice as stable.

The cost of a ferrite element is estimated at less than half that of a comparable quartz element and should be even lower when used in banks. A molded plastic form is being used to replace the paper tube and split brass ring construction.

Applications

Many uses exist for banks of narrow-band filters if they are cheap and compact. Spectrum analyzers could be made in the band from 20 kc to 200 kc with intrinsic bandwidths of 3 cps and 30 cps respectively. Band-pass filters can be made with bandwidths up to 200 cps while damped single elements will yield bandwidths up to 50 cps.

The input to the banks can be easily arranged. If the primaries are series fed, the input current will be the same for each filter and the outputs can then be equalized to better than 0.1 db.

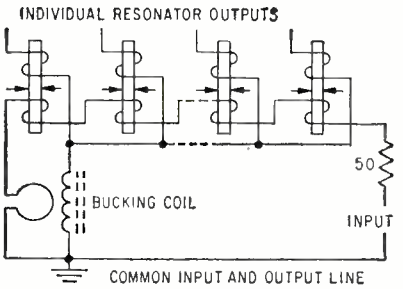

FIG. 6—Circuit for typical comb filter

When used in a radar or communications system, a comb filter acts similarly to the ear, tuning to an incoming signal and rejecting other signals or noise outside a certain bandwidth.

Doppler Radar

A comb filter is used with 10 channels, each 10 cps wide, for an overall bandwidth 100 cps. The 10 outputs are detected and read on meters. With no input signal, only noise is detected and all outputs are equal. The noise in each channel will be 1/10 that in the complete bank. Feeding a c-w input signal at the center frequency of one channel will give an output on only one meter. The effective signal/noise ratio is increased by 10 and the Doppler frequency is determined. Limitations of crystal detectors prevent the full 10 to 1 improvement in s/n ratio.

This arrangement could be used for practical radar, with the output of a particular channel with its enhanced s/n ratio being fed to a computer. If target velocity information is not required, circuits can be arranged to accept only the signal from the filter with the maximum output and display it on a single indicator.

A comb filter can be used in a pulse radar in a different way. A bank of filters is used with center frequencies each separated by the prf. The bank acts as a short-term store, successive signals from targets being added arithmetically while noise received in random phase is added rms fashion. Signals a_n add to Σa_n while uncorrelated noise b_n adds to $\Sigma b_n^2)\frac{1}{2}$. The s/n ratio is thus improved as $(\Sigma a_n)^2/\Sigma b_n^2$. Improvements greater than 10 db can be obtained in this way, the limitation being the square-law characteristic of detectors at low power levels. The natural time decay of the stored signals places limits on the effective integration which can actually be done.

Acknowledgment is due chief scientist, ministry of supply and to K. Foster and E. J. Dyer.

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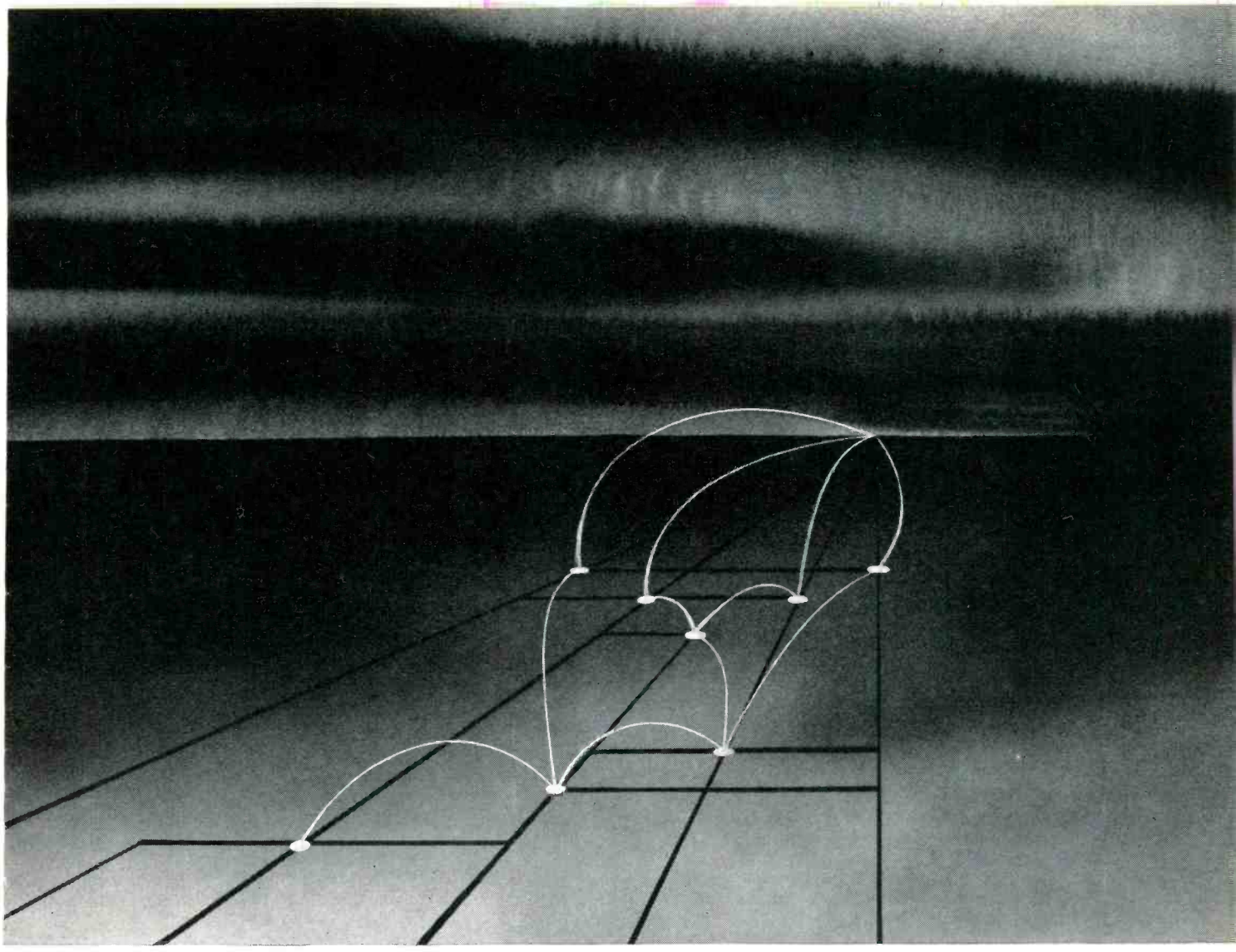

Report from IBM *Yorktown Research Center, New York*

ORGANIZING A MAXIMAL-SPEED COMPUTER

In designing a computer suitable for extremely high information-processing rates, it becomes necessary to re-examine basic concepts of machine organization in the light of new devices, new programming techniques and new applications. This study is being conducted by a machine organization group at the IBM Yorktown Research Center.

Investigations into the principles of computers are leading to the design of a completely superconducting machine. Its computing speed and capacity will be so high that the finite velocity of propagation of electromagnetic signals becomes the limiting speed factor. Therefore, the design must not only provide for the unique properties of superconductors but must minimize the effects of information transmission delays. This will be accomplished by a machine organization which causes information to be confined in packets as it is processed through the machine, and by the use of miniature circuits. In addition, the machine will provide the facility for simultaneous or parallel calculations of different parts of a problem. Furthermore, whereas most machines have been synchronous (in that information flow is controlled by traffic signals operated by a common clock), methods of completely asynchronous operation are now being investigated.

A machine such as this superconductor computer may well lead to important theoretical advances in many scientific fields. This study is part of a broad research program in computer organization extending the mathematical theories of computers and their application to information processing systems of all kinds.

IBM® RESEARCH

Transistor Rectifier Gives D-C of Either Polarity

Diagonally symmetrical power transistor circuit permits smooth load current variation over range of several amperes at either polarity. Power into two-terminal load can be four times maximum allowable transistor power dissipation

By **R. R. BOCKEMUEHL**, General Motors Research Laboratories, Warren, Mich.

SMOOTHLY VARIABLE DIRECT-CURRENT SOURCES capable of supplying positive and negative currents in the ampere region are often needed for testing magnetic materials, solenoids, meters, reactors and other low impedance electrical devices. In many cases passive circuits are impractical for this purpose because of the poor resolution and contact noise of high-power, low-resistance rheostats.

Basic Circuit

In the basic diagonally symmetrical circuit shown in Fig. 1, power transistors Q_1 and Q_2 and voltage sources E_s form two loops in common with load R_L. Control voltage E_b is applied between the transistor bases resulting in a control current which flows through the two transistor base-emitter circuits with an opposite sense, thus promoting conduction of one transistor while cutting off the other. Reversal of control voltage polarity transfers conduction to the opposite transistor, thereby reversing the load current.

The conducting transistor loop forms a common-collector circuit having the emitter-base reverse resistance of the cut off transistor in series with the control voltage source. Voltage gain is approximately unity, current gain is approximately β and input resistance is approximately βR_L.

Characteristics of this diagonally symmetrical circuit are similar to those obtained more simply with complementary symmetry circuits[1]; however, complementary transistors which have high power capabilities are not commercially available.

Practical Circuit

A practical diagonally symmetrical circuit is shown in Fig. 2. Transistors Q_1 and Q_3 serve as drivers for the output transistors Q_2 and Q_4. The driver circuit increases the input resistance to $\beta^2 R_L$ which permits use of a 5,000-ohm, high-resolution control potentiometer and reduces battery drain. Greater resolution can be obtained using potentiometers with larger resistance, but a sacrifice in linearity resulting from potentiometer loading occurs.

Shunt Resistors

Emitter-base resistances are shunted by 220- and 20-ohm resistors which have a negligible effect on the input resistance of the conducting circuit. The 47,000-ohm resistors bias the transistors so that they conduct slightly with zero control voltage; hence, under any condition at least one transistor pair is conducting.

A maximum of 4 amp can be supplied to the 2.5-ohm load giving an output of 40 watts. Maximum collector dissipation is 14.5 watts. Similar circuits can be designed for different load resistance by suitable selection of supply and control voltages and base bias resistors.

Other Applications

Control voltage can be obtained from electronic circuits thereby permitting the general circuit configuration to be used as a relatively high-power output stage for d-c servo applications. Also, since the circuit responds to frequencies from d-c through the audio range, similar circuits have been designed for audio power amplification[2] with direct connection to the loudspeaker voice coil.

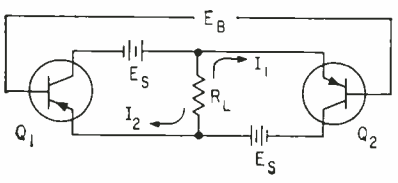

FIG. 1—Emitter currents in basic diagonally symmetrical circuit flow in opposite directions through load

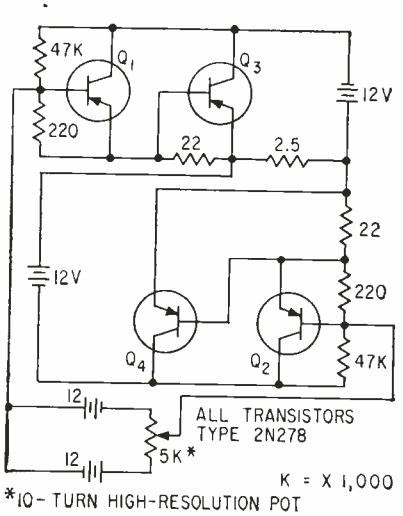

FIG. 2—Automotive storage batteries are used for 12-v transistor supplies in practical circuit although rectifier supplies would be used. Maximum current drain from two 12-v dry cells in control voltage circuit is 7 ma

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(2) Application Note 5-B, Delco Radio Division, General Motors Corp., Jan. 1958.

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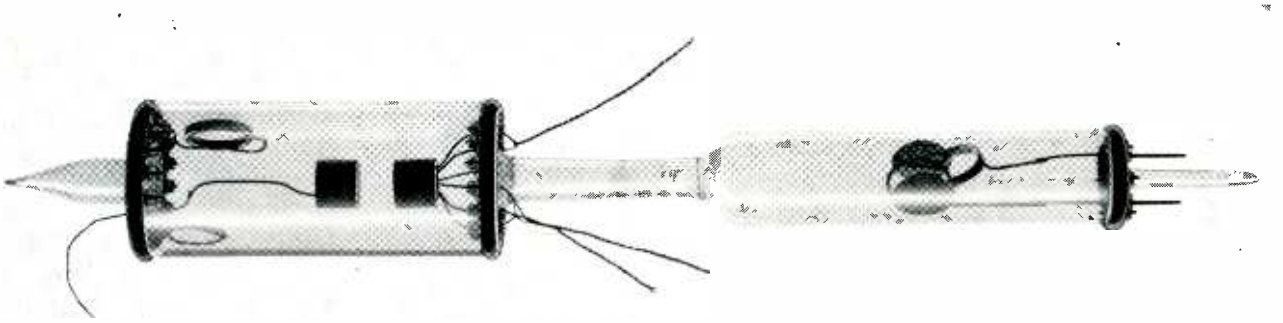

Methods for exhausting prototype vacuum tube to low pressure levels require simple, low-cost equipment

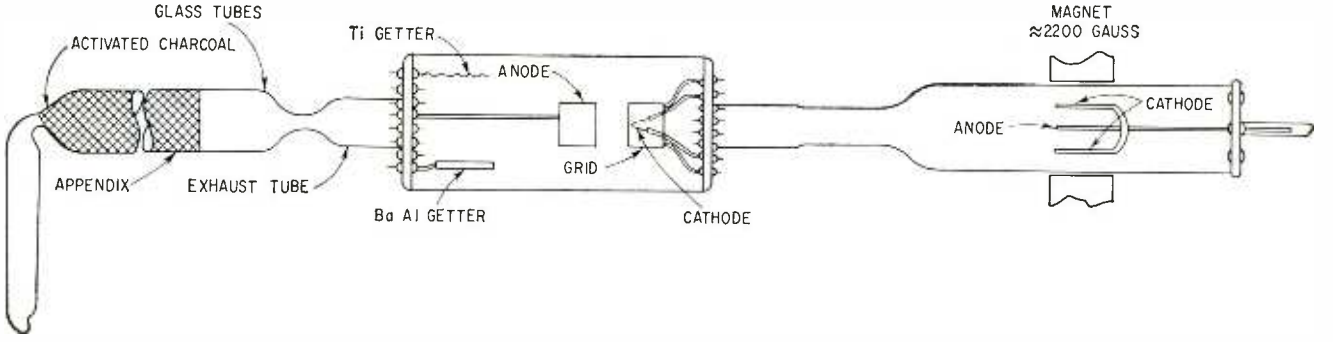

FIG. 1—Prototype vacuum tube uses adsorption principle for exhausting

Tube Exhaust Methods Use Simple Gear

By J. H. OWEN HARRIES, Owen Harries, Consulting Engineers, Bermuda

RESEARCH program led to techniques for exhausting vacuum envelopes from atmospheric to very low pressures without mechanical or diffusion pumps. Although originally developed for physics demonstrations, the simplicity and low cost of the approach suggests applications in research or even production exhausting.

Conventional mechanical pumps and oil or mercury diffusion pumps produce contamination. Contamination from pumps or other sources causes difficulties in attaining long life and low shrinkage in commercial production of vacuum tubes.

J. R. Zacharias of Massachusetts Institute of Technology requested us to devise a simple way for high school students to make vacuum tubes. Making tubes is part of new physics courses being devised by the Physical Science Study Committee.

Only very simple tools and materials would be available and only fundamental glassblowing operations possible. No spot welders nor vacuum or hydrogen furnaces could be required.

The prototype tube in Fig. 1 has an appendix for activated charcoal. This tube can be exhausted to pressures between 10^{-7} and 10^{-8} mm Hg. Similar tube without the appendix uses a mechanical pump with getters (but no diffusion pumps or cold traps).

Materials

Glass tubing and commercially available multiwire glass stems are joined with Corning Solder Glass 7570 to form the envelopes. The solder glass is fused in an oven at 570 C. Glassblowing is reduced to joining glass tubes not exceeding 0.5 inch in diameter and to making and sealing constrictions.

The electrodes of 305 stainless steel are washed and degreased in a home-made vapor degreaser. Spot welding is avoided by crimping.

Willemite is dusted on the anode electrode to obtain a visible electron beam spot. Ba Al and titanium getters are used, with each getter fired through a pair of leads from the inside of the envelope. No induction furnace is needed. More elaborate electrode systems than that used in the prototypes will be designed. Some or all of the 28 wire leads available through the commercial glass stems can be used.

A vacuum gage of the cold-cathode type is used either to pump continuously while measuring pressure or switched on for the shortest possible time so pressure is reduced little by the pumping action. The pumping action of the gage can be used to assure very low working pressure despite lack of clean assembly facilities. Continuous pumping with the vacuum gage is unnecessary since pressures as low as 10^{-5} to 10^{-6} mm Hg were recorded without continuous pumping by the gage. Lower pressures can be ob-

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tained without a vacuum gage by operating the electron gun for a few hours.

Adsorption Exhaust

The tube, gage and appendix (containing about 140 cc of 6-14 mesh activated charcoal) for the adsorption exhaust arrangement in Fig. 2 are baked at 350 C in a homemade oven. Glass tube orifices *A* and *B* are open to the atmosphere. After one hour and with temperature maintained at 350 C, carbon dioxide gas is injected through orifice *B*.

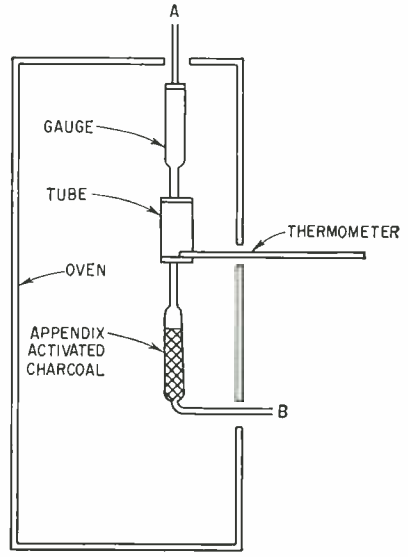


FIG. 2—Simple arrangement for baking tube requires home-made oven

The orifices are then sealed off while maintaining the same temperature. The appendix containing the activated charcoal is then immersed in solid CO_2 and trichlorethylene, reducing pressure sufficiently for the vacuum gage to be switched on. The Ba Al and Ti getters shown in Fig. 1 are then fired in that order to reduce pressure to 10^{-7} to 10^{-8} mm Hg.

Mechanical Exhaust

Alternatively, an inexpensive mechanical fore-pump can be used without the appendix containing activated charcoal. The tube shown in Fig. 3 is connected to the mechanical pump via a P_2O_5 trap. It is sealed off after pumping and baking at 350 C. Pressure is then about 10^{-3} to 10^{-4} mm Hg. After firing the Ba Al and Ti getters (in that order) and operating the vacuum gage, pressure falls to 10^{-7} to 10^{-8} mm Hg.

