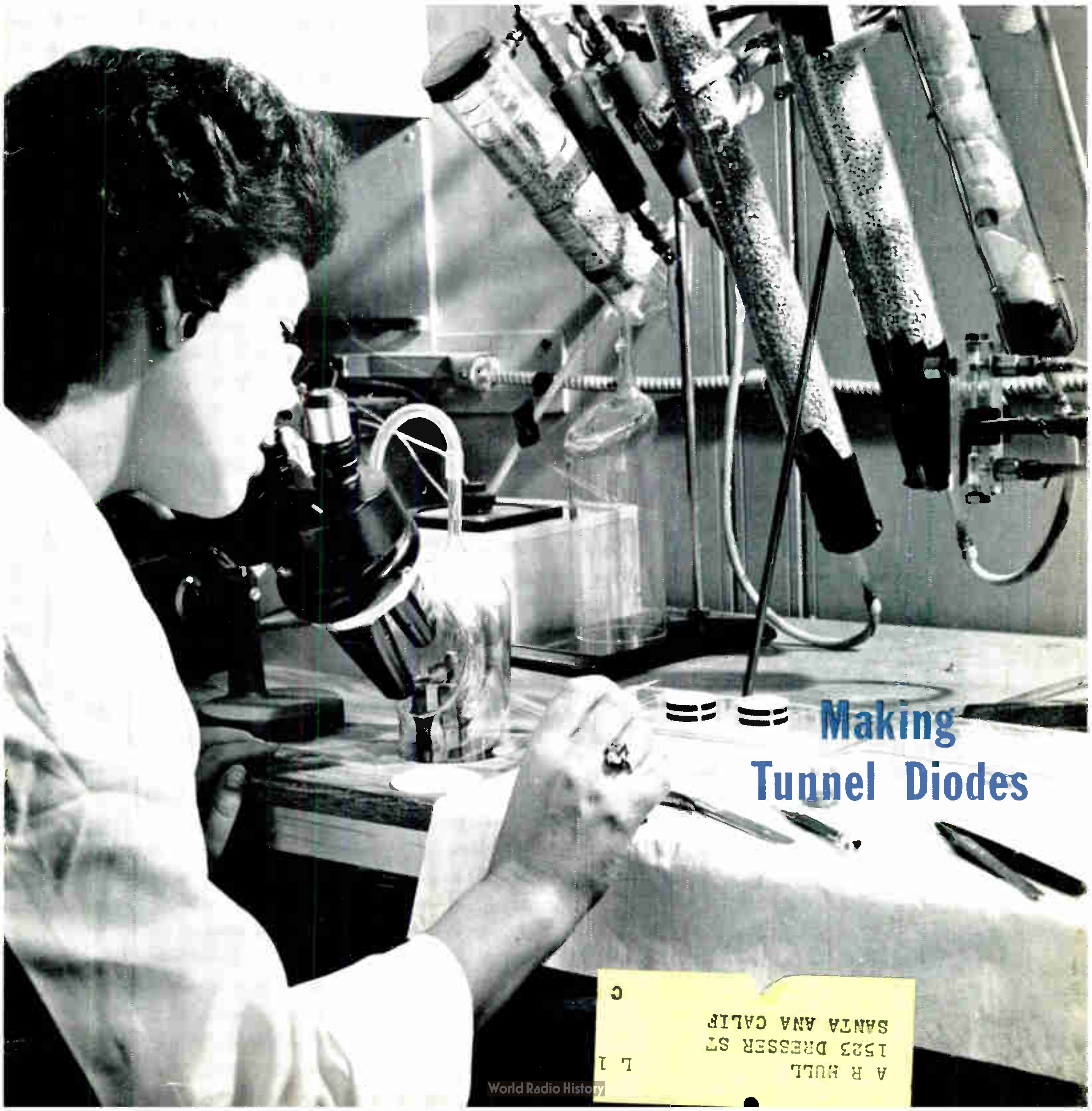
Latest on Soviets' Planning

page 34

NOVEMBER 27, 1959

electronics

A McGRAW-HILL PUBLICATION VOL. 32, No. 48 PRICE SEVENTY-FIVE CENTS



electronics

NOVEMBER 27, 1959

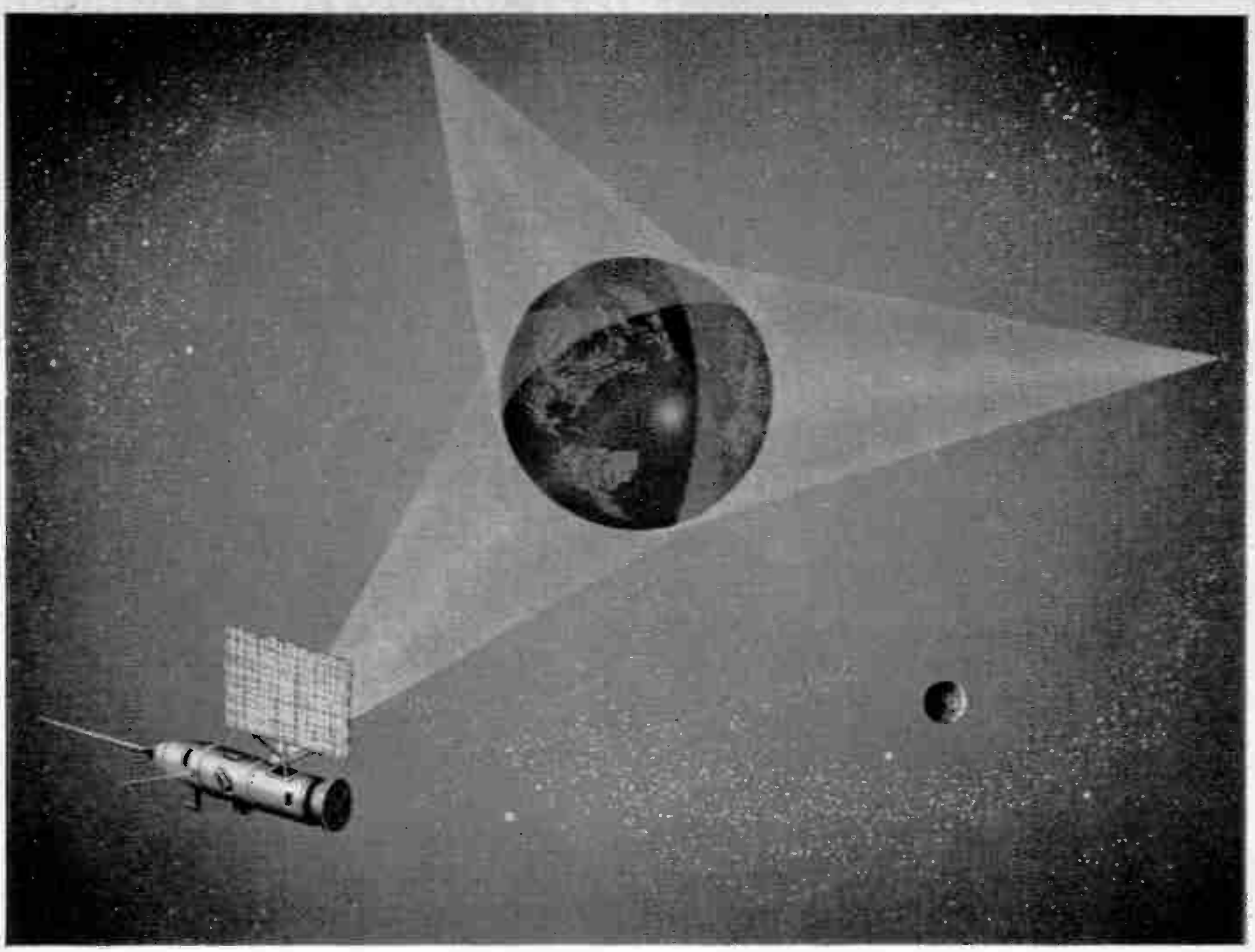
A McGRAW-HILL PUBLICATION
Vol. 32 No. 48

Issue at a Glance

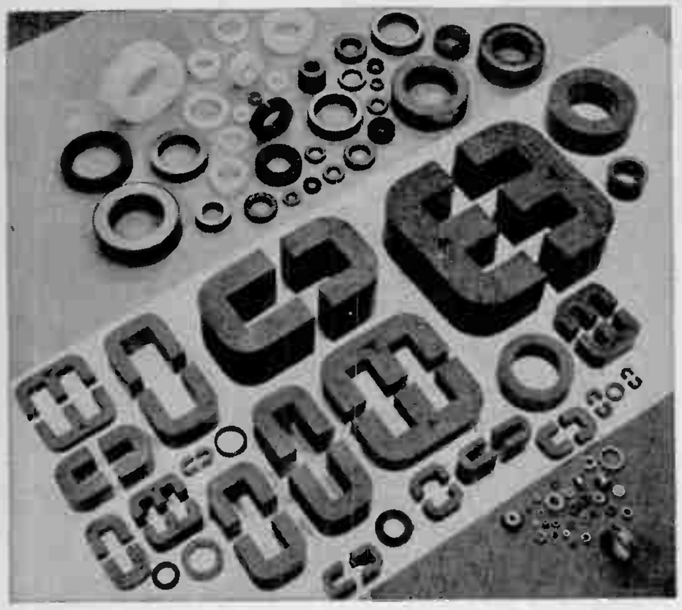
Business

Engineering

Departments



Specify "ARNOLD" for your MAGNETIC CORE requirements



Top to bottom: Tape wound cores, Silectron C, E and O cores, and bobbin cores.

Top to bottom: Mo-Permalloy powder cores, iron powder cores, and Sendust cores.

SILECTRON C-CORES, E-CORES and TOROIDS Arnold C and E cores are made from precision-rolled Silectron strip in 1, 2, 4 and 12 mil thicknesses.

They are supplied in a wide variety of shapes, and in sizes from a fraction of an ounce to several hundred pounds. In addition to standard transformer applications, they may also be supplied for special applications such as saturable reactors, instrument transformers and pulse transformers.

Over 1,000 stock cores are listed in the Arnold Silectron catalog. A wide selection of preferred sizes are carried in stock for immediate shipment. For complete data on C and E cores and Silectron toroids, *write for Bulletin SC-107A.*

TAPE WOUND CORES of High Permeability Materials Arnold tape wound cores are available made of Deltamax, 4-79 Mo-Permalloy, Supermalloy, Mumetal, 4750 Electrical Metal, Silectron, or the new rectangular-loop material, Supermendur. All except Supermendur cores are available in standard tape thicknesses of 1, 2 and 4 mils; also in special tape thicknesses of ½ mil, 12 mil or other, as required or feasible. Supermendur is presently available in 4 mil cores.

Toroidal cores are made in 30 standard sizes with protective nylon or aluminum cases. Special sizes of toroidal cores are produced to individual requirements. *Write for Bulletin TC-101A. (TC-113A for Supermendur Cores.)*

BOBBIN CORES Arnold bobbin cores are available in a wide range of sizes, tape thicknesses, widths and number of wraps to suit the ultimate use of the core in electronic computer assemblies. Magnetic materials usually employed are Deltamax and Square Permalloy in standard thicknesses of 1, ½, ¼ and ⅛ mil. Bobbins are supplied in ceramic or stainless steel. *Write for Bulletin TC-108A.*

MO-PERMALLOY POWDER CORES Available in a wide range of sizes, from .260" OD to 5.218" OD. They are given various types of enamel and varnish finishes, some of which permit winding with heavy Formex insulated wire without supplementary insulation over the core.

These powder cores are supplied in four standard permeabilities: 125, 60, 26 and 14 Mu. They provide constant permeability over a wide range of flux density, and in many cases may be furnished stabilized to provide essentially constant permeability over a specific temperature range. Large warehouse stocks of preferred sizes are carried for immediate shipment. *Write for Bulletin PC-104C.*

IRON POWDER CORES A wide selection of cores is available, from simple cylinders to special cores of complicated design. The line includes all standard types of threaded cores, cup, sleeve, slug and cylindrical insert cores: for use in antenna and RF coils, oscillator coils, IF coils, perm tuning, FM coils, television coils, noise filter coils, induction heating and bombarder coils, and other low frequency applications. Preferred sizes are carried in warehouse stock for quick shipment. A standard series of iron powder toroids is also manufactured, conforming to the standard sizes proposed by the Metal Powder Industries. *Write for Bulletin PC-109.*

SENDUST POWDER CORES Available in a wide selection of sizes, ranging from .800" OD to 3.346" OD, and in permeabilities of 10, 13, 25, 30, 50 and 80, although not all sizes are available in all permeabilities. They possess magnetic properties generally superior to iron powder cores, but inferior to Mo-Permalloy powder cores in the audio and carrier frequency range. *Write for Bulletin SDC-110.*

SPECIAL MATERIALS

2V PERMENDUR . . . a ferromagnetic alloy of cobalt, vanadium and iron that possesses high flux density saturation properties. Its magnetostrictive properties are useful in many transducer applications. *Write for Bulletin EM-23.*

VIBRALLOY . . . a ferromagnetic alloy of nickel, molybdenum and iron whose temperature coefficient of elastic modulus is controllable over a wide range. It has high ferromagnetic permeability, and a rather high coefficient of magnetostriction. Used in applications where a zero or controlled thermo-elastic coefficient is desired.

BARIUM TITANATE . . . A piezoelectric ceramic widely used in accelerometers, phono pickups, microphones, ultrasonic grinding and cleaning devices and underwater signaling devices. For more information, *write for Bulletin CM-116.*

7507 B

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CIRCLE 3 ON READER SERVICE CARD

electronics

November 27, 1959 Vol. 32, No. 48

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SHOPTALK . . . editorial

TECHNICAL MEETINGS. Attending technical meetings can be a full time job for an engineer. ELECTRONICS listed 117 meetings during 1958; there will be more this year. They are held in every corner of U. S. and abroad.

Can you attend 117 meetings a year, and split yourself like a paramecium into two or more parts when simultaneous sessions are held? Do you even wish to try?

Associate Editors Weber and Wolff attended last month's Electron Devices meeting in Washington and heard a lot that sounded familiar. Reason: many of the subjects under discussion were covered in articles either already printed in this magazine or well along in production.

Tunnel diodes received attention. Our Nov. 6 issue had a Hughes article on tunnel diode theory, and this issue has a GE paper on applications and circuits.

On Dec. 4 we will carry a Stanford University paper comparing traveling-wave tubes and parametric amplifiers for low-noise application. Included in this will be the latest technique for reducing noise in twt's. This topic was also covered in a talk by H. Heffner of Stanford on low-noise devices.

The last talk was delivered by I. M. Ross of Bell Telephone Labs. He described the latest trends in building functional devices, including micromodules and molecular electronics. We are presently editing a comprehensive article by R. Langford of Daystrom describing several approaches to microminiaturization.

Coming In Our December 4 Issue . . .

MATERIALS. Electronic materials, especially in the case of advanced weapons systems, have become the tail that wags the dog. "We have reached the stage where most of the designs on the boards cannot be carried out because we have used up the capabilities of present materials." This comment, made recently by I. V. Williams of Bell Telephone Laboratories to Associate Editor Sideris, sums up why next week's issue will carry a special report on materials for extreme environments.

Sideris' report describes the progress being made in materials research at private and government laboratories and how materials are being developed for applications involving high temperatures, radiation, corrosion and stress. You'll learn about environmental conditions tomorrow's electronic systems will have to meet and what you can do now to select materials for these environments. You'll discover how research is raising the endurance of materials like structural metals, conductors and magnetic materials, as well as components such as transducers, semiconductor devices, capacitors and resistors. We believe that Sideris' useful and informative survey successfully captures the wide scope and dynamic nature of materials research. You won't want to miss it.

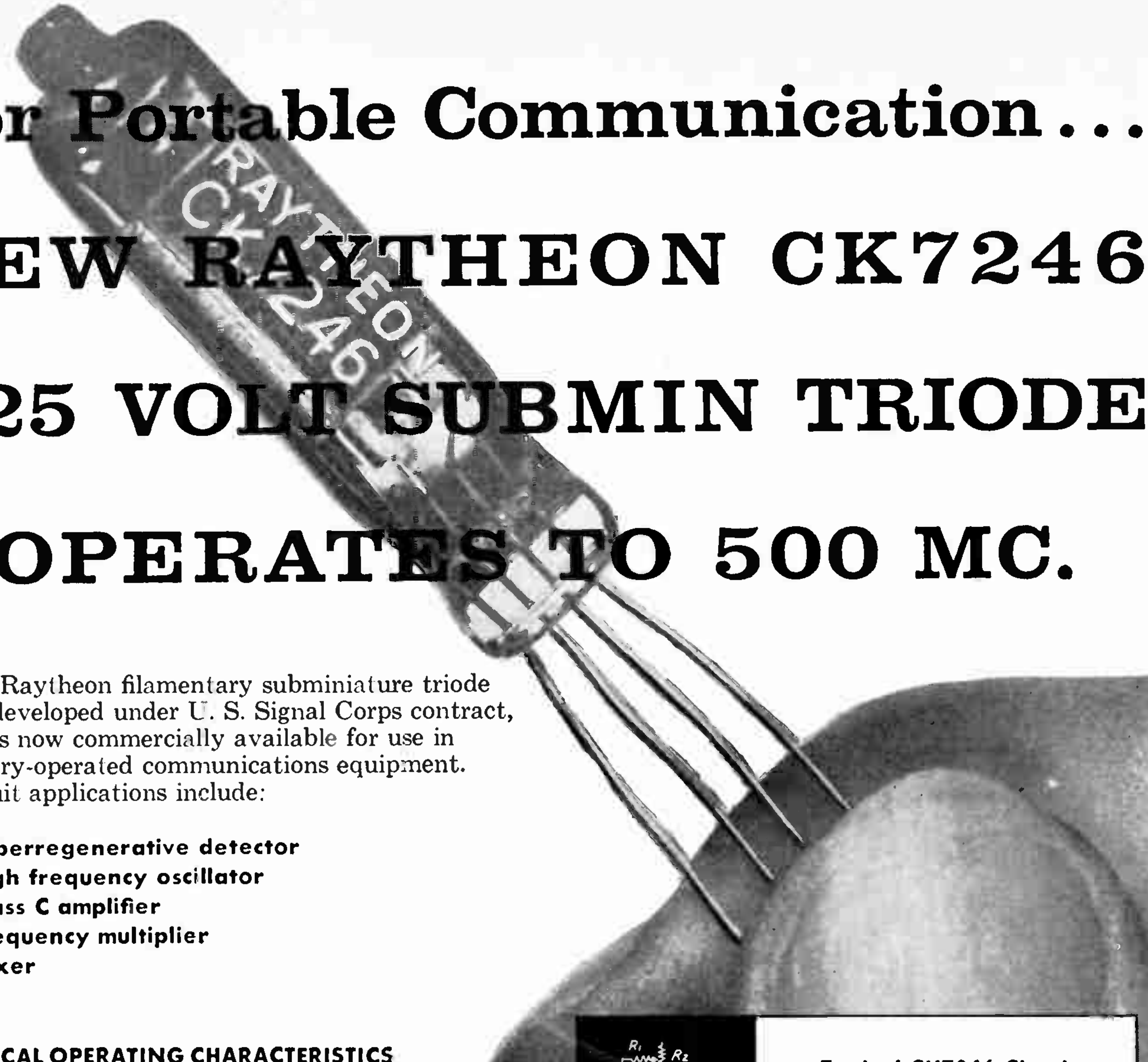
NEC HIGHLIGHTS. When Associate Editors Solomon and Perugini attended the National Electronics Conference in Chicago recently, they found the emphasis to be on systems rather than components. As a result, next week's roundup of the significant developments unveiled at the NEC show will deal with an electroluminescent typewriter, ultrasensitive thermistor bridge, d-c power regulator controlled by a magnetic amplifier, electronic switchboard and high-speed encoder. You'll also learn about some of the latest developments in microcircuitry and airborne data acquisition systems.

For Portable Communication...

NEW RAYTHEON CK7246

1.25 VOLT SUBMIN TRIODE

OPERATES TO 500 MC.



This Raytheon filamentary subminiature triode was developed under U. S. Signal Corps contract, and is now commercially available for use in battery-operated communications equipment. Circuit applications include:

- **Superregenerative detector**
- **High frequency oscillator**
- **Class C amplifier**
- **Frequency multiplier**
- **Mixer**

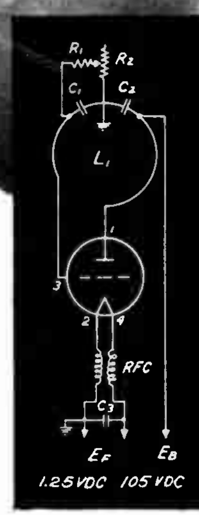
TYPICAL OPERATING CHARACTERISTICS

Class A Amplifier

Filament voltage (dc)	1.25 v.
Filament current	150 ma.
Plate voltage	105 v.
Plate current	4.5 ma.
Grid voltage	—2.5 v.
Transconductance	2700 μmhos
Amplification factor	22

Class C Oscillator (465 mc.)

Filament voltage (dc)	1.25 v.
Filament current	150 ma.
Plate voltage	105 v.
Plate current	6 ma.
Grid current	0.9 ma.
Power output	60 mw.



Typical CK7246 Circuit
465 mc. Class C Oscillator

L_1: 1 turn No. 12 copper, ¾ inch O.D.

RFC: bifilar wound 8 turns #26 En. ⅛" I.D., 1" long

C_1, C_2, C_3: 250 μμf feed-thru button type

R_1: 4.7K ½ w.

R_2: 10K 2w pot.

RAYTHEON

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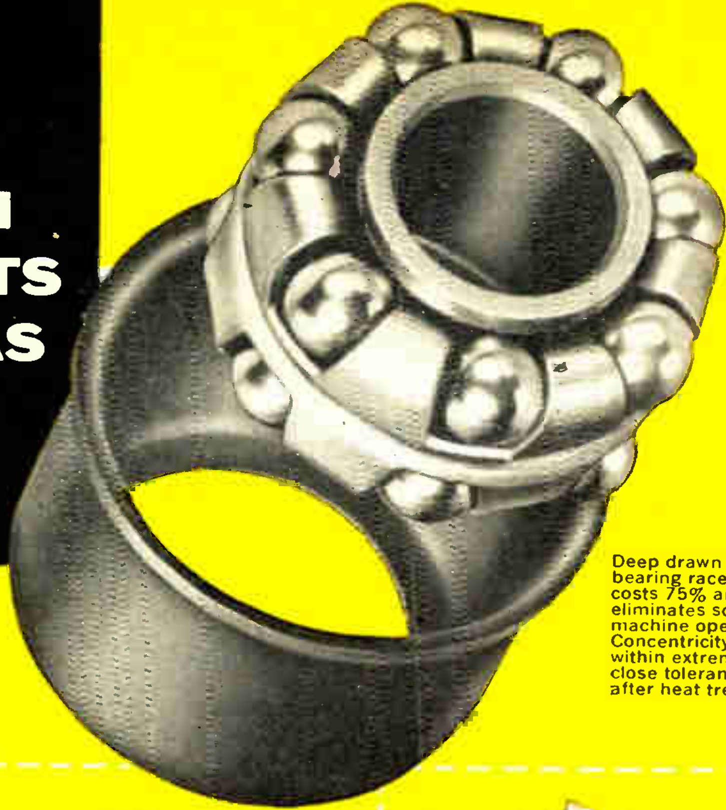
Small order and prototype quantities available directly from your local Raytheon electronic parts distributor

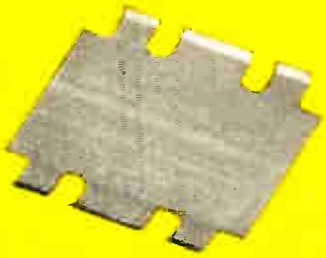
CUT PRECISION PARTS COSTS AS MUCH AS 75%



Deep drawn ball bearing race cuts costs 75% and eliminates screw machine operation. Concentricity held within extremely close tolerance even after heat treating.

Transistor dome has .018 weld flange made from .013 stock, without showing any indentation on reverse side.

Full stock thickness at top of draw on .018 brass case improved watch quality and saved assembly time.



Spring for razor blade dispenser feeds automatically in high-speed assembly machine. Spring steel properties are held during heat treating. Parts are produced free of burrs, without finishing.

- **Improve quality at lower cost**
- **Increase production and speed assembly**
- **Eliminate screw machine costs**

Now a ball bearing race is being made for a textile machine by deep drawing 1050CR steel to .843 within tolerances previously believed impossible. Savings of 75% are reported and the 25% reject rate experienced when this part was made on screw machines was eliminated.

This is only one of a host of examples where United's specialized skill in metal forming provides production economies on made-to-order eyelet-like and other metal specialties for many industries.

Special conveyor-type austempering furnaces are used when required to produce uniform toughness, with specified hardness. Parts are clean, free of quench cracks, and have minimum distortion. Call or write today for analysis and quotation on your most challenging problem.

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Multi-channel—telegraph A1 or telephone A3

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High stability (.003%) under normal operating conditions

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Components conservatively rated. Completely tropicalized

FROM GROUND TO AIR OR POINT TO POINT

Here's the ideal general-purpose high frequency transmitter! Model 446, suitable for point-to-point or ground-to-air communication. Can be remotely located from operating position. Coaxial fittings to accept frequency shift signals.

This transmitter operates on 4 crystal-controlled frequencies (plus 2 closely spaced frequencies) in the band 2.5-24.0 Mcs (1.6-2.5 Mcs available). Operates on one frequency at a time; channeling time 2 seconds. Carrier power 350 watts, A1 or A3. Stability .003%. Nominal 220 volt, 50/60 cycle supply. Conservatively rated, sturdily constructed. Complete technical data on request.

Now! Complete-package, 192 channel, H.F., 75 lb. airborne communications equipment by Aer-O-Com! Write us today for details!

AER-O-COM

A-131

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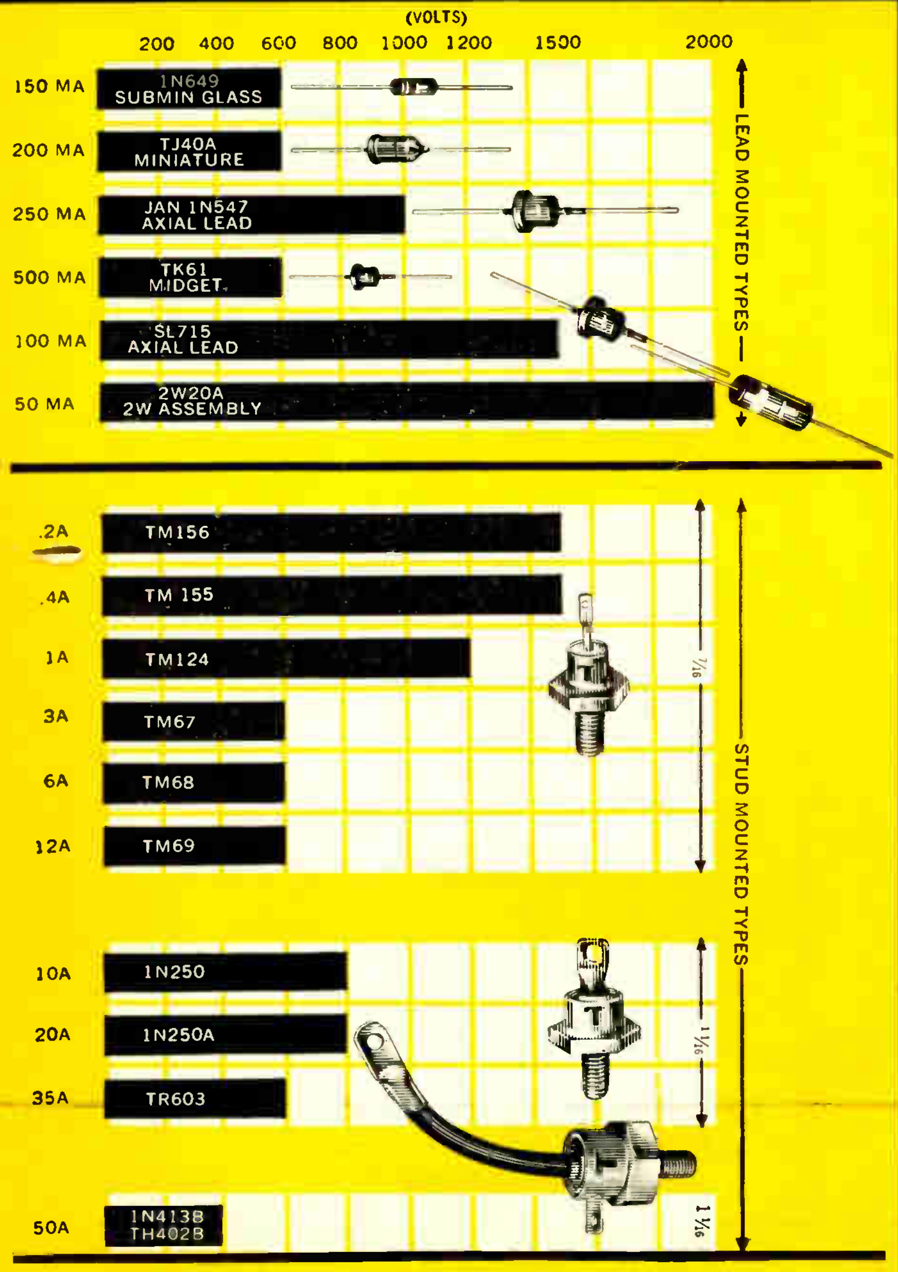
INDUSTRY'S MOST COMPLETE SILICON RECTIFIER LINE



CIRCLE 8 ON READER SERVICE CARD

SILICON CERAMIC BASE RECTIFIERS

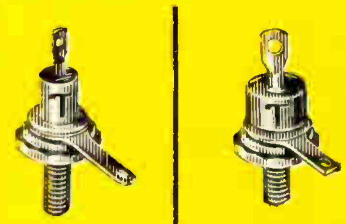


Fig. 1 Fig. 2

Ceramic base rectifiers of compact design now eliminate the need for insulating hardware and "reverse polarity" units. These rugged stud-mounted silicon power rectifiers achieve their versatility by virtue of an alumina ceramic disc mounted between the top hat assembly and the hex base. The ceramic disc offers low thermal resistance and high electrical insulation properties. Further, bridge assemblies are now simplified and standardization of components is subsequently advanced.

The ceramic base rectifiers are available in ½" hex base configuration up to 12 amperes @ 150°C case, and in 1¹⁄₁₆" hex base configuration up to 20 amperes @ 150°C case.

For example:

Type	Peak Recurrent Inverse Voltage (Volts)	Maximum Average Forward Current @ 150°C Case (amps)	Figure
IN 341/C	400	.400	1
IN 250 A/C	200	20	2

For further information write in for bulletin TE-1351R.

Number 12, 13, 14 and 15 in a series of 37 new Transitron Products to be announced before 1960!

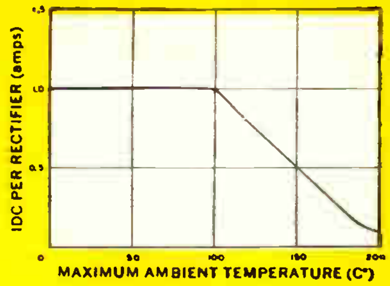
CIRCLE 9 ON READER SERVICE CARD →

. . . designed to meet ALL your circuit requirements: current, voltage, temperature, size . . . now available from Transitron.

A complete description of the lead and stud mounted types, which are summarized below, is in bulletin TE-1351.

We welcome your inquiries concerning special requirements such as high frequency, fast recovery and high voltage applications.

MIDGET RECTIFIER
1 AMP @ 100°C

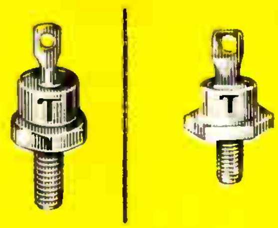


Transitron announces, higher ratings and *smaller* size in a lifetested lead mounted silicon rectifier. By establishing a high level of designed quality, these rectifiers feature reliable 200°C operation. Remember, the size is SMALLER, the flange is GONE! These units will meet all electrical and environmental requirements of the JAN-1N 547 series.

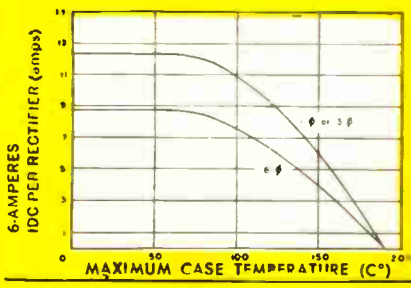
Type	Peak Recurrent Inverse Voltage (Volts)	Maximum Average Forward Current @ 200°C (Milliamps)	Maximum Average Forward Current @ 100°C (Amps)	Maximum Forward Voltage @ 25°C (Volts) (Milliamps)
TK61	600	100	1.0	1.0 @ 750
TK41	400	100	1.0	1.0 @ 750
TK21	200	100	1.0	1.0 @ 750

Write for bulletin PB-58

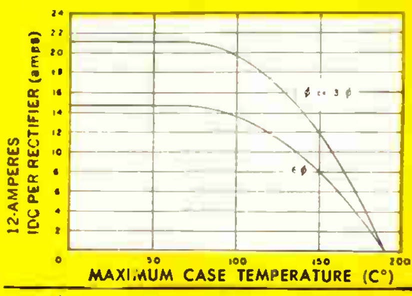
HIGH CURRENT RECTIFIERS



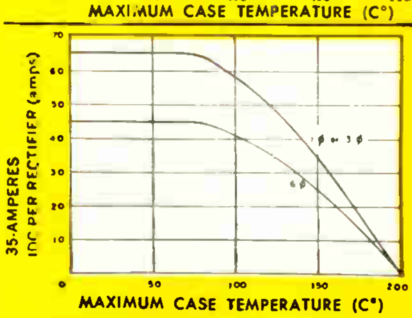
Now, from Transitron, stud-mounted silicon power rectifiers which combine high power handling ability with a minimum of size and weight . . . The extremely low forward resistance and thermal impedance of these units allow operation up to 12 amperes @ 150°C case temperature in the 7/16" hex base configuration, and similarly up to 35 amperes @ 150°C case temperature in the 11/16" hex base configuration. Still further, the inherently low leakage currents and high peak inverse voltage ratings allow flexibility in the design of both power supply and magnetic amplifier circuits.



Type	Peak Recurrent Inverse Voltage (Volts)	Maximum Forward Voltage @ 25°C (Volts) @ (Amps)	Maximum Average *Inverse Current 150°C (Milliamps)
TM68	600	1.1 @ 6	2
TM58	500	1.1 @ 6	2
TM48	400	1.1 @ 6	2
TM38	300	1.1 @ 6	2
TM28	200	1.1 @ 6	2
TM18	100	1.1 @ 6	2
TM8	50	1.1 @ 6	2



Type	Peak Recurrent Inverse Voltage (Volts)	Maximum Forward Voltage @ 25°C (Volts) @ (Amps)	Maximum Average *Inverse Current 150°C (Milliamps)
TM69	600	1.2 @ 12	2
TM59	500	1.2 @ 12	2
TM49	400	1.2 @ 12	2
TM39	300	1.2 @ 12	2
TM29	200	1.2 @ 12	2
TM19	100	1.2 @ 12	2
TM9	50	1.2 @ 12	2



Type	Peak Recurrent Inverse Voltage (Volts)	Maximum Forward Voltage @ 25°C (Volts) @ (Amps)	Maximum Average *Inverse Current 150°C (Milliamps)
TR603	600	1.5 @ 100	5
TR503	500	1.5 @ 100	5
TR403	400	1.5 @ 100	5
TR303	300	1.5 @ 100	5
TR203	200	1.5 @ 100	5
TR153	150	1.5 @ 100	5
TR103	100	1.5 @ 100	5
TR53	50	1.5 @ 100	5

*Averaged over one cycle with rectifier operating at full rated current and voltage into a resistance load.

SILICON CONTROLLED RECTIFIER

Handling 10 KW Power

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.

NOW AVAILABLE IN TRANSITRON'S NEW PACKAGE

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
TCR102	100	100	10	20
TCR202	200	200	10	20
TCR302	300	300	10	20
TCR402	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-1356A

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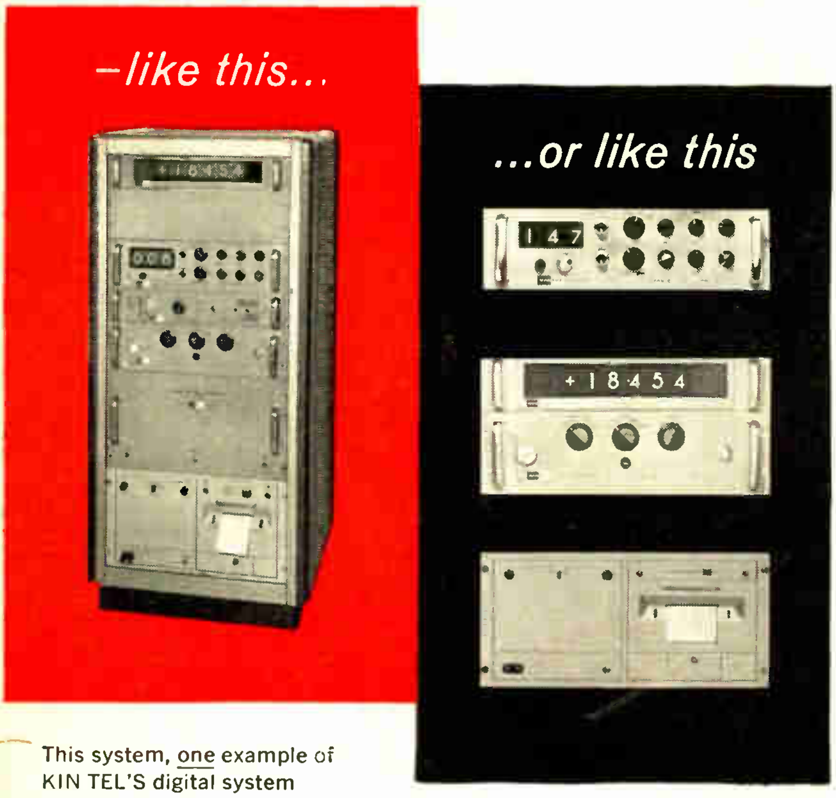
For high-accuracy data logging...to checkout missiles or meters, to test transducers or transistors...checkout a KinTel digital system



This system, one example of KIN TEL'S digital system experience, takes eight measurements at each of 7200 different data points. Outputs include visual readout, digital printer, X-Y recorder, and tape punch. Tape is perforated for direct entry into a digital computer. To provide 0.01% accuracy for low-level inputs, alternate channels scan calibration signals. These, with the unknown input signal, are fed to the computer and correction is made for any inaccuracy in the system itself. Cost: about $20,000.

This data system consists of a KIN TEL 453M scanner and 501 DC digital voltmeter, plus a parallel entry printer. Briefly, the system will accept 400 one-wire, 200 two-wire, or 100 four-wire inputs, and will provide both visual and printed indication of the channel being scanned and DC input signals from ±100 microvolts to ± 1000 volts. Accuracy is 0.01% ±1 digit, and ranging and polarity indication are automatic. The complete system costs approximately $6850. At the present time, delivery is off the shelf.

KIN TEL DIGITAL SYSTEM CAPABILITIES

You can have any number of channels: A single 453M scanner ($2500) accepts 400 one-wire, 200 two-wire, or 100 four-wire inputs. Additional scanners can be added if more inputs are required.

You can measure DC from ±1 µv to ±1000 volts: The KIN TEL 501 DC digital voltmeter ($2995) measures from ±100 µv to ±1000 volts. Addition of a KIN TEL digital preamplifier increases sensitivity to 1 µv DC.

You can measure AC from 10 µv to 1000 volts: Addition of a 452 AC converter ($850) to the 501 DC digital voltmeter permits measurement of RMS AC voltages from 1 mv to 1000 volts in the frequency range of 30 cps to 10 kc. A KIN TEL preamplifier can be added to increase AC measurement sensitivity to 10 µv from 30 cps to 2 kc.

You can measure voltage ratios: The 507B digital voltmeter/ratiometer ($3835) measures DC voltages from ±100 µv to ±1000 volts and DC/DC ratios from .0001:1 to 999.9:1. Accuracy is 0.01% ±1 digit. Addition of appropriate converters permits AC/DC and AC/AC ratio measurements.

You can get 0.01% DC and 0.2% AC accuracy: The KIN TEL 502 AC/DC digital voltmeter ($3845) measures DC from ±100 µv to ±1000 volts with 0.01% ±1 digit of reading accuracy, and AC from 1 mv to 1000 volts, 30 cps to 10 kc, with 0.2% of full scale accuracy.

You can have 10,000 megohm input impedance: The KIN TEL 458A digital voltmeter preamplifier ($1225) has gain positions of 100 (for DC and 30 cps to 2 kc AC measurement) and +1 HI Z (for DC only). On the +1 gain position input impedance is >10,000 megohms and gain accurracy is 0.001%. Input range for +1 operation is 0 to 40 volts.

You can have visual, printed, or any other form of output: KIN TEL digital voltmeters provide visual indication of the measured quantity on a single-plane in-line readout. They are capable of directly driving commercially available 10-line parallel input digital printers. Converters are available for driving other types of printers, paper tape punches, typewriters, and IBM card punches.

To find out how a KIN TEL digital system can solve your particular data acquisition problem, send us an outline of your requirements, or contact your nearest KIN TEL engineering representative.

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ELECTRONICS, INC.

ELECTRONICS NEWSLETTER

SOVIET COMPUTER TECHNOLOGY is advancing rapidly in the opinion of an eight-man team of U. S. experts who visited the Soviet Union in an exchange of computermen. Several team members speculate that the Soviets may not have disclosed all of their latest computer developments and techniques. What they saw appeared to lag a year behind the U. S. First written report of the tour is expected next week in Boston at the Eastern Joint Computer Conference. Some of the group's observations: The Soviets lag in high-speed magnetic tape transports, showed no etched circuit boards; they are pushing machine translation, investigation of deposited thin magnetic films and universal use of deposited carbon resistors. Computer manufacturing techniques and magnetic drum memory devices are comparable to those in the U. S. The Soviets are developing a 50-line-per-sec number printer. They showed diffused-base transistors operating up to 120 mc. For a look at USSR plans, see p 34.

Uhf all-semiconductor airborne receiver that will provide 10,000 hours of continuous operation and be adaptable to the use of microminiature components will be developed by Sylvania under a $450,000 contract from Wright ADC, Wright-Patterson AFB, Ohio.

ELIMINATION OF CANS AND HEADERS in semiconductor devices may be possible eventually through the use of high-temperature oxidation of silicon surfaces. At Bell Telephone Laboratories *n-p* and *p-n* diodes, *npn* and *pnp* structures, as well as *pnpn* switching transistor structures have been stabilized with thin oxide coatings by exposure to oxygen at 920 C. Units showed no change in electrical characteristics after 15 months storage in plastic boxes in room air. However, the stabilization process produces new properties of the device structure which must be considered in device design.

British scientific instrumentmakers expect to boost sales to the USSR by holding an exhibition in Moscow, tentatively slated for the second half of 1960. A three-man delegation of the British Scientific Instrument Manufacturers' Association recently visited Moscow. Some 36 manufacturers have already said they would participate in the exhibition.

MILITARY ELECTRONICS WINTER CONVENTION in Los Angeles will feature tours of the Pacific Missile Range and Naval Ordnance Laboratory. The convention, sponsored by the IRE Professional Group on Military Electronics, will be held Feb. 3, 4 and 5. Other convention field trips: Space Technology Laboratories, System Development Corp., Consolidated Electrodynamics and Consolidated Systems Corp.

CENTAUR SPACE PROBE, a NASA project expected to place a 7,400-lb payload in a 300-mile orbit, a 1,300-lb payload in a 22,000-mile orbit or place a 730-lb payload on the moon, will use a Librascope computer in its Minneapolis-Honeywell inertial guidance system. The General Precision Equipment subsidiary has just received a $1.8-million production contract from M-H. Prime contractor is Convair Astronautics division of General Dynamics. Librascope computer weighs 32 lb, occupies one-half cubic foot of space.

Venus radar bounce was reported this month by British scientists who mounted a klystron from a nuclear research linear accelerator in the Jodrell Bank radiotelescope. Pulses took five minutes for the 60-million-mile round trip.

MICROWAVE BUSINESS DATA LINK transmitting 3,000 words per second has been developed by Pacific Telephone & Telegraph Co. and IBM's Advanced Systems Development division for North American Aviation. System will tie together three scattered divisions and six computers at the Los Angeles division. During system development, data was transmitted 2,000 miles experimentally using spare tv channels.

Actuator system to power control mechanisms of Minuteman will be designed and developed by the Electronics division of Chance Vought Aircraft under a new contract from North American's Autonetics division. Firm says it will use a "new concept" in design which can't be disclosed.

JAPANESE TRANSISTOR RADIO plant in the Irish Republic, planned by Sony Corp. of Japan, is stirring British press comment. There is fear that the new firm, Sony Ltd., will undercut British manufacturers by getting into the U. K. market without quota restriction and with benefit of imperial preference.

Digital control system for positioning the rolls of a hot strip mill and assuring desired sheet steel thickness is announced by Datex Corp. Automatic gage controller provides position data on the screwdown rolls. Five-control-channel system resets to an accuracy of 0.001 inch.

RADAR AIR TRAFFIC CONTROL modernization continues as new equipment is shipped by Texas Instruments to the Federal Aviation Agency. Some 35 new ASR-4's and 50 modification kits are expected to be delivered and installed this winter. TI says the ASR-4's will provide better control of traffic up to 27,000 ft and within a 60-mi radius.

KLYSTRONS FOR NIKE-ZEUS countermissile system have successfully completed tests conducted by the developer, Sylvania, and a first batch has been accepted for delivery by prime contractor Western Electric.

Now meets and exceeds

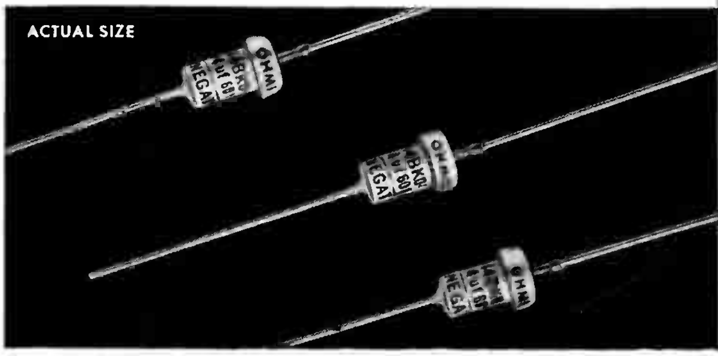
OHMITE®

TAN-O-MITE®

Tantalum Capacitors

Ohmite's supremely equipped laboratory has been approved for official ASESA qualification testing purposes! Here, Ohmite's tantalum electrolytic capacitors are tested on the same type of equipment as used by the military. Furthermore, rigid quality control standards assure 100% testing of every capacitor for its rated parameters—capacitance value, power factor, and leakage current. To meet and surpass the severe military tests, it is apparent that Ohmite capacitors must be more than adequate for any demanding application.

More tantalum capacitor styles are under development at the Ohmite laboratories. Watch for them.

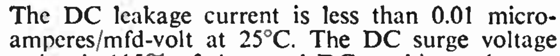


SINTERED SLUG TYPE: MIL-C-3965B, Grade 1, 2, or 3 (Case Size T1, Styles CL44 Uninsulated, CL45 Insulated)

The DC leakage current is less than 0.01 microamperes/mfd-volt at 25°C. The DC surge voltage rating is 115% of the rated DC working voltage.

The anode, a porous slug of sintered tantalum, is sealed into a fine silver case which serves as the cathode and as a container for the wet electrolyte. Axial leads are 1½" long and solderable.

Units are available for operating temperature ranges of –55°C to +85°C and –55°C to +125°C, polar applications only. MIL values available from stock. Other values (which meet MIL requirements) promptly made to order. Write for Bulletin 159



New Slug Type, Straight-Cylindrical Shape

There are no MIL specifications on this type unit at present, but it offers all the characteristics of the slug-type units above with *less* bulk and more convenient mounting. Write for Bulletin 1004

PLAIN FOIL TYPE: MIL-C-3965B (Case Sizes C1, C2, C3; Styles CL34 Uninsulated, CL35 Insulated)

These capacitors now *exceed* the maximum vibration requirements (Grade 3, 5 to 2000 cps) of MIL-C-3965B having been successfully tested at 30 g's, *twice* the required acceleration. They also pass the 50 g shock test of MIL-Std. 202A, Method 205.

DC leakage current is less than 0.035 microamperes/mfd-volt at 25°C; less than 0.20 microamperes/mfd-volt at 85°C (tested in MIL-approved fashion).

The DC surge voltage rating is 116% of the DC rated voltage and the power factor is substantially below the following limits (at 120 cps, 25°C):

Voltage Range	Power Factor
Less than 15-volt rating	15%
15-Volt rating and above	10%

Supplied in polar and nonpolar units although MIL specifications now list only the former. Polar units are protected from current reversals up to 3.75 volts.

Operating temperature range is –55°C to +85°C. In addition to MIL units, many non-MIL values (which meet MIL requirements) are available from .25 to 140 microfarads and up to 150 working volts. MIL values in stock. Other values (which meet MIL requirements) made to order. Write for Bulletin 152

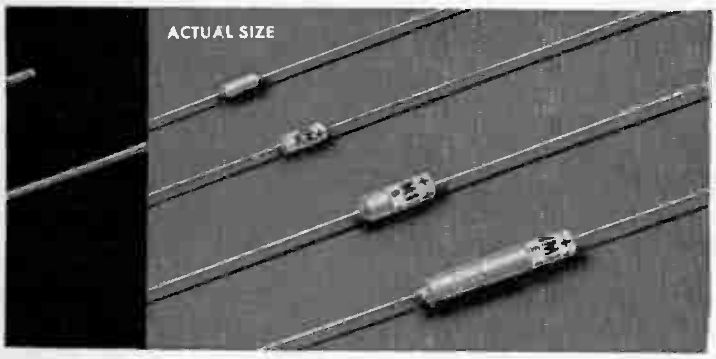
MIL Specifications

Load life and temperature cycling tests are made in this oven under controlled conditions.

Production measurement of capacitance, power factor, and leakage current.

Vibration, acceleration and shock tests for qualification approval purposes are made in this room.

Moisture resistance tests are conducted in this humidity chamber.



Ohmite also has extensive facilities for making such tests as low temperature exposure, high altitude performance, salt spray corrosion . . . almost everything needed to meet and surpass the most extreme operational and environmental conditions.

WIRE TYPE: No MIL Specification Covers This Type of Unit at Present

These subminiature Ohmite units offer amazingly high capacitance for their small size. Price and size advantages have made them widely used in noncritical, nonresonant low voltage, and transistorized circuitry. Compared to aluminum electrolytics, they offer small size, long shelf life, electrical stability, and superior performance under temperature extremes.

A specially processed tantalum wire serves as the anode. A silver case is the cathode and contains the electrolyte. The negative lead is connected directly to the end of the case. The open end of the case is sealed with a "Teflon" bushing, plus plastic embedment through which the welded anode lead wire projects.

Operating temperature range is −55°C to +85°C. Power factor is generally less than 50%. DC leakage current is less than .09 microamperes/mfd/volt for units of 0.5 mfd or more; less than 0.4 microamperes/mfd/volt for units under 0.5 mfd.

Eleven case sizes satisfy virtually any need. Capacitances from .01 to 80 mfds; voltage ratings to 150. Many stock sizes and values are available.

Write for Bulletin 148

Available from Ohmite Distributors or direct from the factory.

OHMITE®

OHMITE MANUFACTURING COMPANY
3610 Howard Street, Skokie, Illinois

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

WASHINGTON OUTLOOK

U. S. EXPORTS OF ELECTRONIC PRODUCTS will benefit from removal of so-called dollar discriminations against foreign imports of U. S. goods announced or planned by several countries. But trade analysts in Washington are cautioning domestic manufacturers not to regard these moves as a panacea for their export troubles.

Great Britain, England, France, Japan and other U. S. trading allies have agreed to call a halt to specific restrictions against imports from the dollar area. Washington has made removal of these barriers a major campaign in its drive to boost U. S. exports. There's concern here over the U. S. imbalance of international payments.

Electron tubes and other component parts are among the items that one or more foreign governments have taken off their lists of dollar-restricted imports. Within a year or two, Washington hopes, all discriminatory controls against U. S. exports will be ended by all nations except those short of dollars—primarily underdeveloped nations.

However, dollar discriminations are not the only trade restrictions used by other nations. They still have tariffs, some quotas (although these are generally being eased), licensing procedures and customs taxes. Washington's hope is that in next year's round of tariff negotiations under the General Agreement on Tariffs and Trade (GATT), foreign buyers of U. S. goods will move toward more liberal acceptance of U. S. exports.

But removal of all dollar discriminations alone would open the way for only some $100 million to $150 million a year in additional U. S. sales, some experts estimate. For any single export category, such as electronic products, the benefit would therefore be small.

Trade experts say the export future for electronic products may be brighter than other categories of goods. This prediction is based on the theory that U. S. sales overseas from now on will be concentrated on advanced items in which the U. S. can best specialize. The solution Washington officials are pushing, however, is a stepped-up overseas sales campaign including better credit and delivery terms, servicing and design.

- **U. S. and Great Britain have reached agreement** on construction of a BMEWS station in Newcastle, England. U. S. will supply tracking radars for the site, the British will pay for construction. Air Force procurement of the electronic gear is getting under way.

  The powerful acquisition radars being set up at the two other BMEWS stations, in Alaska and Greenland, will not be installed at the new British site.

- **Facsimile transmission between post offices** in Washington, Detroit and Battle Creek, Mich., will be tried out soon. FCC has given AT&T special permission to file a request for operation of a closed-circuit system. No date has been set, but the experiment is understood to be imminent. Transmission will be limited to test material and government correspondence during the trial.

  The commission said AT&T proposes to supply the Post Office department with two sets of television channels. One will link Washington and Detroit, the other will link Washington and Battle Creek.

  In each setup, one television channel will be used to transmit letter-text and the second channel will be used at the originating point to observe on a television screen the reception of the text at the other end.

  It was disclosed that Western Union Telegraph Co., which has announced a new facsimile telegram service among five major cities, had protested the government's application.

Easy-to-use, low cost, precision

FREQUENCY, TACHOMETRY INSTRUMENTS

-*hp*- 500B Electronic Frequency Meter

Model 500B is a rugged, precision instrument widely used for direct-reading laboratory or production line measurements of ac frequency from 3 cps to 100 KC. With -*hp*- 508A-D Tachometer Generators or -*hp*- 506A Optical Tachometer Pickup, the 500B also provides direct tachometry readings.

Typical applications include rf signal beat frequency comparisons, crystal frequency deviations, audio frequency and FM measurements, oscillator stability, machinery rotational speed, average frequency of random events, checking vibration or torsion in gear trains, etc.

Model 500B has an expanded scale feature permitting any 10% or 30% of selected range to be viewed full scale. It also offers a pulse output synchronous with an input pulse for measuring FM components of input signals or syncing a stroboscope or oscilloscope. Readings are independent of line voltage, input signal or vacuum tube variations. $285.00.

-*hp*- 500C Electronic Tachometer Indicator

Model 500C is identical to 500B except for meter calibration which is in rpm for greater convenience in tachometry measurements. With appropriate -*hp*- transducers (506A or 508A-D series), -*hp*- 500C will measure rpm from 15 to 6,000,000 rpm in 9 ranges. $285.00.

-*hp*- Rotational Speed Transducers

NO MECHANICAL CONNECTION

-*hp*- *506A Optical Tachometer Pickup* measures speeds 300 to 300,000 rpm of moving parts which have small energy or can not be connected mechanically to measuring devices. Employing a phototube and operated by reflected-light interruptions from light and dark areas on a shaft, -*hp*- 506A may be used with -*hp*- 500B Electronic Frequency Meter, -*hp*- 500C Electronic Tachometer Indicator, -*hp*- 521 and 522 Electronic Counters, and similar instruments. Output voltage is 1 volt rms minimum into 1 megohm; light source is a 21 candlepower, 6 volt automotive bulb; phototube is Type 1P41. $125.00.

MECHANICAL CONNECTION

-*hp*- *508A/B/C/D Tachometer Generators* are for use with electronic counters or frequency meters in rpm measurements from 15 to 40,000 rpm where direct mechanical connection can be made to the rotating part under measurement. -*hp*- 508A produces 60 output pulses per shaft revolution. When connected to an indicating instrument calibrated in rps, it permits direct readings in rpm. Relationship between output voltage and shaft speed is virtually linear to 5,000 pps, simplifying oscilloscope presentation of shaft speed as a function of time for analyzing clutches, brakes and acceleration rates.

-*hp*- *508B, C and D* are identical to -*hp*- 508A except output is 100, 120 and 360 pulses per revolution respectively, and output voltage peaks at successively slower shaft speeds. -*hp*- 508A, B, C or D, $100.00.