A Ti getter operates more effectively than a commercial Ba Al getter only if pressure is low and dirty gas from the pumps and electrodes is absent. Although a Ba Al getter is not as readily inhibited, in practice it does not produce pressures nearly as low as Ti when dirty gas is absent. Therefore the Ba Al getter is fired first.

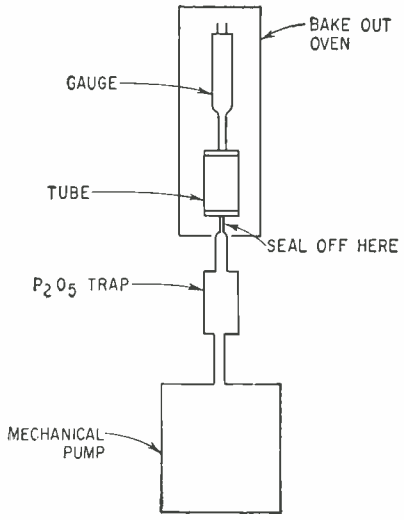


FIG. 3—Mechanical fore-pump is used in this approach to exhausting

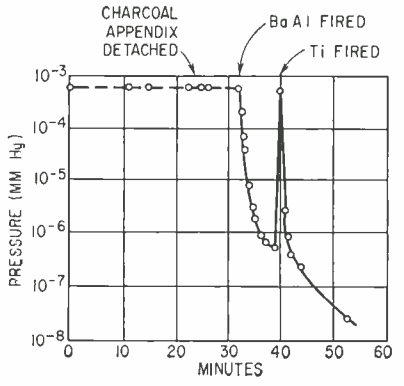


FIG. 4—Pressure is platted against time for prototype vacuum tube

Performance during adsorption exhaust is shown in Fig. 4. The appendix containing charcoal was immersed in solid CO_2 and trichlorethylene at zero time. Before firing the getters, the characteristic blue glow of CO_2 gas appeared between the gage electrodes.

Thoriated tungsten wire cathodes are used because Ba Sr oxide cathode coatings are probably too difficult to prepare. However, adsorption exhaust techniques have been used successfully with oxide coated cathodes.

The author thanks Mr. D. F. Fetigan of this laboratory who constructed, exhausted and tested the high school tubes.

Printed Circuit Can Take 1,300 F

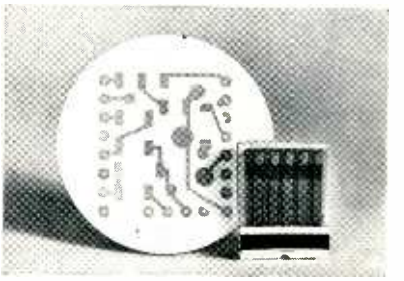
ALUMINA, an oxide of aluminum, is the base-board ceramic material on which the circuit, a molybdenum-manganese compound is fired and brazed. The molybdenum-manganese wiring is permanently bonded to the aluminum oxide base and cannot be removed without destroying the ceramic, nor can the circuit be broken or shaken from its board. It is called a Molumina circuit.

This ceramic board with its firmly-embedded circuit will operate in the 1,300 F heat generated in the ionosphere. Electrical resistances are about three times those of copper and the circuit can be plated for lower requirements.

The printed circuit will not absorb water, it returns to its original shape after exposure to high temperatures and it can operate in the presence of corrosive chemicals. If an electric arc occurs, the alumina will not be destroyed or carbon track.

The circuit can carry a greater electrical load than other materials because of its capacity to withstand heat. It gives great dielectric strength, tensile strength, rupture strength and compression strength. There is little chance that subsequent manufacturing processes could damage the circuit's physical or electrical properties. Field changes can be made by simply adding or removing jumper wires.

The circuit was developed by George L. Heitman of Advanced Vacuum Products, Inc., Stamford, Conn., a subsidiary of General Ceramics. About a dozen developmental units are now in the hands of electronics manufacturers.



Folder of matches indicates size of ceramic circuit board

Molymanganese printed circuit subjected to heat of a Bunsen burner

Studying Radiation Effects

CONSTRUCTION is now beginning at Air Force Cambridge Research Center on new facilities for research into the radiation damage of electronic materials. Facilities will be used by the Electronic Material Sciences Laboratory to investigate the effects of radiation on semiconductors, dielectrics and various electronic components. Of equal importance, research on materials modification by radiation to enhance their electronic properties will be carried out.

The special radiation physics building will house a three MEV Van de Graff generator and a cobalt 60 source of about 10,000 curies. The Van de Graff generator is capable of accelerating protons, duterons and electrons to vary high energies; the cobalt 60 source provides a high intensity gamma ray field. The facility, scheduled for completion in 1960, will also contain equipment for the remote handling of material in a hot cell. Cook Electric Company is responsible for the design and construction of the facility.

Magnetic Materials

Permanent magnets survive far greater dosages of nuclear radiation than is normally required of them, according to a comprehensive study of permanent magnetic materials. Unlike soft magnetic materials, some of which show drastic degradation under radiation, the permanent magnet materials tested showed no measurable changes following exposure in the Brookhaven National Laboratory Reactor. The materials met or exceeded radiation environmental requirements established by the Defense Department for electronics equipment likely to be employed in nuclear-powered aircraft and ballistic missiles.

Results of the NOL tests indicated, from the military point of view, that most of the major hard magnetic materials now available commercially can readily be used in designs for nuclear aircraft and missiles. This contrasts sharply with the findings on radiation effects upon soft magnetic materials, some of which could not function in such an environment for any significant length of time.

The investigation of hard magnetic materials in part of a broader NOL study of radiation effects on both permanent magnets and soft magnetic core materials.

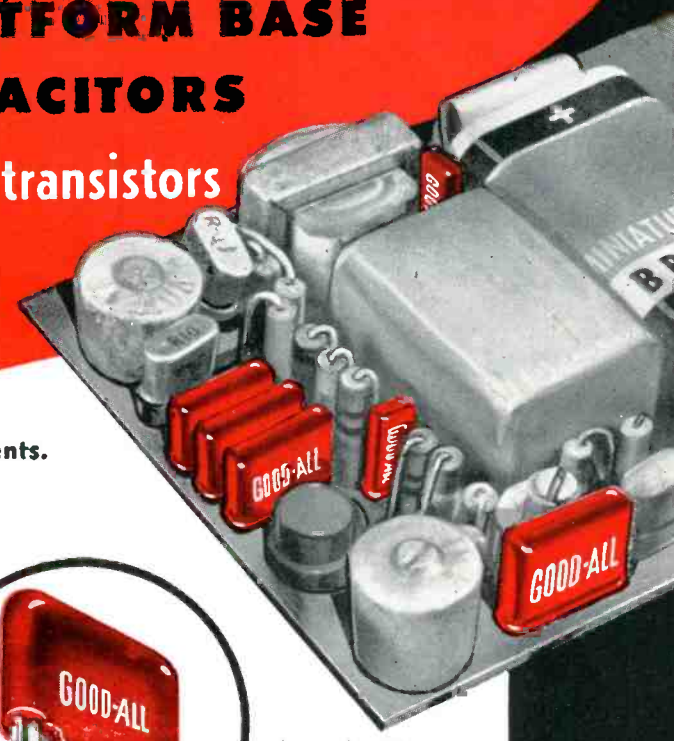
Last Fall, a two-year study was completed by laboratory physicists measuring the extent to which soft magnetic cores deteriorated under nuclear radiation. All 14 soft core materials tested were found insensitive to all types of reactor radiation except fast neutrons, which caused varying degree of deterioration in magnetic properties.

The magnetic materials tested were 3.5 chromium-steel; 36 cobalt-steel; Alnico II, V and XII; Cunico I; Silmanal; fine irons; platinum-cobalt; unoriented barium-ferrite. and oriented barium-ferrite. D. I.

Good-All

New SLIM-LINE TYPE 602 PLATFORM BASE CAPACITORS

...tailored for transistors

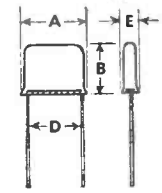


This is a special-purpose version of the popular, space saving Good-All SLIM LINE (Type 601PE) and is designed to meet **rugged vibration requirements.** The mounting platform of Epoxy-glass laminate securely seats the 602 capacitor on a printed circuit chassis. Added stability under vibration is provided by heavy gauge leads.

Tough, moisture-tight Epoxy coating

Miniature "platform" of Epoxy-glass laminate

Heavy Gauge leads precisely spaced



TYPE 602 DIMENSIONS (AVAILABLE IN 50 VOLT RATINGS ONLY)

CAP. (Mfd.)	A	B	D	E	CAP. (Mfd.)	A	B	D	E
.01	.562	.300	.440	.200	.10	.650	.525	.558	.225
.022	.562	.339	.440	.210	.15	.671	.650	.558	.260
.033	.531	.386	.440	.210	.22	.748	.717	.558	.296
.047	.531	.433	.440	.235	.33	.843	.780	.690	.312
.068	.575	.480	.440	.260					

SPECIFICATIONS

INSULATION RESISTANCE — Greater than 75,000 megohms when measured at 100 volts D.C. at 25° C for a maximum of 2 minutes.

WINDING CONSTRUCTION — Extended foil (non-inductive) MYLAR* Dielectric.

LEAD LENGTH — Standard 1" min. as shown. Available, on special order, to exact length required by application.

CAPACITY TOLERANCE — Standard tolerance is 20%.

DISSIPATION FACTOR — Less than 1% at 1,000 cycles per second at 25° C.

DIELECTRIC STRENGTH — 100 volts D.C. for 1 to 5 seconds thru a minimum current limiting resistance of 100 ohms per volt.

TEMPERATURE RANGE — May be operated at full rated voltage to 85° C. Derate to 50% when operating at 125° C.

*DuPont's trademark for polyester film.

Write for Technical Brochure on this new type.

GOOD-ALL ELECTRIC MFG. CO. • OGALLALA, NEBRASKA

In Canada, 700 Weston Road, Toronto 9, Ontario

GOOD-ALL CAPACITORS NOW AVAILABLE AT YOUR LOCAL DISTRIBUTOR

Gordon, R. S. Serry and R. H. Lundsten of the Applied Physics Department of Naval Research Laboratory are compiling data for a detailed report to be ready later in the year.

Depletion-Region Transistor Made

FROM Philips of Einhoven, Holland, comes word of a semiconductor claimed to make use of the depletion region surrounding an alloy contact in near-intrinsic germanium, and called a Deplistor. However it is apparently not intended for small-signal, high-frequency operation.

Figure 1A shows an *n*-type contact, the control electrode, alloyed into a thin circular wafer of intrinsic germanium opposite a small *p*-type alloy contact, called the

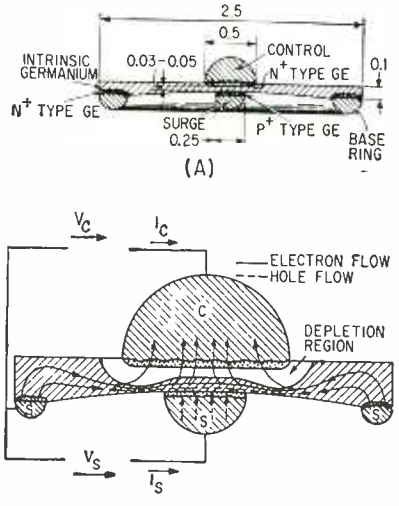


FIG. 1—Cross section of Deplistor (A) gives the dimensions in mm. The current-flow pattern in the on condition is shown in (B)

surge electrode. The third electrode is formed by an *n*-type base ring alloyed along the circumference of the wafer. Figure 1B shows the current flow pattern in the *on* condition, when appreciable current flows through the surge electrode. Only small saturation currents are carried in the non-conducting state.

The current-voltage characteristic, measured between the surge and base electrodes, exhibit a negative differential resistance under certain conditions.

Typical data reported: $V_c = 20$ v,

V_s = 0 non-conducting bias gives I_s = 50, μa and I_s = −10, μa and an a-c differential resistance of more than 100,000 ohms. I_s = 0 and V_s = 1 v conducting bias gives a surge current I_s = 20 to 50 ma and an a-c differential resistance of between five and 10 ohms.

A PN Diode

According to the description, the so-called Deplistor is like a *pn* junction diode between surge and base electrode, the current flow through which is modulated by more or less reverse bias on the control electrode.

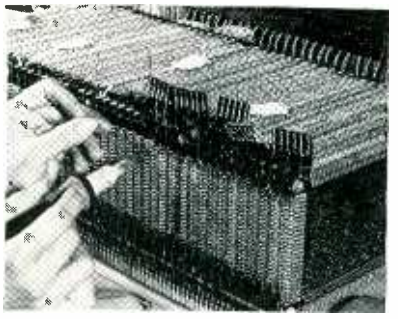
As such, the Deplistor seems to resemble the unipolar field-effect transistor of Shockley's except that in the field-effect transistor, the material between *source* and *drain* (corresponding to *surge* and *base* in the deplistor), is a homogeneous high-resistivity semiconductor and not a junction.

Grown Silicon Lenses For Infrared Sensing

INDIVIDUAL GROWN silicon lenses to ten-inches in dia. and silicon domes to 8-inches in dia. for infrared use are now available in production and evaluation quantities from Knapic Electro-Physics, Inc. of Palo Alto, California. The principal use of this new large-diameter material is in the manufacture of lenses for infrared sensing devices. Coated silicon lenses from this material will pass 92 to 97 percent of the infrared wave length band between 1 to 8.5 microns.

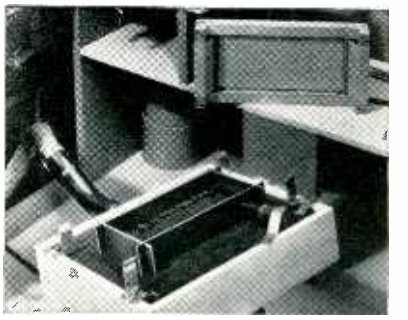
Development of this new large-diameter material is of considerable significance to national defense, since silicon lenses are essential components in many military infrared devices. The availability of large-diameter lenses is important since the detecting power of the lens is related to the square of the lens diameter. Previously available material has not been larger than 5 inches in dia.

Silicon lenses are used in infrared cameras, homing missiles and early warning devices similar in application to present radar systems.



Memory stack may contain up to 10 million cores

Hand wiring of memory core array. Improved methods are less tedious



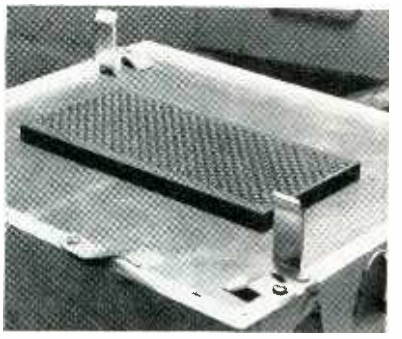
Vibration-vacuum fixture to align cores. Tape transfer fixture is above

Memory Windings May Be Printed

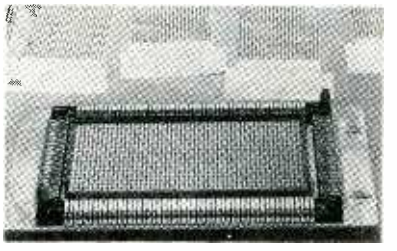
PRINTED CIRCUIT techniques may eliminate tedious hand assembly of ferrite core memory arrays. Attempts are being made to metalize a pattern through the core center while circuit connections are printed.

Hand array wiring techniques are reaching a limit in cost and miniaturization, it was reported by E. R. Gamson, Telemeter Magnetics, Inc., Los Angeles, Calif., at this month's IRE Professional Group on Production Techniques Third National Conference, San Mateo, Calif.

In a paper coauthored by F. J. Saltus and D. A. Zumwalt, he detailed methods now used. A single array may have more than 16,000 cores with common windings. Cores were aligned by hand. Vibration-vacuum methods are now used. Locating plates are etched from copper, reducing tooling costs to $100 or $200, compared with $2,000 to $3,000 for the molded plastic plates formerly used. Adhesive tape transfers cores to the wiring fixture without losing alignment. The tape is pressed over the cores with a wood fixture and rubber roller.



Copper locating plate is made by etched wiring techniques



Array winding fixture with clips to hold wires. Unwired cores are held on tape

One-step Circuits

A trend away from component assembly and towards fabrication of complete solid state circuitry was predicted by D. W. Moore, Servomechanisms, Inc., Goleta, Calif. An interim stage, reached with micromodules (ELECTRONICS, p 62, May 15, and p 51, May 22, 1959), is still compatible with specialized component manufacture. Solid state circuitry would require a merger of specialties.

Production Cleaning

A. K. Baker, The Baker Co., Inc., Biddeford, Maine, discussed prevention of contamination by micron-sized particles in the production atmosphere. He reviewed equipment and materials his firm uses in constructing clean rooms and pressurized workbench enclosures, methods of monitoring air cleanliness, personnel practices and precautions for preserving cleanliness.

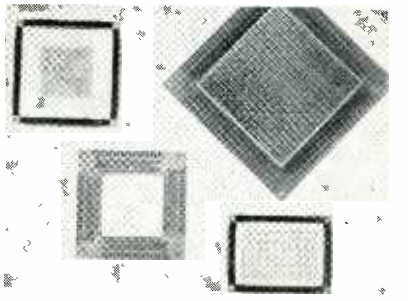
For example, ordinary paper, pencils and erasers should not be used. Ball point pens and vellum will yield less dust. The best solution is carbon paperless duplicating forms in plastic envelopes and a simple stylus.