HEWLETT-PACKARD COMPANY
4870A PAGE MILL ROAD • PALO ALTO, CALIFORNIA, U.S.A.
CABLE "HEWPACK" • DAVENPORT 5-4451
FIELD REPRESENTATIVES IN ALL PRINCIPAL AREAS

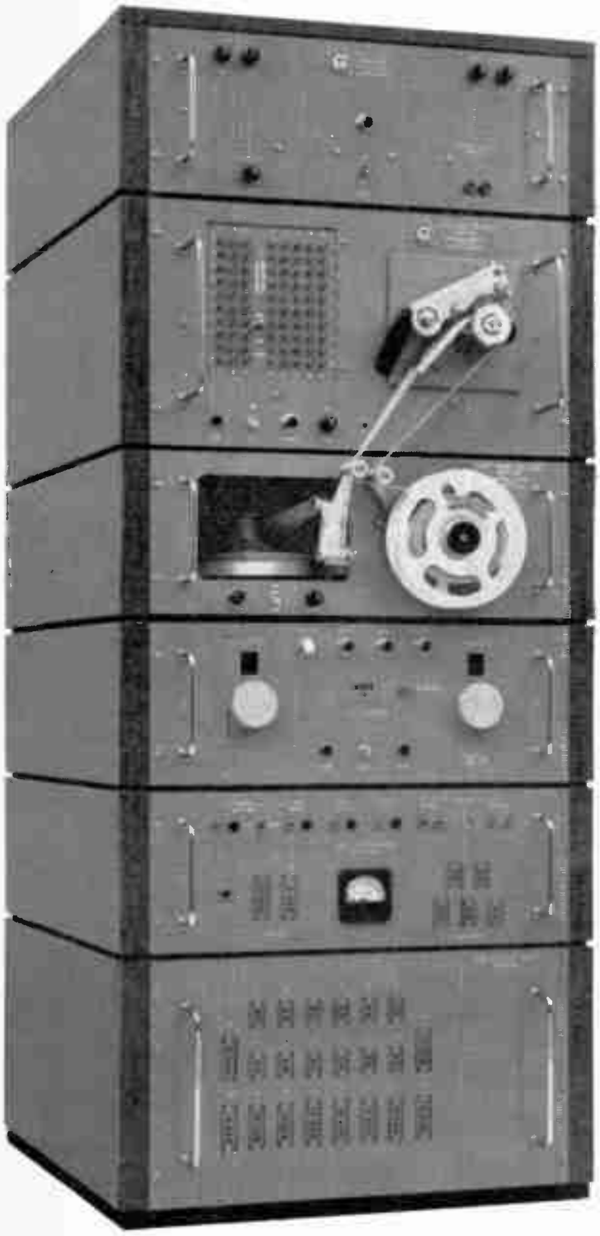
Data subject to change without notice. Prices f.o.b. factory

hp Ask about new -*hp*- 200 KC oscilloscope—$435.00

Electronic test and maintenance costs

REDUCED 90%

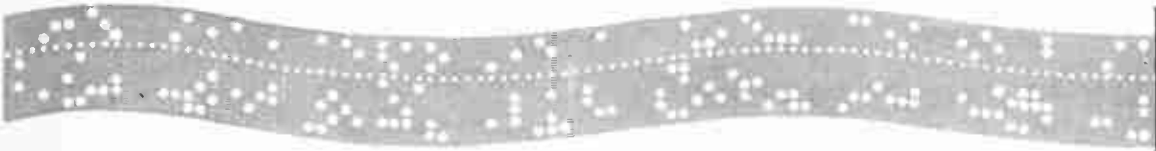
with the Tape-Programmed SUPERTESTER®



Drastically reduced test costs, increased equipment reliability and quality, incipient failures located during routine maintenance, decreased down time for vital equipment, production bottlenecks eliminated, no time wasted overhauling good units and needlessly replacing good components, exceedingly valuable in ground support—these are a few of the many reasons that CTI Supertesters are so widely used for all types of electronic and electrical testing from production to field maintenance. In making complete static and dynamic measurements on constituent circuits or in analyzing performance of entire systems, Supertesters have demonstrated time and again their advantages over other test methods.

Proved in over one year of use, the Model 180 Tape-Programmed Supertester is bringing a new versatility into automatic testing. With the accessory Tape Punch and Tape Duplicator, identical or revised copies of tapes can be made in seconds, an important feature where numerous design changes are of concern. Copies of tapes used by the original equipment manufacturer can be supplied for field use, always assuring that equipment is meeting the latest design specifications. In addition, lengthy test specifications are eliminated and the test instruments for a large variety of units are kept to a minimum—one CTI Supertester.

Write for complete specifications on the Model 180. A brief outline of your test requirements will enable us to advise you in more detail on the application of our testers to your needs. Related CTI products are the Model 165 Cable-Harness Analyzer, Model 176 card-programmed Component Tester, and Model 100 Supertester.



The new Model 180 Tape-Programmed Supertester has the same outstanding features that have made CTI automatic test equipment the leader in the field—high accuracy, go/no-go bridge measurements, widest scope of tests and auxiliary operations, and complete customer confidence in test results through fail-safe circuitry and self-testing ability.

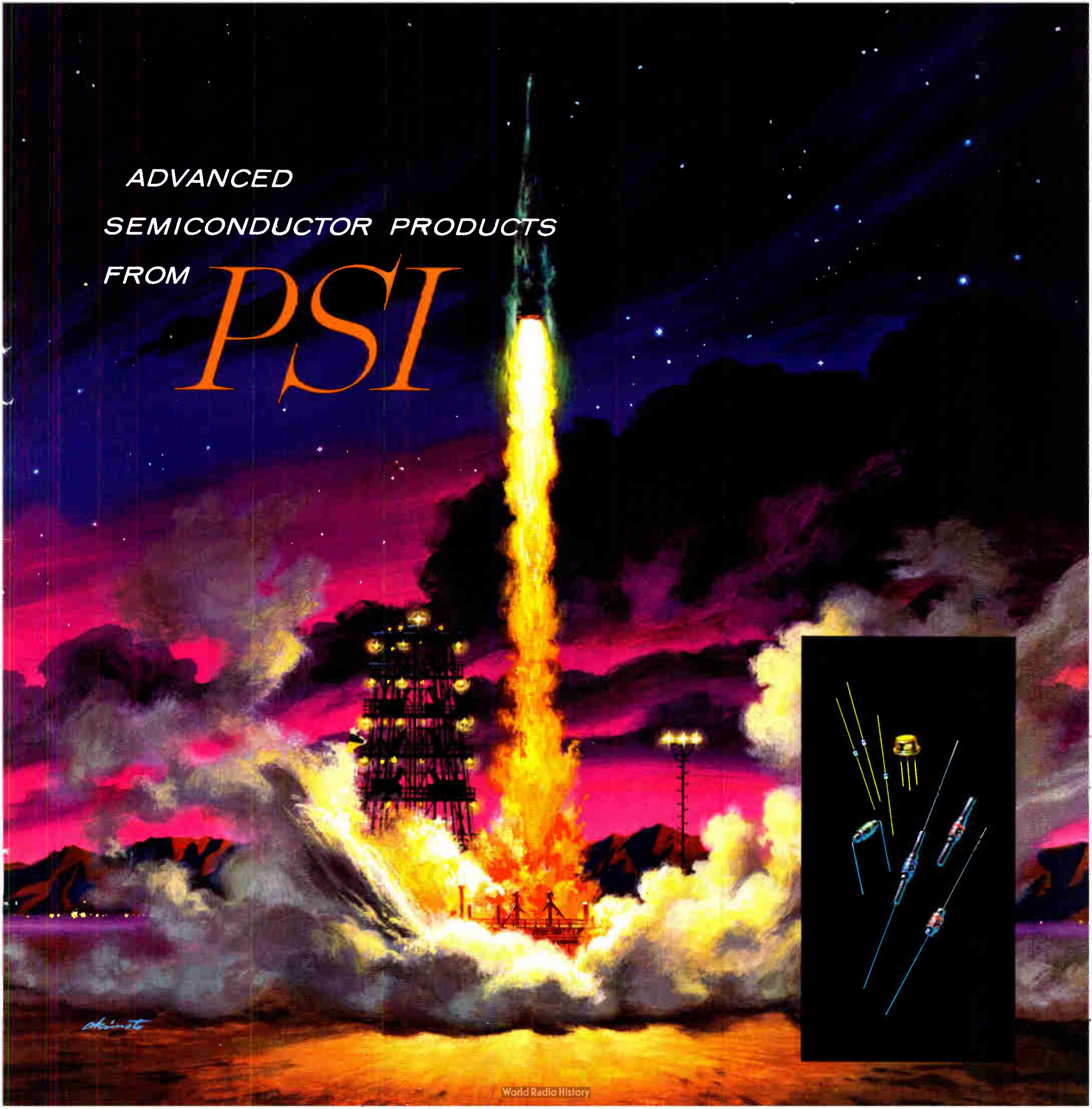
Engineers: Career opportunities are currently available at CTI

CALIFORNIA TECHNICAL INDUSTRIES

DIVISION OF TEXTRON, INC.

BELMONT 8, CALIFORNIA

Foremost in Automatic Testing


ADVANCED
SEMICONDUCTOR PRODUCTS
FROM PSI

Close behind the bulldozers . . . a new home for PSI.

NEW PLANT & LABORATORIES . . . DESIGNED *SPECIFICALLY* FOR SEMICONDUCTOR WORK

Here, at a site near Los Angeles International Airport, is the company's modern research, development and manufacturing plant for semiconductor devices. It is the new home of Pacific Semiconductors, Inc.

The first 90,000 sq. ft. module of this environment-controlled facility is occupied—and bulldozers will soon be reshaping the land to expand the building to 250,000 square feet. These new facilities are in addition to the original PSI plant in Culver City.

Teams of PSI physical scientists and engineers are working on highly advanced devices such as a VHF silicon transistor to deliver 300 mw output at 400 mc . . . a very high power silicon transistor capable of up to 100 amperes collector current . . . a hyper-sensitive voltage-variable capacitor . . . and numerous other development programs destined to bring new and significant advances to the state of the art.

Research at PSI serves as a foundation for all of the company's products. To augment its research and technical staffs, the company is now adding new talents . . . men and women whose professional capability, depth of training and experience will help PSI achieve its goal of leadership in the semiconductor industry.

Introducing . . . typical members of the PSI technical staff

ART FELOON
B.S. College of the City of New York, is PSI Director of Reliability & Quality Control. He and associates are working on reliability levels far beyond today's standards. He is an ardent fan of the sports and theatrical fare so abundant in Southern California.

BILL ECKESS
M.S.E.E. St. Louis University, has been with PSI less than a year and is now Head, Applications Engineering. Busy with a growing staff, he still finds time to explore the coves and lagoons of the nearby Pacific.

TOM HALL
Ph.D. University of California at Los Angeles, is Program Director, Surface Studies. At Bell Labs he did fundamental research on semiconductor surfaces and initiated the PSI surface studies program.

MORGAN McMAHON
M.S.E.E. University of California, is Manager, Product Engineering. He is supervising production engineering on a family of VHF silicon power transistors and has published a number of papers on voltage-variable capacitors (PSI trademarked "VARICAP"). Like many PSI staff members, he is a confirmed sports car devotee.

MASON CLARK
M.S.E.E. Northwestern Technological Institute, is Head of Development. At Bell Labs he was group supervisor on development of high frequency transistors. At PSI his group is developing an extensive family of Very High Frequency silicon power transistors.

ELMO MAIDEN
M.S. Mechanical Engineering, University of Kansas, is Manager, Special Products. Widely experienced in semiconductor package & device development, he is gaining wide recognition for this work on the PSI micro-miniaturized Micro-Diode.

Why

Because we are growing so rapidly

The semiconductor industry has mushroomed — and Pacific Semiconductors, Inc. has grown with it. Company sales in 1959 are approximately ten times 1957 sales. During this same period the number of people on the payroll has increased threefold — a rather remarkable record for a young company that is now emerging as one of the country's major semiconductor producers.

Because people are vital to our growth

In its first three years, PSI was busy laying a foundation in research, development and engineering, and in perfecting its manufacturing techniques and capabilities. Saleswise, the company was on its way by the second quarter of 1957 — but PSI has never abandoned its concept of original development nor engaged in "facsimile" production. Its emphasis on R & D has been unusual for a young company — and unusually successful.

Because PSI is committed to a role of leadership

This is no statement of ivory-tower philosophy. PSI is a highly technical venture that is managed by scientists and engineers — a number of them with graduate business school degrees — who are dedicated to a goal of leadership in the semiconductor industry.

As a subsidiary of Thompson Ramo Wooldridge Inc., PSI moves freely in a dynamic industry. The company's energies and capabilities, backed strongly by the parent organization, are concentrated solely in the field of semiconductor devices.

Some companies have not been so fortunate at the management level. Of the 85 or more companies that entered the semiconductor business after 1948, more than 50 have failed to establish a firm foothold. Today 15 companies are accounting for 95% of the total business. PSI is one of those 15.

DOES PSI NEED SO MANY GOOD PEOPLE?

Because the nature of our business requires diverse talents

In all probability, no other business today requires the many talents our industry does. We need men of unusual competence in the fields of physics, electrical engineering, metallurgy, and literally all branches of the physical sciences.

By recognizing the importance of people to its technical venture, PSI has attracted a team of skilled, thoroughly experienced physical scientists and engineers. And PSI keeps these people. The company has an outstanding record of employee retention. It is still new enough and small enough to offer opportunities for rapid advancement. It is firmly established and soundly backed, promising even more opportunity in the future.

This "working" climate of growth and opportunity for PSI men is matched by an ideal "living" climate for their families. California's leisure-time, cultural, educational and recreational activities are limitless.

Because we believe in the limitless future of the semiconductor industry

In a highly dynamic industry, a company cannot afford to sacrifice advanced development in the name of immediate profits — nor can a company be so concerned with developing for the future as to overlook the fact that survival and success require profitability.

In striking the proper balance, PSI demands continued profits, and at the same time maintains a leading position in research, development and engineering. PSI profits and additional capital funds are being invested for further expansion and for the development of new products to add to the company's already broad product line.

This philosophy of business management assures a continuing need for talented people seeking growth opportunities in the country's most exciting, dynamic and rewarding scientific field.

THESE PSI TECHNICAL STAFF OPENINGS ARE AVAILABLE NOW...

Here are some of the major positions now open on the Technical Staff at Pacific Semiconductors, Inc. Write for information regarding other PSI opportunities.

RESEARCH PHYSICISTS—With a knowledge of solid state physics, to work in surface phenomena research.

RESEARCH PHYSICISTS—With a knowledge of solid state physics and experience in semiconductor materials, specifically in inter-metallic compounds. To do original research in crystal phenomena.

ORGANIC CHEMISTS—interested in physical chemistry and curious about new kinds of layers chemically bonded to silicon surfaces.

INORGANIC CHEMISTS—for work in semiconductor process engineering and development.

SALES ENGINEERS—Important sales positions on both coasts and Mid-Continent.

ELECTRICAL ENGINEERS—Characterization, evaluation, and applications research for transistors and diodes. Test equipment design and development engineers. Very High Frequency and Very High Power Transistor and advance diode development engineers.

MECHANICAL ENGINEERS—for design and development of machinery and equipment used in device manufacture.

METALLURGISTS—Research and Development in semiconductor materials. Device development engineering.

DEVICE PHYSICISTS—for a diversified program of work on highly advanced solid state devices.

CALL US COLLECT!...OR MAIL THIS CARD FOR CONFIDENTIAL INFORMATION TODAY!

PSI will give your query prompt, discreet attention. If you are qualified for a PSI Technical Staff Position, call collect...and talk it over in confidence with Joe Ross, Culver City, UPton 0-4881 (day), or Los Angeles, ORegon 8-0046 (night).

TO KEEP YOUR QUERY CONFIDENTIAL...
FOLD AND STAPLE OR TAPE TOGETHER.

My training is in the field of ________________

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I am interested in ________________

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- ☐ Research
- ☐ Device Development
- ☐ Applications Engineering
- ☐ Process Engineering
- ☐ Please send more information about opportunities in my field.
- ☐ Please send Employment Application form.
- ☐ If you wish, you may call me at my home.

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Born in Research...
Proved in Sales

The people of PSI have established an enviable reputation as originators...searching for the new...trying the untried...improving the improved.

The 1N643 Fast Recovery Silicon Diffusion Computer diode and the High Conductance 1N663 have become industry standards. The new PS760 Computer diode which introduces new standards of performance and reliability, is an outstanding example of product origination typifying the thinking at PSI.

Actually PSI pioneered the Fast Recovery Silicon Diffusion diode field...PSI was the pioneer in high volume test by automatic procedures and has refined the technique to a high order.

Other examples of original thinking are the PSI triple diffused silicon mesa transistors which, in a continuing program, are being developed to ever higher frequency and higher power capabilities. The PSI Micro-Diode (1/20 the size of subminiature diodes) is a major technical accomplishment. The company is recognized as the leader in work on voltage-variable capacitors (Varicap*) which have been advanced to extraordinary levels of high Q and wide tuning range.

Still other originations are in Research and Development, including 10 amp switching transistors to be delivered on Air Force contract later this year. Fifty and 100 amp transistors are to follow. Research and Development work is being accelerated on VHF silicon power transistors, extremely low capacitance diodes and extremely high conductance diodes.

Yes, PSI needs good people in many fields to help carry on this exciting work—people to grow in stature and responsibility in one of the most rewarding professional opportunities in the semiconductor industry.

**"Varicap" is the trade-mark of silicon voltage-variable capacitors manufactured by Pacific Semiconductors, Inc.*

BUSINESS REPLY MAIL

NO POSTAGE STAMP NECESSARY IF MAILED IN UNITED STATES

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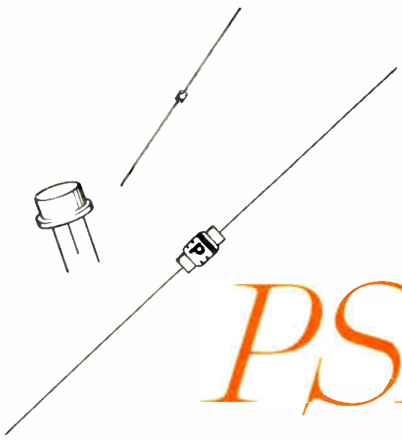

PSI

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10451 West Jefferson Boulevard
Culver City, California

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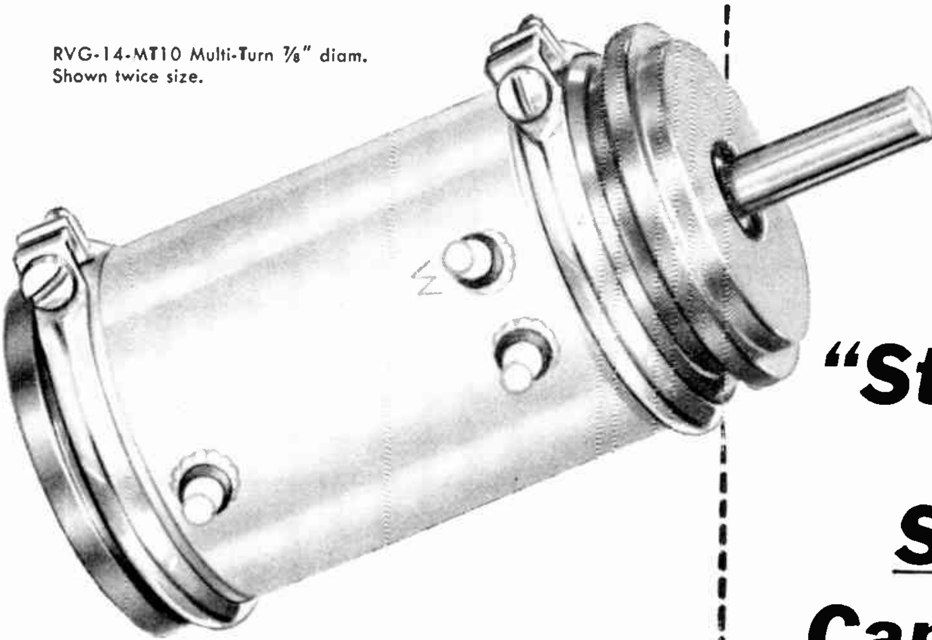
RVG-14-MT10 Multi-Turn ⅞" diam.
Shown twice size.



New "Standard" WITH *Special* Capabilities!

EXTRA RUGGEDNESS

- Anodized Aluminum Housing for Stability
- Individual, High-Strength Terminals Resist Elevated Temperatures
- High-Temperature Epoxy-Glass Insulation Protects Coil
- Sturdy Shock-Proof Shaft Stops Won't Loosen

EXTRA PRECISION

- Linearity (Independent) up to ±0.05%
- Close Concentricity between Coil and Wiper
- Wiper Pigtailed to Terminal to Eliminate Sliding Contact
- Exclusive Spring-Pressure Terminal-and-Tap Design Assures Positive Contact

EXTRA VERSATILITY

- Operation Up to 150°C
- 10, 5, or 3 Turn Units
- Resistance Range from 250 ohms to 300 K ohms
- Tap Locations Limited Only by Physical Spacing
- 5.5 watts @ 85°C (derated to 0 @ 150°C)

EXTRA SMOOTHNESS

- Stainless-Steel Class 7 Ball Bearings
- Wear-Compensating Slider for Zero Backlash
- Wiper Pigtailed to Terminal to Eliminate Sliding Contact
- Meets applicable sections of MIL-E-5272A and NAS-710. Write for detailed RVG-14-MT10 specifications.

A glance at the performance characteristics of this new Gamewell precision potentiometer tells the story! It fully meets applicable MIL specs — and much more. In addition, it gives you important *extras* that permit you to do *more* with a *standard potentiometer*. In many cases you can save the cost of a "special."

Of course, Gamewell supplies special pots — both linear and non-linear whenever necessary. Extensive facilities for their design, development, and production are constantly at your disposal.

Meet the challenge of shrinking component space . . . tougher environmental demands . . . tighter limits of precision . . . *economically* with Gamewell Precision Potentiometers. Bring your pot problems to THE GAMEWELL COMPANY, Dept. 13B, Newton Upper Falls 64, Massachusetts.

Gamewell

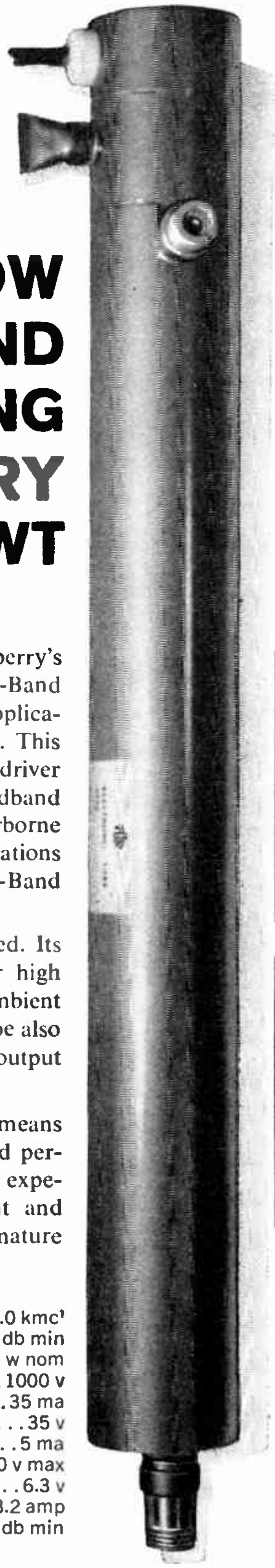
PRECISION POTENTIOMETERS

"Integrals of High Performance"

CIRCLE 25 ON READER SERVICE CARD

Precision is assured at SPERRY

Quality is closely guarded in TWT production. Here optical comparator magnifies helix for inspection.



NOW 60DB GAIN IN L-BAND PPM FOCUSING NEW SPERRY TWT

STL-222

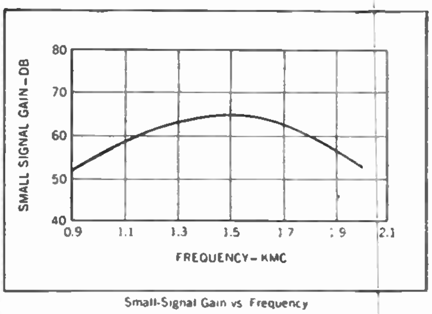
. . . cuts Space, Weight, Cost, Power Requirements — Sperry's new STL-222 provides twice the gain of ordinary L-Band tubes—actually takes the place of two tubes in most applications — yet is only 20″ long, weighs only 8.5 pounds. This important advantage suits this new CW amplifier and driver perfectly to airborne applications. Its excellent broadband stability recommends it for ground support and airborne radar equipment . . . communications . . . drone applications . . . noise generators . . . switching devices and other L-Band uses.

The STL-222 is periodic permanent magnet focused. Its tough metal and ceramic construction provides for high environmental capability, stable operation at high ambient temperatures and under extremes of vibration. This tube also features a high-mu modulating grid and high input-to-output isolation. It is short circuit stable.

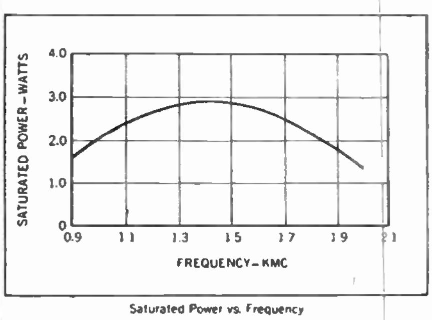
The STL-222 is now in production at Sperry, which means lower unit cost and fast delivery schedules. Advanced performance and dependability result from Sperry's long experience in klystron and TWT research, development and production. Write for complete data, outlining the nature of your application.

Specifications

Frequency Range	1.0 to 2.0 kmc'
Small-signal gain	48 db min
Saturated Power Output	2 w nom
Beam Voltage	1000 v
Beam Current	35 ma
Grid Bias	35 v
Grid Current	5 ma
Grid Cut-off Signal	–20 v max
Heater Voltage	6.3 v
Heater Current	3.2 amp
Input-Output Isolation	75 db min



Small-Signal Gain vs Frequency



Saturated Power vs. Frequency

SPERRY

SPERRY ELECTRONIC TUBE DIVISION, SPERRY RAND CORPORATION, GAINESVILLE, FLORIDA

Address inquiries: Gainesville, or Sperry Offices in Brooklyn • Boston • Philadelphia • Chicago • Los Angeles • Montreal • Export Dept., Great Neck, N.Y.

New Stock Split Planned

STOCK SPLIT has been recommended by the board of directors of **Westinghouse Electric Corp.** Shareholders will vote on the proposal at a special meeting slated for Jan. 4 in Pittsburgh. Prior to this announcement company officials raised the annual dividend from $2.00 to $2.40 on common stock, payable next Tuesday. If the stock split is approved, the quarterly dividend on the new common shares will be 30 cents. As a result of improved cost control programs, the company reports higher profits for the first nine months of this year over 1958 on sales that totaled only slightly more. Net income for the third quarter was $22 million, a 16-percent increase over 1958.

• Last week's flurry in ITT and **Raytheon** stocks (see table below for activity) is attributed by Wall St. sources to rumors that a merger is in the offing. ELECTRONICS checked with Richard Krafve, executive v-p of Raytheon, who termed the speculation as "utter nonsense". A spokesman for ITT said substantially the same thing.

• **Litton Industries**, Beverly Hills, Calif., announces signing of agreements with shareholders of the Swedish firm, **Svenska Dataregister, AB**, Stockholm, whereby Litton acquires majority interest in the Scandinavian firm. Simultaneously, Litton has purchased 100-percent ownership of two firms distributing the Swedish products in USA, Mexico and Switzerland.

• **Texas Instruments**, Dallas, Tex., discloses that third-quarter sales amounted to $46,700,000 this year, compared with $21,867,000 for the same period of 1958. Net earnings after income taxes were more than $3[illegible] million or 89 cents per share of common stock. In the third quarter of 1958, net earnings were $1,448,000, or 44 cents per share or common stock. Total nine months' sales and earnings this year were $140,899,000 and $9,877,000 respectively, compared with $64,056,000 and $3,591,000 for the first nine months of 1958.

• **Loral Electronics Corp.**, New York, whose stock went on the American Exchange 10 days ago, reports record sales and earnings for the first half year. Sales for the six-month period ended Sept. 30 this year more than doubled, while earnings increased almost five times, as compared with the same period last year. Net sales for the first half of 1959 amounted to $6,810,000, compared to $3,220,000 in 1958. Earnings for the first half of this year were $249,468, compared with $52,040 last year.

25 MOST ACTIVE STOCKS

WEEK ENDING NOVEMBER 13

	SHARES (IN 100's)	HIGH	LOW	CLOSE
Elec & Mus Ind	4,069	11¼	9	11¼
Int'l Tel & Tel	2,065	42½	37⅞	42⅜
Raytheon	1,461	54	48⅜	51⅛
Lear	1,248	21¾	20⅛	20¼
Varian Assoc	1,050	47½	39½	46
Avco Corp	965	14¼	13⅛	13¾
Sperry Rand	789	23¾	22¾	23
General Inst	785	30⅜	25	29⅛
RCA	765	67⅜	64⅛	66
Dynamics Corp Amer	733	11¼	9⅞	11⅛
Zenith Radio	725	120⅜	114	116½
Univ Control	712	18¼	16⅜	18
Burroughs Corp	696	33⅞	31¾	33
Philco Corp	687	27¼	24⅜	27
Gen Dynamics	637	46¼	44½	45⅝
Gen Electric	609	84¼	81⅝	82¼
Motorola	541	148	126¼	142¼
Ampex	538	117¾	103	116½
Muntz TV	467	3¾	3⅛	3⅛
Clarostat Mfg	447	11⅝	9⅝	11½
Gen Precis	440	53⅝	48½	51¼
Amer Bosch Arma	421	28⅞	25½	27½
Gen Tel & Elec	409	77¼	74½	75⅛
Barnes Eng	403	29½	23¼	29¼
Cons Elec Ind	355	46⅝	41⅛	46⅛

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

DIVIDEND ANNOUNCEMENTS

	Amount per Share	Date Payable
Dynamics Corp Amer	$.50	Dec. 15
Erie Resistor	.22½	Dec. 15
General Precision	.25	Dec. 15
Lockheed Aircraft	.30	Dec. 11
Minneapolis Honeywell	.50	Dec. 10

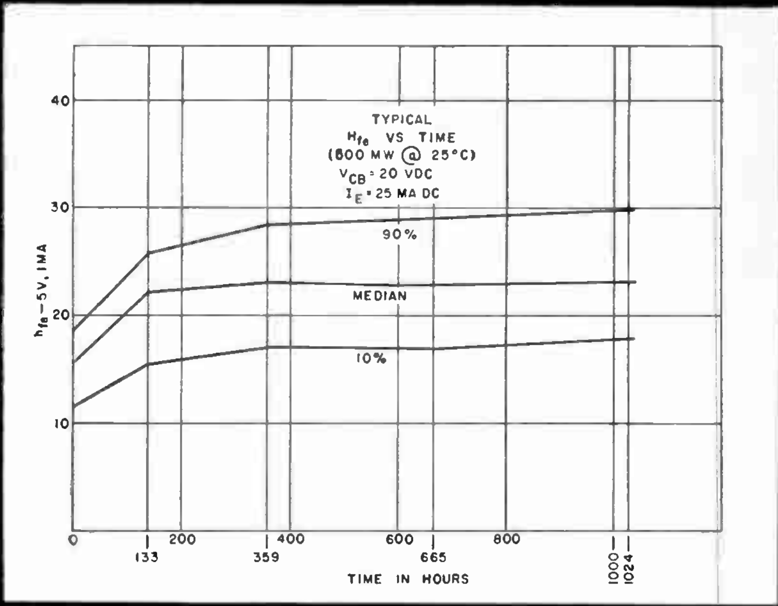
NEW ISSUES PLANNED

	No. of Shares	Issue Date
Bowmar Instrument Corp	45,000	*
Gulton Industries	60,000	*
Nucleonics Chem & Elec	90,000	*
Transitron Electronics	1,000,000	Dec. 8

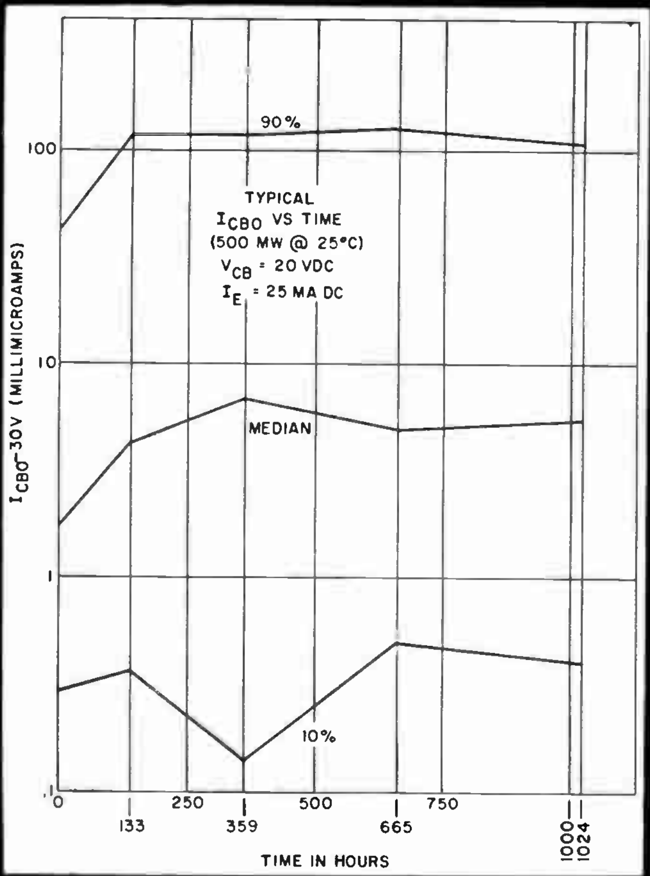
*To be announced

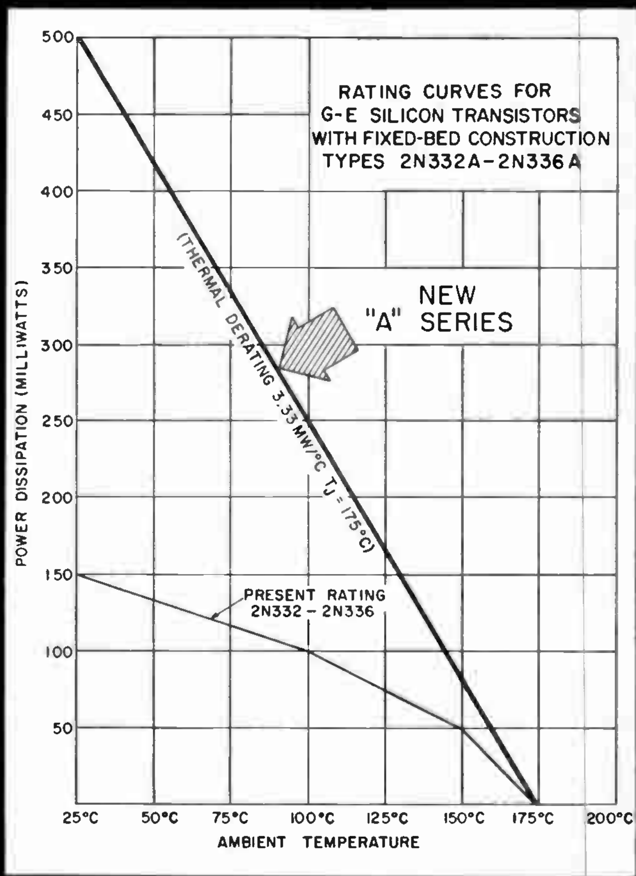
New silicon triodes dissipate

Greatly magnified photo of silicon transistor showing Fixed Bed Construction. All parts are firmly fastened, with no suspended parts except wire lead. Transistor reacts as a solid block in resisting shock and vibration. Power dissipation is inherently higher.



Power dissipation of the 2N332A-through-2N336A silicon transistors (see chart below) ranges from 500 mw at 25°C to 83 mw at 150°C without heat sink. Note also (see chart below, left) the extremely low I_{CBO} throughout 1000 hours of testing. Nearly 90% of units fall within 100 mμa. Beta spread (chart above) is stable out to 1000 hours.





500 mw without heat sink at 25°C

FIXED BED MOUNTED TRANSISTORS 2N332A-through-2N336A ALSO FEATURE:
4 VOLT V_{EB} . . . GUARANTEED 45 VOLT V_{CE} . . . .005 μa MAX. I_{CBO}
AT 25°C AND 30 VOLTS . . . PHYSICAL AND ELECTRICAL STABILITY

The 2N332A-through-2N336A line of silicon NPN triodes is a new series of amplifier and switching transistors capable of much higher performance than ever before achieved.

Collector dissipation without heat sink is 500 mw at 25°C . . . 83 mw at 150°C. Since reliability is related to junction temperature, even those designs which do not require maximum-rated power may be enhanced greatly by this device series because of the wide safety-factor potential provided.

FOUR OTHER ADVANTAGES—Collector-to-emitter voltage is guaranteed at 45 volts. Collector leakage current is a maximum of 500 mμa at 30 volts and 25°C. Collector-to-emitter leakage current is 60 μa at 150°C. Minimum cutoff frequency is 2.5 mc, typical f_{ab} is 10 to 15 mc.

FIXED BED MOUNTING—Fixed Bed Mounting is an exclusive G-E construction technique which contributes to the extreme stability obtained by this series of transistors. Storage and operating tests have resulted in a performance rate of better than 99.2% after 1000 hours.

Besides the demonstrated electrical characteristics, General Electric's silicon transistors can absorb physical punishment far beyond normal specifications. All parts are solidly fixed together and react as a solid block in resisting shock and vibration. Test units have been fired from a shotgun, struck with a golf club and rattled freely in an auto hubcap for 700 miles—and worked afterward.

IMMEDIATELY AVAILABLE—All types are available now from warehouse stock. Call your General Electric Semiconductor Sales Representative for complete details on the "hot" transistor line that operates the coolest. General Electric Company, Semiconductor Products Dept., Electronics Park, Syracuse, N. Y.

TYPE 2N333-THROUGH-2N335 SILICON TRANSISTORS MEET MIL-T-19500/37A SPEC.

Designing to the new MIL-T-19500/37A Spec? General Electric types 2N333, 2N334 and 2N335 can be supplied from warehouse stock to meet this specification.

SPECIFICATIONS

Absolute Maximum Ratings (25°C)

Voltages		
Collector to Base	V_{CB}	45 volts
Collector to Emitter	V_{CE}	45 volts
Emitter to Base	V_{EB}	4 volts
Current		
Collector	I_C	25 ma
Power		
Collector Dissipation RMS	P_C	500 mw @ 25°C (Free Air)
	P_C	83 mw @ 150°C (Free Air)
Temperature		
Storage	T_{STG}	−65 to 200°C
Operating Junction	T_J	−65 to 175°C

Electrical Characteristics (Typical at 25°C)

		2N332A	2N333A	2N334A	2N335A	2N336A	
D C Characteristics							
Forward Current Transfer Ratio (low current) (I_C=1 ma, V_{CE}=5 V)	h_{FE}	16	27	36	45	75	
Saturation Voltage (I_B=1 ma, I_C=5 ma)	V_{CE} (Sat)	.5	.45	.42	.4	.4	volts
Cutoff Characteristics							
Collector Current (V_{CB}=30 V; I_E=O; T_A =25°C)	I_{CBO}	1	1	1	1	1	mμa
Collector Emitter Current (V_{CE}=30 V; I_B=O; T_A =150°C)	I_{CEO}	60	60	60	60	60	μa
Low Frequency Characteristics (V_{CB}=5 V; I_E= −1 ma; f=1000 cps)							
Forward Current Transfer Ratio	h_{fe}	16	30	38	52	95	
Input Impedance	h_{ie}	750	1300	1700	2000	3700	ohms
Output Admittance	h_{oe}	3.5	5.0	6.0	7.0	8.0	μmhos
Output Admittance	h_{ob}	.25	.2	.18	.15	.13	μmhos
High Frequency Characteristics (Common Base) (V_{CB}=5 V; I_E= −1 ma)							
Output Capacity (f=1 mc)	C_{ob}	7	7	7	7	7	μμf
Cutoff Frequency	f_{ab}	10	11	12	13	15	mc
Power Gain (common emitter) (V_{CE}=20 V; I_E= −2 ma; f=5 mc)	G_e	11	11	12	12	12	db

GENERAL ELECTRIC

MARKET RESEARCH

Defense Market Holding Firm

MANY electronics industry members have been uncertain about trends of military spending ever since the Eisenhower-Khrushchev meetings and discussions.

Until recently many military and electronics leaders have been somewhat hazy in their comments on future defense spending—primarily because of these peace talks.

Confidence Mounts

However, the defense market picture is clearing. In fact, it's felt in some quarters that we can expect substantial, even rising, levels of defense spending. This viewpoint was shared by a wide variety of government and industry experts on defense spending who recently addressed a special American Management Association briefing on Marketing in the New Defense Market.

Forty-one billion dollars has been established as the preliminary planning objective for the 1961 defense budget, said John M. Sprague, deputy assistant secretary of defense (comptroller).

The fiscal year 1961 defense budget is still under development and a number of important decisions are still to be made. But, this is the figure DOD is planning for.

Comptroller Sprague indicated he was purposely vague about the specific content of the 1961 defense budget because of the items still under consideration.

However, he estimated $3 billion will be put into the ballistic missile program—Atlas, Titan, Minuteman, Polaris, Thor and Jupiter—in fiscal 1960. A total of $7 billion had already been committed to the program through June 30, 1959.

John M. Richardson, director of marketing for Hughes Aircraft, told the AMA group that the military market currently amounts to about $45 billion. Recent estimates of future military budgets fix the market at some $60 billion by 1968, he said.

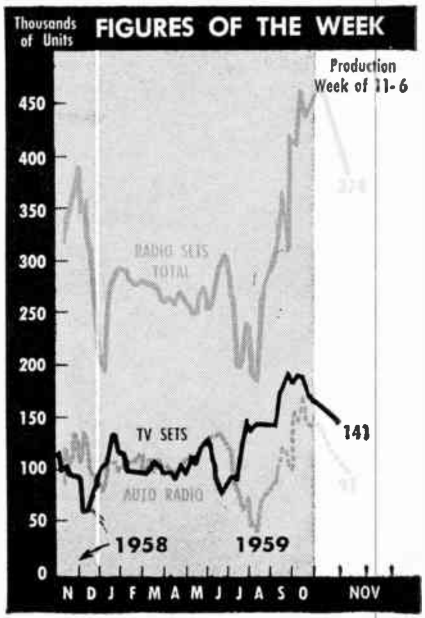
However, the growth rate of the military market is slowing down, he pointed out. Over the next decade it should grow at the compound rate of three percent per year. This rate contrasts with an 11-percent annual military market growth rate since the end of World War II. It also contrasts with growth of the gross national product, which is better than 3 percent per year (GNP is total value of goods and services produced).

Sees Two-Fold Rise

"The United States defense budget will exceed $40 billion annually for the foreseeable future," Jack Anderson, marketing vice president of Hoffman Labs, told the meeting. Military electronics business should at least double in the next decade, he added.

A recent change in military procurement aims is worth noting, he said. Current purchases tend to be for smaller volumes and more complex equipment. Since the missile now occupies the dominant procurement position formerly held by the airplane, the need is for fewer units.

- Tv set production in September of 808,377 units was well ahead of the 621,734 sets produced in September, 1958, Electronic Industries Association reports. Cumulative production for the first nine months of this year, totaled 4,488,857 sets, against 3,572,189 sets made during the like nine months last year.



WHICH BENDIX TRANSISTOR IS BEST FOR THE JOB?

TYPICAL OPERATION AND MAXIMUM RATINGS OF BENDIX GERMANIUM PNP TRANSISTORS

Type Number	PRIMARY APPLICATIONS				MAXIMUM RATINGS				TYPICAL OPERATION			
	Audio	Push-Pull	Switch	Power Supply	Collector Voltage Vce (a)	Collector Current Ic	Thermal Resistance (b)	Junction Temp. Tj	Current Gain hFE —	Current Gain Ic Adc	Circuit Gain db	Power Output W
High Power Transistors (g)												
2N155	X				30 Vcb	3 Adc	3° C/W	85°C	40 (c)	0.5	33	2
2N176	X				40 Vcb	3	—	90	45 (c)	0.5	35	2
2N234A	X				30	3	2	90	25 (c)	0.5	30	2
2N235A, B	X				40	3	2	90	40, 60 (c)	0.5	33, 36	2
2N236A, B	X			X	40	3	2	95	40, 60 (c)	0.75	33, 36	4
2N242	X				45 Vcb	2	3	100	—	—	35	1
2N255	X	X			15 Vcb	3	3	85	40	0.5	22	1
2N256	X	X			30 Vcb	3	3	85	40	0.5	25	2
2N257	X•				40	—	—	85	55 (c)	0.5	35	1
2N268, A	X		X		80 Vcb	—	—	85, 90	—, 40	—, 2.0	31, —	1, —
2N285A	X			X	40	3	2	95	150 (c)	0.5	40	2
2N297			X		60 Vcb	5	2	95	70	0.5	—	50 (d)
2N301, A	X				40, 60 Vcb	3	—	—	63 (c)	0.7	33	3
2N307, A	X				35 Vcb	1, 2	5, 3	75	80	0.2	—, 27	—, 1
2N399	X	X			40	3	2	90	40 (c)	0.75	33	8 (e)
2N400	X			X	40	3	2	95	50 (c)	1.0	36	6
2N401	X	X			40	3	2	90	40 (c)	0.5	30	5 (e)
2N418			X	X	80	5	2	100	50	4.0	—	100 (d)
2N419				X	45	3	2	95	60 (c)	0.5	—	5
2N420, A			X	X	40, 70	5	2	100	50	4.0	—	—
2N637, A, B	X		X	X	40, 70, 80	5	2	100	45	3.0	—	35, 70 (d)
2N638, A, B	X		X	X	40, 70, 80	5	2	100	30	3.0	—	35, 70 (d)
2N639, A, B	X		X	X	40, 70, 80	5	2	100	23	3.0	—	35, 70 (d)
2N677, A, B, C and 2N1029, A, B, C replaced by 2N1031, A, B, C												
2N678, A, B, C and 2N1030, A, B, C replaced by 2N1032, A, B, C												
2N1031, A, B, C	X		X	X	30, 40, 70, 80	15	1.5	100	40	10.0	—	75, 125, 250 (d)
2N1032, A, B, C	X		X	X	30, 40, 70, 80	15	1.5	100	75	10.0	—	75, 125, 250 (d)
2N1073, A, B (i)	X		X		40, 80, 120	10	2.0	100	40	5.0	—	100, 150, 200 (d)
2N1136, A, B	X		X	X	40, 70, 80	5	2.0	100	75	3.0	—	35, 70 (d)
2N1137, A, B	X		X	X	40, 70, 80	5	2.0	100	115	3.0	—	35, 70 (d)
2N1138, A, B	X		X	X	40, 70, 80	5	2.0	100	150	3.0	—	35, 70 (d)
B-177	X			X	30	3	2.2	90	150 (c)	0.5	39	2
B-178	X				30	3	2.2	90	40 (c)	0.5	33	2
B-179	X				40	3	2.2	90	25 (c)	0.5	28	2
Medium Power Transistors (h)												
2N1008, A, B	X	X	X		20, 40, 60	300mA	0.15°C/mW	85	95 (c)	10mA	—	400mW (f)
2N1176, A, B	X		X		20, 40, 60	300mA	0.20°C/mW	85	50 (c)	10mA	—	300mW (f)
Military Types												
2N297A (g)	X		X	X	50	5	2.0	95	70	0.5	—	35 (f)
2N331 (h)	X		X		30 Vcb	200mA	0.15°C/mW	85	50 (c)	1.0mA	—	400mW (f)
2N1011 (g)	X		X	X	70	5	2.0	95	55	3.0	—	70 (d)
2N1120 (g)	X		X	X	70	15	1.5	95	35	10.0	—	250 (d)

(a) Vce except where noted. Equivalent Vcb's are 20-50% higher. (b) Collector dissipation is the difference between the maximum junction temperature and the mounting base temperature divided by the thermal resistance. (c) hfe, AC current gain. (d) Square wave output power. (e) Push-pull output. (f) Pc—Maximum collector dissipation 25°C. (g) TO-3 package. (h) TO-9 package. (i) Diffused-Alloy-Power DAP transistor.

CHARACTERISTICS OF BENDIX SILICON RECTIFIERS

Type Number	Io Adc	PIV Vdc	Lib	Type Number	Io Adc	PIV Vdc	Lib	Type Number	Io Adc	PIV Vdc	Lib
1N536	0.75	50	10 uAdc (At 25°C)	1N1434	30	50	5 mAdc (At 150°C)	1N1612	5	50	1 mAdc (At 150°C)
1N537	0.75	100	10 uAdc	1N1435	30	100	5 mAdc	1N1613	5	100	1 mAdc
1N538	0.75	200	10 uAdc	1N1436	30	200	5 mAdc	1N1614	5	200	1 mAdc
1N539	0.75	300	10 uAdc	1N1437	30	400	5 mAdc	1N1615	5	400	1 mAdc
1N540	0.75	400	10 uAdc	1N1438	30	600	5 mAdc	1N1616	5	600	1 mAdc
1N547	0.75	600	10 uAdc								

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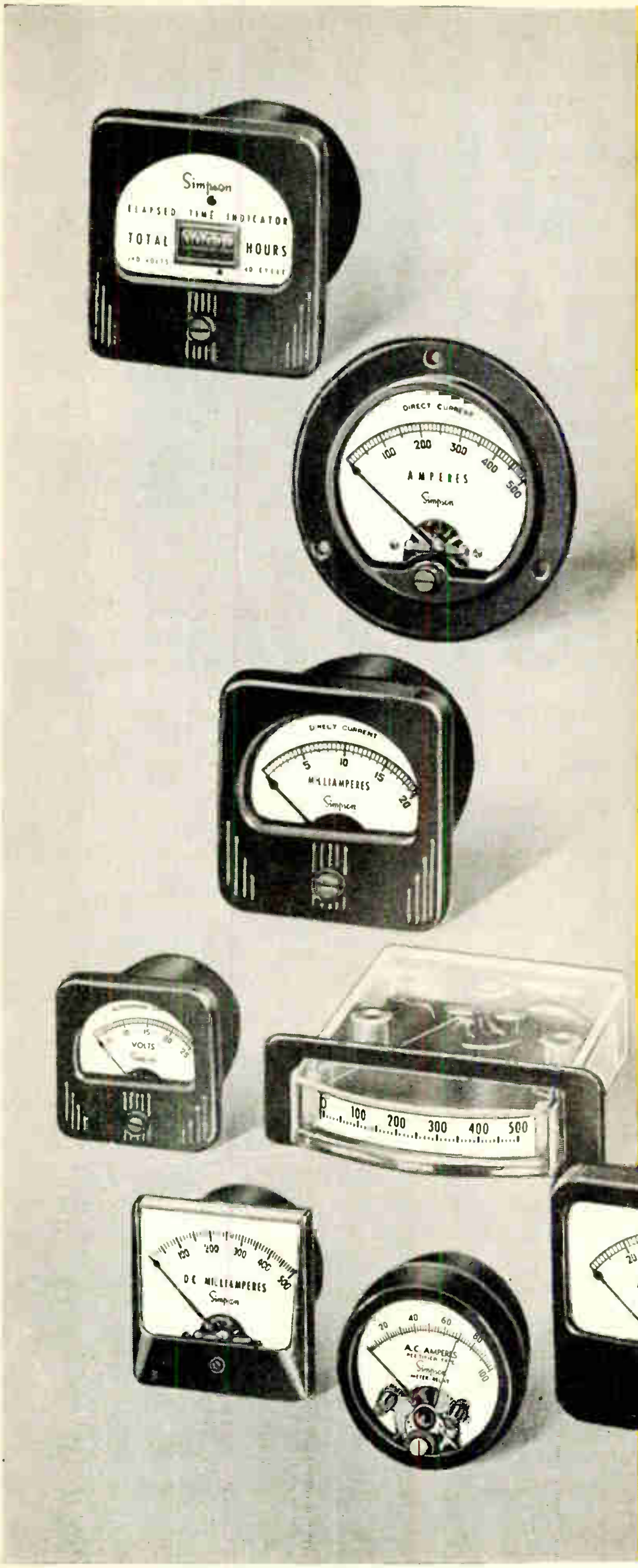
Instruments that Stay Accurate



After More Than 600 Separate Inspections – One Panel Instrument

Sounds like a lot of inspecting, but it's one of the things that makes possible Simpson's fine panel instruments.

Take pivots, for example, which support the rotating armature of a meter movement. Because Simpson quality standards are so high, Simpson makes its own pivots which require more than 60 separate inspections during manufacture. Among these are 100% inspection under a 100X microscope and sampling inspection under a 400X microscope to check radius, cone angle, finish and other characteristics. One result is pivot points with a radius tolerance maintained to within .000010". Moreover, Simpson inspects each and every group of pivots for correct hardness so they won't deform under rough use.

Through such meticulous care as this, Simpson is able to offer you panel instruments with accuracy limits that are 100% guaranteed . . . instruments with conservative ratings on which you can rely . . . instruments that *stay* accurate . . . instruments you can specify with confidence.

Write for Catalog 2059A.

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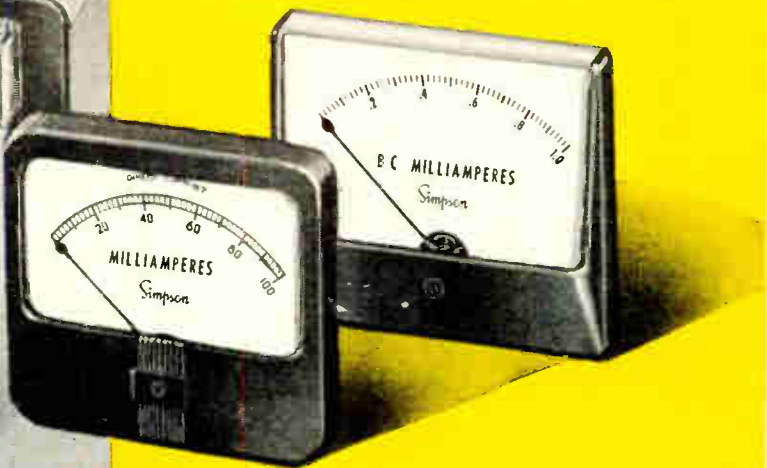
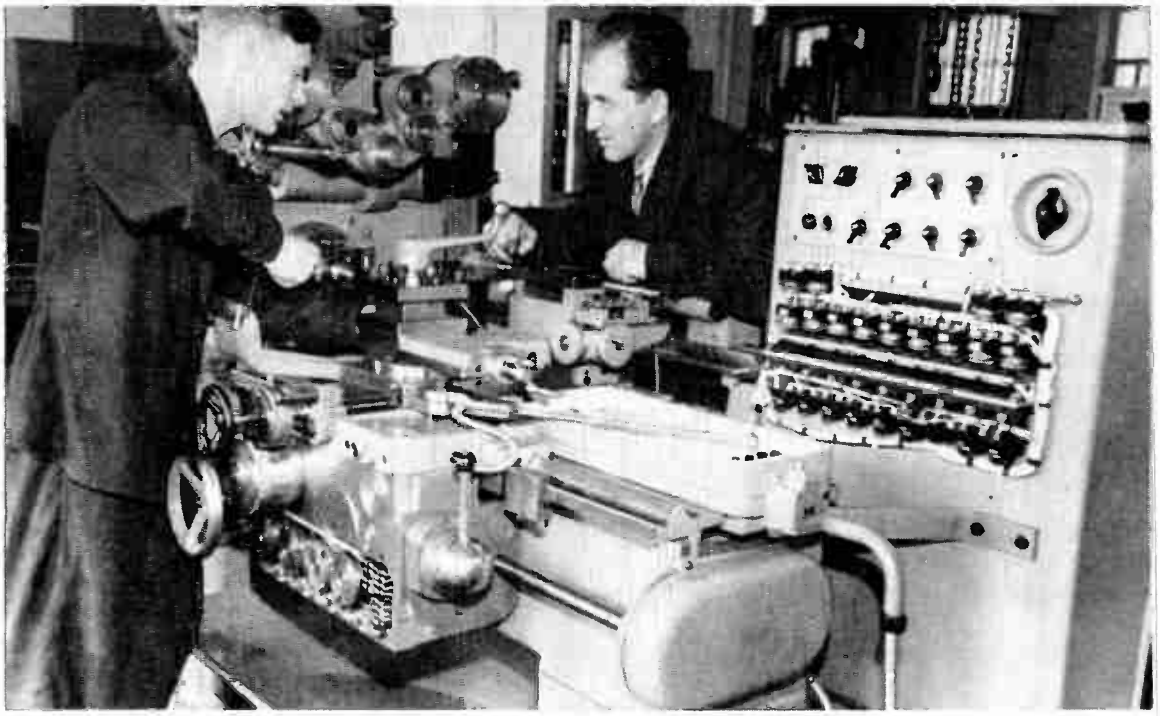




Model IK-62M automatic program-controlled lathe manufactured in Soviet Union is adjusted. Machine was designed by the Moscow Krasny Proletary Machine Tool Plant. Research engineer S. Shakhnovsky (right) gives instructions to fitter Y. Korolyov

Electronics in Soviet Planning

By next Tuesday, says the Communist Party of the USSR, experts must submit proposals on automating industries to meet seven-year plan goals

By **HOWARD K. JANIS,** Associate Editor

DECENTRALIZED administration of the 1959-1965 Soviet economic plan is spreading electronics like a gigantic octopus across the Soviet Union, from Tallinn, Estonia, to Irkutsk in Siberia.

Involved in the plan are research, development, production and applications engineering. The apparent objectives are:

(1) An across-the-boards boost for the USSR economy through electronics applications in other decentralized industries.

(2) Increased entertainment electronics production in line with new emphasis on consumer goods.

(3) New achievements and prestige for Soviet scientists which might be turned into new propaganda gains in convincing the world that Soviet communism is superior to American capitalism.

Automation Crusade

Electronics is slated to provide a major contribution to the fulfillment of Premier Khrushchev's seven-year plan, the object of which is to increase per capita labor productivity while easing working conditions and reducing the work week at the same time. Automation has become a Communist Party crusade, and the significance of applying electronics in achieving automated factories has not escaped party decree.

Last June the 21st party congress called for the submission to the Council of Ministers, before next Tuesday (Dec. 1), of proposals on the order and time limits for working towards automation in various industries. These proposals are to come from the Gosplan or state economic planning committee, the state committee on automation and machine building of the Council of Ministers, the councils of ministers of the various Soviet republics and from regional groups called sovnarkhozes.

Specifically, the party congress noted "the great opportunities of electronics in automation of production processes." It decreed that the state committee on radio-electronics of the Council of Ministers participate with the Gosplan, the committee on automation and machine building and the union republics in agreeing to a plan for the introduction of electronics into all branches of industry.

The master plan for Soviet automation goes far beyond the technical problems of introducing electronically controlled machine tools and industrial process controls. It calls for appropriate agencies to give advance information this year on the specific character of economic effects in individual industries.

Orders Special Training

To prepare for large-scale automation the party also decreed that special training on integration of techniques of mechanization into production be instituted for workers, engineers and other technical personnel. Again, the party is specific in stating what it wants:

"The state scientific technical committee of the USSR Council of Ministers, the Ministry of Higher and Secondary Specialized Education of the Soviet Union, and the state committee of the USSR Council of Ministers on labor and wages, must work out programs, textbooks and the publication of visual aids on integrated mechanization and automation of production."