G. G. Brown, Bendix Aviation Corp., Davenport, Ohio, in a survey of ultrasonic cleaning equipment components and practices, gave several tips on solving ultrasonic cleaning problems:

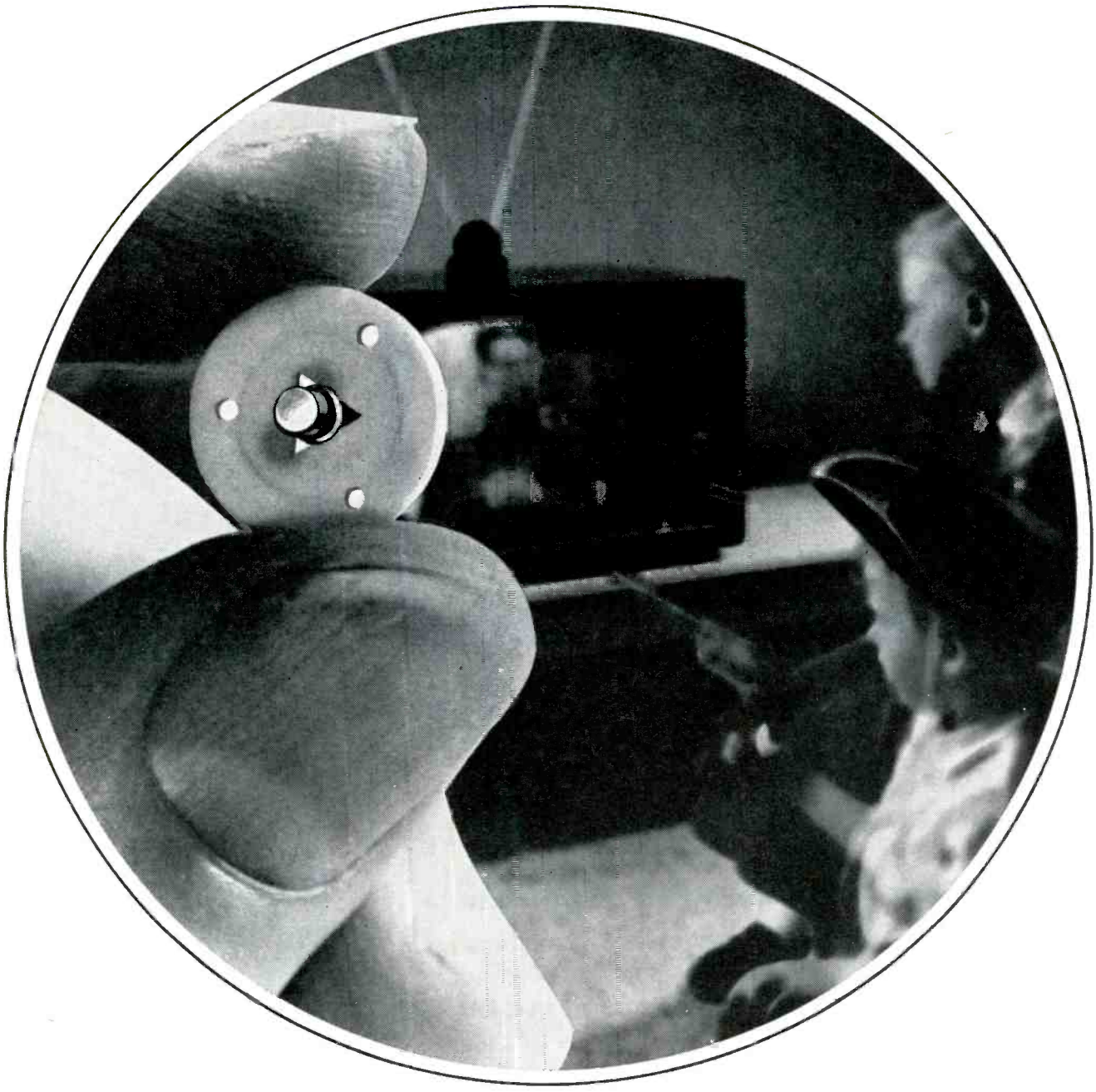
Parts cleaning baskets may reflect half the sonic energy if improperly designed. An automatic shutoff timer avoids unnecessary deterioration of the system. A mistuned generator may reduce cleaning efficiency 80 percent; retune it each shift. Use preferential placement to clean blind cavities; expel entrapped air. Keep bath temperatures below the Curie point of the transducer material.

R. H. Watson, Lockheed Aircraft Corp., Sunnyvale, Calif., urged engineering personnel to advise production personnel well in advance of new components and equipment to avoid production problems.

One example he gave concerned



Various types of array frames



Improved Ceramic Design Gives Faster TV Warmup

See the triangular hole in the center of this new Superior Tube disc cathode. Only three tiny points touch the cathode shank. So there's practically no path for heat loss to delay warmup.

Obviously this low heat loss is especially desirable wherever 300 and 450 ma heaters are used.

The crimping of the embosses in disc cathode manufacture creates a locking key effect in the triangular hole to resist rotation of the cathode shank. The 3-point contact provides no axis for an undesirable rocking action to take place.

In this design, breather holes in the ceramic may not be required.

The shadow groove is placed further out to give better protection against sublimation leakage.

Available now in the miniature assembly. Will be available in all types shortly. For information, write Superior Tube Company, 2500 Germantown Ave., Norristown, Pa.

Superior Tube

The big name in small tubing

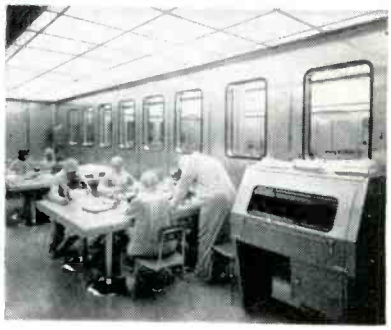
NORRISTOWN, PA.

Johnson & Hoffman Mfg. Corp., Mineola, N.Y.—an affiliated company making precision metal stampings and deep-drawn parts

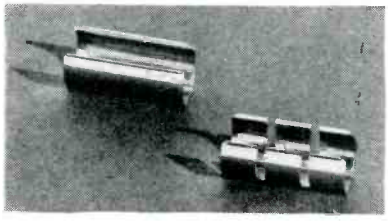
production selection of transistors for minimum beta and internal feedback. No suitable capacitor had sufficient range to neutralize all the transistors. Instead of culling transistors to suit a standard capacitor, a method of matching capacitors to each transistor was devised.

E. J. Meyer, Hughes Aircraft Co., Tuscon, Ariz., outlined reliability considerations in missile production. Sometimes, changes in production can avoid redesign. Among cases cited were:

Air shower room of prefabricated clean room installed in Sperry-Farragut plant by Baker. Liquid soap and hot air driers also avoid dust



Concentration of airborne contaminants can be held to a few hundred particles (mostly submicron in size) per liter in a room like this



Hughes Aircraft found shock mounting clip at right compensates for variations in tube envelope dimensions

Tube shock mounting was improved by replacing solid spring clips with finger spring clips to compensate for tube envelope variations. Tube heater to cathode leakage exceeded specs; chassis were preaged before final test to weed out

unsatisfactory tubes. A battery was modified with a heat diffuser to cool a power supply. Overheating of a resistor, causing solder joint melting, was cured by mechanical mountings which provided a heat sink.

Nickel Plate Protects Tinning Dip from Brass

DIRECT IMMERSION of intricate components in molten tin or solder, followed by centrifuging, separating and quenching gives excellent hot tinning results in many cases, according to the 1958 annual report of the International Tin Research Council, Tin Research Institute, Greenford, Middlesex, England.

Bath Conservation

However, when hot tinning brass by this method, the dipping bath may quickly be contaminated with copper and zinc. The problem may be overcome by first applying a thin coating of electro-deposited nickel to the components.

High centrifuging speeds may result in too thin a coating. Barrel hot tinning is satisfactory for many shapes and sizes. The work is rotated in a heated container with a measured amount of molten tin or solder and flux.

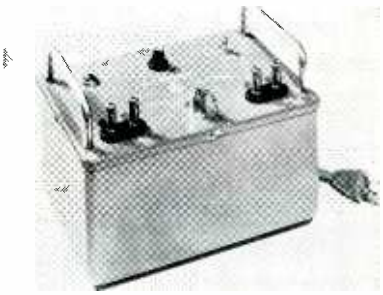
Tin Porosity

An electrochemical method of providing a numerical index of the porosity of coatings of tin and other metals has been devised. The metal carrying the coating is made the anode in a test cell. Electrolyte and current density are chosen so that current is carried only by exposed base metal and so that polarization of the metal is insensitive to small changes of current.

Variation of the measured potential of the test piece with changes of applied current is governed by the electrical resistivity of the electrolyte contained in the pores. The resistance values for the pores depends on their number, area, shape and length. The method is expected to be useful also in research on sources of pores and behavior of porous coatings in corrosive environments.

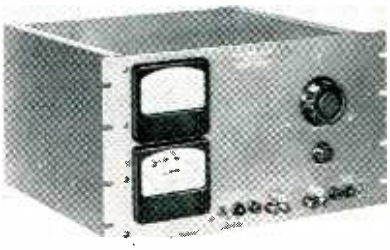
On The Market

D-C Amplifier
multipurpose



HOUSTON INSTRUMENT CORP., 1717 Clay Ave., Houston 3, Texas. Model M-10 multipurpose chopper-stabilized d-c amplifier is a versatile reliable instrument suitable for many laboratory and industrial applications where low-level d-c amplification is required. It will deliver 1 ma into loads of up to 5,000 ohms with a 10 mv input. The high input impedance and current feedback loop make it possible for the M-10 to operate from a current or voltage source and provide either a current or voltage output when proper shunts are added.

CIRCLE NO. 200 READER SERVICE CARD



Lab Power Supply
wide range

DRESSEN-BARNES CORP., 250 N. Vinedo Ave., Pasadena, Calif. A new 500 ma laboratory power supply has a voltage range from 3 to 1,000 v d-c, providing high versatility. Unit is continuously variable throughout the range with one twist of the knob. A vernier voltage control permits fine settings. D-C regulation for load and line is excellent. Maximum ripple is 8 mv rms. Price is $695.

CIRCLE NO. 201 READER SERVICE CARD

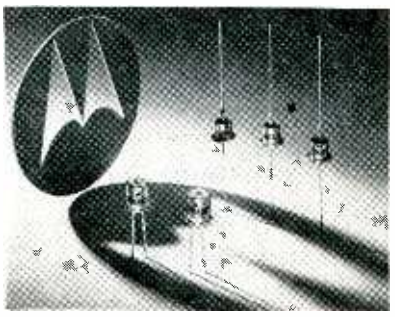
Nylon Cap Nut
self-locking

LEHIGH METAL PRODUCTS CO., 134 Alewife Brook Parkway, Cambridge, Mass., announces a Nylon, self-locking cap nut with uses in the electronics industry. Rustproof and antimagnetic, the Relok nut is molded of Plaskon Nylon, a material said to possess high strength and impact resistance. The deepest end of the nut's inside is left unthreaded so that the forward end of the bolt self-taps itself in place. A variety of sizes is available.

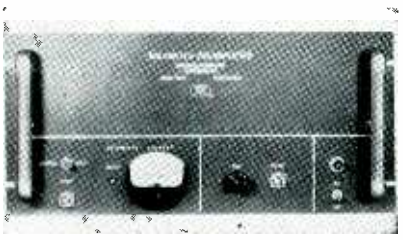
CIRCLE NO. 202 READER SERVICE CARD

Silicon Zener Diodes
two types

MOTOROLA INC., 5005 McDowell Rd., Phoenix, Ariz. Types 1MZ (1 w) and 1.5 MZ (1.5 w) silicon Zener diodes are rated at voltages from 10 to 200 v. They are tested at both high and low currents to insure a sharp knee on the breakdown curve and to eliminate unstable units. An outstanding characteristic is their very low Zener impedance. The rugged, hermetically sealed packages are designed to meet or exceed mechanical and environment requirements of MIL-E-1 and MIL-S-19500.



CIRCLE NO. '203 READER SERVICE CARD



Bolometer Preamp
new features

WEINSCHEL ENGINEERING, 10503 Metropolitan Ave., Kensington, Md. Model BA-1 bolometer preamplifier is now available in a new version, the BA-1C, which incorporates new features. Unit is used for the measurement of r-f power ratios up to 30 db between 20 and 90,000 mc at maximum r-f level of 200 μw without switching of attenuators or change of amplifier gain. It can be used either with barretters or with video crystals. A well-regulated,

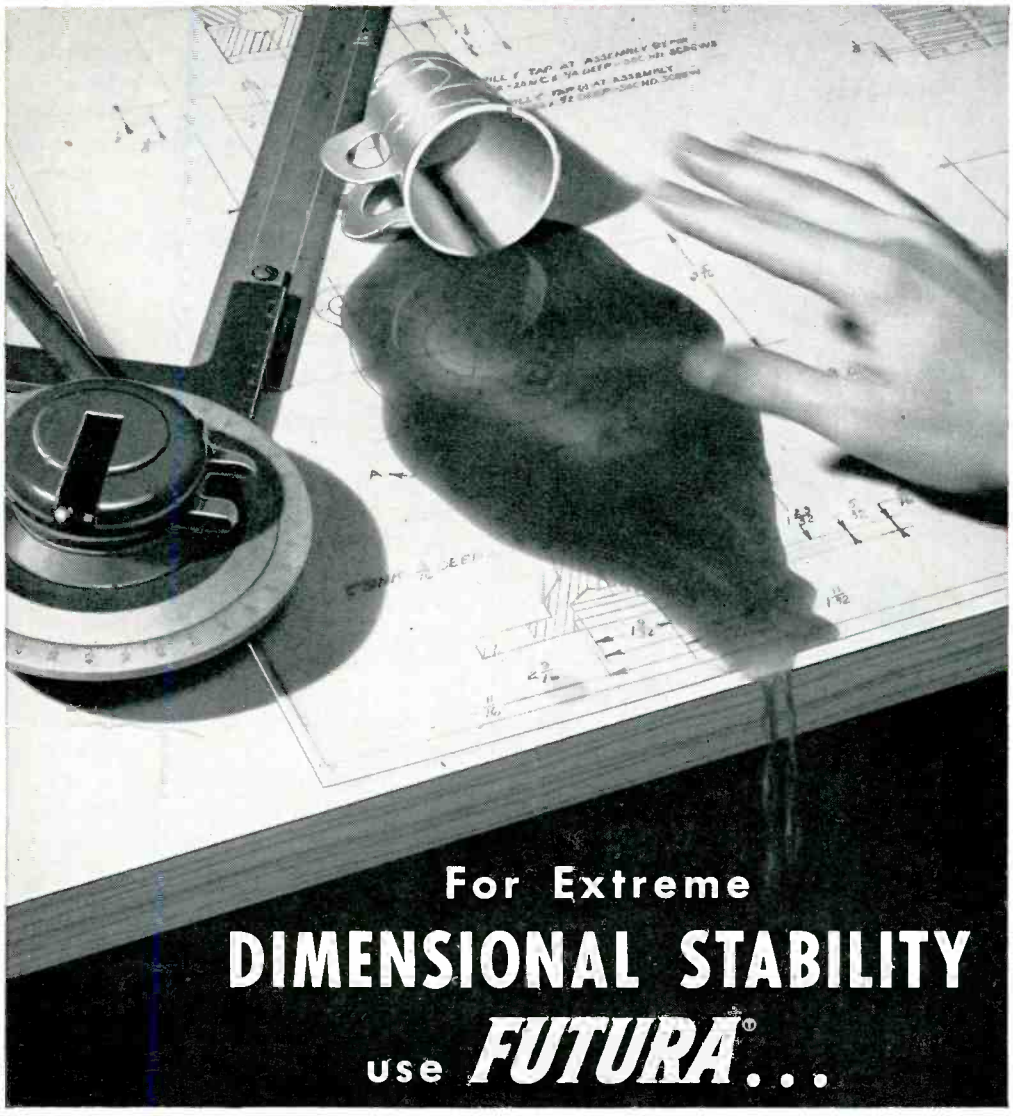
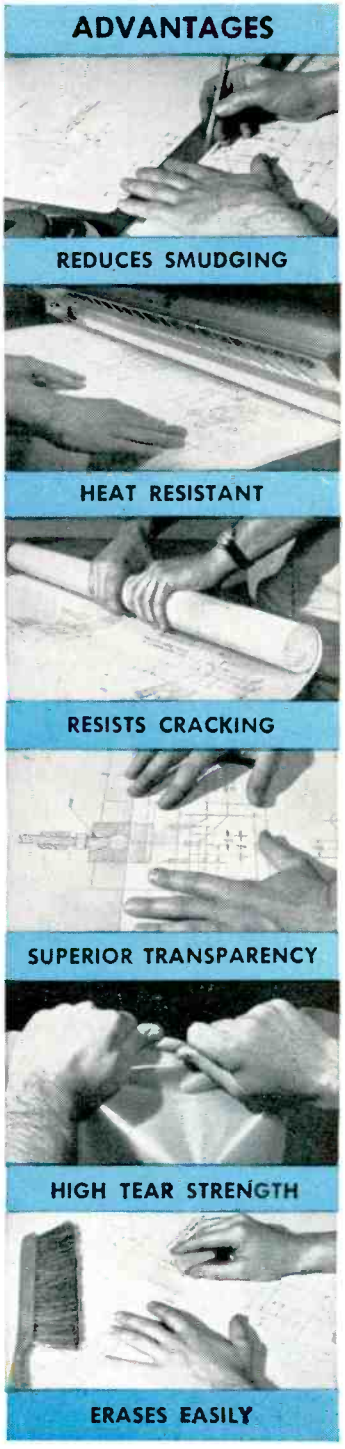


Chart-Pak's New Drafting Film

This remarkable drafting film on "Cronar"* withstands all kinds of punishment. *(Spilled coffee wipes right off!)* Won't stretch, shrink or pucker. Ideal for printed circuits and all types of drawings — pencil or ink. Lasts indefinitely, and costs no more than cloths or vellums! Matte finish on one or both sides — no extra cost. Keep *your* valuable drawings SAFE on durable Futura drafting film! *Send for a free sample now!*

*A registered DuPont trademark



Tomorrow's drafting film | Today

Chart-Pak
FUTURA® Drafting Film
on "Cronar"*

*DuPont's registered trade mark

Other Advantages of *FUTURA*

- Moisture Proof
- Very Flexible
- No Stretch or Shrink
- Lies Flat
- Won't Yellow with Age
- Doesn't "Dog-ear"

CHART-PAK INC.

ORIGINATOR OF THE TAPE METHOD OF DRAFTING

246 River Road, Leeds, Mass.

self-contained barretter bias circuit replaces the battery supply, while the extremely low noise level and burn-out protection for barretters has been maintained. Also featured is a new concentric fine gain control.

CIRCLE NO. 204 READER SERVICE CARD

Insulation Testers meet ASTM standards

BETA ELECTRIC DIVISION of Sorensen & Co., Inc., Richards Ave., South Norwalk, Conn. Easily fulfilling the ASTM standards for dielectric testing, these a-c insulation testers supply up to 100 kva of dependable power in four ranges: 0-25, 0-50, 0-100, and 0-150 kv. These supplies are conservatively designed and are aged for at least 12 hr at 110 percent of rated voltage. Final inspection includes test at 110 percent of rated output current, and the output is repeatedly short-circuited to check the protective devices.

CIRCLE NO. 205 READER SERVICE CARD

Panel Light tiny, powerful

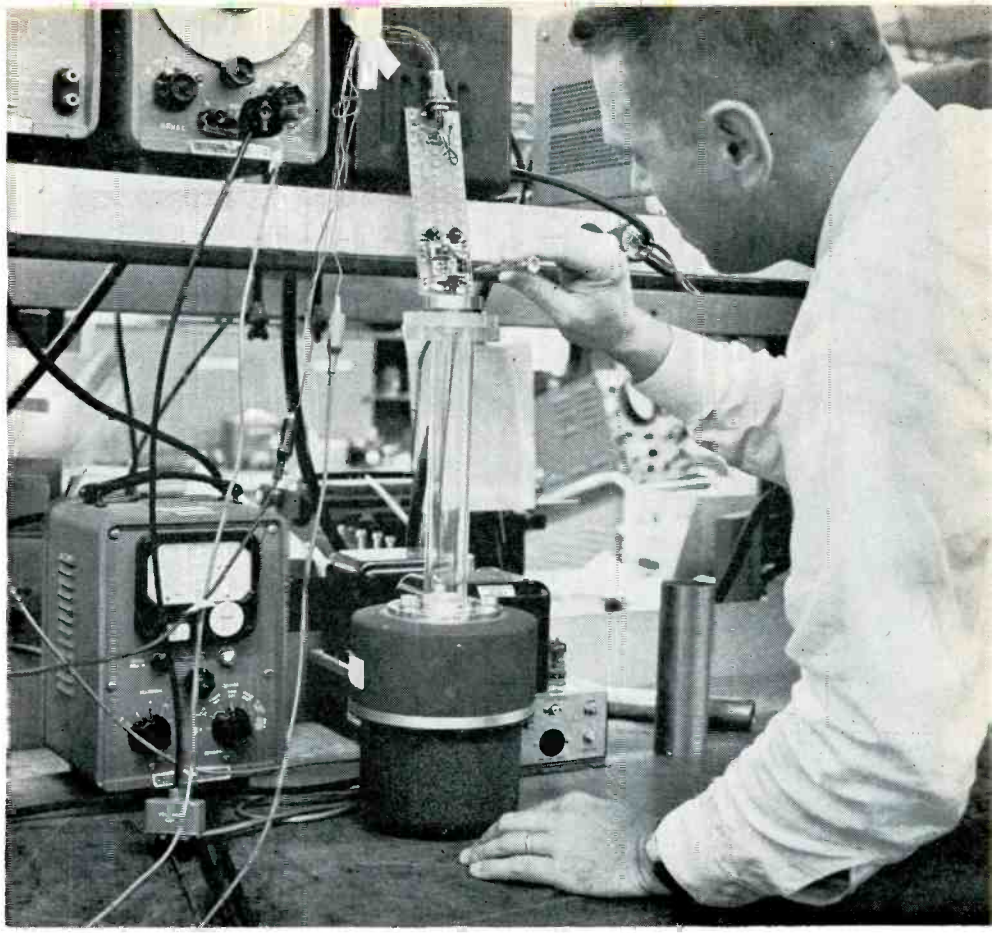
THE SLOAN CO., 4029 Burbank Blvd., Burbank, Calif. Model T-1, a tiny, yet powerful Color-Lite is guaranteed for 100,000 hr at 5 v; 60,000 hr at 6.3 v. It is designed for missile, missile test stand, aircraft, computer and production equipment applications. It is said to be the first standard panel indicator light only ¼ in. in diameter.

CIRCLE NO. 206 READER SERVICE CARD

Power Transformer circuit design aid

TRIAD TRANSFORMER CORP., 4055 Redwood Ave., Venice, Calif. Development of voltage doubler circuits using silicon rectifier power supplies is now possible with the

New noise microphone reports sonic damage to missiles in flight.



Expanding the Frontiers of Space Technology

INSTRUMENTATION

Lockheed has an extensive research capability in the development of transducers and instrumentation for missile and spacecraft applications.

Under investigation are the properties of liquids and certain rubber-like solids as a function of amplitude and frequency of excitation; research on piezoresistive materials such as silicon, germanium, and indium antimonide in an effort to develop better transducers; research on capacitive methods of measuring extremely small displacements to 10^{-12} inch, and on a variety of other physical problems.

Scientists and engineers of outstanding talent and inquiring mind are invited to join us in the nation's most interesting and challenging basic research and development programs. Write: Research and Development Staff, Dept. F-22, 962 W. El Camino Real, Sunnyvale, Calif. U.S. citizenship required.

"The organization that contributed most in the past year to the advancement of the art of missiles and astronautics."
NATIONAL MISSILE INDUSTRY CONFERENCE AWARD

Lockheed / MISSILES AND SPACE DIVISION

Weapons Systems Manager for the Navy POLARIS FBM; DISCOVERER SATELLITE; Army KINGFISHER; Air Force Q-5 and X-7

SUNNYVALE, PALO ALTO, VAN NUYS, SANTA CRUZ, SANTA MARIA, CALIFORNIA · CAPE CANAVERAL, FLORIDA · ALAMOGORDO, NEW MEXICO · HAWAII

(left) Research and Development facilities in the Stanford Industrial Park at Palo Alto, California, provide the latest in technical equipment.

(right) Ultrasonic temperature probe measures speed of sound in various gases—another Lockheed contribution.

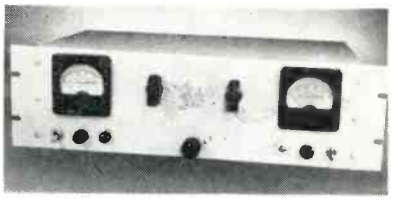
new R-93A power transformer. It provides taps on both primary and secondary windings to allow several variations of output voltage, and is electrostatically shielded. Rated at 110/120 v, 60 cps primary and 150/160/170 v at 500 ma secondary, it also supplies filament power of 6.3 v-6 amperes center tapped for hum reduction. In a voltage doubler circuit, the maximum d-c available for preamps and amplifiers is 250 ma with approximately 480 v.

CIRCLE NO. 207 READER SERVICE CARD

Wideband amplifiers
two new models

INSTRUMENTS FOR INDUSTRY, INC., 101 New South Road, Hicksville, L. I., N. Y. M-630 and M-680 super video amplifiers. Two can be housed in cabinet with power supply and front panel connections. Each amplifier section has a 90 ohm input and output impedance, separate input and output connectors. For two channels, each amplifier can be used as a separate amplifier with gain of 20 db (M-680) or 60 db (M-630) with 2 v rms output. In cascade, M-680 has gain up to 40 db and M-630 up to 120 db. Amplifier sections can operate in parallel or push-pull.

CIRCLE NO. 208 READER SERVICE CARD



D-C Power Supply
low ripple

NJE CORP., 345 Carnegie Ave., Kenilworth, N. J. Model S-325 power supply brings the regulation and

CIRCLE NO. 94 READER SERVICE CARD

CIRCLE NO. 95 READER SERVICE CARD →

AlSiMag®

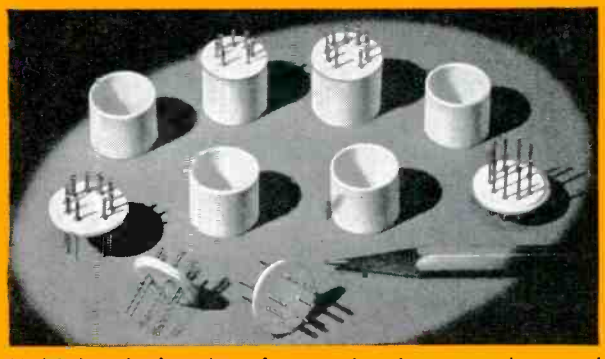
CERAMICS and METAL-CERAMICS for MISSILES

AlSiMag high-alumina ceramics offer unusual reliability. High temperature resistance, superior insulating characteristics, great mechanical strength, resistance to abrasion, corrosion and chemical attack are among the advantages particularly important when maximum performance and reliability must be packed into minimum space.

Both soft solder and hard solder terminals are available. A new technique is producing strong high temperature metal-ceramic hermetic seals.

Precision tolerances can be maintained. Custom designs are made in an unusually broad range including ultra-thin or miniature components of unusual complexity.

AlSiMag special purpose compositions based on alumina, steatite, zircon, Forsterite, cordierite, titania, aluminum silicate, magnesium silicate, silicon carbide and other materials may answer special requirements. The AlSiMag family of ceramic compositions is the largest in the industry . . . and it is backed by more than half a century of specialized experience over the widest area of design and production in the technical ceramic field. Your inquiries will have prompt and interested attention.



Multiple pin headers for use in electron tubes and other demanding applications are made in AlSiMag with pins hermetically sealed. The AlSiMag ceramic may be safely used in working temperatures up to 2800° F. The limiting factors are the metal components. The parts shown have tantalum pins with nickel braze alloy combined with the ceramic in a strong hermetic seal for operating temperatures in the 1000° F. range. The materials have been carefully selected for ruggedness and for their low vapor pressure characteristics. This base and envelope allow higher bake-out temperatures during assembly.

A Subsidiary of Minnesota Mining and Manufacturing Company

AMERICAN LAVA CORPORATION

CHATTANOOGA 5, TENN.
57TH YEAR OF CERAMIC LEADERSHIP

For service, contact American Lava representatives in Offices of Minnesota Mining & Manufacturing Co. in these cities (see your local telephone directory): Boston: Newton Center, Mass. • Chicago: Bedford Park, Ill. • Cleveland, O. • Dallas, Texas • Los Angeles, Cal. New York: Ridgefield, N. J. • Philadelphia, Pa. • St. Louis, Mo. • St. Paul, Minn. • So. San Francisco, Cal. • Seattle, Wash.
All other export: Minnesota Mining & Manufacturing Co., International Division, 99 Park Ave., New York, N. Y.

stability of the laboratory-reference supply to the high-voltage ranges required by photomultipliers, klystrons, radiation counters, and c-r devices, at low cost and in compact form. Regulation against line voltage fluctuations is better than ±50 parts per million. Ripple is never more than 10 parts per million. Load regulation is never more than ±60 parts per million, over the entire output range of 500-2,500 v and 0-10 ma d-c.

CIRCLE NO. 209 READER SERVICE CARD

P-M D-C Motors subminiature

CRAMER CONTROLS CORP., Centerbrook, Conn. Type 810 d-c motors are of permanent magnet design, combining high torque output at high speeds in a unit of extremely small size and light weight. They are available for operation on any specified d-c voltage between 3 and 30 v, with armatures wound to produce any desired no-load motor speed between 5,000 and 20,000 rpm at the specified input voltage. Locked-rotor (maximum) output torque for the motor without gear train is approximately 0.7 oz-in., with working torques in the range of 0.5 to 0.1 oz-in. between the output speeds of 5,000 and 15,000 rpm.

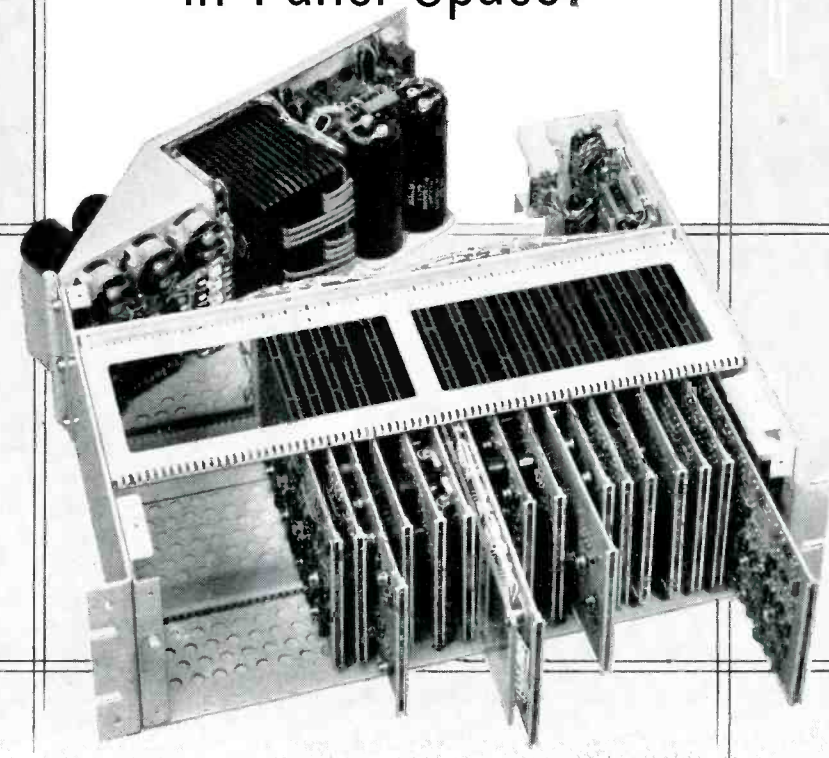
CIRCLE NO. 210 READER SERVICE CARD

Spectrum Analyzers single-package

PANORAMIC RADIO PRODUCTS, INC., 514 S. Fulton Ave., Mt. Vernon, N. Y. Models SPA-3 and SPA-3/25 spectrum analyzers make available in low-cost, single-package form, frequency ranges of 200 cps to 25 mc (SPA-3/25) and 200 cps to 15 mc (SPA-3), with 200 cps resolution capability, and up to 20 μv

Magnetic Core Buffer Memory Sets New Design Standards for Data Handling Systems

80% Saving in Panel Space!



Requires only 5¼" of Space in a 19" Rack

From General Ceramics—Four new magnetic core buffer memories that are setting new design standards among data handling system designers requiring increased efficiency in smaller physical packages.

Now available in either random access or sequential designs:

144 M4A — 144 characters in 9x16 array with a word length of four bits.
144 M8A — 144 characters in 9x16 array with a word length of eight bits.
512 M8A — 144 characters in 16x32 array with a word length of eight bits.
1024 M8A—1024 characters in 32x32 array with a word length of eight bits.

Design Features Include—

1. **SPACE-SAVING**—Require only 5¼" of standard rack space . . . permit smaller overall system design.
2. **VARIABLE CHARACTER AND BIT LENGTHS**—Unique design of driver circuit permits circuitry of existing data handling system to be enlarged without costly redesign.
3. **HIGHER OPERATING TEMPERATURE RANGE**—Contributes to miniaturized system design because memory functions satisfactorily under higher ambient temperature conditions.
4. **EASE OF MAINTENANCE**—All components are within easy reach. All circuits are on plug-in cards except power supply which is hinged across the back; swings out for easy accessibility.
5. **EXTRA FEATURES**—All units are equipped with an electronic clear and output register at no extra cost.

Complete detailed technical information will be supplied promptly on request. Please address inquiries to Dept. E.

GENERAL CERAMICS
ORIGINATOR OF THE SQUARE LOOP FERRITE

Applied Logics Division
GENERAL CERAMICS CORPORATION
KEASBEY, NEW JERSEY, U.S.A.

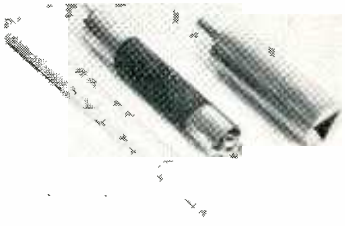
sensitivity for full-scale deflection. The single-package design offers built-in, flexible operation to enable analysis of such phenomena as pulse spectra, noise, line spectra, and other complex ultrasonic and low r-f waveforms.

CIRCLE NO. 211 READER SERVICE CARD

Transformers for transistors

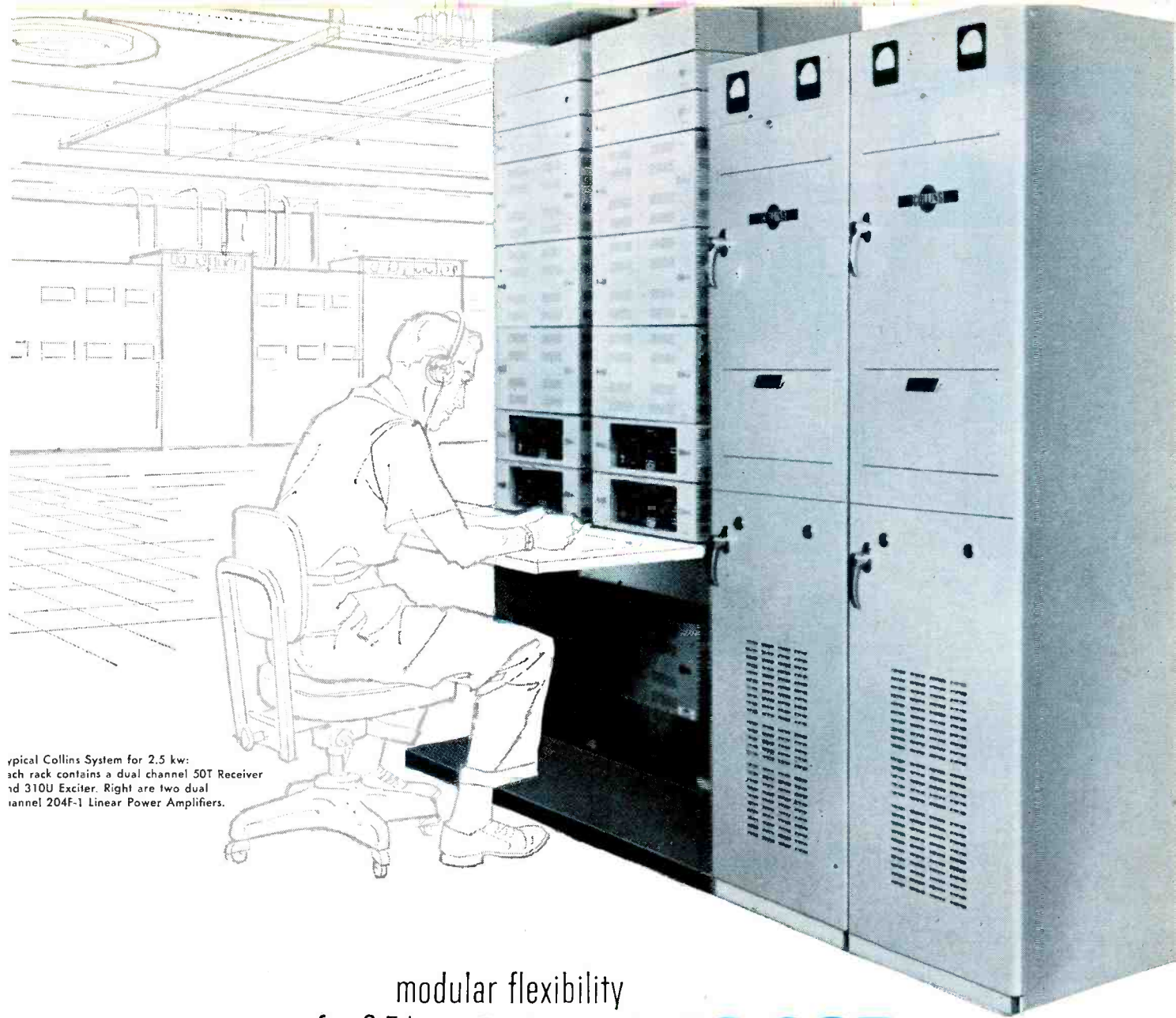
MICROTRAN CO., INC., 145 E. Mineola Ave., Valley Stream, N. Y. Five new microminiature transistor transformers are available in round hermetic case with glass bead headers or epoxy-molded construction. Size is approximately ½ cu in. with a weight of ½ oz. Impedance ranges were designed to meet the requirements of many new transistors. Small quantity price ranges from $3.45 to $9.75 depending on construction.