As for the research necessary to make new devices and techniques constantly available for production use, the party congress called on all Soviet scientists—from those with the USSR Academy of Sciences to those in lesser known institutes—to keep "new theoretical research, conclusions, recommendations and discoveries" flowing to all industries.

By January 1, the Council of Ministers is scheduled to receive research proposals from the Gosplan, councils of ministers of the republics, and numerous state committees and ministries. The proposals will deal with the establishment of research institutes on the sites of major enterprises, the amalgamation of some institutes with universities and the consolidation of certain scientific organizations working in the same field.

1,300 Automatic Lines

Vladimir Lukin, vice chairman of the State Committee on Automation and Machine Building, declared recently that the Soviets already have much experience in designing automatic lines. He said the task set by the party congress of putting 1,300 automatic lines into operation during the seven-year plan would "undoubtedly be considerably overfulfilled."

Lukin spoke of the development of instruments that numerically record production processes and direct them automatically. He said high-speed electronic recording and control devices would find extensive industrial use soon, added that a highly automated "electrotechnical works" will shortly be built near Moscow.

Progress in carrying out the economic program set by last June's party congress was reported last month by economic ministers and other delegates to the USSR Supreme Soviet, which met in Moscow to approve the plan and budget of the second year of the seven-year plan. Lithuanian and Estonian speakers singled out advances in instrument-making, radio engineering and machine building.

A delegate from Soviet Georgia spoke of shifts in the republic's economy, reported electrical engineering and instrument-making industries had been set up within the last two years.

The Armenian council of ministers chairman told the Supreme Soviet that, while industrial production in his republic would increase by about 10 percent in 1960, the output of the radio-engineering industry would go up 4.4 times.

A representative from the central Asian republic of Tadzhik said next year would see the inauguration of an electrotechnical industry.

'City of Science'

The importance placed by Khrushchev on accelerated scientific and engineering effort in Siberia was shown by a visit last month, on his way home after his U. S. trip, to the "city of science" on the outskirts of Novosibirsk. This is the headquarters of the Siberian department of the Academy of Science, whose leadership comes largely from scientists who were moved there from Moscow and other western cities.

Among the types of institutes reported to exist in Siberia are those of radiophysics and electronics, both recently moved to new premises, and hydrodynamics. Institutes of chemistry, nuclear physics, and mathematics are reportedly being set up, along with an electronic computer center.

In addition, there is the institute of automation and electrometrics of the Siberian branch of the Academy of Sciences, which recently celebrated its first anniversary. Apparently it was set up in conjunction with the seven-year plan.

During its year of existence this institute has reportedly developed automatic control equipment for electrolytic capacitors, now being tested out at the Novosibirsk radio component works. It is said to be completing work on similar equipment for mica and paper capacitors.

This work of the institute is carried out under the auspices of the state committee for radio-electronics. Development of the control devices is expected to lead to development of automatic lines and shops for making capacitors. Another goal: development of measuring equipment using computers that will provide readout in the form of discrete figures easily seen on a simple meter.

Control Evolution

The institute has also done work on new instruments for geophysical exploration. However, its primary goal is development of measuring techniques that can evolve first into automatic controls and then into automatic production line control. In this connection, the institute says semiconductor equipment will be needed.

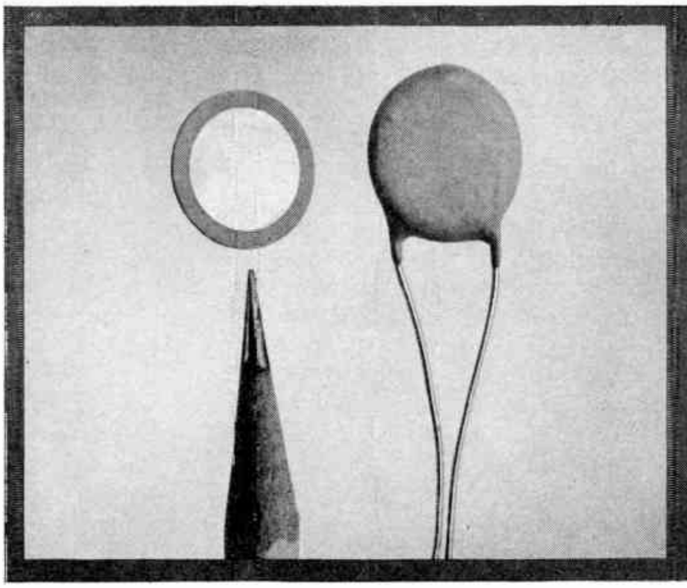
On the consumer side of the Soviet electronics picture, there is word that production of radios and television sets in the first nine months of the seven-year plan is running ahead of last year's output. The three million radio sets produced is 3 percent above the previous nine-month period; the 924,000 tv sets runs 30 percent above the period last year and is said so far to overfulfill the plan for this year. Data comes from a Central Statistical Administration statement.

KHRUSHCHEV VISITS SCIENTISTS IN SIBERIA

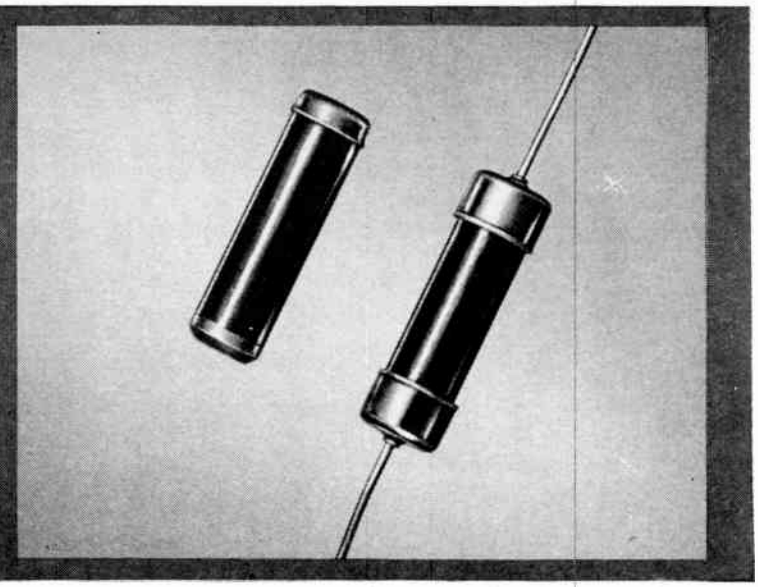
GROWTH of the Siberian department of the USSR Academy of Sciences indicates the support already developing for rapid strides in production slated for that vast area in the seven-year plan.

During his recent visit to Novosibirsk, where a scientific community has been under construction for some time, Premier Khrushchev was introduced to top scientists by M. A. Lavrentyev, president of the Siberian department and vice president of the Academy of Science of the USSR.

The Pravda article which reported Khrushchev's visit said he was introduced to "outstanding Soviet scientists" who head various institutes within the Siberian department



• A Du Pont silver coating has been fired onto the barium titanate ceramic capacitor disc shown above. This disc is then solder-dipped to attach wire leads.



• This deposited carbon resistor has been silvered at its ends to attach wire leads. Special Du Pont silver thermosetting compositions are used in this application.

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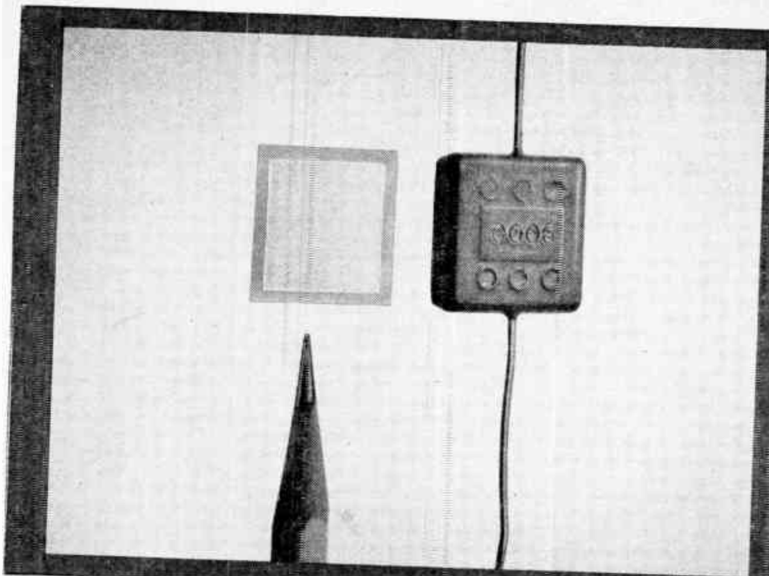
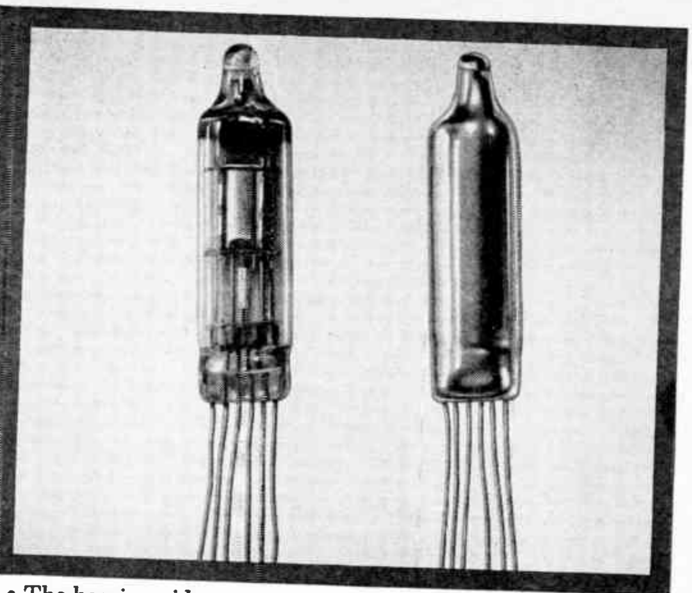


• This mica film has been coated with special Du Pont silver preparations and is used in the manufacture of silver-mica capacitors (shown above).



• The hearing aid vacuum tube (above right) has been coated with a Du Pont air-dry silver preparation to form a static shield. For information on Du Pont coatings, write address below.

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Machine Language Study

Efforts to find a common computer language are past the talking stage. Serious work is being done on several levels. Here's a roundup

COMMON LANGUAGE PROCESSING for computers promises to be a major evolution in the computer industry. Next month marks the target date set by the Committee on Data Systems Languages for the first stage of development.

This group, made up of 26 large users and 10 major computer manufacturers, aims to design a common business language which is problem-oriented and interchangeable among different computers.

At a computer applications symposium held last month in Chicago under sponsorship of the Armour Research Foundation, some requirements for this common computer language were defined by E. J. Albertson of U. S. Steel's Methods Planning Division:

- Independence — the language must express the processing procedure in terms of the problem, not in terms of the computer.
- Simplicity—the language must be composed of simple English.
- Translatibility—there must be an automatic (machine) method to translate the common language into the language of all present and future computers.
- Efficiency—the language must be efficient in its use of both human and machine time.

In addition, says Albertson, the language must have an inherent capability for revision and a method for testing the logic and arithmetic of processing procedures stated.

Charles Katz, manager of General Electric's computer department in Phoenix, Ariz., warns that the prospective computer customer is growing increasingly selective. Future machine requirements, he predicts, will call for a full library of subroutines, diagnostic routines, sort and merge generators and algebraic as well as English compilers.

One prime aspect cited by the GE executive as contributing to problems of machine translation is the growing number of computer users who are not professionals.

"This has been one of the major factors in creating the need for automatic coding systems," he told the symposium. "Use of synthetic languages has, in turn, pulled users farther away from details of machine functioning, thereby creating the need for more sophisticated automatic systems. These systems will have to make decisions for the user, conduct automatic programming rather than just automatic coding, and serve to carry use of the source language through.

Interest Is Worldwide

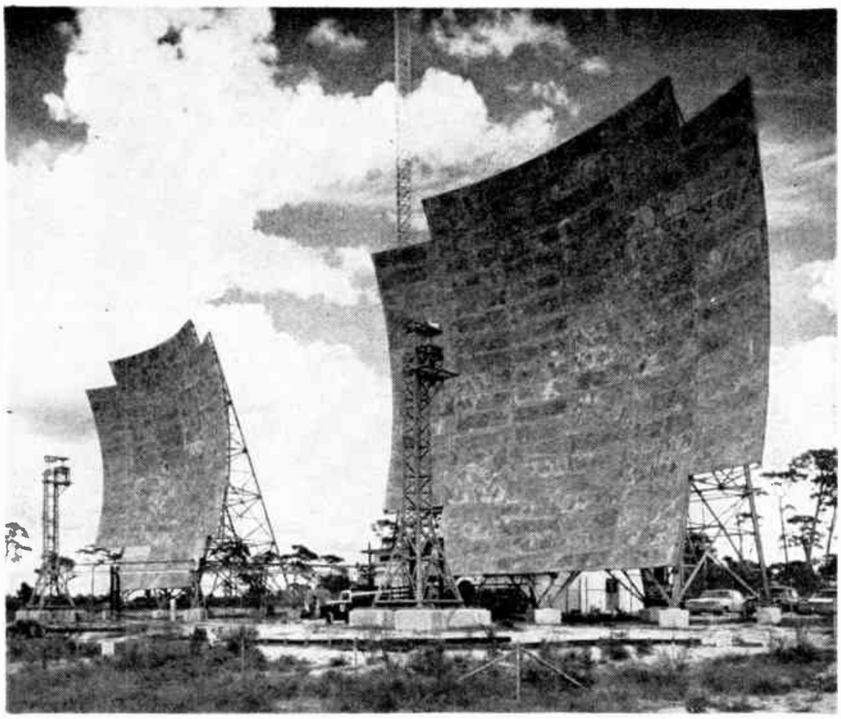
An earlier conference on this subject was held in September in Cleveland under joint sponsorship of Western Reserve University and Rand Development Corp. Representatives of 13 nations gathered to discuss machine translation.

Delegates expressed hope that the stage may be set for cooperative processing and exchanging of encoded materials for machine searching of the world's scientific literature. Also stressed was the desirability of coded information designed for use among computer systems of different manufacture.

Among U. S. firms represented as interested in such a development are IBM, Thompson Ramo Wooldridge, General Electric, Magnavox, Systems Development Corp., Zater Co. and Eastman Kodak.

From the academic side, papers were read by delegates from Western Reserve, University of Michigan, John Carroll University and the University of Bristol, England. Overseas spokesmen included scientists from Japan, India, USSR, Italy, Germany, France and Brazil.

New Antennas for Test Range



Tropospheric scatter antennas form link in USAF Eglin Gulf Test Range communications network. Built by Blaw-Knox, these 60-ft twin antennas are at Anclote Point, near Tampa, Fla. Two others are at Cape San Blas, Fla., 180 mi across Gulf of Mexico

Growing

At the Chicago meeting, Samuel Alexander, chief of the U.S. National Bureau of Standards, reported on his recent trip to Russia.

"I found an excess of programmers and numerical analysts," he said. "Russia is doing good work with poorer computers because of educational backup in computational mathematics. With new and better computers coming soon, Russia's technology will probably outstrip ours in 3 to 5 years."

Means Are Under Study

Means of achieving the common-language goal are not yet firm, but several feasible solutions have come forth. At the Chicago conference it was pointed out that the relatively new field of numerical methods has no commonly accepted notation.

It is entirely conceivable that a mathematical system called "Algol" will become the basis of symbology for this field. Algol is derived from the Algorithmic system—a mathematical procedure in which each succeeding increment of a problem solution is predicated in the result derived in the step preceding.

In practice, Algol may be not only the vehicle for written communication for Algorithms, but also the "language" of instruction. Several German universities have already begun to use Algol in the numerical methods classroom.

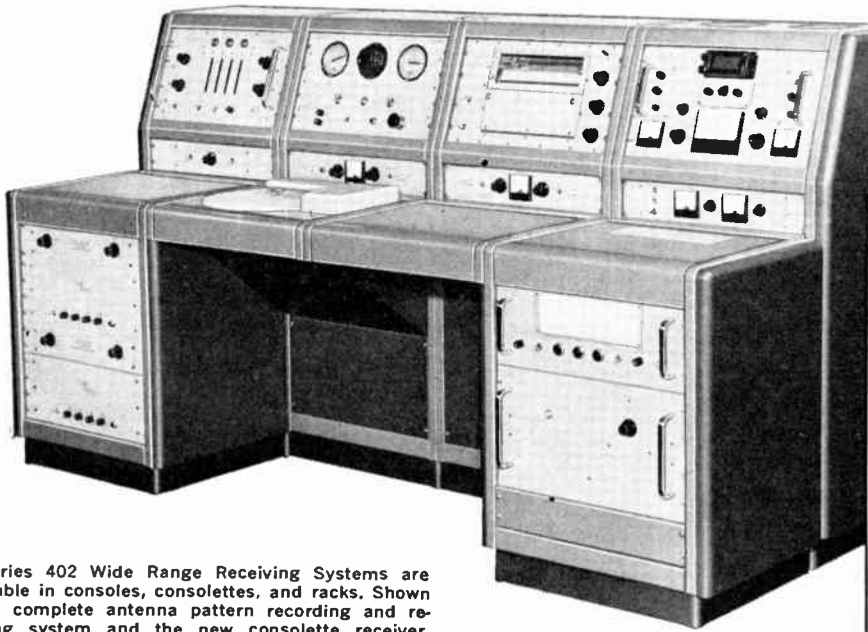
C. A. Phillips, director of the Defense Dept.'s Data Systems Research Staff, mentions another approach. He says manufacturers have been asked to develop compilers capable of translating.

Manufacturers, Phillips adds, have demonstrated the feasibility of a common business language in joint projects involving the Air Force, Sperry Rand's Univac division and, recently, U.S. Steel.

Some manufacturers have already planned to conform to the International Algebraic Language and would agree to a common business language if a majority decision were derived. Presently, the Data Systems Research Staff is conducting a fact-finding study on "what's wrong and right with existing business compilers" in regard to interchangeability.

MAJORS and MINORS

. . . A Message to the Antenna Designer



● Series 402 Wide Range Receiving Systems are available in consoles, consolettes, and racks. Shown are a complete antenna pattern recording and receiving system and the new consolette receiver.

A crowded spectrum plus high power radar and communication systems critically compound the problems of the antenna design engineer.

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A recent development, S-A's P-4 modification adds 20 db to the normal 40 db dynamic range. The modification takes advantage of the gain vs AGC voltage characteristics of the Series 402. Existing receivers can be modified at the factory.

New Modification Z Broadens Use

Modification Z adds a precision IF attenuator and VTVM to the Series 402. Now RF and microwave signal level, gain, and isolation measurements can be made with fewer components and instruments. *For instance*, an X band 80 db attenuator can be calibrated to within ±0.5 db with a 1 mw signal source, a flap attenuator, a mixer, and an S-A Series 402Z Receiver. Antenna gain can be measured by direct comparison with a standard gain antenna. Signal levels can be compared against a reference standard.

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Series 402, 2 to above 100 kmc	$7500
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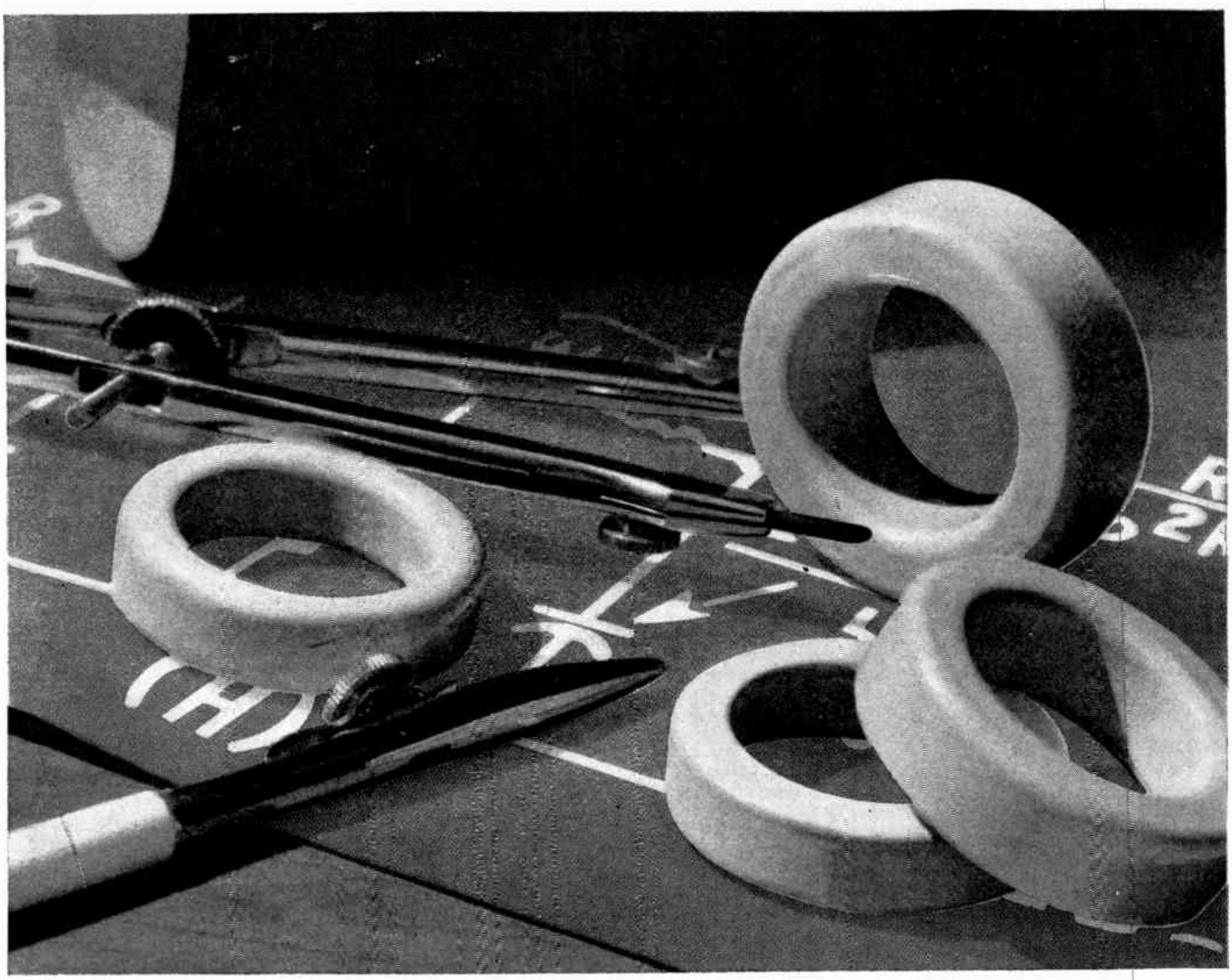

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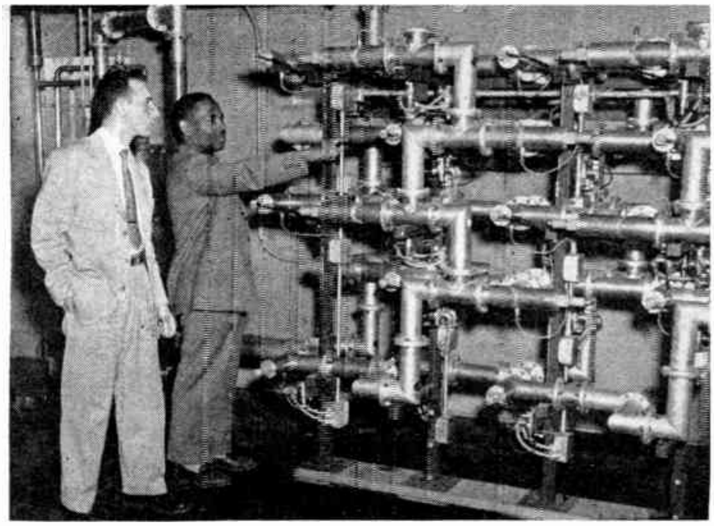
Air Force Buys New Radio Gear



Plumber's nightmare at Rome Air Development Center is diode matrix connecting four transmitters to any of five antennas

Birdcall systems pass legibility and reliability tests with flying colors, are now going into field use

COMMUNICATIONS MEN in the Air Force are pretty pleased with a new synchronous single-sideband system now coming into widespread use in the strategic and tactical commands.

The system was built by Collins Radio under guidance of Rome Air Development Center, Rome, N. Y. It is a suppressed-carrier system designed for voice communications only. Subjected to standard Harvard word-list test, it came through with flying colors.

The word lists were read from the ground, recorded aloft on magnetic tape, and then played back at USAF's Human Factors lab for a sample audience. The percentage of words understood per list was statistically evaluated over a number of runs for mean "legibility" and standard deviation.

For the ssb system, mean legibility was 0.77 with standard deviation computed at 15.6. These figures stack up nicely against figures for a stock a-m system: mean legibility 0.59 with standard deviation of 21.2. They are even more impressive when you consider that 67-percent legibility for randomly ordered words (as in the Harvard word lists) is equivalent, according to the information theory, to 100-percent legibility for clear-text messages.

Birdcall Equipment

The system, which is known provocatively enough as Birdcall, comprises both groundbased and airborne gear. Fixed-station ground transmitters are made to put out either 45 or 12 kw. The airborne transmitter-receiver, the ARC-58, is a 1-kw set. Two transportable systems are provided for ground use; one is a repackaged ARC-58 at 1 kw, the other a larger set putting out 2½ kw.

Transmitters can operate on 28,000 channels in the 2-to-30-mc range. Voice channels are 3 kc wide, separated by 1 kc. Frequency stability is of the order of 1 in 10^8. The channel-selector mechanism not only tunes to the correct channel but also selects and tunes the antenna. Airborne gear weighs about 150 lb.

Big ground stations are equipped with a switching matrix (pictured) which permits a number of transmitters to work into any of several antennas. The 4-by-5 matrix in the picture permits the four transmitters at Rome to work into any of five antennas; larger matrices are under development, ELECTRONICS learned. The matrix is a big but electrically conventional diode switching arrangement.

Fixed-station antenna systems are a complicated array of half-wave radiators and reflectors arranged in a series of fence-like concentric circles. The largest circle, the outermost fence, is 600 ft in diameter and 150 ft tall. This outer circle is made up of a number of vertical antennas for low-frequency transmission; inside this is a fence of reflectors. Inside these circles is a fence of supports for horizontal dipoles in the high-frequency range, spaced orthogonally to the outer fence so that the two antennas don't "see" each other. The fourth circle is made up of reflectors for the h-f radiators.

A separate and smaller system of two such fences covers the 14-to-30-mc range.

This antenna array permits the transmitter to put out a steerable beam which can move to follow aircraft movements. The beam is switched in 40-deg increments for transmitting and 20-deg increments for receiving.

Field Trials

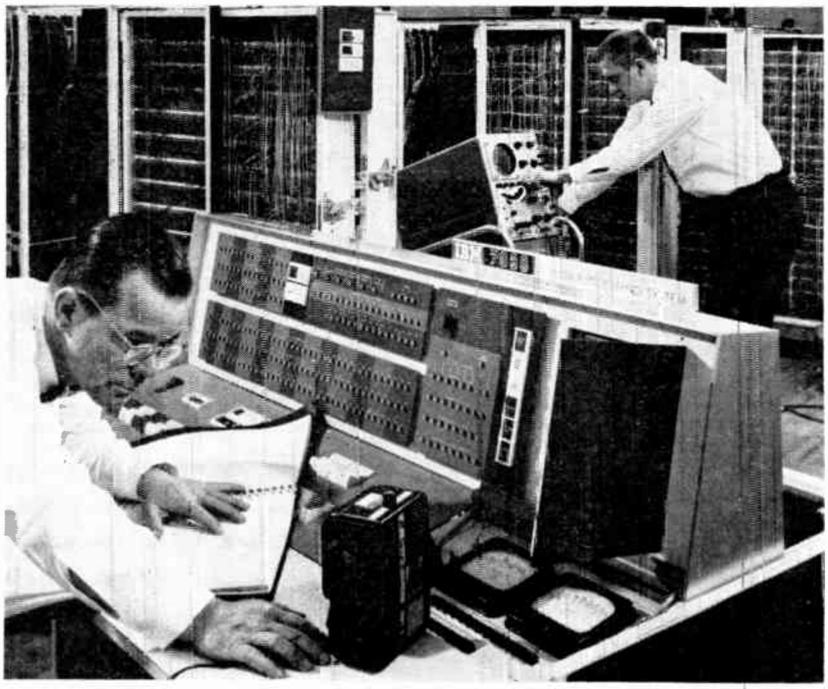
Preproduction equipment was given exhaustive checkout in six B-52's and six KC-135's operating out of Castle AFB, Calif. An intensive program at Castle and Travis AFB is now evaluating production gear to verify reliability improvements.

The gear is about 60 percent transistorized. Early in the design planning stage, Collins rigorously derated all component parts and kept the design within established goals. For example, of the 46 tubes used in the ARC-58, only two or three operate at more than 50 percent of rated dissipation. Besides, the firm set up a careful follow-up program to track down causes of failure. Reliability evaluation program now is verifying a previously calculated mean-time-between-failures of 200 hours under normal operating conditions.

Considerably more than 100 airborne sets have been delivered to the Air Force; ELECTRONICS learns from USAF officials that "within a short time" upwards of 500 will be in use. Air Force research and development people are currently pushing to make present-day a-m voice systems compatible with the new Birdcall gear.