CIRCLE NO. 212 READER SERVICE CARD



Ceramic Capacitors extruded or molded

PACKARD-BELL CO., 12333 W. Olympic Blvd., Los Angeles 64, Calif. New ceramic capacitors are internally cross-braced thus imparting greater strength to the part. They feature reduced size and cost as well as greater reliability. Four areas in which they should prove commercially valuable are: as a replacement for the paper capacitor in values between 0.01 and 0.25 μf; as direct replacement of mica capacitors in values from 300 $\mu\mu$f to 0.01 μf; as a military component



ypical Collins System for 2.5 kw:
ach rack contains a dual channel 50T Receiver
id 310U Exciter. Right are two dual
iannel 204F-1 Linear Power Amplifiers.

modular flexibility for 2.5 kw communication stations

COLLINS SSB

The building block nature of the linear power amplifiers, exciters and receivers in Collins' single sideband line enables tailoring a system to the specific functions required or updating that system to expand these functions.

In the typical Collins system shown, the basic exciter is the 310U. This exciter uses plug-in modules as required to provide from 1 to 10 crystal-controlled channels in the 2 to 30 mc range. Exceptional circuit simplicity and reliability is achieved by a single conversion frequency generation scheme, with a crystal filter rejecting spurious products ahead of the RF amplifiers.

Although suitable for linear power amplifiers with higher output power, the 310U is employed in this illustration with the 2.5 kw PEP 204F-1 Linear Power Amplifier. This power amplifier has two sets of tuned circuits for rapid selection of either of two channels. Each channel is manually pretuned to any frequency in the 2 to 30 mc range.

Another 2.5 kw PEP linear power amplifier that might be employed is the 204H-1, which automatically senses the exciter signal frequency and tunes itself to that frequency.

Closely related to the 310U is the 50T Receiver. It has up to 10 channels in the 2 to 30 mc range, with single conversion and modular flexibility. A crystal filter ahead of the RF stages provides exceptional RF selectivity.

Other equipment in the complete Collins SSB line can provide from 100 watts to 45 kilowatts output with manual or automatic servo tuning. For more details, write for literature or contact a Collins representative.

COLLINS

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

CIRCLE NO. 99 READER SERVICE CARD

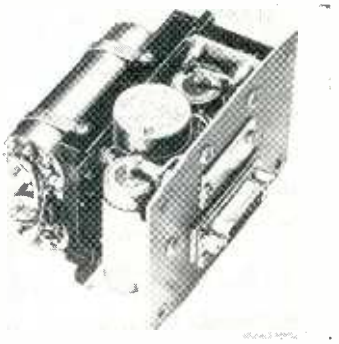
with indefinite life and ability to withstand high temperatures; and for use as a cost saver in radio and tv receivers.

CIRCLE NO. 213 READER SERVICE CARD

Enclosures
heavy-duty type

AMCO ENGINEERING CO., 7333 W. Ainslie St., Chicago 31, Ill. A new enclosure line is designed to complement and extend the range of application of the company's modular instrument enclosure system. System utilizes a wide (22⅛ in.) frame with a semi-custom look achieved through multiwidth cowling. Provision for flush mounting 19 in. wide panels of any thickness are built into the frame. These same panels may be recessed to any desired depth in the frame. Design of the enclosures provides for rugged protection and mobility for the more severe requirements in modular or single unit applications.

CIRCLE NO. 214 READER SERVICE CARD



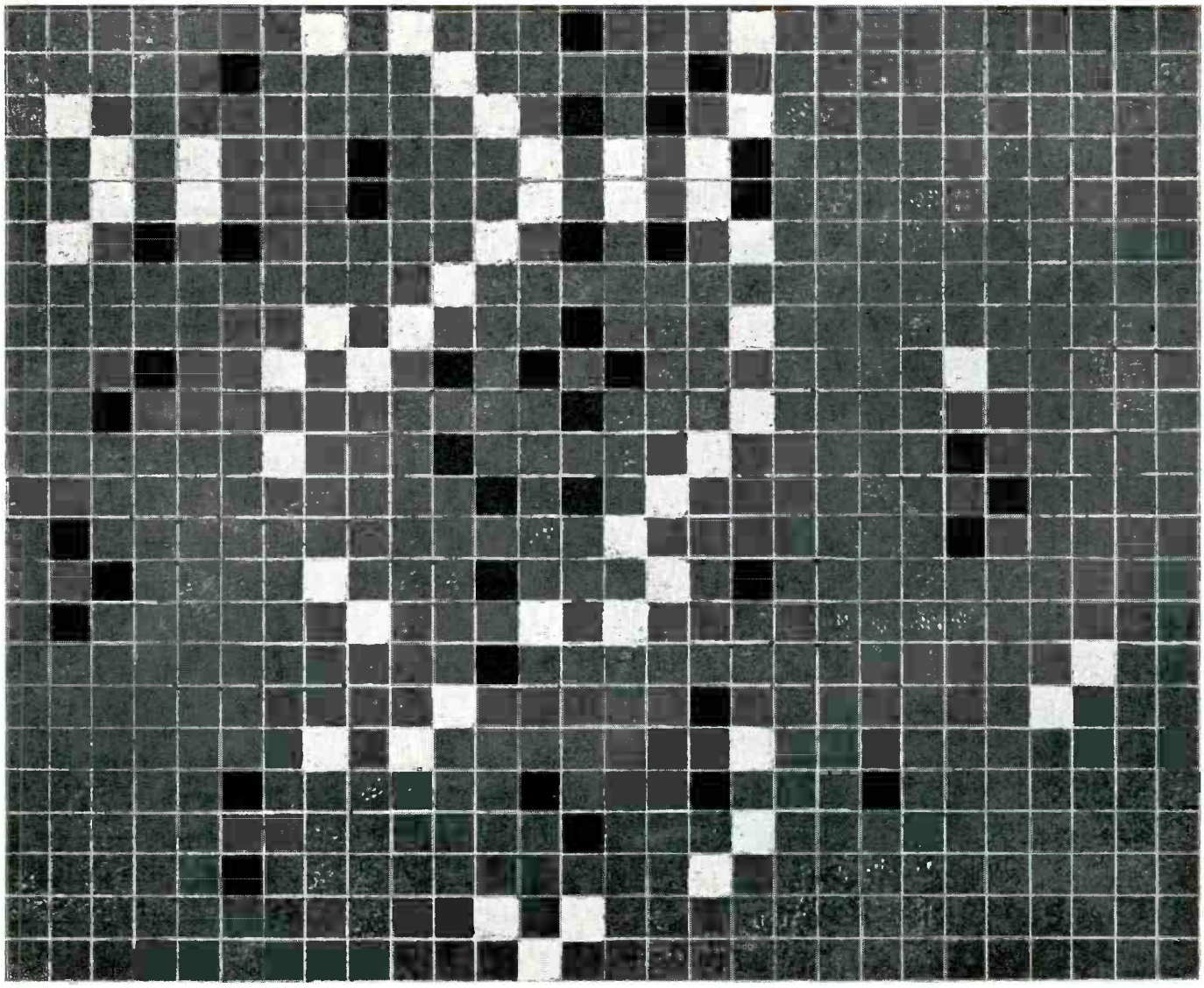
Gyro Package
subminiature

SANDERS ASSOCIATES, INC., Nashua, N. H. Model 21 gyro package provides a complete three-axis angular velocity sensor in a compact, lightweight package for roll, pitch and yaw indication. Measuring only 3 by 3 by 3 in. overall, and weighing less than 1 lb, the multiaxis package requires fewer components, is simpler to install and costs less than three separately packaged gyros.

CIRCLE NO. 215 READER SERVICE CARD

A-C Voltmeter
pocket-sized

METRONIX, INC., Chesterland, Ohio, announces the model 332 a-c elec-



A NEW DIMENSION IN COMPUTER TECHNOLOGY

Never has so vast and complex a project been undertaken in data processing and data communications. Billions of bits to be handled . . . information flowing in from hundreds of electronic sources, processed by digital techniques, displayed, solutions and commands issued . . . in precious seconds.

A very short time ago we were a newly created subsidiary of International Telephone and Telegraph Corporation. Today we are a purposeful engineering management group actively forging ahead with the myriad problems of our challenging project.

As systems manager we are charged with the development and production of a world-wide electronic control system which will transmit, process and display information required in military operations — global, in seconds. This project demands a wealth of engineering imagination. It will result in creation of a wholly new technology in digital computer science.

If your interests as an engineer lie in electronic systems engineering, in data processing and communications, you will find in this project unusual opportunity to express imagination and creative competence, in a degree surpassing anything previously undertaken in computer engineering.

To obtain information on engineer openings write A. J. Crawford, Personnel Manager. A resume of your education and experience is essential. An interview will be arranged at your convenience.

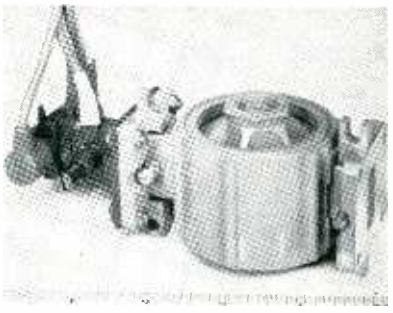
INTERNATIONAL ELECTRIC CORPORATION

Route 17 & Garden State Parkway, Paramus, New Jersey

A Subsidiary of International Telephone and Telegraph Corporation

tronic voltmeter. Panel-mounted, it uses a 2½-in. meter and has a barrel only 2 in. in diameter and less than 4¾ in. long. With a basic range of 0 to 100 mv rms, the unit is most suitable for applications of medium sensitivity. Input impedance is 1 megohm, paralleled by 10 $\mu\mu$f, so that it adds almost no load to the circuit being measured. It can be provided with any voltage range up to 300 v rms. Frequency response is 20 cps to 20 kc, ±2 percent. Accuracy is ±3 percent of full scale deflection.

CIRCLE NO. 216 READER SERVICE CARD



Stalo Cavity with hermetic seal

VARIAN ASSOCIATES, 611 Hansen Way, Palo Alto, Calif., announces the VA-1299 stalo cavity. Frequency is fixed tuned (with ±15 mc trim) at any frequency from 8,500 to 9,600 mc. Stabilization factor is 20 (with VA-101B klystron; insertion loss, 10 db; unloaded Q, 20,000; temperature coefficient, less than 5 kc per deg. C; weight, approximately 1 lb.

CIRCLE NO. 217 READER SERVICE CARD

Printout System expandable

DATRAN ELECTRONICS, 1836 Rosecrans Ave., Manhattan Beach, Calif. Model 10EC-C strain gage printout system is expandable from its basic 10 channels to any capacity by plugging additional modules of 10 channels each into existing receptacles. The data which is automatically recorded on standard adding machine paper tape includes a two-digit channel number, one digit for span or range, plus or minus sign, three digits of data for ranges of 1, 2 or 4. For ranges of 10, 20 or 40 the data is followed

How Indiana Steel's engineers help you solve micro-wave magnetic problems

Engineers at The Indiana Steel Products Company are in constant contact with leading manufacturers of micro-wave equipment on problems involving permanent magnets. Consultations with Indiana's magnet specialists have resulted in time and cost savings — often eliminating expensive redesign.

CASE IN POINT:

A leading micro-wave component manufacturer. *Problem:* Produce a special load isolator magnet to fit smaller space contour in a new radar unit. Also, deliver the new magnet to the customer in 12 days.

Solution: Indiana engineers turned to their previous design files, selected an existing magnet and modified it to meet the new size specifications. Gauss tests showed that the new design met the customer's specified magnetic field range. The magnet was delivered within the time specified.

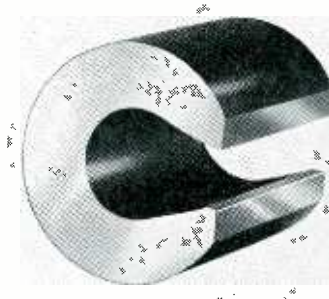
This is just one of many hundreds of cases where Indiana permanent magnet specialists have applied their unequaled experience to solve a magnet problem *ahead* of a customer's deadline. Indiana not only has the engineering know-how, but also manufacturing equipment from previously designed magnets which may be quickly adapted to meet special requirements.

THREE BASIC DESIGNS FOR LOAD ISOLATOR APPLICATIONS

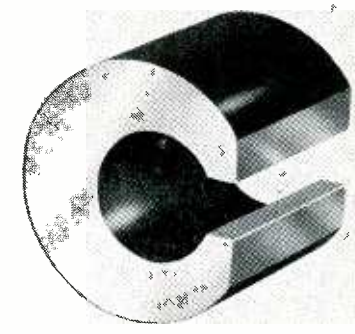
Permanent magnet specialists at Indiana Steel utilize three basic magnet designs for load isolator applications. These are, two variations of the C magnet, and the U magnet. All three of these designs can be varied to meet specific customer requirements. Actual size and shape of any individual magnet is dependent upon size limitation of the load isolator, and the magnetic field strength needed.

WIDE EXPERIENCE IN MICRO-WAVE APPLICATIONS

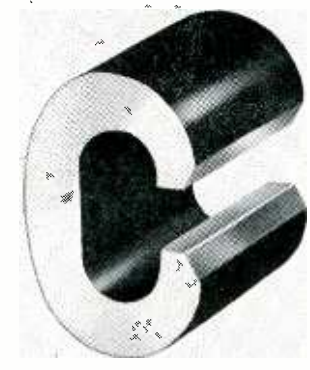
Magnet specialists at Indiana have designed and produced permanent magnets for a wide range of micro-wave applications including pm-focus traveling wave tubes, load isolators, radar magnetrons, backward wave oscillators. And, you can be sure the material selected is *best* for your particular application because Indiana Steel produces *all* permanent magnet materials. Our engineers will give prompt attention to your micro-wave problems or any other permanent magnet applications. Call your Indiana man or write us direct. Ask for Catalog No. 20, "Alnico V Load Isolator Magnets." Dept. A-6



U Magnet



C Magnet



Flat C Magnet

Sales Offices in:
Boston, Chicago, Cleveland, Los Angeles, New York, Philadelphia, Rochester

THE INDIANA STEEL PRODUCTS COMPANY
VALPARAISO, INDIANA

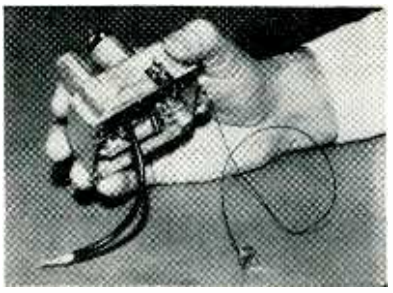
WORLD'S LARGEST MANUFACTURER OF PERMANENT MAGNETS

INDIANA PERMANENT MAGNETS

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

by a zero to indicate a "tens" multiplier. For offscale conditions, an N or P is recorded in the "sign" position to indicate negative or positive offscale conditions.

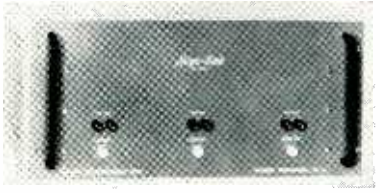
CIRCLE NO. 218 READER SERVICE CARD



Miniature Tuner for f-m radio

GENERAL INSTRUMENT CORP., 65 Gouverneur St., Newark 4, N. J., announces a low-cost, miniaturized, ultrasensitive f-m radio tuner which, the company states: is smaller and less sensitive than comparable devices; is expected to reduce retail prices of f-m sets; can be used in straight f-m, combination a-m/f-m or the newest 2-tuner stero f-m radio sets; and reduces radiation and drift to imperceptible levels.

CIRCLE NO. 219 READER SERVICE CARD



Frequency Calibrator highly accurate

KAY ELECTRIC CO., 14 Maple Ave., Pine Brook, N. J. The Mega-Stub passive frequency calibrator is a highly accurate, low-drift device providing sharply defined harmonic responses in three spectral ranges from 10 mc to 3,000 mc. Passive networks, consisting of various lengths of coaxial cable terminated in a short circuit, provide a choice of responses at multiples of 10, 100 and 1,000 mc. An r-f signal is applied to the input terminal and the detected output is observed on an oscilloscope (d-c coupled) or on a sensitive d-c voltmeter.

CIRCLE NO. 220 READER SERVICE CARD

Timing Motor moisture-proof

HAYDON DIVISION OF GENERAL TIME CORP., 245 E. Elm St., Torrington, Conn., announces a low cost, moisture-proof timing motor designed for chart drives, timing devices, and other similar applications in the instrumentation and commercial field. The motor capsule offers an extremely good protective surface against highly corrosive atmospheres found in various chemical and processing plants. The MP11 is a heavy duty, permanent synchronous type with a guaranteed torque of 30 oz-in. at 1 rpm.

CIRCLE NO. 221 READER SERVICE CARD

Resistor deposited carbon

DALE PRODUCTS, INC., Columbus, Neb. The DCH-5 resistor is pure crystalline carbon, deposited on a ceramic rod. No binder or filler is used. This element is hermetically sealed in a non-hygroscopic ceramic envelope, offering great stability under adverse environmental conditions. The DCH-5, rated at 5 w, measures 4¼ in. by ⅝ in. and has a resistance range from 100 ohms to 150 megohms.

CIRCLE NO. 222 READER SERVICE CARD

Power Supply missile-borne

BOGUE ELECTRIC MFG. CO., 52 Iowa Ave., Paterson 3, N. J., has developed a new turbine-driven electric power generator for missiles. It is a thermal lag generator using its own mass as a heat sink to absorb the heat losses during its 20-minute mission. The power supply delivers 15 kva of 400-cycle, 120/208-v, 3-phase power. Output voltage is regulated to ±1 percent by a transistor-magnetic amplifier regulator. The system voltage recovers within 1 percent of its steady state value in less than 25 millisec on application or removal of its full

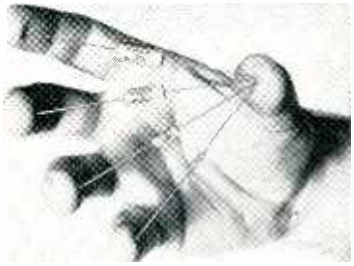
load. Overshoot is less than 10 percent.