Computer Gets New

Nationwide reservation system will use general-purpose computer linked to 1,100 sales points



IBM's transistorized 7090 computer will serve as nerve center for the Sabre system

ADVANCED COMPUTER TECHNIQUES will be put to work by American Airlines to solve one of its knottiest problems: customer reservations.

New reservation system announced earlier this month by American and computermaker IBM is dubbed Sabre by the airline and IBM 9090 by its developer. It combines a fast and sophisticated digital computer with a hefty memory system, and represents a substantial step forward in information gathering and retrieval systems.

One key departure in the Sabre is the use of a general-purpose computer with its inherent flexibility. Previous reservation systems used a large-volume storage device with a different control and indexing system.

American's president, C. R. Smith, figures the system will start going in late in 1961, and be finished by 1962. AA and IBM have been working on development of the 9090 since 1953.

Communications Network

More than 10,400 miles of leased telephone lines will link American's 1,100-odd reservation sales desks directly with the reservations processing center in New York. In the processing center two IBM 7090's will be duplexed to process reservation queries, keep records of all transactions, report on available space for all flights.

Magnetic-core storage internal to the computer will store instructions, frequently used reference tables and transactions in progress. High-capacity disk memories of the type used in IBM's Ramac systems will store the seat inventory for each flight, including numbers of seats sold and available; passenger reservations records; flight and schedule data, fares and so forth. The disk file can store 600 million characters of information.

Additional storage on magnetic tape will hold messages for later transmission, journals of transactions, and historical records. Card readers and punches will permit processing-center people to monitor system operation and enter schedule changes or other information into the system.

Special control gear will schedule data input and output, switch the remote sets in and out in sequence,

Airline Job

and control the flow of information between computer and disk file.

The console to be used by the agents uses magnetically coded cards listing all company flights and some heavily-travelled connecting flights of other airlines. One side of the card contains route information in one direction between two points; the flip side holds return route data.

How It Works

The agent puts the card into his set and pushes buttons to key in date and number of seats requested. The code from the card is sensed and transmitted to the computer, along with the other data. The computer sends back availability indications which appear as lights next to the card. Other pushbuttons permit the agent to sell, confirm or cancel space as required.

From a typewriter keyboard the agent can enter passenger's name, phone number, itinerary and other identifying information. A printer lets the operator read the record he enters and the computer's responses. If the passenger record is incomplete when the agent signifies end-of-transaction, the computer asks for additional data. The complete record is stored in the file.

For flights on other than AA routes, the 9090 will compose a teleprinter message and send it to the other airline. When the answer comes back, it will go directly to the computer, which will relay a note to the agent to confirm or deny the space to the passenger.

Requests from other airlines for connecting flights on American will be routinely handled by the computer through the same type of direct teleprinter connection.

American's spokesmen indicate that the system can be tied in directly to other airlines' systems—if other airlines install them.

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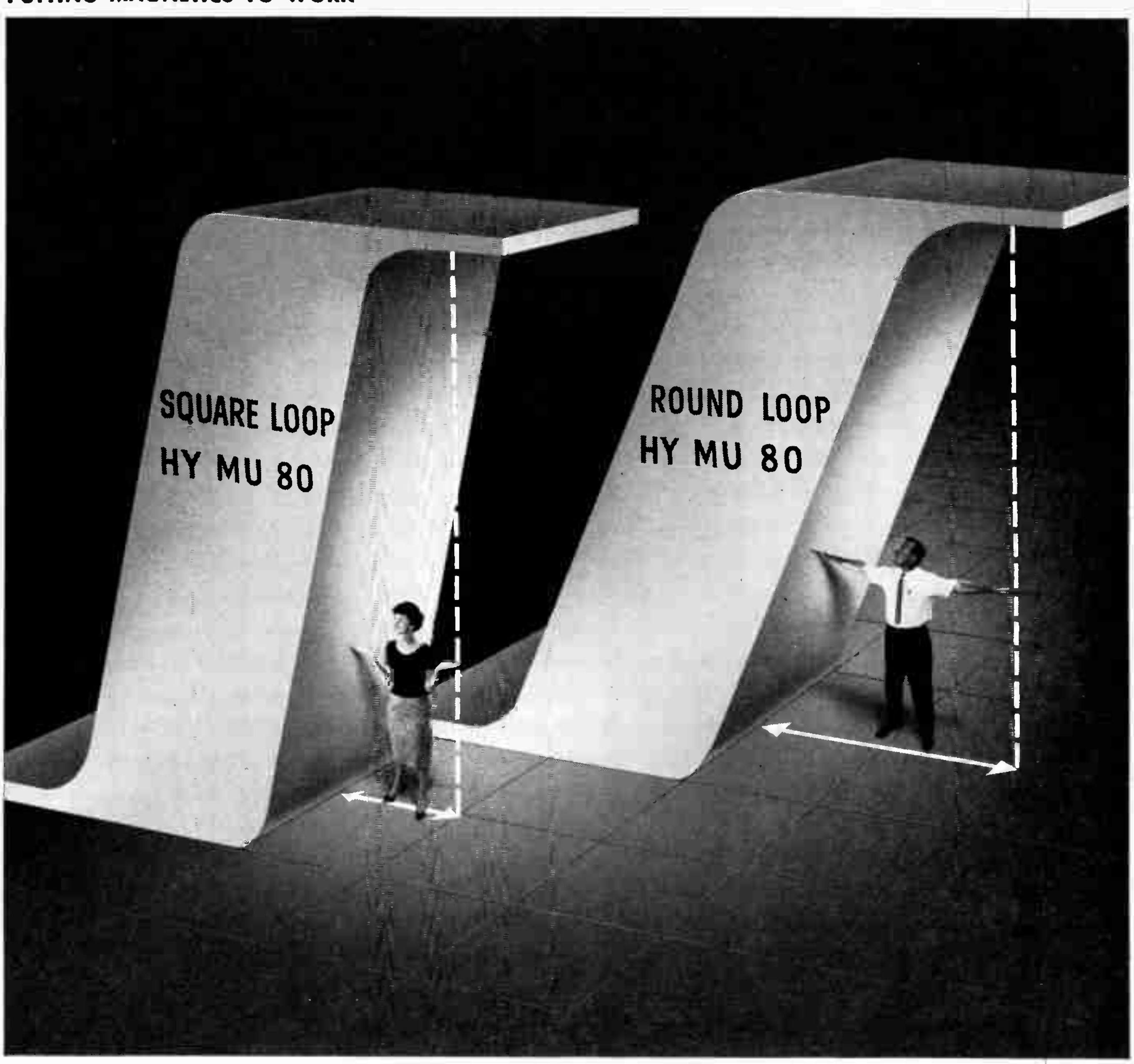

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	VOLTS	VOLTS	AMPS	AMPS	VOLTS	MICRO AMP	
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1N2358	1500	1050	.4	15	2	1	—
1N2359	1600	1120	.4	15	2	1	—
1N2360	1800	1260	.4	15	2	1	—
1N2361	2000	1400	.4	15	2	1	—
STUD 7/16"							
1N2362	1400	980	1	15	2	1	1N2363
1N2364	1500	1050	1	15	2	1	1N2365
1N2366	1600	1120	1	15	2	1	1N2367
1N2368	1800	1260	1	15	2	1	1N2369
1N2370	2000	1400	1	15	2	1	1N2371
1N2362A	1400	980	5	20	2	1	1N2363A
1N2364A	1500	050	5	20	2	1	1N2365A
1N2366A	1600	120	5	20	2	1	1N2367A
1N2368A	1800	260	5	20	2	1	1N2369A
1N2370A	2000	400	5	20	2	1	1N2371A
1N2362B	1400	980	10	25	2	1	1N2363B
1N2364B	1500	1050	10	25	2	1	1N2365B
1N2366B	1600	1120	10	25	2	1	1N2367B
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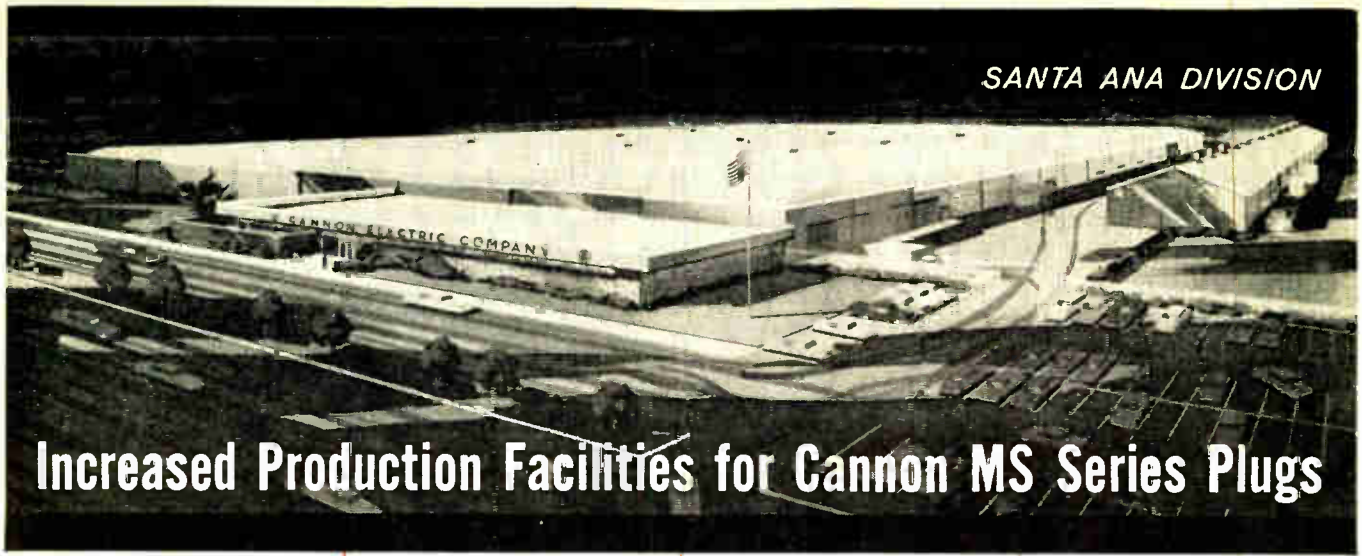

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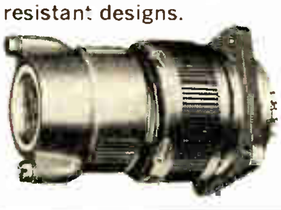

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Doppler Guiding Fighter Plane

New $20-million award goes to one company. Here are details on radar navigating equipment

RECEIPT of a $20-million follow-on contract for Doppler radar navigating equipment was announced last week by Boston's Laboratory For Electronics, Inc. The order brings LFE's business on this item to some $60 million.

Designated the AN/APN-131, the equipment is used on Republic F-105D Thunderchief fighter-bombers of the Tactical Air Command. The Doppler navigator costs about $125,000; some 90 have already been delivered.

The F-105D is reportedly funded by the Air Force through 1961.

Preselected Course

The equipment weighs 210 lb, occupies less than seven cubic ft, and requires a small fuselage aperture. It permits a combat fighter pilot to follow a preselected course between points on the world designated only by their latitude and longitude without reference to fixed navigational aids.

Presentations include: present position coordinates, ground speed, track course, distance and time to destination, alternate destination selector, wind vector, and wind memory.

Mundy I. Peale (left), president of Republic Aviation, and Henry W. Harding, president of Laboratory for Electronics, view LFE navigation system installed in Republic's F-105D Thunderchief fighter-bomber. The equipment includes a radar transmitter, receiver, antenna and two electronic computers

How It Works

The unit is essentially an x-band radar set that directs three interrupted beams at the ground through a dielectric lens antenna. A digital computer derives positional information in three orthogonal coordinates from the Doppler frequency shift of the three beams. These beams are obtained from a single transmitter through a three-way power divider.

The transmitter has a 50-percent duty cycle with a peak pulse power of 1.5 w. It uses a reflex klystron master oscillator and three double-cavity klystron amplifiers in cascade.

A crystal oscillator operating on 500 kc supplies local oscillator and frequency sidestepping signals. The signal is multiplied to 40 mc for local oscillator use. This signal is mixed with the 9,800-mc klystron output and the upper (9,840 mc) sideband selected for the transmitter.

To prevent undesired signal feedthrough, the transmitter frequency is then sidestepped by mixing with a 9-mc signal, also derived from the crystal oscillator. The returned signal from the antenna is mixed with the klystron master oscillator signal which is sidestepped by 51 mc.

Frequency Varies

Pulse-repetition frequency varies with the airplane's altitude for optimum range considerations. A 125-kc prf is used at 2,000 ft; an 8-kc rate at 40,000 ft.

The company also makes a transistor Doppler navigator.

The unit weighs under one hundred pounds.

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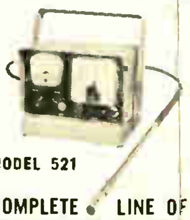

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Dec. 1-2: Circuit Theory, Mid-West Symposium, PGCT of IRE, Brooks Memorial Union, Marquette Univ., Milwaukee.

Dec. 1-3: Eastern Joint Computer Conf., AIEE, ACM, PGEC of IRE, Hotel Statler, Boston.

Dec. 3-4: Vehicular Communications, Annual Meeting, PGVC of IRE, Colonial Inn & Desert Ranch, St. Petersburg, Fla.

Dec. 8-10: Electrical Insulation, Applications, Nat. Conf., AIEE, NEMA, Shoreham Hotel, Cleveland.

Jan. 11-13: Reliability & Quality Control, National Symposium, ASQC, IRE, EIA, AIEE, Statler Hotel, Washington, D. C.

Jan. 12-15: Plastics Conference, Annual, Society of Plastics Engineers, Inc., Conrad Hilton, Chicago.

Jan. 25-27: Plant Maintenance and Engineering Conf., Philadelphia.

Jan. 31-Feb. 5: Comparison of Control Computers, Winter General Meeting, AIEE, New York City.

Feb. 3-5: Military Electronics, Winter Convention, Biltmore Hotel, Los Angeles.

Feb. 10-12: Solid-State Circuits Conf., AIEE, IRE, Univ. of Penn., Philadelphia.

Feb. 11-13: Electronic Representatives Assoc., Annual Convention, Drake Hotel, Chicago.

Feb. 20-29: Component Parts and Electronic Tubes, International Exhibition, Porte de Versailles, Place Balard, Paris.

Mar. 21-24: Institute of Radio Engineers, National Convention, Coliseum & Waldorf-Astoria Hotel, N. Y. C.

Apr. 4-7: Nuclear Congress, EJC, PGNS of IRE, New York Coliseum, New York City.

Apr. 11-13: Protective Relay Engineers, Annual, A&M College of Texas, College Station, Texas.

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

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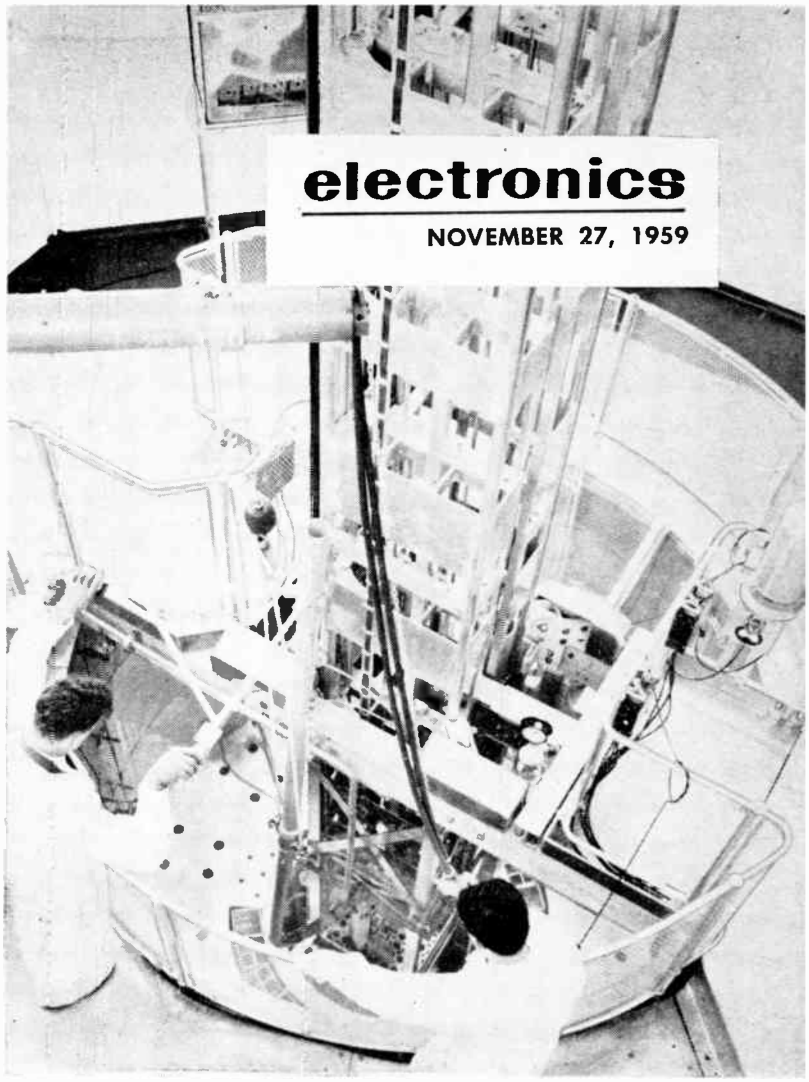

Merlin, Britain's first private-enterprise reactor, will help scientists study behavior of materials under nuclear radiation. Nuclear reactors are typical of radiation environments to which semiconductors might normally be exposed. Others include Van Allen radiation belts and cosmic rays

How Radiation Affects Semiconductor Devices

Understanding behavior of semiconductor devices and circuits in radiation environments leads to radiation-tolerant designs

By MICHAEL F. WOLFF, Assistant Editor

INVESTIGATIONS into radiation effects on semiconductors are advancing the design of radiation-tolerant solid-state circuits and devices. Studies of semiconductors under neutron and electron bombardment show that protection can be increased through proper choice of transistors and diodes as well as by special circuit design techniques.

RADIATION EFFECTS — Because the purity of semiconductor materials permits their electronic properties to be controlled by a small number of imperfections, the defects introduced by radiation can radically alter the characteristics of transistors and similar devices. Specifically, conductivity, minority carrier lifetime and surface recombination velocity are all changed by radiation.[1, 2]

Exposure of semiconductors to radiation leads to two types of effect: transient and permanent. Transient effects arise from the ionization caused by an energetic photon or charged particle passing through the semiconductor. Such a burst of ionization injects excess minority carriers into the device and can sometimes give rise to a noise source in an electronic device. Ionization produces transient changes in surface recombination velocity.

Permanent bulk effects are produced by transmutation and displacement. Both processes introduce new levels into the forbidden energy gap, causing permanent changes in conductivity and minority carrier lifetime. In the case of transmutations, which

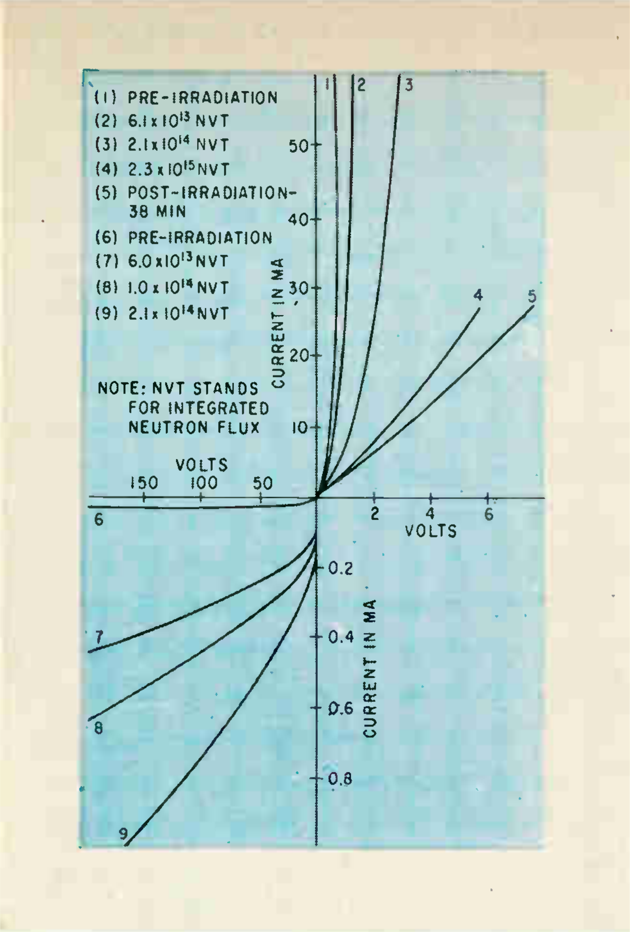

FIG. 1—Typical set of characteristic curves for 1N538 diode shows degraded behavior with increasing neutron flux

are produced largely by thermal neutrons, the new levels are caused by the chemical impurities that radioactive decay introduces into the crystal lattice. These impurities exert their greatest influence on conductivity. However, it is thought possible that at the time of formation the impurities may emit sufficiently energetic beta or gamma rays so that the transmuting atom will experience a recoil that displaces it from its normal lattice site.

The lattice defect, which results when an atom is displaced from its original position, is the source of most of the damage to semiconductors that are exposed to nuclear radiation. If the displaced atom receives enough kinetic energy to make it dislodge other atoms in the lattice, the total number of displacements resulting from a single initial collision can become appreciable. The displacement effect results in a decrease in minority carrier lifetime with increasing neutron dosage.

TRANSISTOR DAMAGE—Net effect of the changes in transistor parameters is a reduction in forward current gain and an increase in reverse collector-to-base leakage with increasing radiation levels. Forward current gain is reduced because minority carrier lifetime is reduced. The increase in leakage results from the combination of surface effects at the collector-base junction and changes in bulk semiconductor characteristics which tend to destroy the barrier. These changes appear in the transistor circuit parameters as decreases in forward current transfer ratio, α, and increases in reverse leakage current, I_{co}.

DIODE DAMAGE — Lifetime changes resulting from radiation exposure cause a marked deterioration in the forward and reverse characteristics of semiconductor diodes. An accelerating increase in forward resistance and a corresponding decrease in reverse resistance, shown in Fig. 1, with integrated neutron flux have been reported.[3,4]

The breakdown of three typical commercial diodes under electron bombardment is shown in Fig. 2.[5] The characteristics of a more electron-resistant *p-n* diode are shown for comparison purposes. Construction details of the new diode, which was developed by General Atomic Division of General Dynamics Corp. under contract with the Air Force Cambridge Research Center, have not yet been announced.

CIRCUIT BEHAVIOR — An example of circuit behavior with neutron bombardment is provided by studies conducted at Bell Telephone Laboratories under an Air Force contract on the feedback amplifier shown in Fig. 3.[6] The amplifier was designed for 12-db gain between 75-ohm terminations from 20 to 40 mc. Feedback of 20 db at midband is used around all three stages but the input and output transformers are outside the feedback loop.

Figure 4 shows the amplifier gain as a function of frequency for various radiation levels. For exposures up to 2.9×10^{15} neutrons/cm^2 a reduction of less than 1 db of gain occurs throughout the band. At 5.8×10^{15} neutrons/cm^2, the loss in gain is 1 db at midband and 2.5 db at the lower edge of the band.

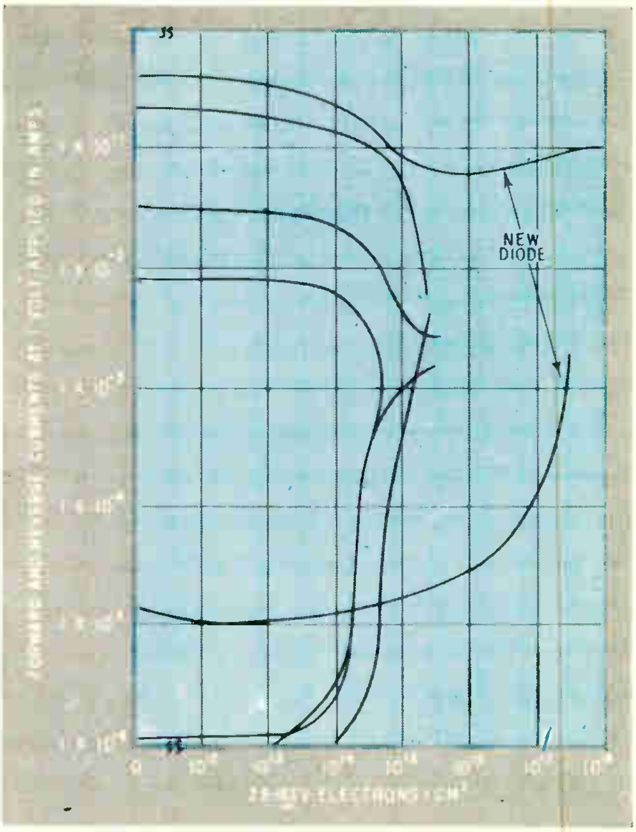

FIG. 2—Diode currents at different electron flux levels

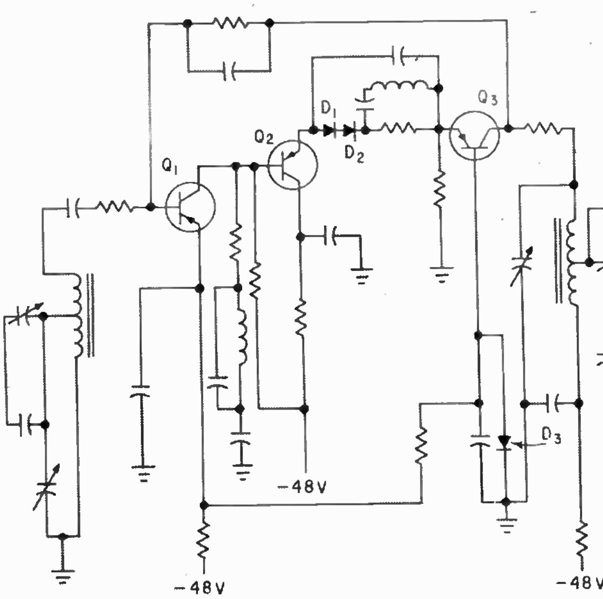

FIG. 3—Amplifier for 20-40-mc range consists of grounded-emitter transistor Q_1 driving grounded-collector transistor Q_2 which, in turn, drives grounded-base transistor Q_3

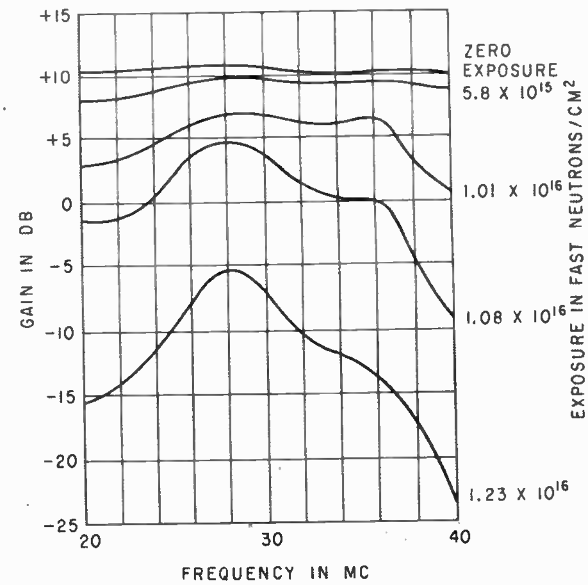

FIG. 4—Amplifier gain as a function of frequency for different neutron flux levels. With new transistors, gain neared original value two months after irradiation

Finally the amplifier becomes an attenuator.

Amplifier degradation is attributed to the decrease in α of the transistors which eventually practically eliminated feedback. This allowed the resonant characteristics of the two shaping networks to appear in the gain curve. At 1.2×10^{16} neutrons/cm² the upper resonant peak in the gain curve was damped out because of the deterioration of the collector junction reverse characteristic of Q_3. The d-c biases remained fairly constant because of the stabilizing influence of reference diodes D_1, D_2 and D_3 which were only slightly affected by the radiation.

RADIATION-RESISTANT CIRCUITS — Researchers at IBM have shown that by paying attention to component behavior, they can construct entire logic circuits capable of withstanding short duration, high flux neutron plus gamma pulses.[7] These circuits were designed with thin base, high speed germanium transistors and found to be undamaged by radiation pulses from the Los Alamos Godiva reactor.

Germanium, with its higher atomic weight, is preferable to silicon because it suffers less lifetime degradation. Germanium transistors of the same frequency class and base width are reported degraded on the average of a factor of 10 less than comparable silicon units.

Thin base width transistors have two advantages. Because the I_{co} experienced by many transistors during a pulse of radiation is proportional to the product of base width and the cross sectional area of the collector-to-base junction, I_{co} is minimized in narrow base transistors. Secondly, the gain change resulting from the degraded minority carrier lifetime in the base region is a less important factor in thinner base transistors because the carriers diffuse throughout a shorter distance through the narrow base region.

In addition to the choice of transistors, certain other design techniques contributed to the radiation resistance. The circuits were designed for fairly wide tolerances and employed carbon composition resistors and small-value capacitors.