CIRCLE NO. 223 READER SERVICE CARD

Tape Reader
high speed

FERRANTI ELECTRIC INC., 95 Madison Ave., Hempstead, L. I., N. Y. The TR7 photoelectric tape reader is a self-contained, free standing unit suitable for reading 5, 7 or 8 level tape at any speed up to 1,000 characters per sec. A fast rewind is also provided giving less than 30 sec rewind time for 1,200 ft of tape. The reader operates under either computer or manual control and will read character by character at high speed.

CIRCLE NO. 224 READER SERVICE CARD



Tantalum Capacitors
high reliability

TEXAS INSTRUMENTS INC., P. O. Box 312, Dallas, Texas. Type SRM tan-TI-cap solid tantalum capacitors are specially designed, processed and tested to meet the most exacting requirements of military and industrial electronic equipment. Performance specifications require rated voltage operation at temperatures from —55 to +85 C, and at +125 C for 2,000 hr. Controlled d-c leakage assures long operating life and low failure rates. The units are available in 134 industry standard 10 percent decade capacity ratings from 1 to 330 μf, 6 to 35 v; 10 percent capacity tolerance is standard.

CIRCLE NO. 225 READER SERVICE CARD

Adjustable Motor
viscous damped

JOHN OSTER MFG. CO., 1 Main St., Racine, Wisc., has developed an adjustable viscous damped size 11 motor which is smaller, lighter

and more economical than a motor tach used in feedback damping applications. Type 5752-05 consumes less power and presents no null or phasing problems in the feedback loops as compared with the motor tach which it replaces. Damping and gain may be independently adjusted. No load speed can be quickly, easily adjusted to any speed desired between 4,800 and 7,300 rpm depending upon damping characteristic required in the system.

CIRCLE NO. 226 READER SERVICE CARD

Vacuum Gage
wide-range

CONSOLIDATED ELECTRODYNAMICS CORP., 1775 Mt. Read Blvd., Rochester 3, N. Y., has available a thermal-conductivity-type constant temperature vacuum gage having excellent sensitivity in two ranges, from 1 micron to 100 microns and from 1 micron to 500 mm. The Magnevac has a built-in pressure-sensitive switching circuit which is adjustable to operate anywhere within the pressure range of the instrument. This circuit may be used as a protective switch for the vacuum system or as an aid in automating the vacuum process.

CIRCLE NO. 227 READER SERVICE CARD

Miniature Contacts
re-entrancy type

U. S. COMPONENTS, INC., 454 E. 148th St., New York 55, N. Y. Embodying an advanced design principle, REMI re-entrancy miniature contacts can be removed or replaced easily with pliers or by hand, eliminating the need for special tools. REMI employs metallic sleeves with long cantilever springs to insure ease of insertion, withdrawal, and operational stability, providing the optimum in re-entrancy or closed entrancy performance. The new metallic sleeve de-

sign permits interchangeability of male and female contacts at all times.

CIRCLE NO. 228 READER SERVICE CARD

Bearing Analyzer
bench type

BEARING INSPECTION, INC., 3311 E. Gage Ave., Huntington Park, Calif. A new all-electronic instrument, model BA-20, positively identifies unserviceable bearings both visually and audibly. Complete check of balls or rollers and all raceways is achieved in ½ to 2 minutes. The user can set his own standards, or a standard rejection limit may be built into the instrument at the factory. The compact unit requires a minimum of maintenance. Its cost is about $1,000.

CIRCLE NO. 229 READER SERVICE CARD

B-W Oscillator
voltage tunable

RAYTHEON MFG. CO., Waltham 54, Mass. The QK634 is a voltage tunable wide-band (8,150 to 11,000 mc) c-w backward wave oscillator, providing a minimum power output of 150 w and a nominal power output of 200 to 250 w over the band. Tuning sensitivity is approximately 1.0mc/v. Tube is designed with an integral permanent magnet and weighs approximately 20 lb. It is liquid cooled and may be mounted in any position.

CIRCLE NO. 230 READER SERVICE CARD

Test Instrument
transistor and tube

BAIRD-ATOMIC, INC., 33 University Rd., Cambridge 38, Mass. The MW-1 curve tracer is designed to display families of characteristic curves of *pnp* and *npn* transistors in either common base or common emitter configurations. A compan-

ion feature is the MWT-1 vacuum tube adapter, an independent, self-powered unit, designed to plug into the curve tracer, which can be mounted securely on it. The adapter extends the curve tracer versatility allowing vacuum tube and tetrode transistor measurements by providing necessary power supplies and measuring circuits.

CIRCLE NO. 231 READER SERVICE CARD

Voltmeter multipurpose

HEWLETT-PACKARD CO., 275 Page Mill Road, Palo Alto, Calif. Model 412A compact meter measures voltage between 100 μv and 1,000 v. Maximum full scale sensitivity is 1 mv; accuracy, 1 percent of full scale. Measures current from 0.1 μa to 1 ampere; maximum full scale sensitivity, 1 μa; accuracy, 2 percent of full scale. As an ohmmeter, it measures resistance from 0.02 ohm to 5,000 megohms. Unit's high stability and low drift suit it for high gain d-c amplification.

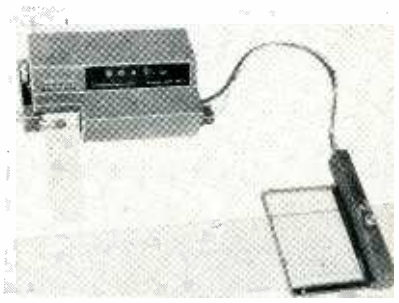
CIRCLE NO. 232 READER SERVICE CARD

Linear Detector checks distortion

BARKER & WILLIAMSON, INC., Bristol, Pa. Model 404 linear detector checks audio and r-f distortion. It incorporates a vacuum tube rectifier for r-f detection and a bridging transformer. Unit meets requirements for FCC proof-of-performance measurements. It operates on a 20-30 v r-f carrier and has a frequency range of 400 kc to 30 mc. When operated as a bridging transformer, input impedance of the detector is approximately 6,000 ohms

and the insertion loss is 1 db. Frequency response is essentially flat from 20 to 50,000 cycles.

CIRCLE NO. 233 READER SERVICE CARD



Amplitude Tabulator for oscillograms

THE GERBER SCIENTIFIC INSTRUMENT CO., 89 Spruce St., Hartford 1, Conn. The GOAT (Gerber Oscillogram Amplitude Tabulator) is an automatic data reduction instrument which performs many functions simply at a very low cost. It consists of two parts: a stationary unit which is placed on the desk out of the way consisting of a printing counter and the necessary servos, and a hand-held rectangular frame with a fixed and a variable hairline which can be moved in either direction by means of a control knob. Instrument reads oscillogram and strip chart amplitudes up to 6½ in. and prints the information on an adding machine tape.

CIRCLE NO. 234 READER SERVICE CARD

Metal Cabinets wide range of sizes

BARGAR METAL FABRICATING CO., 1028 E. 134th St., Cleveland 10, Ohio. Cabinets and enclosures of steel, stainless steel, or aluminum are offered on a custom basis in any desired quantity. Frequently intended for mounting and protecting electrical apparatus, switchgear, and similar equipment, the cabinets range in size from tiny pushbutton-switch enclosures to those measuring 30 ft long, 12 ft high and 3 ft deep.

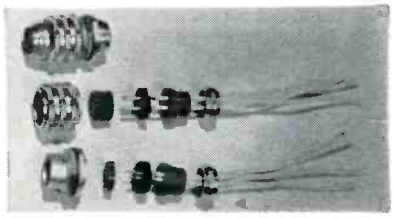
CIRCLE NO. 235 READER SERVICE CARD

Core Testers fully automatic

RESE ENGINEERING, INC., 731 Arch St., Philadelphia 6, Pa. Model 2040

REACT is a fully automatic magnetic core tester that accurately measures peak or instantaneous values of core response directly, in the production testing and laboratory analysis of bobbin type or ferrite memory cores. Of modular construction, operating at test rates up to 10 cores per sec, it uses a unique fail-safe system approach to insure that "bad" cores are not tested or accepted as "good" cores.

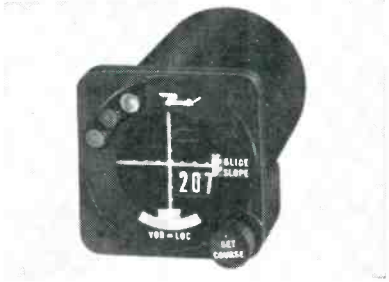
CIRCLE NO. 236 READER SERVICE CARD



Snap-In Connectors
removable contacts

THE DEUTSCH CO., 7000 Avalon Blvd., Los Angeles 3, Calif. The new DS snap-in miniature connector with crimp-type terminations completely eliminates soldering. Contacts are crimped to the wire and snapped into the connector. The DS offers continuous dielectric separation with no voids, is completely environmental up to 30 psi, withstands temperature extremes from −100 to 300 F, and has a contact retention of 25 lb.

CIRCLE NO. 237 READER SERVICE CARD



VOR/ILS Indicator
for airborne use

BENDIX RADIO DIVISION, Bendix Aviation Corp., Baltimore 4, Md. The INA-21A VOR/ILS indicator is a standard 3-in. instrument for cockpit mounting. It provides—in the one unit—VOR and localizer pointer, glide slope pointer, TO-FROM indicators, three marker beacon

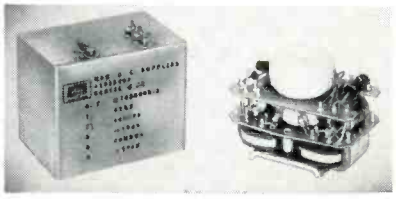
indicator lamps, an omni-bearing selector, and flag alarms for both VOR/localizer and glide slope pointers. The indicator is designed for maximum visibility.

CIRCLE NO. 238 READER SERVICE CARD

Toggle Switches
wide range of uses

KULKA ELECTRIC CORP., 633-643 So. Fulton Ave., Mt. Vernon, N. Y. Made originally for aircraft use (MIL-S-3950A), these compact and rugged toggle switches are available for a wide range of applications. They measure only $1\frac{1}{8}$ in. by $\frac{5}{8}$ in. by $1\frac{3}{64}$ in. deep, and may be had with either screw or solder-lug terminals. They feature $\frac{1}{3\frac{1}{2}}$ in. bushing with nuts, for one-hole mounting. Spst, spdt, dpst and dpdt types are available. Double-pole units are slightly larger.

CIRCLE NO. 239 READER SERVICE CARD



Power Supply
airborne type

AVION DIVISION, ACF Industries, Inc., 11 Park Place, Paramus, N. J. Model 90122 airborne power supply: input of 115 v ±5 percent 400 cps +5 cps; outputs of 100 v ±5 v for 65 ma ±25 percent and −100 v ±5 v for 20 ma ±25 percent. Maximum primary current under nominal line and load conditions is 250 ma rms. Ripple factor equals 2 percent. Temperature range is −35 C to +100 C ambient. Unit is hermetically sealed.

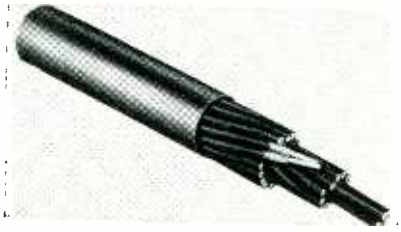
CIRCLE NO. 240 READER SERVICE CARD

Analyzer
pulse height

RADIATION INSTRUMENT DEVELOPMENT LABORATORY, INC., 5737 South Halsted St., Chicago 21, Ill. Model 34-9 400 channel analyzer uses ferrite core memory system for rapid, accurate spectrum analysis. Burroughs beam switching tubes greatly simplify electronics of analyzer. Linearity is better than 0.5

percent. Average dead-time is 120 μsec. Normal capacity per channel is 65,535 counts. Unit includes Auto-Print memory subgrouping, external programming, spectrum transfer circuit. Maximum input counting rate without distortion or shift of data is greater than 5×10^6 counts per min.

CIRCLE NO. 241 READER SERVICE CARD



Coaxial Cables
multiconductor

TIMES WIRE AND CABLE CO., INC., Wallingford, Conn., is producing multiconductor coaxial cables in practically any construction and length. The cabled 95-ohm miniaturized coaxial conductors with Teflon dielectric and vinyl jacketing, are arranged in three layers around a center conductor. Teflon jacketing can be substituted for vinyl if desired. Such multiconductor coaxial cables can be made up with as many as 92 conductors.

CIRCLE NO. 242 READER SERVICE CARD

Spectrum Analyzer
200 cps resolution

PANORAMIC RADIO PRODUCTS, INC., 520 S. Fulton Ave., Mt. Vernon, N. Y. SPA-2 spectrum analyzer examines narrow band (1 mc or less) microwave spectra in detail. Half and quarter power points, lobe symmetry, and other characteristics of broad pulsed r-f are delineated,

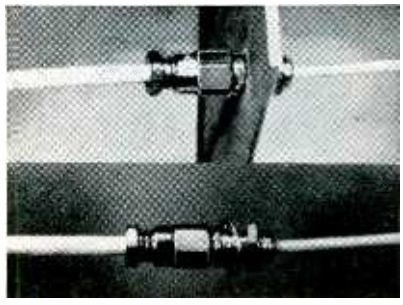
scan after scan. It is designed for analysis of standard f-m and a-m systems, noise spectra, oscillator instabilities, and many other dynamic phenomena.

CIRCLE NO. 243 READER SERVICE CARD

Power Supply for klystron use

POLYTECHNIC RESEARCH & DEVELOPMENT CO., INC., 202 Tillary St., Brooklyn 1, N. Y. The PRD 812 wide-range klystron power supply features digital read-out for beam and reflector voltages; dual outputs for simultaneous operation of two klystrons; and front panel provision for checking calibration of reflector and grid voltage readings. It also provides multirange beam current overload protection; safety lock on transferring from negative to positive grid voltage; and external triggering of internal pulse generator.

CIRCLE NO. 244 READER SERVICE CARD



R-F Connector grounded-shield

SEALECTRO CORP., 610 Fayette Ave., Mamaroneck, N. Y., announces the ConheX grounded-shield feed-through, type 3006. This one-piece connector, doing away with mated parts, serves as a cable lock, holding the coax cable while grounding its braided conductor to the chassis, and passing the insulated center conductor through to the other side.

CIRCLE NO. 245 READER SERVICE CARD

Servo Motor small and light

SERVO DYNAMICS CORP., Somersworth, N. H. A new size 8¾ in. servo motor conforms to BuOrd standards and is designed and guar-

anteed to operate at ambients to 200 C. It is completely enclosed on the back end and can be certified environmentally under MIL-E-5272A and MIL-T-5422C. It produces 1 in. oz of torque at zero rpm and may be fitted with output shaft configurations or gear reductions to customer specifications. Input power range is 6 to 115 v a-c.

CIRCLE NO. 246 READER SERVICE CARD

WWV Receiver transistorized

SPECIFIC PRODUCTS, 21051 Costanso St., Woodland Hills, Calif., announces model WWVT, a new, portable transistorized WWV receiver. It features small size (9 in. by 12 in. by 5 in.), light weight (6 lb), and ruggedness (sealed metal case and potted components). It is battery operated and designed especially for remote operations under extreme environmental conditions. It meets MIL-8189B specifications.

CIRCLE NO. 247 READER SERVICE CARD

Regulated Supply adjustable

GENERAL RADIO CO., West Concord, Mass. Type 1205-B continuously-adjustable 120-w regulated power supply provides uniform performance over a 0-300 v, d-c, output range (at 200 ma, maximum), in one-fifth conventional size. Output regulation, from no load to full load, is 0.1 v with a 0.75-v change for a ±10 percent change in line voltage. Price: $290 net.

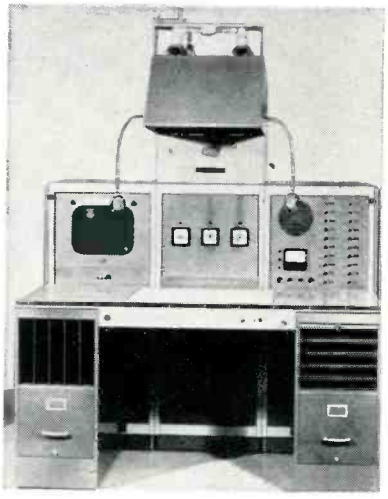
CIRCLE NO. 248 READER SERVICE CARD

Oscilloscope versatile triggering

TEKTRONIX, INC., P. O. Box 831, Portland 7, Ore., announces the type 581 oscilloscope. Risetime is 3.5 millimicroseconds, passband d-c to approximately 100 mc with type 80 plug-in preamplifier and probe. Maximum calibrated deflection factor is 0.1 v/cm; probe at-

tenuator heads provide steps of 0.2, 0.5, 1, 2 and 5 v/cm. Sweeps are calibrated in 24 steps from 0.05 μsec/cm to 2 sec/cm with 5-X magnifier to increase calibrated sweep time to 0.01 μsec/cm. Versatile triggering includes amplitude-level control and preset stability for operating convenience.

CIRCLE NO. 249 READER SERVICE CARD



C-C Tv System
for offices, plants

DAGE TELEVISION DIVISION, Thompson Ramo Wooldridge, Inc., Michigan City, Ind. Instantaneous access to visual data by any number of offices or throughout a factory or plant is made possible by "Dial-Data", a new c-c tv system. Heart of the system is a data console equipped with a special camera. The console contains racks of records, files, information sheets, schedules or other constantly changing data of continual interest to various users. Automatic dial equipment determines which rack is viewed by the camera, and thus, what information is sent over the system. Cost is approximately $20,000.

CIRCLE NO. 250 READER SERVICE CARD

A-C Power Source
portable unit

BEHLMAN ENGINEERING CO., 2911 Winona Ave., Burbank, Calif., announces the portable model 151-C-IE Invertron, electronic a-c power source. It measures 9 in. wide, 13 in. high, and 14¾ in. deep. It requires an input of 115 v, 60 cps,

NEED SPECIAL BLOWERS?

ELECTRONIC COOLING

HEAVY MACHINERY COOLING

INSULATED FOR TEMPERATURES

NO-CORROSION ALUMINUM CONSTRUCTION

PEERLESS ELECTRIC SUPPLIES BOTH BLOWERS AND MOTORS AS A COMPLETE UNIT!

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- Special finishes, fungus-treated, insulated, etc.!
- High and low temperature requirements!
- Special units for space conditions!