RADIATION-RESISTANT DEVICES — Compound semiconductors with relatively large bandgaps are being studied for possible device application.[8] The ability of compound semiconductors to operate at higher temperatures than germanium or silicon devices points to their use in radiation environments because at higher temperatures the defects tend to anneal out almost as rapidly as they are formed.

Another promising radiation-resistant device is the tunnel diode, which has a certain tolerance because it does not depend on minority carrier action.

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Except for (3) the papers listed below were all presented at the 1959 Second Conference on Nuclear Radiation Effects on Semiconductor Devices, Materials and Circuits.

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(8) L. W. Aukerman, Radiation Effects in Compound Semiconductors.

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J. C. Pigg and C. C. Robinson, Effect of Radiation on Semiconductors, *Elect Mfg*, p 116, April 1957.

Blocking Oscillator for

Frequency stability equivalent to that found in conventional circuit operating at 1:1 synchronization ratio is obtained. Novel self-gating feature provides almost ideal control grid waveform for triggering

CIRCUITS COMMONLY used in frequency synchronization or count-down stages are the multivibrator and blocking oscillator. Each of these circuits is limited in its useful stable synchronization ratio by the exponential nature of its control grid waveform.

The circuit discussed here combines a basic multivibrator and blocking oscillator into a novel self-gated blocking oscillator. Synchronization ratios of 10:1 or greater are obtainable with a stability equal to or greater than that of a conventional circuit operating at a synchronization ratio of 1:1.

Typical Blocking Oscillator

Because of the exponential characteristic of the control grid waveform, a blocking oscillator used in a frequency synchronization circuit exhibits poor stability at frequency ratios greater than 2:1 or 3:1. Figure 1 shows the control grid voltage waveform of a typical frequency synchronizing blocking oscillator operating at a 3:1 synchronization ratio.

As the ratio of input frequency to output frequency becomes larger, the voltage level of the undesired trigger pulse, $n - 1$, approaches the voltage level of the desired trigger pulse, n. Reduction of the voltage differential, V_1, between the peak of pulse $n - 1$ and the peak of pulse n results in poor selectivity of the triggering pulse and, consequently, in unstable operation. It is readily apparent that as the frequency ratio increases, V_1 decreases.

A typical blocking oscillator having the control grid waveform of Fig. 1 is shown in Fig. 2. This circuit must be adjusted so that the cutoff voltage, e_{co}, falls below the voltage level of $E_b + E_n$ and above the voltage level of $E_b + E_{n-1}$ peak, that is, e_{co} must fall within the range of V_1. Thus, maximum stability is obtained when V_1 is large and minimum stability is obtained when V_1 is small.

Ideal Voltage Waveform

An idealized voltage waveform for the grid circuit of a synchronous blocking oscillator is shown in Fig. 3. By making the voltage $-E_{cc}$ large compared to the input trigger amplitude, all undesired trigger pulses from the trigger source will reach the same voltage level at the blocking oscillator grid. Thus, the V_1 voltage (Fig. 1) becomes very large giving maximum stability and rejection of the undesired trigger pulse.

Period t_a is ideally adjusted to equal $(n - 1)\ T + T/2$ where T is the period of the incoming pulse chain. This adjustment is made to allow for circuit variations which may occur in the time delay generator producing the negative clamp voltage, $-E_{cc}$.

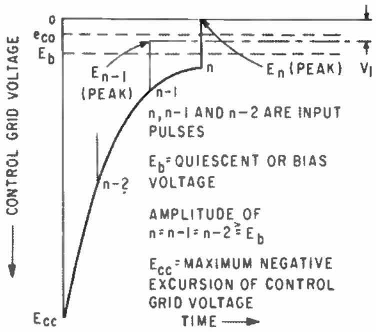
The exponential rise occuring between t_a and t_1 is the result of the grid timing elements of the blocking oscillator. Ideally, the time $t_1 - t_a$ would be equal to or less than $T/2$.

If these conditions are met, the grid of the blocking oscillator is held below cut-off until a time $T/2$ prior to the occurrence of the desired trigger pulse. When E_{cc} is removed, the clamp releases the control grid and the grid voltage exponentially rises to the normal bias level E_b before the occurrence of the desired trigger pulse. The grid voltage recovery time is determined by the grid circuit time constant. A control grid waveform of this type eliminates the tendency of the blocking oscillator to trigger on any input pulse except the desired pulse. Extreme synchronization ratios can be expected with no sacrifice in stability.

Blocking Oscillator Circuit

A circuit for producing such a waveform is illustrated in Fig. 4. The grid voltage waveform of this circuit, shown in Fig. 5, departs from the idealized waveform to the extent that the period t_a is equal to $(n - 1)T$ instead of $(n - 1)T + T/2$.

In the quiescent state, tube V_{1B} of the multivibrator is nonconducting. This establishes the plate voltage of V_{1B} and, consequently, the bias voltage of the blocking oscillator V_2 at $-E_b$. This state is main-



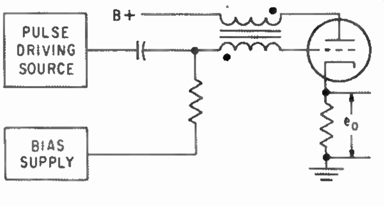


FIG. 2—Typical blocking oscillator

FIG. 1—Control grid voltage waveform for typical frequency synchronizing blocking oscillator

Ten-to-One Synchronization

By **W. W. WHATLEY,** Project Test Engineer, Hughes Aircraft Co., Tucson, Ariz.

tained by the high current drawn through cathode resistor R_1 by tube V_{1A} which produces sufficient bias to keep V_{1B} cut off. Because $-E_c$ is applied to the grid of V_2 through R_2 and R_3 the blocking oscillator is also clamped in the off condition.

When a positive trigger whose amplitude is greater than $-E_c$ is applied to the grid of V_2, the blocking oscillator operates in a conventional manner and produces one output pulse. The flow of current through R_1 produces a positive pulse at the cathode of V_2. This positive pulse is capacitively coupled by C_1 to the grid of tube V_{1B} driving V_{1B} into conduction and V_{1A} into cutoff. Because the cathode of tube V_1 is returned to a negative voltage, the plate of V_{1B} will bottom to a high negative potential, thus biasing the grid of V_2 highly negative.

Tube V_{1B} continues in this state until the negative charge which has accumulated on C_2 is discharged to such a point that V_{1A} again conducts. At this time, the delay multivibrator V_1 is ready to reset. The delay period of the multivibrator (t_0 of Fig. 3) is thus determined by the time constant $R_5 C_2$.

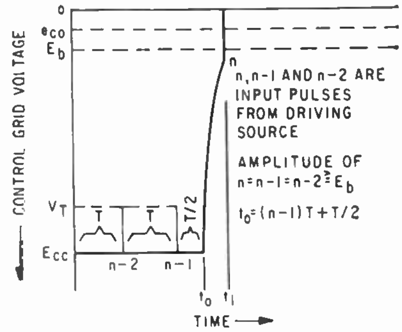


FIG. 3—Idealized control grid waveform for synchronous blocking oscillator

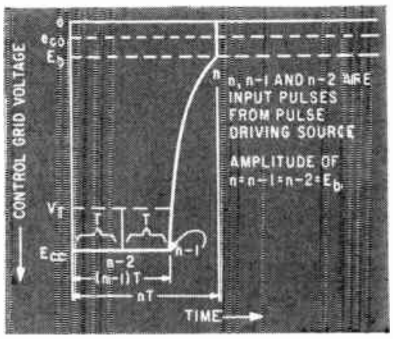


FIG. 5—Control grid voltage waveform for circuit in Fig. 4

During the time that the plate of V_{1B} is holding the grid of V_2 at a high negative potential, the blocking oscillator is insensitive to input pulses from the driving source.

Performance

Figure 5 shows the grid waveform as it appeared in the test circuit. Because of cross coupling of the input trigger pulse from the driving source into the grid of V_{1B}, a vernier control of the multivibrator delay was not possible. Therefore, the delay was adjusted to $(n-1)T$. The exponential waveform shown between $(n-1)T$ and nT is the recovery of the V_{1B} plate and the V_2 grid to quiescence.

Checks made at synchronization ratios as high as 10:1 indicate allowable variations of input parameters such as B +, filament's and input trigger level to be 50 to 30 percent before miscounting occurs.

The highest frequency used in operational tests was 15 kc. Thus far, limits of operation have not been investigated; however, it seems apparent that the high frequency limit will be determined by practical limits on the values of the blocking oscillator grid circuit timing components $R_2 + R_3$ and C_1.

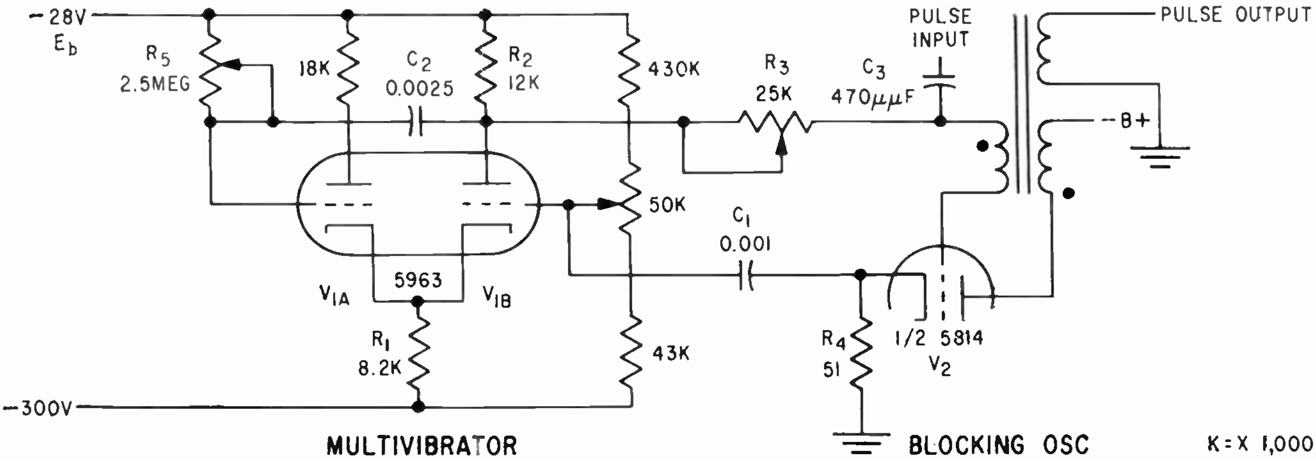


FIG. 4—Self-gated synchronous blocking oscillator is used to obtain synchronization ratios as high as 10:1

The Tunnel Diode—

THE FRONT COVER—Technicion prepares to attach leads to tunnel diode with aid of micromanipulator. Diode is assembled in bell jar containing inert gas

TUNNEL DIODE PARAMETERS

Parameter values for typical experimental tunnel diodes, with 1 ma peak currents, are $C = 5\ \mu\mu f$, $-g = 1/150$ mho, $R_s = 1$ ohm and $L_s = 2\ n\ \mu h$. In general, to find the parameters for other values of current (I_p) in ma., use $C = 5\ I_p\ \mu\mu f$, $g = I_p/150$ mho, $R_s = 1/I_p$ ohm and $L_s = 2\ n\ \mu h$ (controlled by case design).

TUNNEL DIODES are characterized by a negative conductance region that results when the current falls from an excessively high value at very low forward voltages to a value somewhat above that of a normal *p-n* junction at a higher forward voltage[1,2,3]. Hence, the tunnel diode tends to be a high current, low-voltage device with a large negative conductance (ELECTRONICS, p 54, Nov. 6, 1959). These features make tunnel diodes useful in many types of circuits, several of which are described in this article.

There are two requirements that must be met if a *p-n* junction is to be made into a tunnel diode. The first is that the junction (space charge region) must be narrow—on the order of 150 A. This means that the transition from *p*-type to *n*-type must be abrupt. The second requirement is that both the *p*-type and *n*-type regions must be degenerate; that is, the Fermi level must be within the conduction band on the *n*-type side and within (or very close to) the valence band on the *p*-type side, or the reverse. For a good tunnel diode, this requires very high impurity concentrations—greater than 5×10^{19} per cubic centimeter for silicon and greater than 2×10^{19} per cubic centimeter for germanium.

Silicon tunnel diodes at liquid helium temperatures (4.2 K) exhibit an anomalous behavior in the tunnel region. Four nodes exist in this region where the slope of the current-voltage characteristic decreases and then increases. This effect has been observed in a variety of tunnel diodes and due to phonon interaction in the tunneling process[5].

One of the tunnel diode's important features is its resistance to nuclear radiation. Preliminary experimental results have shown tunnel diodes to be at least ten times more resistant to nuclear radiation than transistors.

Transistors and other semiconductor devices are degraded by radiation because lifetime is lowered, resistivity changes (usually rises), and noise and transients are produced by ionization in the bulk and on the surface (see p 55). The tunnel diode does not depend upon carrier injection or extraction to produce its negative resistance region,

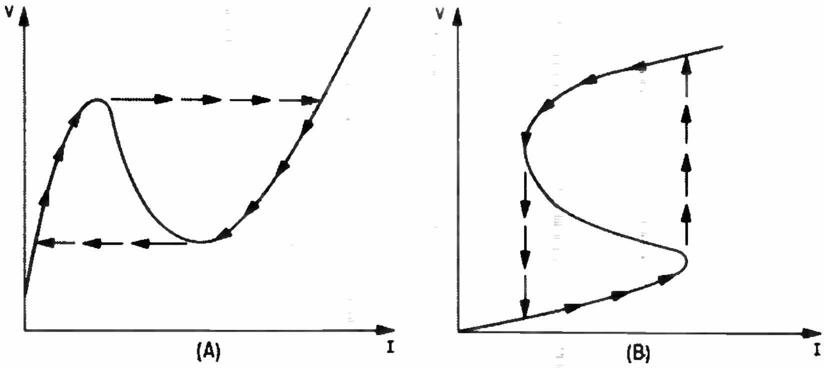


FIG. 1—(Left) Negative resistance characteristics for n-type (A) and s-type (B) devices

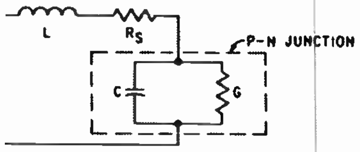


FIG. 2—Tunnel diode equivalent circuit has junction capacitance, C. The G is given by low-frequency characteristic. Semiconductor and leads give L and Rs

Circuits and Applications

Characteristics of tunnel diodes make them useful in oscillators, sweep circuits, detectors, multivibrators and amplifiers. Here are some typical circuits

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so lifetime is a minor consideration.

Resistivity will not change until very large dosages have been applied because it is so low initially on both sides of the junction. Also, since the tunnel diode can work to such high temperatures, it can be heated during irradiation to anneal damage as it occurs. Germanium tunnel diodes have a practical upper temperature limit of 200 C (ELECTRONICS p 43, Oct. 30, 1959). Tunnel diodes should be much less affected by ionizing transients because they are quite insensitive to surface changes and to minority carriers produced by ionizing radiation for example, light.

Tunnel Diode Combinations

Simple combinations of tunnel diodes can be used to give some novel circuit characteristics. A symmetrical switch can be made by connecting two tunnel diodes in opposition. If many tunnel diodes with slightly different peak currents are connected in series, an n-stage stepping device results. If two groups of such tunnel diodes are placed in opposition, a symmetrical n-stage stepping device results. This type of device would find application in such areas as memories and analog-to-digital converters.

If a tunnel diode is placed in series with a backward diode (a diode with no tunnel diode characteristic during forward biasing), the negative conductance region is shifted to a high voltage. This could also be done with a normal diode, in which case the inverse characteristics would be rectifying instead of conducting. If two such series combinations are placed in series opposition, a symmetrical higher voltage switch is obtained. Each additional diode connected in an opposing section adds a state to each polarity.

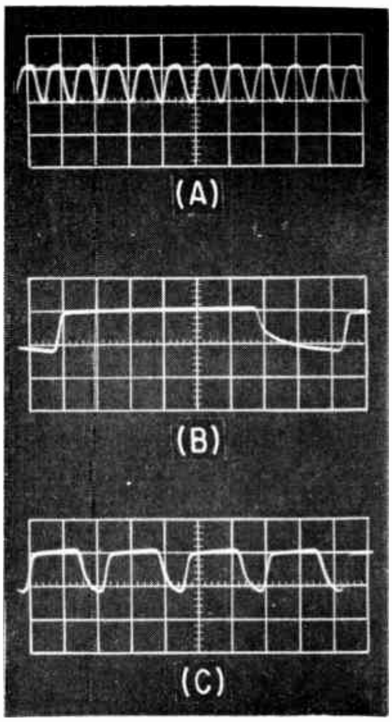

FIG. 3—Waveforms for tunnel diode relaxation oscillator with series inductance of 4.7 μh (A), 68 μh (B) and 15 μh (C). Scale is 0.1 μsec/cm

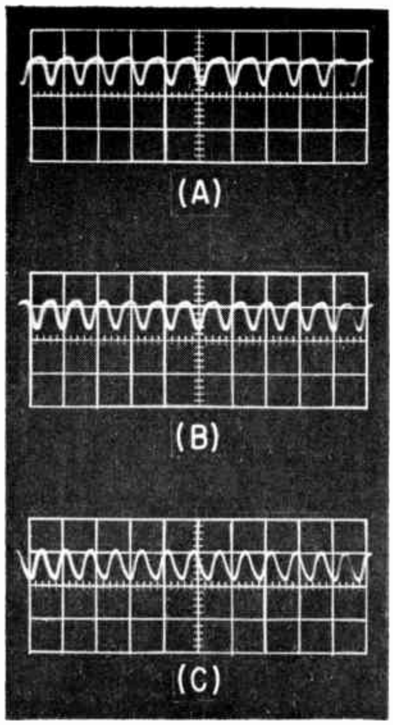

FIG. 4—Waveforms for 12-mc relaxation oscillator with 5 μh series inductor show effects of R_s of 8 ohms (A), 25 ohms (B) and 50 ohms (C). Scale is 0.1 μsec/cm

Relaxation Oscillator

Distinction is made between voltage-stable and current-stable negative resistance devices by calling the former an s characteristic and the latter an n characteristic. These characteristics are shown in Fig. 1, with arrows indicating the idealized direction of rotation in the current-voltage plane when the device is operated as a relaxation oscillator.

The unijunction and avalanche transistors, four-layer diodes and controlled rectifiers are current-stable, while the tunnel diode is an example of the less common voltage-stable device. The type of stability is defined with respect to that ordinate which intercepts the device characteristic at one point only.

From considerations of tunneling and p-n junction theory, and practical fabrication limitations, the equivalent circuit of a tunnel diode

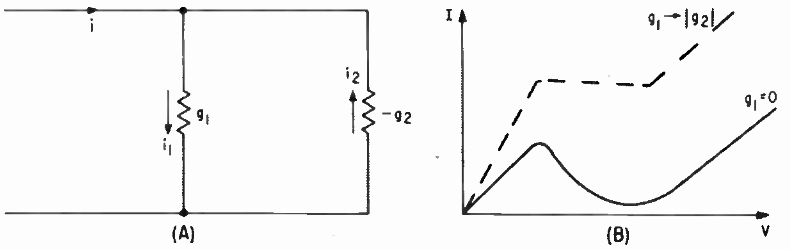

FIG. 5—Equivalent circuit (A) and characteristic (B) for parallel conductance operation. Input characteristic follows dotted line as g_1 approaches $|g_2|$

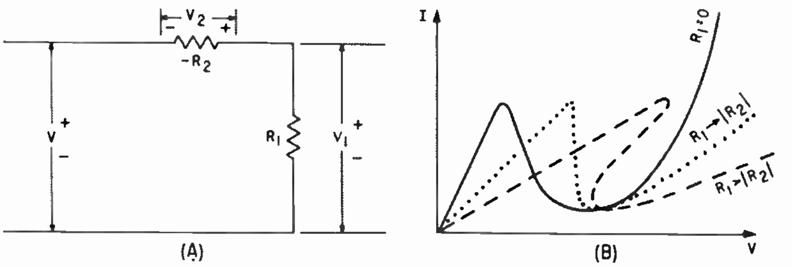

FIG. 6—Equivalent circuit (A) and characteristic (B) for series resistance operation. Dotted curve results when R_1 approaches $|R_2|$

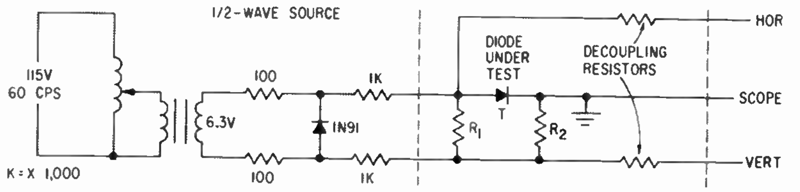

FIG. 7—Value of $R_1 + R_2$ is critical in tunnel diode current-voltage curve tracer. Too small a value leads to circuit oscillation

may be drawn as shown in Fig. 2. For small signal operation, $Z_{in} = [R_s + G/(G^2 + \omega^2C^2)] + j[\omega L - \omega C/(G^2 + \omega^2C^2)]$

For operation in the negative conductance region, G is defined as $-g$. Negative input resistance will occur as long as R_s is less than $g/(g^2 + \omega^2 c^2)$. Letting ω_o be the frequency above which a negative input resistance no longer exists, then $\omega_o = (g/c)[(1/gR_s) - 1]^{\frac{1}{2}}$.

Waveforms for a relaxation oscillator using a series inductor and a voltage source are shown in Fig. 3. Since R_s includes the source resistance, the waveform is controlled by varying R_s so as to make ω_o approach ω, in which region the oscillations become sinusoidal. Oscillation is stopped by making ω_o less than ω. Effects of R_s are shown in Fig. 4.

Consider the parallel arrangement of a conductance and a negative conductance shown in Fig. 5A. Here $Z_{in} = 1/(g_1 - g_2)$ and $v_{in} = i/(g_1 - g_2)$, while the current amplification $i_1/i = 1/(1 - g_2/g_1)$.

To stabilize the device in the negative conductance region requires that $g_1 > |g_2|$ and as g_1 approaches $|g_2|$ the input current-voltage characteristic follows the dotted line in Fig. 5B. A series connection is shown in Fig. 6A. Here $Z_{in} = R_1 - R_2$ and $i_{in} = v/(R_1 - R_2)$ while the voltage amplification $v_1/v = 1/(1 - R_2/R_1) = 1/(1 - g_1/g_2)$.

As R_1 approaches $|R_2|$ the dotted curve shown in Fig. 6B, results. For $R_1 > |R_2|$, the dashed curve shows the current-voltage characteristic.

It is apparent that different results are obtained when operating into a series or parallel circuit. Thus, for a harmonic-rich oscillator a series voltage mode is best, while for amplification current coupling should be used. The circuits for a mixer oscillator have been constructed (ELECTRONICS, p 43, Oct. 30, 1959).

Sweep Circuits and Curve Tracers

The usual form of a curve tracer is illustrated in Fig. 7. One must be particularly careful to avoid distributed capacitance across the diode or oscillations will be introduced. The value of $R_1 + R_2$ is also critical. Where $(R_1 + R_2) > 1/|g|$ the device can only switch and the *s* characteristic will not be seen (Fig. 8). (The negative conductance region is not seen in Fig. 8 because the relatively high input impedance of the curve tracer results in a voltage jump at the peak and valley points.)

Too small a value of $(R_1 + R_2)$ (or R_s) can also lead to oscillations because some parasitic inductance, as well as capacitance, cannot be avoided. As both the circuit Q and ω are increased with decreasing R_s there exists a minimum R_s below which the oscillations cannot be avoided.

The sweep circuit can be used to much greater advantage than is immediately apparent. As has been mentioned, the presence of oscillation can easily be seen. In addition, the circuit can be used to obtain visual indications of other r-f signals.

Figure 9 shows the pip or beating between the self-oscillating tunnel diode and a high-frequency injected signal. Since the diode voltage (and negative conductance and capacitance) is changing at a 60-cps rate, the self oscillating frequency is being frequency modulated.

Figure 10 shows the result of mixing where the signal injected is the output of the input stage of a superregenerative receiver (a series of r-f bursts). This allows using a tunnel diode as a relatively narrow-band (10-mc at 100-mc) spectrum analyzer.

The averaged-out effects of r-f input are shown in Fig. 11 where the effect on the apparent characteristics of modulated r-f is illustrated. When two r-f signals are mixed in a tunnel diode, the negative conductance amplifies the resultant output as well. This leads to application in "reflexed" receiver circuits.

The effect of voltage on frequency of oscillation leads to the usual f-m oscillator applications. By impressing an audio signal current across R_s, 100-mc f-m oscillators have been built. The signals are amplitude modulated as well, but another tunnel diode can be used as an amplitude-limiter to eliminate this effect.

Detectors

Both tunnel diodes and backward diodes have such a low crossover voltage that an immediate application is evident as a low-level r-f detector and voltmeter rectifier. When the circuit shown in Fig. 12 was used, some effects were observed which may lead to further possible applications.

Figure 13 shows the d-c output as a function of r-f input. In some instances, one mv of r-f gave 50 mv of d-c output. Most significant is the r-f level at which the effect occurs. The backward diode presents the same phenomenon, but to a lesser extent. This may be because the nature of the characteristic in the crossover region of both will produce a gradual buildup of charge on the capacitor with time, thereby leading to d-c voltages which can exceed the peak r-f swing.

The very large d-c output after an r-f threshold has been reached suggests applications in amplified or augmented agc control circuits. The fact that the d-c output is nonlinearly related to the r-f amplitude may limit straight rectifier-detector applications. However, it should be possible to parallel the diode with a suitable resistor so that the conductance in the active region of both is slightly positive, thereby approaching ideal rectifier characteristics.

In addition, the characteristics displayed in Fig. 13 have two straight-line segments on a log/log plot. This suggests some additional uses in analog circuits.

Oscillators

To date tunnel diodes have been operated as sinusoidal oscillators in a transmission-line structure up to fundamental frequencies of kmc. It is noted that as nonlinear analysis shows, the device can generate so many harmonics and subharmonics, as well as all the cross products of these frequencies, determining what is the fundamental frequency can be a problem.

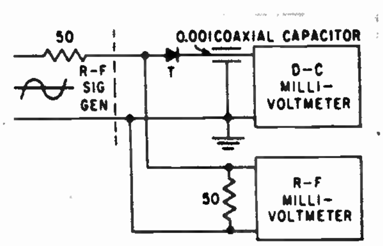

FIG. 12—R-f rectifier test circuit makes use of tunnel diode

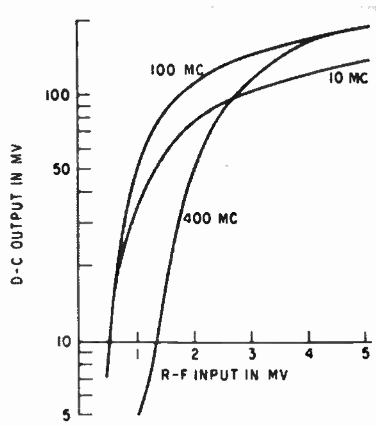

FIG. 13—Graph shows d-c output as function of r-f input for tunnel diode low-level rectifier

Figure 10 should not, therefore, be taken to mean that the tunnel diode was oscillating at 365 mc but only that the diode was detecting it. The fact that the local oscillator can pull the tunnel diode oscillator when using superheterodyne detection techniques and that the negative conductance may cause an absorption wavemeter to oscillate (or the tunnel diode oscillator may track the detector when using tuning stubs), demands some strenuous countermeasures to avoid confusion. Using suitable attenuators to decouple the oscillating and measuring circuits will prove helpful.

Strong harmonics of a 300-mc oscillator have been observed to greater than 2 kmc (frequency being limited by the detection system at hand). Some of this energy may of course be coupled into a resonant cavity and utilized.