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FAN AND BLOWER DIVISION

THE Peerless-Electric® CO

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★ ULTRA LOW *capacitance & attenuation*

TYPE	μμ F/ft	IMPED.Ω	O.D.
C 1	7.3	150	.36"
C 11	6.3	173	.36"
C 2	6.3	171	.44"
C 22	5.5	184	.44"
C 3	5.4	197	.64"
C 33	4.8	220	.64"
C 4	4.6	229	1.03"
C 44	4.1	252	1.03"

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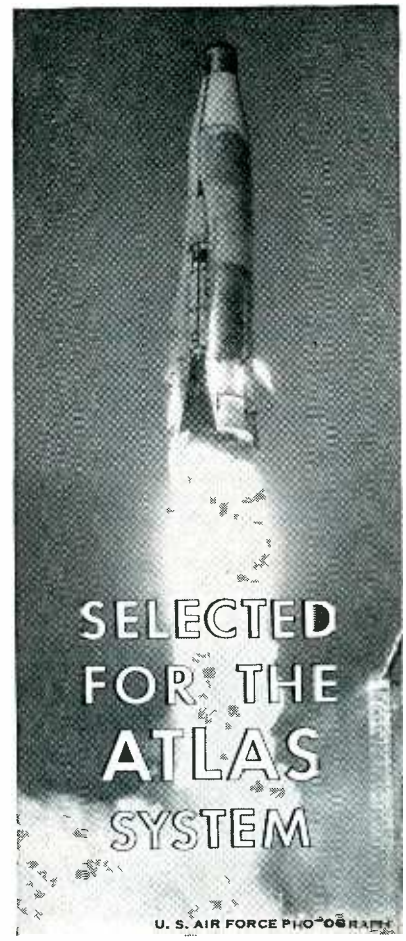

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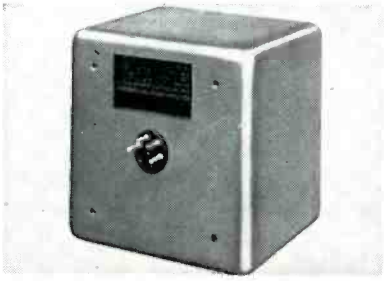
CIRCLE NO. 119 READER SERVICE CARD

single phase, producing an output of 150 va, 0-130 v, 400 cps, single phase. Output frequency is held to an accuracy of 0.5 percent. A front panel jack will permit use of an external signal over the range of 100 to 4,000 cps, for use as a power amplifier.

CIRCLE NO. 251 READER SERVICE CARD



Voltage Regulator
stud mounted

KAVAMIL CO., INC., 1417 W. El Segundo Blvd., Compton, Calif., announces an a-c line voltage regulator especially designed for voltage regulations on ground support and airborne equipment. Model LVR-150's electrical characteristics include: input voltage, 90-135 v a-c; output voltage, 115 v ± 1 percent for input of 90-135 v; frequency range, 50-65 cps; response time, approximately 100 millisec; rating, 150 va.

CIRCLE NO. 252 READER SERVICE CARD

A-C Regulator
automatic

ELECTRONIC MEASUREMENTS CO., INC., Eatontown, N. J., announces a line voltage regulator that may be used to regulate either 110 or 220 v lines. With a 115 v a-c input, the output is adjustable to give 110 to 120 v a-c. With a 230 v a-c input, the output is adjustable to give 210 to 220 v a-c. Regulation is ±1 percent at 6 kva with a range of ±15 v correction with 115 v a-c input and ±30 v correction with 230 v a-c input.

CIRCLE NO. 253 READER SERVICE CARD

Literature of the Week

MATERIALS

Epoxy Resins. John C. Dolph Co., Monmouth Junction, N. J., has available a selection chart for Dolphon epoxy resins formulated specifically for the electrical and electronic industries.
CIRCLE NO. 260 READER SERVICE CARD

Load Isolator Magnets. The Indiana Steel Products Co., Valparaiso, Ind. Catalog 20 covers Alnico V permanent magnets for microwave load isolators.
CIRCLE NO. 261 READER SERVICE CARD

COMPONENTS

Glass-To-Metal Seals. Palmer Associates Inc., 55 Hall St., Brockton, Mass. A 4-page brochure lists some of the extra advantages gained when using glass-to-metal seals made by the company.
CIRCLE NO. 262 READER SERVICE CARD

Electrolytic Capacitors. Ohmite Mfg. Co., 3673 Howard St., Skokie, Ill. Bulletin 148F provides complete data on an expanded line of tantalum wire electrolytic capacitors.
CIRCLE NO. 263 READER SERVICE CARD

Synchro Data Chart. Theta Instrument Corp., 48 Pine St., East Paterson, N. J. The synchro data chart, with detailed definitions of the electrical parameters of synchros and resolvers, has been revised in accordance with the latest military specifications.
CIRCLE NO. 264 READER SERVICE CARD

R-F Chokes. Essex Electronics, 550 Springfield Ave., Berkeley Heights, N. J. A new data sheet covers Wee-Ductor r-f chokes which are so small that 200,000 can be packed to a cubic foot.
CIRCLE NO. 265 READER SERVICE CARD

Silicon Transistors. General Transistor Corp., 91-27 138th Place, Jamaica 35, N. Y. Brochure

S-100 is a 6-page illustrated description of the company's *pnp* alloyed junction silicon transistors.

CIRCLE NO. 266 READER SERVICE CARD

EQUIPMENT

Panel Instruments. The Triplett Electrical Instrument Co., Bluffton, Ohio, has released a new panel instrument catalog, No. 59-I. It includes among many items a newly announced line of 4-in. Unimeters.

CIRCLE NO. 267 READER SERVICE CARD

Power Supplies. Perkin Engineering Corp., 345 Kansas St., El Segundo, Calif., has available a new catalog of d-c power supplies, a-c line voltage regulators, airborne radar power supplies, and static inverters and converters. Ask for catalog E59A.

Automatic Relay Tester. Mid-Eastern Electronics, Inc., 32 Commerce St., Springfield, N. J., offers a two-page catalog bulletin describing the application and operation of an automatic relay tester.

CIRCLE NO. 268 READER SERVICE CARD

VTVM. Elsin Electronics Corp., Eileen Way, Syosset, N. Y. A recent flyer illustrates and describes a new vtvm which assures 2 percent accuracy from 1 mv to 1,000 v and is priced at $185.

CIRCLE NO. 269 READER SERVICE CARD

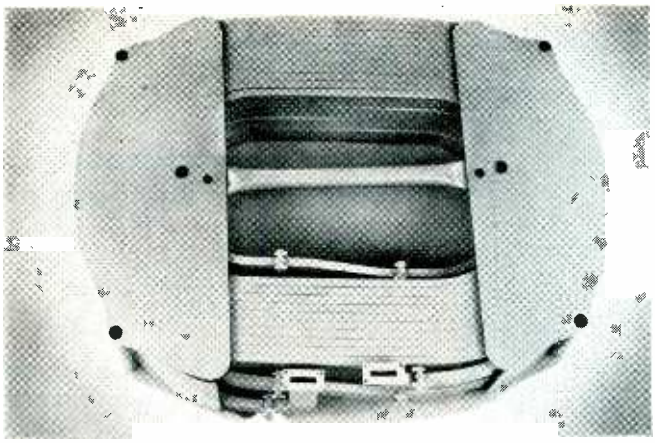
FACILITIES

Cable Equipment. Interstate Electronics Corp., 707 E. Vermont Ave., Anaheim, Calif. A recent 4-page mailing piece discusses the company's expanded cabling facility to meet the demands of the missile, aircraft, and electronic industries.

CIRCLE NO. 270 READER SERVICE CARD

Milliammeter. Hewlett-Packard Co., 5025A Page Mill Road, Palo Alto, Calif. A reprint of Ad No. 5025 fully describes model 428A milliammeter. Company's facilities and services are discussed.

CIRCLE NO. 271 READER SERVICE CARD



PACKAGED X-BAND DELAY LINES

SINGLE COILS UP TO 78 FEET IN LENGTH
MULTIPLE INTERCONNECTED SYSTEMS ANY LENGTH

Turbo "packaged" delay lines are readily contained in standard test racks. Typical 1000 ft. assembly is 2 ft. dia. x 15" high. Complete test assemblies, and slotted waveguide antenna assemblies, built to specification. Bulletin on request.

TURBO DELAY LINES

TURBO MACHINE COMPANY. LANSDALE, PA.

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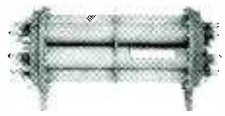
E PLURIBUS



Many bits of information to transmit... one optimum antenna. If this is the problem to be solved (as it was in the Titan), Rantec **multiplexers** can couple two, three, four or six telemetry signals of different frequencies to one antenna system. Insertion loss (only 1.5 db on model above) is minimum, weight is minimum, space is minimum, and isolation (20 db) is maximum.

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calabasas, california

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CIRCLE NO. 149 READER SERVICE CARD

Thomas Emma, BA, Columbia, is a U.S. Naval Reserve officer who was formerly a technical writer with IT&T. Tom prepares "Financial Roundup"—a regular weekly business feature. In the coming months Tom will be concerned with radio communications, but he will be specifically involved with spectrum useage problems. To keep abreast of finance in electronics, turn to Tom's weekly coverage of latest developments. To subscribe or renew your subscription, fill in box on Reader Service Card. Easy to use. Postage free.

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NEW BOOKS

Synthesis of Linear Communication Networks . . Vol. I and II

By WILHELM CAUER.

McGraw-Hill Book Co., New York, 1958, 866 p, $19.50.

Until recently a shortage of texts existed in the field of linear network synthesis. Consequently Wilhelm Cauer's "Theorie der linearen Wechselstromschaltungen," first published in 1941 and generally available in this country since 1948, has proved a valuable reference. The second edition (1954) of this classical work, appropriately retitled "Synthesis of Linear Communication Networks," has now been translated from the German by G. E. Knausenberger and J. N. Warfield.

Although the translation is listed as volumes I and II, both are bound within the same cover. Volume I begins with two short chapters summarizing the book and outlining the synthesis problem. Then come two chapters that treat in some detail the analysis of general circuits and of two-terminal-pair networks and which introduce the image parameters of the two-terminal-pair network. Next, the concept of positive-reality is discussed and the general reactance synthesis theorems for two-terminal and two-terminal-pair networks are produced. Volume I concludes with two chapters on image parameter synthesis and two appendices of formulae, tables, and design data.

Volume II contains three chapters, one each on insertion-parameter design, band-separation networks and reactance networks equivalence. In addition there are four appendices of mathematical background and practical design techniques. Of these, perhaps the most interesting is one on Chebyshev polynominals and approximations.

The principal weakness of this book is that it does not treat recent work in the field. The translators have attempted to alleviate this defect by the addition of a lengthy appendix in which they discuss recent advances very briefly and give an extensive bibliography.—JOHN

B. THOMAS, *Ass't. Prof. of Elec. Eng., Princeton University, Princeton, N. J.*

THUMBNAIL REVIEWS

Electronic Technician. Research Publishing Co., Inc., P. O. Box 245, Boston 1, Mass., 1958, 24 p, $1.00. This little booklet sums up the various factors that are of interest to young people considering the advantages and disadvantages of becoming electronic technicians. Among the factors considered are required qualifications, working conditions, promotional opportunities, salary ranges, etc.

Electronic Hobbyists' Handbook. By Rufus P. Turner, Gernsback Library Inc., New York, N. Y., 1958, 160 p, $2.50. Complete how-to-build-it information on more than 100 amplifiers, oscillators, power supplies, communications equipment, control devices and photoelectric units. Chapters on safety practices and shop techniques are included.

Proceedings of the Sixth Scintillation Counter Symposium. IRE Professional Group on Nuclear Science, 1 East 79 St., New York, N. Y., 1958, 221 p, $7.50. These proceedings of the symposium held in Washington, D. C., during Jan. 1958 are an excellent review of the present status of photomultiplier phototubes, scintillating media and nuclear counters based on computations of the two.

Fundamental Principles of Transistors. By J. Evans, D. Van Nostrand Co., Inc., Princeton, N. J., 1958, 255 p, $6.75. This excellent book is aimed at graduate electrical engineers and specialists in other fields who wish to acquire a sound basic knowledge of transistors. This is not a circuit book, rather it deals with the theory of semiconductors, *pn* junctions and transistor operation. Transistor manufacture, measurement of transistor parameters and a discussion of the properties of transistor materials are included.

Properties and Testing of Plastic Materials. By A. E. Lever and J. Rhys, Chemical Publishing Co., Inc., New York, 1958, 197 p, $4.75. A wide variety of plastics properties, testing techniques and test apparatus are summarized, consolidating literature in the field. Practical considerations, such as tests for properties related to production methods and end product use, are stressed. To make full use of the book, the reader will need access to a good library of American and British technical and trade publications.

Eimac: $2.5-Million Plant

EITEL-MCCULLOUGH, INC., recently climaxed the dedication of its new $2.5-million San Carlos, Calif., plant by bouncing a radio signal originating at College, Alaska, off the moon. Shot into space by means of an Eimac 10,000-watt, 440,000-mc klystron, the signal was picked up two and one-half seconds later by a 30-ft parabolic antenna at the San Carlos site.

The firm, operating two other plants in San Bruno, Calif., and Salt Lake City, specializes in the design and production of high power transmitting tubes, and currently produces more than 100 tube types. Its humble beginning in 1934, with a three-man staff, was financed with $5,000, and its initial product was a triode manufactured for amateur radio operators.

Eimac's first big order came from Western Electric in 1940, and called for delivery of 10,000 tubes. This put the company on a mass-production basis, and after the outbreak of World War II, production was increased to well over 100,000 tubes per month.

Today the firm has a backlog of $12.5 million, and employs 1,800 people. Gross sales in 1958 exceeded $16 million, and a volume of $24 million is forecast for this year. Tube types include amplifier klystron, reflex klystrons, rectifiers, traveling wave tubes, planar triodes, radial-beam tetrodes, and ceramic receiving tubes for commercial, industrial, and military applications. The Salt Lake City plant for a while produced both round and rectangular tv picture tubes 16 to 27 inches in size. Currently, Eimac's largest production tube is 10 ft high, sells for $25,000, and is being turned out at a rate of 10 per month. Major troposcatter early warning systems utilize Eimac klystrons.

The new glass and concrete plant stands two stories high and contains 150,000 sq ft of floor space. Near-future plans call for adding another 27,000 sq ft of manufacturing space.

Throughout the production area, the "flow" system is utilized to achieve maximum efficiency. Critical assembly is carried on in "clean rooms" pressurized with filtered, conditioned air. Up-to-the-minute facilities include a 57-ft-high automatic high temperature kiln for processing ceramic materials, and four giant rotary vacuum pumps capable of producing high vacuums in thousands of tubes per day.

Founders W. W. Eitel and J. A. McCullough still actively guide operations of their firm as president and executive vice president, respectively.

Name Executives At M. C. Jones Co.

NEW OFFICERS of the M. C. Jones Electronics Co., Inc., Bristol, Conn., recently purchased by the Bendix Aviation Corp., have been named.

G. E. Steiner, general manager of the Scintilla division of Bendix, was appointed president and a director. Stanley T. Urbank, one of the original founders of the Jones company and formerly chief executive officer, was named vice president, general manager and a director.

The Jones company, founded in 1947, manufactures equipment for monitoring coaxial transmission lines in both commercial and military applications. Bendix will promote the further development of Jones products and also continue the development of other items now being researched.

Appoint Reynolds Executive V-P

FRANK J. REYNOLDS, formerly vice president for operations, Stavid Engineering, Inc., Plainfield, N. J., was recently named to the new post of executive vice president of the company. His duties include responsibility for sales, preliminary design, engineering and manufacturing operations.

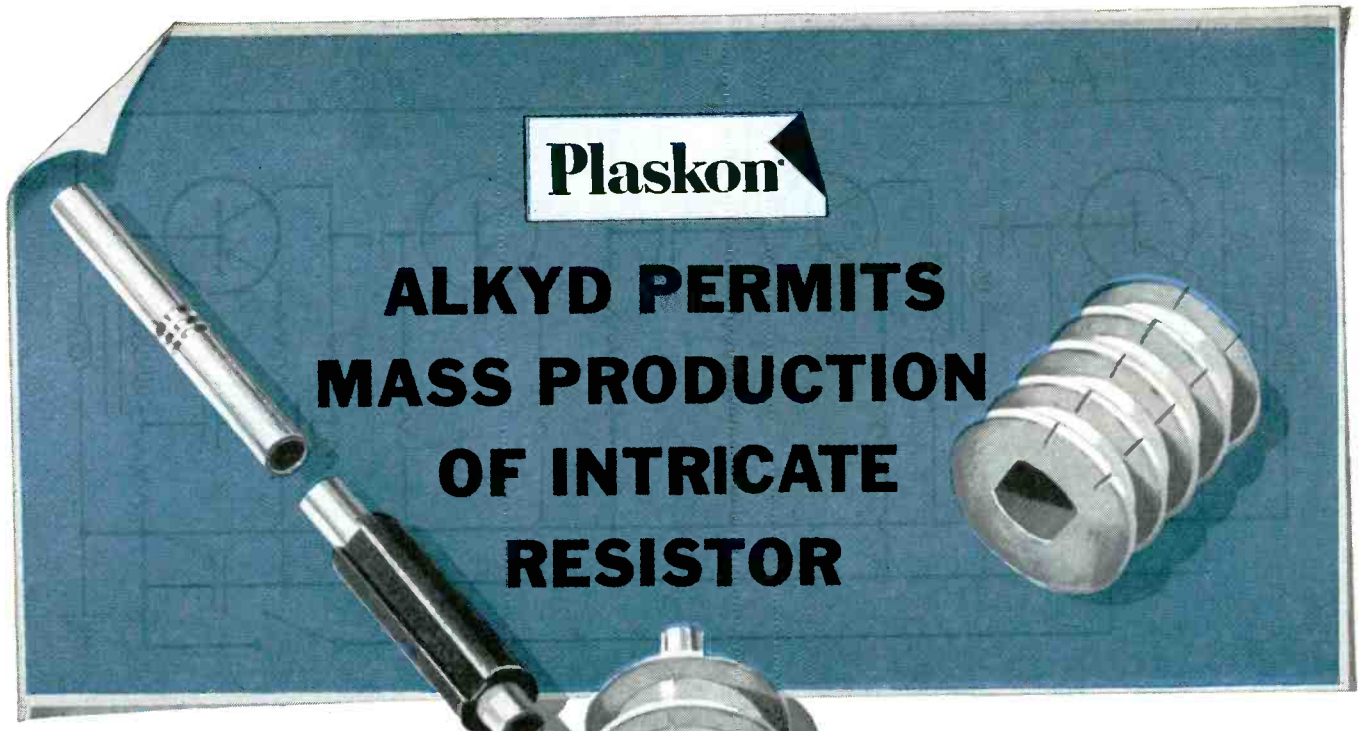
Reynolds joined Stavid in 1949 as contract manager and was appointed vice president for sales in 1952. Prior to that he was in charge of Navy contracts for the Western Electric Co. where he received the civilian Navy Department commendation for outstanding performance.

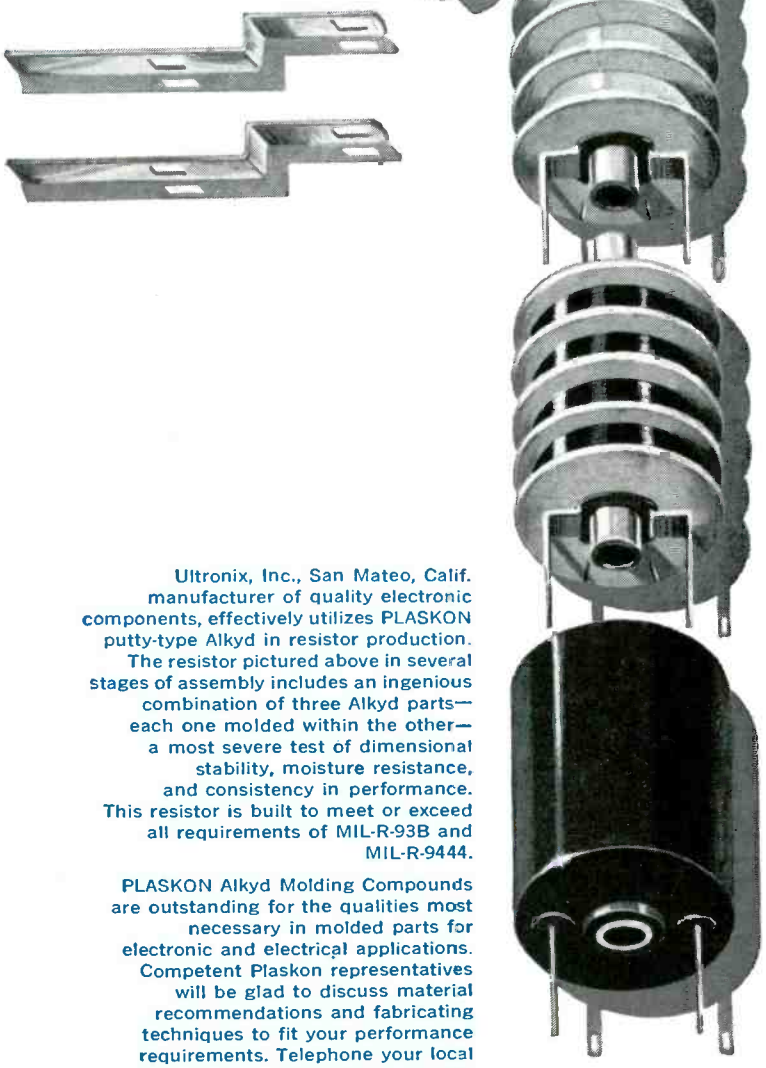
Ace Electronics Promotes Berni

LOUIS BERNI, chief engineer of Ace Electronics Associates, Inc., Somerville, Mass., has been named vice president in charge of engineering. He has been with the company since its inception in 1952, and his responsibilities will include overall

Plaskon

ALKYD PERMITS MASS PRODUCTION OF INTRICATE RESISTOR





Encapsulation with putty-type Alkyd satisfies need for reliability by resistor maker and customers.

Today's creative engineers design with PLASKON Alkyd in mind for the manufacture of delicate electronic components. Here are reasons why electronic engineers prefer PLASKON putty-type Alkyds as *the* encapsulation medium:

- Simple to fabricate . . . molds quickly at extremely low pressures . . . permits rapid production cycles.
- Clean to handle . . . nothing to mix.
- Dimensional stability prevents distortion or damage to delicate inserts.
- Coefficient of linear thermal expansion is similar to that of popular wire alloys . . . reduces strain in service . . . aids the functioning of encapsulated units.
- Thermal conductivity helps to dissipate heat faster, resulting in less change in resistance value before and after encapsulation.
- Available in colors, for coding.
- More economical than most encapsulating processes.

Ultronix, Inc., San Mateo, Calif. manufacturer of quality electronic components, effectively utilizes PLASKON putty-type Alkyd in resistor production. The resistor pictured above in several stages of assembly includes an ingenious combination of three Alkyd parts—each one molded within the other—a most severe test of dimensional stability, moisture resistance, and consistency in performance. This resistor is built to meet or exceed all requirements of MIL-R-93B and MIL-R-9444.

PLASKON Alkyd Molding Compounds are outstanding for the qualities most necessary in molded parts for electronic and electrical applications. Competent Plaskon representatives will be glad to discuss material recommendations and fabricating techniques to fit your performance requirements. Telephone your local Plaskon representative or write to:

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40 Rector Street, New York 6, N. Y.

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supervision of specifications, research, development, quality control and testing of its products.

Ace Electronics Associates, Inc., manufactures linear and nonlinear potentiometers, subminiature relays and other special precision products.

Elsin Appoints M. L. Goodman

MAURICE L. GOODMAN, formerly general sales manager of Universal Transistor Products Corp., was recently named sales manager of Elsin Electronics Corporation's new facility in Syosset, New York.

Elsin manufactures precision electronic equipment for industry and the military.

News of Reps

Texport Company of Dallas, Texas, has been appointed manufacturer's rep for Sonotone Corp., Elmsford, N. Y., in Texas, Oklahoma, Louisiana and Arkansas.

A. H. "Bud" Hilker will represent Magnetics, Inc., Butler, Pa., in North Carolina, South Carolina, and Virginia (with the exception of Arlington and Fairfax counties), maintaining headquarters in Winston-Salem, N. C.

Selection of **Burlingame Associates** of Mt. Vernon, N. Y., as rep for Menlo Park Engineering Co. of Menlo Park, Calif., is announced. The appointment pro-

vides the principal with Burlingame sales reps in Syracuse, N. Y.; Boston, Mass.; Philadelphia, Pa.; and Washington, D. C.

Mid-Eastern Electronics, Inc., Springfield, N. J., has named **Longstreet Smith Associates, Inc.,** Denver, Colo., sales rep in Colorado, Utah, New Mexico and Wyoming.

The Amerelay Corp., New Hyde Park, N. Y., names **R. G. Daily Co.** of Ann Arbor as its rep for the state of Michigan; and **Emory Designs and Equipment Co.** of Birmingham, Ala. for the states of Alabama, Florida, Georgia and Tennessee.

Telerad Mfg. Corp., New York, N. Y., appoints three new reps:

G. B. Ellis Sales Co. of Palo Alto, Calif., for northern California and northern Nevada areas; **Wallace & Wallace** of Los Angeles, Calif., for southern California area; and **Premmco of Arizona,** of Scottsdale, Ariz., for Arizona, New Mexico and Utah areas.

Silicon Transistor Corp., Carle Place, N. Y., has appointed **Harold Gray Associates** of Tenafly, N. J., to cover northern New Jersey and metropolitan New York.

Chemtronics Inc., Brooklyn, N. Y., recently appointed **Active Radio and T.V. Ltd.** of Toronto, to represent it in Canada.

Newton Wayne has joined the **G. E. Moxon Co.,** west coast electronic manufacturer's rep, and will act in the capacity of sales engineer.

Aero Electronics Corp., Gardena, Calif., manufacturer of Aeropot miniature wirewound trimming potentiometers, announces appointment of four new sales reps:

C. R. Dalton Associates of San Carlos, Calif., for northern California and Nevada; **Electro-Mechanical Corp.** of New Rochelle, N. Y., for all of New York state except metropolitan New York City; **J. Neal and Co.** of Miami, Fla., for Florida, Georgia and Alabama; and **Wayne B. Palioca Co.** of Lexington, Mass., for New England.

COMMENT

Hard Magnets

I must protest against the misleading implications and actual mistakes in your short article "Hard Magnets for 500 C" (p 63, Jan. 9).

As regards factual mistakes: curie points are wrongly stated for Alnico I and IV; BH_{max} of Indalloy has been increased approximately 10 times. You do not define permanent change, but I take this to mean a modification in the hysteresis loop characteristics as measured at room temperature; in which case the figure of 480 C for Alnico IV is very low.

As regards the general implications, we have carried out numerous investigations on the very similar alloys made in this country, and find that it is impossible to specify the conditions under which permanent magnets can be used at high temperatures without a clear definition of the considerations which arise. These include: a permanent change in the hysteresis loop; an irreversible loss of magnetization due to heating which can be removed by remagnetizing; when both the previous points have been covered, a reversible change in magnetization with temperature.

It is also necessary to give some consideration to the dimension ratio of the permanent magnet in question, and it is possible that your misleading information in particular arises from a poor choice of dimension ratios.

As regards use of temperatures up to 700 C with Alnico V and similar alloys, prolonged exposure to 700 C causes very marked changes in the demagnetization curve and is quite likely to involve flux losses of up to 75 percent. As regards the use of carbon steel or tungsten steel at 500 C, this temperature is nearly sufficient to cause complete annealing, and I feel sure that permanent magnets in these materials could not be considered satisfactory for such use.

J. E. GOULD
PERMANENT MAGNET ASSOCIATION
SHEFFIELD, ENGLAND

As we already mentioned in these columns previously, the BH_{max} of Indalloy was given as 9 million instead of 900,000 because

of a typographical error. Reader Gould's other comments regarding errors of fact or implication are substantiated by research reports prepared by his organization; our data was compiled chiefly from three Wright Air Development Center reports. One of these, WADC Technical Note 57-211, contained a serious error which was first brought to our attention by R. K. Tenzer, chief scientist of Indiana Steel Products Co.; the error is also caught in Reader Gould's last paragraph. Reader Tenzer wrote:

According to our experiments, Alnico V magnets show losses in excess of 20 percent when they are exposed to 700 C even for a period of only one hour. Remanence values determined at room temperature after the exposure were 39 to 70 percent below the original ones. The loss depended on the operating point of the magnet. . . . We can only warn people not to use Alnico V and VI magnets at 700 C. . . .

We are beginning to prepare a technical note about the influence of elevated temperatures on permanent magnet properties. This note will be published by the Department of Commerce. . . .

R. K. TENZER
INDIANA STEEL PRODUCTS CO.
VALPARAISO, IND.

The ironic thing is that the statement in WADC Technical Note 57-211, that Alnico V and VI magnets "are usable to 700 C with 20 percent loss of total energy," was supposed to have been part of a summary of Dr. Tenzer's own research results.

We will cover this subject in greater detail in our coming special report on materials for critical environments.

Nomographs

Your nomographs and handy-dandy calculator charts have found wide acceptance and use. The Radio System Calculator and Tropo System Design nomographs are classics. Please do one equally fine and comprehensive on the transmission of information—from the information theory standpoint.

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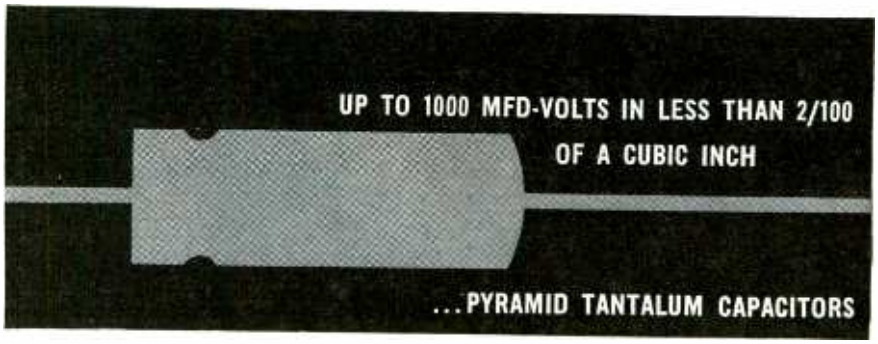

Miniaturized to provide maximum space economy.

New Pyramid Tantalum slug capacitors have cylindrical cases and contain a non-corrosive electrolyte. Due to the special construction of materials used in the manufacture of Pyramid Tantalum slug capacitors, these units are both seep and vibration proof. In addition, this type of capacitor assures long service life and corrosion resistance—made to meet MIL-C-3965 Specifications.

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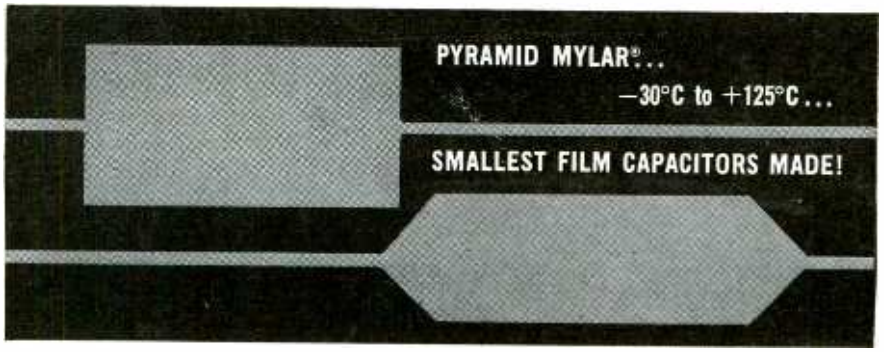

Pyramid new Mylar capacitors have extremely high insulation resistance, high dielectric strength and resistance to moisture penetration.

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Construction Styles:

Basic No.	Type Winding	Shape
101	Inserted Tabs	Flat
103	Extended Foil	Flat
106	Inserted Tabs	Round
107	Extended Foil	Round

Tolerance: The standard capacitance tolerance is ± 20%. Closer tolerances can be specified.

Electrical Characteristics: Operating range for Mylar capacitors—from —55° C to +85° C and to +125° C with voltage de-rating.

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Temperature	IR x mfd	Maximum IR Requirements
25° C	50,000	15,000 megohms
85° C	1,000	6,000 "
125° C	50	300 "

Pyramid Mylar capacitors are subject to the following tests:

Test Voltage—Mylar capacitors shall withstand 200% of rated D.C. voltage for 1 minute at 25° C.

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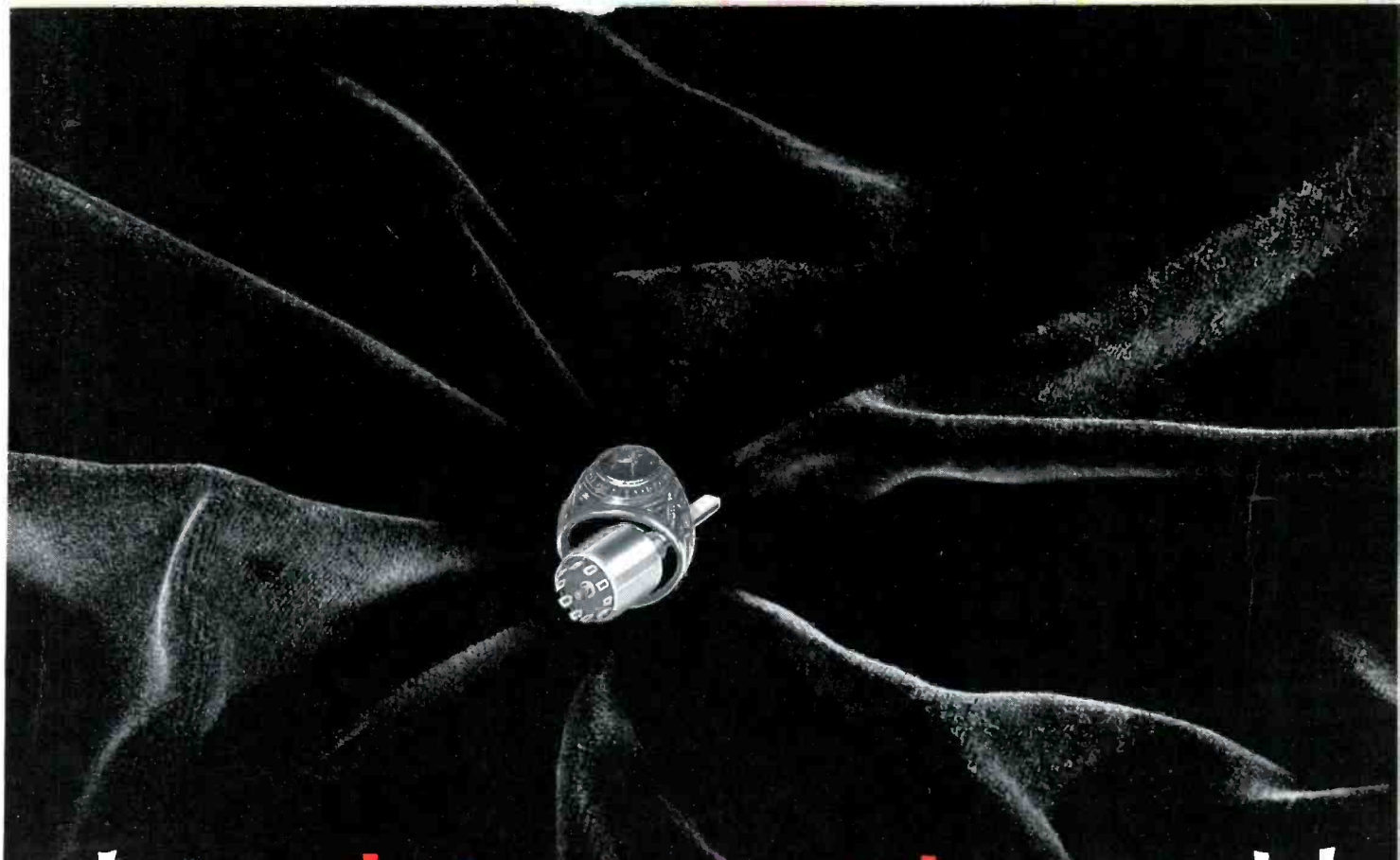

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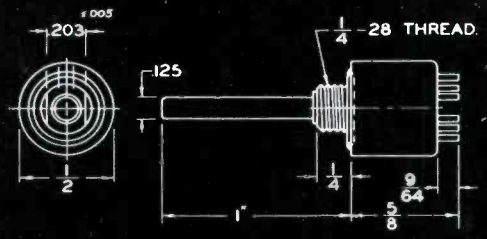

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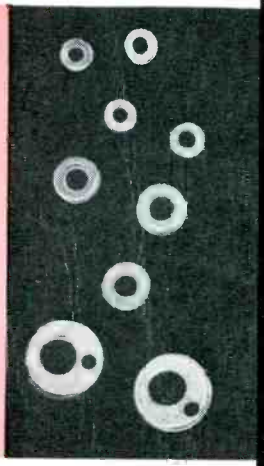

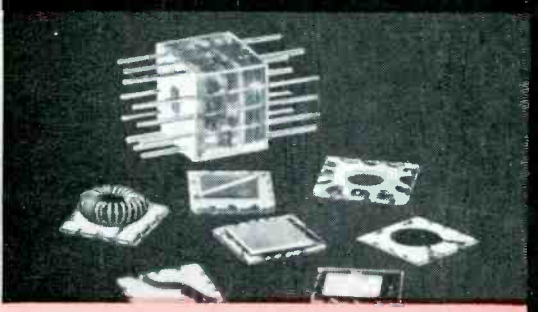

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