Relaxation oscillators have been built and observed to 10 mc. Since the oscilloscope used has only a 30-mc bandwidth, odd harmonics of any frequency greater than 10 mc would be very rapidly attenuated. However, there is no reason to suppose that this is by any means a

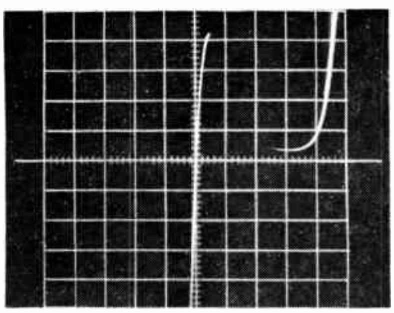

FIG. 8—Typical tunnel diode characteristic is shown with 0.2ma/div vertical scale and 0.1 v/div horizontal scale

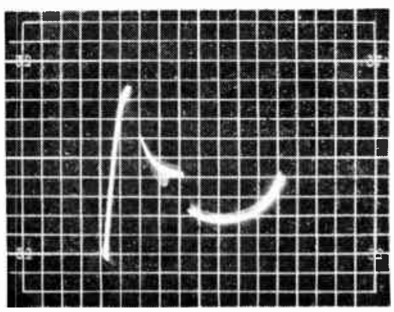

FIG. 10—X-Y sweep (self-oscillating with 10 $\mu\mu$f across diode) shows beat with 365-mc output of receiver

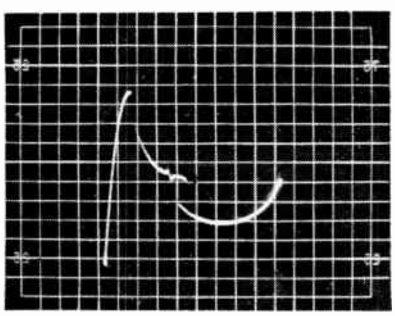

FIG. 9—X-Y sweep (self-oscillating with 10 $\mu\mu$f across diode) shows pip with 730-mc r-f signal

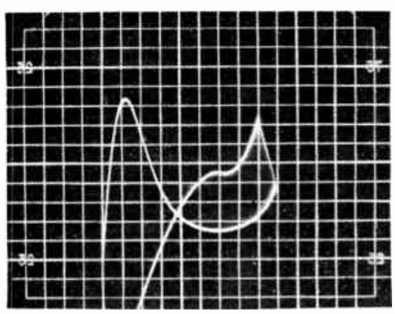

FIG. 11—Change in apparent characteristics with 70-mv, r-f (200 mc), 100-percent, 1-kc modulation

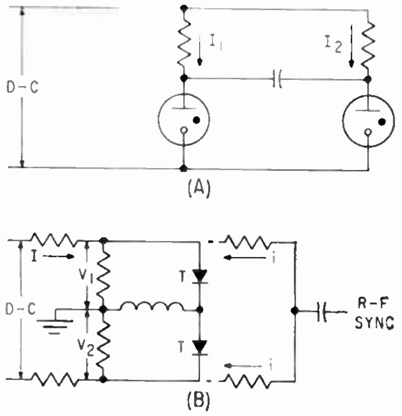

FIG. 14—Gas tube free-running multivibrator circuit (A) is basis for tunnel diode dual circuit (B)

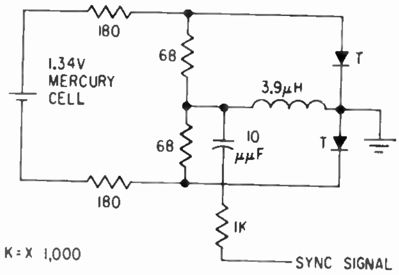

FIG. 15—Ten-mc multivibrator uses two 1 ma, —0.01-mho tunnel diodes

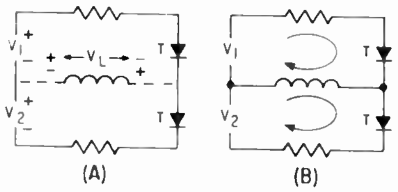

FIG. 16—Free-running tunnel diode multivibrator equivalent circuit during switching (A) and dwell (B) periods

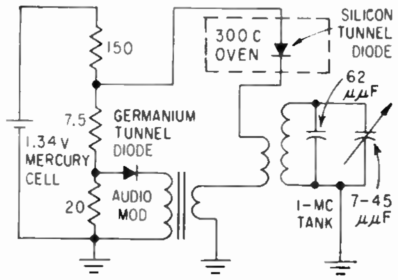

FIG. 17—Audio-modulated, 1-mc tuned oscillator circuit withstands wide temperature range

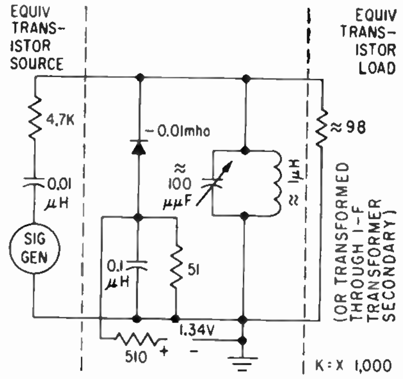

FIG. 18—Tunnel diode 445-kc amplifier has approximately 20-db gain

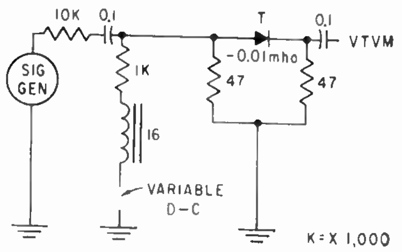

FIG. 19—Tunnel diode audio amplifier

limit. In fact from the mathematics and the harmonic content of our 300-mc oscillator, this too is likely to be of the relaxation type of operation.

Coupled Pairs

The relaxation oscillator leads one naturally to apply two such units as some form of multivibrator. From an analysis of the familiar *n* type free-running neon tube multivibrator shown in Fig. 14, the obvious tunnel diode dual circuit was obtained.

We have found little difficulty in constructing the 10-mc free running multivibrator shown in Fig. 15. Pulling effects have been observed on this multivibrator with 200-mc sync signals, but we cannot be sure of the effects since the scope used will not see the sync signal. However this leads one to expect that 30 and even 50-mc operation is possible.

Figure 16 illustrates the two conditions that exist for the tunnel diode multivibrator circuit. The first condition (A) is during switching when the current in the inductor does not change. Condition (B) is the dwell period when this current does change. From (A) it can be seen that the current change in both tunnel diodes must be the same. This change together with the voltage appearing across the inductor steers the direction of switching. Since current in the diodes can change, the gyration is not quite that of a relaxation oscillator.

From Fig. 6 it can be seen that sensitivity can be improved at the expense of frequency response by having R_s approach $|R_n|$. The operating time will be affected by the d-c bias level.

By suitably increasing R_s and adjusting the bias conditions the free-running multivibrator can be converted into a stable flip-flop for counting and logic circuits.

Transistors are obvious drivers for tunnel diodes and the reverse is also true. Many such applications can be visualized in logic and switching circuits. Small-signal combined circuits can be anticipated where the best features of both are used to maximum advantage, or where the interaction of both will produce unique applications impossible for either alone.

To demonstrate the versatility of tunnel diodes in oscillators, as well as their temperature range and freedom from surface effects, the audio modulated 1-mc tuned oscillator shown in Fig. 17 was made. The silicon tunnel diode, with no surface protection, may be dipped in liquid nitrogen (77 K), placed in a furnace at 300 C, and immersed in acid, the effect being only a minor change in oscillator and modulation frequencies.

Use of tunnel diodes in amplifiers is shown in Figs. 18 and 19.

The authors wish to acknowledge the contributions of R. N. Hall, J. J. Tiemann and C. S. Kim, and the assistance of G. K. Wessel, H. A. Jensen, S. F. Bevacqua and Mrs. M. Roehrig.

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R. L. Batdorf, An Esaki Type Diode In InSb
H. S. Sommers, Jr., and H. Nelson, Tunnel Diodes as High Frequency Devices.
R. N. Hall and J. H. Racette, Tunnel Diodes in III-V Semiconductors.
J. J. Tiemann and R. L. Watters, Noise Considerations of Tunnel Diode Amplifiers.
N. Holonyak, Jr. and I. A. Lesk, Anomalous Behavior of Silicon Tunnel Diodes at Low Temperatures.

Inorganic Insulations For High Temperatures

Hope for electrical insulations that can withstand continuous operation at 500 C and above is offered by inorganic, ceramic-type materials. Here is a listing of some now being used and under developmen'

By E. J. CROOP and C. H. VONDRACEK, Westinghouse Electric Corp., Pittsburgh, Pa.

ELECTRICAL EQUIPMENT for aircraft, missiles, rockets, and nuclear reactors requires electrical insulation which will perform reliably at high ambient temperatures. Operational capability over a temperature range from −65 C to greater than 500 C is now a common objective.

Other environmental conditions which must be met are nuclear radiation, vibration, mechanical shock up to 50 g or more, thermal shock, low atmospheric pressures equivalent to altitudes of 100,000 feet or more, and severe humidity. Problems created by these conditions combine to make selection of a successful insulation system difficult.

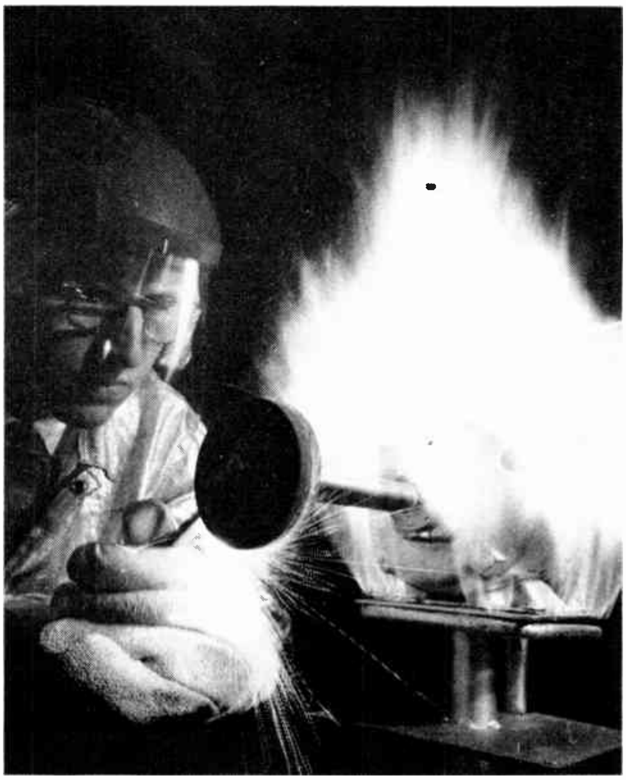
INORGANIC MATERIALS—Hope for successful electrical insulation is offered by inorganic, ceramic-type materials. They have one serious drawback, however—extreme inflexibility. Mica, the most widely used and accepted inorganic insulation, dehydrates at temperatures in excess of 600 C, depending upon the specific type. The desirable properties of asbestos also begin to deteriorate at these temperatures.

Unfortunately, work of the past fifty years has yielded practically no flexible ceramic-type materials. Therefore, to use these inorganic materials, it is necessary to engineer around the inflexibility. This means that in general the inorganic materials must be applied in a form in which they are flexible or viscous and then converted by a chemical reaction or other means to a strong rigid state.

TYPES OF INSULATION—Electrical insulation materials can generally be classified into the following categories: conductor insulation; potting, encapsulating, and impregnating compounds; reinforced structural materials; and flexible sheet insulation.

Table I which compares inorganic, silicone and organic materials shows some of the requirements and properties of electrical insulation. In a table of this type it is difficult to state a single representative value for each property, since the properties of individual types of materials vary widely. Most of the values listed are for room temperature. At higher temperatures up to 500 C most of the materials deteriorate to some extent, although deterioration is most pronounced in organic and silicone materials.

Table II shows the different types of materials



Hot Test: **This one-half horsepower induction motor, conventional except for the bearings and a completely inorganic electrical insulation system, survived more than 500 hours operation at 500 C. The insulation materials, developed at Westinghouse, were based on the use of a phosphate solution as a binder in combination with glass cloth, mica, and various refractory fillers**

which are now being used or which are under development as high temperature insulation.

CONDUCTOR INSULATION—The combination of high temperatures and severe mechanical stress produces undesirable interactions between conductor insulation and conductor metal. For specific design purposes, therefore, a careful analysis not only of the insulation materials but also of the conductor metal is imperative.

Aging for even short periods at temperatures in the vicinity of 500 C will decrease the conductivity of common conductor materials such as copper and copper alloys. Silver and nickel-plated copper offer most promise as high conductivity materials for operation at this temperature.

Relatively new conductor combinations such as nickel-copper alloys, stainless steel-clad copper and Inconel-clad copper have improved resistance to aging but at a sacrifice of electrical conductivity. When plated or clad conductors are exposed to high temperatures the protective metal diffuses into the conductor metal and vice versa, resulting in a brittle, weak and low-conductivity conductor.

GLASS-SERVED WIRE—By careful designing, conventional glass-served wire has been used successfully in apparatus operating at 500 C. Unfortunately, however, glass will react with silver at 600 C and above, causing severe embrittlement of the silver. Most glasses containing alkali metal oxides will not only embrittle silver but will also become conductive at high temperatures.

Even with wire served with a glass fiber contain-

Table I—Requirements for High Temperature Insulation

PROPERTIES	Required	Inorganic	Silicone	Organic (Phenolic)
GENERAL PORPERTIES				
temperature limit (C)	500–5,000	700	180–250	150
specific gravity	low as possible	1.9–2.5	1.6–2.0	1.75–1.95
moisture resistance				
initial	excellent	fair	good	good
after thermal cycling to 500 C	excellent	fair	poor	poor
flexibility				
sheet insulation and wire	excellent	good	excellent	excellent
thermal conductivity				
(10^{-4} cal/sec/cm² per C/cm)	high as possible	13.4	7.5	10–15
heat distortion (C)	500	600	250–500	300–450
burning rate	none	none	none to slow	none to slow
ELECTRICAL PROPERTIES				
electric strength				
short time, vpm at room temperature	200–500	100	250–400	110–370
vpm at 500 C	200–500	400	50	50
power factor (60 cycles)	low as possible	0.008	0.004–0.03	0.001–0.03
volume resistivity (ohm-cm)	10^{14}	10^{9}	10^{10}–10^{11}	10^{11}–10^{12}
dielectric constant (60 cps)	low as possible	7.0	3.0–5.0	7.1
arc resistance (secs)	420	420	20–250	4–150
MECHANICAL PROPERTIES				
tensile strength (psi)	high as possible	2,000	30,000	10,000
compressive strength (psi)	high as possible	15,000	10,000	40–80,000
flexural strength (psi)	high as possible	3,000	30,000	40–70,000
impact strength (ft lb/in of notch)	high as possible	0.4	5–15	10–40
CHEMICAL RESISTANCE				
sunlight	none	none	none to slight	darkening
organic solvents	none	none	attacked by some	none
weak acids	none	slight	none to slight	none to slight
weak alkalies	none	none	none to slight	none to slight
ozone	none	none	slight	slight
RADIATION RESISTANCE				
beta	excellent	good	fair	fair
gamma	excellent	very good	poor	poor
neutrons	excellent	fair	very poor	very poor

ing little or no alkali metals an additional inorganic treatment is usually required. The served wire is first impregnated with ceramic materials; only after the treated wire is used in a particular piece of apparatus is the unit fired to convert the insulation into a hard mass.

METALLIC OXIDE COATINGS—Anodized aluminum as well as other metallic oxide coatings are attractive for high temperature insulation. However, these oxides have not yet proven to be flexible and their electric strength has seldom been greater than that of air, particularly after thermal aging. Their advantage is that the insulation barriers are thin and have excellent space factors.

POTTING MATERIALS—As with conventional electrical insulation systems, impregnation or potting with suitable bonding materials not only retains wound coil structures in rigid configurations, but also improves the resistance of the coils to moisture and mechanical shock. However, in place of conventional low viscosity organic varnishes and resins, researchers are trying to develop low viscosity glassy materials.

Unfortunately, most low temperature fluxing agents contain lithium, sodium and potassium ions, and though these fluxing agents usually produce low melting points and low viscosities in glassy mixtures they also increase the electrical conductivities. Thus, the search for ideal glass compositions continues.

PORCELAIN ENAMELS—Porcelain enamels might be used for encapsulating and impregnating materials as well as for conductor insulation except that, as with glassy materials, their fluxing agents produce low resistivity at high temperatures. These enamels are inflexible and crack readily even in extremely thin films. Work is in progress to develop enamels with nonconducting fluxes.

REINFORCED GLASS—Inflexible glassy impregnating materials require reinforcing to withstand severe vibration and shock. Presently under development is a process whereby wound coils are treated with inorganic materials which when fired result in a nonshrinking, highly rigid, mechanically strong body. This body is then coated with powdered glass, the composition of the glass and body being controlled so that subsequent firing produces a moisture-resistant structure of excellent physical strength.

REINFORCED STRUCTURAL MATERIALS—Materials used for potting and impregnating compounds, combined with refractory reinforcing materials, can also be used for some structural applications such as terminal boards, coil forms, and other molded configurations. However, each insulation system requires a particular combination of reinforcing material and potting compound to yield the desired reinforcing structure.

Inorganic molding composition reinforced with glass cloth has been fabricated into flat sheets and tubes. Available materials such as the electrical grade fused ceramics do not lend themselves readily to certain configurations and processing requirements.

FLEXIBLE SHEET INSULATION—At moderate temperatures, mica bonded with organic resins has performed quite well as a thin-sheet insulation material. Mica bonded with inorganic materials is also an excellent thin-sheet insulation for temperatures below the dehydration temperatures of mica.

To withstand higher operating or processing temperatures, it may be necessary to use synthetic mica. Experiments have indicated that metal oxide layers such as anodized aluminum may be suitable for this purpose.

Table II—Materials Used or Under Development As High Temperature Insulation

WIRE INSULATION
- silicone enamels
- anodized aluminum
- ceramic coatings
- glass coatings
- glass-refractory coatings
- manufactured or processed fibers
  - (a) glass
  - (b) quartz
  - (c) asbestos
- inorganic fluoride films

POTTING MATERIALS
- silicones, inorganic filled
- ceramic castables
  - (a) chemical set
  - (b) air drying
- glass coating
- glazes

STRUCTURAL
- devitrified glass (pyroceram)
- fused ceramics
  - (a) alumina
  - (b) Fosterite
  - (c) steatite, etc
- glass-bonded mica
- inorganic laminates

SHEET INSULATION
- mica paper, silicone bond
- mica paper, inorganic bond
- asbestos, inorganic bond
- manufactured inorganic fibrous paper
  - (a) aluminum silicate
  - (b) quartz
  - (c) leached glass

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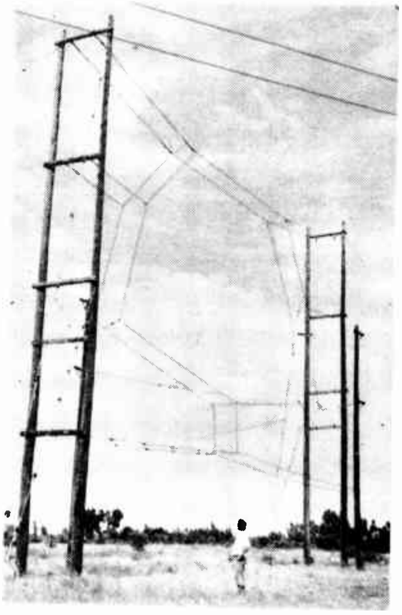
Ganging Transmitters

Radio-frequency combining network enables four transmitters on same wavelength to operate into a common antenna to raise power



General view of the 4-transmitter combiner

Growing use of high power in international broadcast bands and added jamming activities have made it desirable that a method be devised to allow increasing power output of transmitters on certain channels. Consequently, experiments have been conducted at the Gloria, Portugal transmitter plant of RARET (Radio Free Europe) to determine the feasibility of combining the output of four transmitters into one antenna.

Envisioned was a system using existing transmitters and construction of a combining network using linear elements to isolate one transmitter from another. A combiner was indicated because output terminals of the transmitters are separated by several wavelengths. It was feared that merely to parallel transmitter outputs at a common point might result in excessive voltages or circulating currents in some of the transmitter tank circuits during periods of adjustment or in event of failure of one transmitter during combined operations, due to the impedance transformation effects of the connecting lines between the transmitters.

Arrangement

Basic scheme of the combining network is an arrangement whereby electrical distances between any input connection and any other input connection are an even number of half wavelengths through one path and an odd number of half wavelengths through another, making it impossible to feed power from one input connection to another. Output connection is located at a point where the power of each transmitter adds to the others in phase.

Dummy load is also provided to dissipate power during tuning and prevent high circulating currents in the combiner in the event of improper phasing between transmitters or upon failure of any transmitter. With proper phasing and power balance no power is dissipated in the dummy load.

Preliminary experiments using two 15-mc 100-kw transmitters working into a linear combiner composed of 600-ohm transmission line elements disclosed no abnormalities of operation in the transmitters nor any difficulties in the combiner because of high circulating currents or voltages.

It was decided to proceed with construction of a combiner with four input terminals. This combiner took the electrical form of a pentagon, each side of which was 180 degrees in electrical length (Fig. 1). Transmitters were fed into the combiner at *E*, *D*, *G* and *F*, load connections were taken off at *A* and *C*. Phasing of the transmitters determines how the power divides between the output connections, and proper phasing and power adjustments of the transmitters will cause the combined power to flow into whichever output terminal is desired with little or no power appearing at the alternate output terminal. Figure 2 shows computed voltage, current and impedance conditions existing on the combiner when using four 100-kw transmitters as power sources.

Computations showed use of 4/0 stranded wire would prevent corona on 600-ohm lines at 400-kw power levels; therefore the combiner was constructed using this wire spaced 99 cm. Regular 16-in. antenna strain insulators were used to support elements.

Element lengths were calculated assuming a propagation constant of 0.98. Later measurements indi-

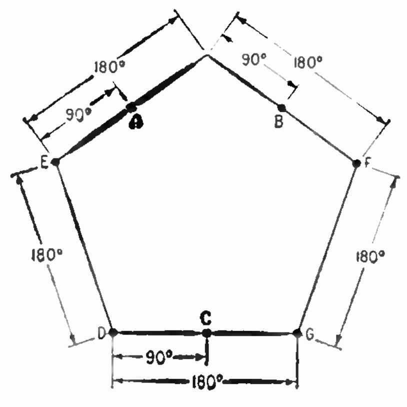


FIG. 1—Electrical phasing of combiner

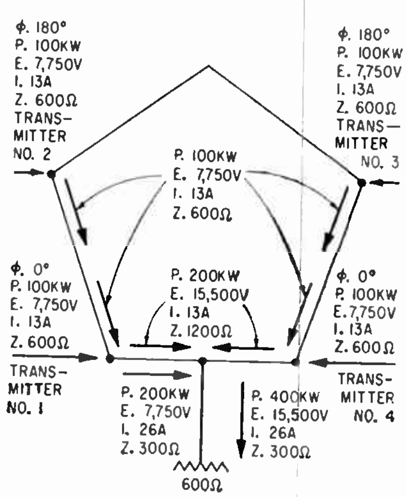


FIG. 2—Computed voltages, currents and impedances with four 100-kw transmitters

to Overcome Jamming

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cated this constant was too low and a value of 1 should have been used. The experimental combiner, Fig. 3, was built to operate at 15,265 kc.

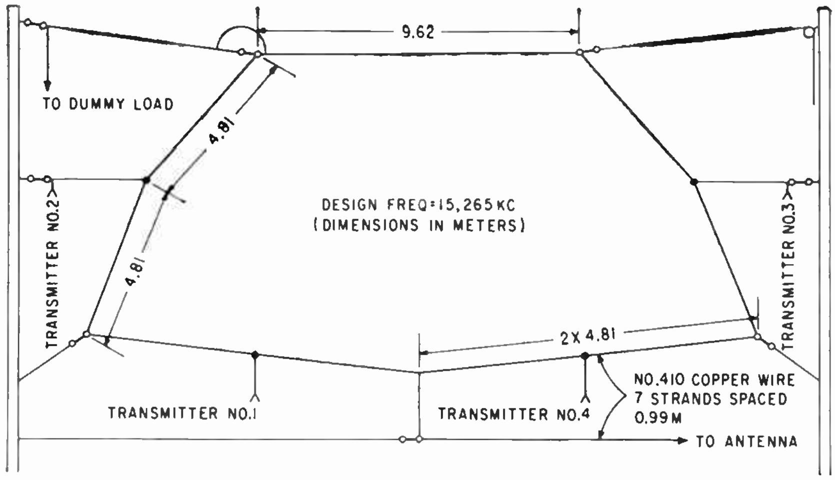

FIG. 3—Structural design data of combiner

Tuning

For tuning, the dummy load is connected to point *A*, Fig. 1. No power is delivered to the load when proper tuning is achieved. A sampling loop on the transmission line to the dummy load was connected to an RG/17U coaxial cable feeding an oscilloscope at the phasing control point in the transmitter room to facilitate tuning. Point *B* could have been used for connection, pairs *AC* or *BC* being possible combinations of antenna-dummy load connection points. In each pair of points, either one can be used as antenna or dummy load connection points requiring only that proper phase relationships between transmitters are maintained.

Combining was accomplished in three steps: phase of transmitters No. 1 and 2 adjusted for maximum signal amplitude in the oscilloscope; phases of No. 3 and 4 adjusted for maximum signal amplitude; and phases of group No. 1 and 2 in relation to group No. 3 and 4 adjusted for minimum amplitude.

It may be preferable to tune transmitters No. 1 and 3 for minimum power in the dummy, then No. 2 and 4 for minimum, and finally Group 1-3 against 2-4 for minimum power in the dummy. Other combinations also are possible.

Transmitters were connected to the combiner through transmission lines of No. 2 Copperweld wire, spaced 40 cm. Combiner load was a ½-wave delta-matched dipole constructed of 2-in. copper tubing.

Four 100-kw transmitters 100-percent modulated were successfully combined on 15.265 kc. Approximately 2 kw of power was dissipated in the dummy load. No corona was observed in the combiner or associated lines or load at any time during the tests. To simulate conditions created by possible failure of one or more transmitters in combination, one, two and three transmitters were turned off. Effect on the remaining transmitters was merely one of changing load. Only a small amount of power was observed on lines to the disabled transmitters. Output quality of the transmitters, as monitored on a receiver, was good.

Operation of the combiner over the 15.1- to 15.45-mc band was studied from theoretical and practical standpoints. Electrical length of the half-wave elements making up the combiner varies only ±2 degrees when going from center

Table I—Admittance vs. Frequency for Transmission Lines

Freq (mc)	G (mmhos)	B (mmhos)	SWR
Transmitters No. 1 Feed Line			
14.5	0.69	−0.23	2.45
14.6	0.85	......	1.93
14.7	1.09	+0.14	1.55
14.8	1.51	+0.05	1.10
14.9	1.66	−0.18	1.10
15.0	1.66	−0.33	1.20
15.1	1.54	−0.53	1.40
15.3	1.23	−0.53	1.60
15.4	1.05	−0.39	1.78
15.5	0.94	−0.24	1.82
15.6	0.82	−0.10	2.02
Transmitter No. 2 Feed Line			
14.6	1.10	+0.23	1.58
14.7	1.44	+0.32	1.29
14.8	1.72	+0.28	1.18
14.9	1.94	......	1.13
15.0	1.87	−0.11	1.13
15.1	1.67	−0.29	1.18
15.2	1.48	−0.19	1.18
15.3	1.34	−0.19	1.28
15.4	1.24	......	1.37
15.5	1.21	+0.21	1.41
15.6	1.19	+0.39	1.55

Table II—Standing-Wave-Ratio on Combiner Input-Output Lines

	Transmitters Operating		
	1	3	2
15,265 kc			
Out Line...	1.25	1.31	1.13
In Line 1...	1.36	1.12	1.96
In Line 2...	1.28	1.37	.
In Line 3...	1.22		
In Line 4...	2.24	8.5*	8.4*
15,115 kc			
Out Line...	1.34	....	....
In Line 1...	1.41	....	....
In Line 2...	3.63	....	....
In Line 3...	1.53	....	....
In Line 4...	1.43	....	....
15,405 kc			
Out Line...	1.1	....	....
In Line 1...	1.58	....	....
In Line 2...	1.17	....	....
In Line 3...	2.86	....	....
In Line 4...	6.1*	....	....

* Cause of high swr not determined

frequency to band edges. This difference is small and results in insignificant diminution of power delivered to the antenna and resultant circulating currents in the whole system. However, at 11 and 17 mc, circulating currents and voltages are of such magnitude that operation becomes impractical. Admittance versus frequency measurements made on two of the transmitter feed lines are shown in Table I.

Bridge measurements were made on the line from transmitter No. 1 by opening all other transmitter feed points and substituting 150 ohms for the antenna load. Similar measurements were made on the line of transmitter No. 2.

Graphs of these measurements are shown in Fig. 4 and 5. The curves have similar shapes, although the values for the transmission line of transmitter No. 1 are somewhat less ideal. It is believed that a sharp turn in this feed line may have caused this difference. Measurements also show that the optimum working frequency of the combiner is between 14.9 and 15.0 mc instead of the 15.265-mc design frequency.

The propagation constant of 0.98 apparently is too low for 4/0 wires spaced 99 cm. Use of a factor of 1 in the computation would make the present dimensions of the combiner correspond to 14.96 mc. Considering this the center frequency, width of the 15-mc band would then correspond approximately to 14.8-15.2 mc. In this band the swr in the line of transmitter No. 2 is below 1.2. In the line of transmitter No. 1 it is higher but, as stated, believed not the fault of the combiner.

Initially, attempts were made to make swr measurements by actually measuring transmission line voltages with a vtvm. Readings were made using the four 100-kw transmitters. Since an appreciable length of time is required to combine these transmitters, all measurements on one frequency could not be made during the same night. Data from one night to the next were not consistent, probably because conditions of combining were not exactly duplicated. The 100-kw transmitters had no provision for varying loading from front panel and difficulty was experienced in balancing power outputs. Subsequently, four 50-kw transmitters having provision for varying loading from front panel were combined and swr measurements made on transmission lines during combined operations. Results of these tests are shown in Table II.

Power in various lines was measured and is shown in Table III as a percentage of total power input to the system. Plus signs indicate power flowing toward the combiner, minus signs away.

The amount of power fed back to a transmitter which has been turned off is a small percentage of the power in the system and is not likely to damage circuits in the shut-down transmitter.

Table III—Percent Total Power with 4, 3 and 2 Units

	Transmitters 1, 2, 3, 4 Operating	Transmitters 1, 2, 4 Operating	Transmitters 1 and 4 Operating
Load	−94	−81.5	−75
Dummy Load	− 6	−16.4	−15
Line 1	+22.6	+11.6	+70.7
Line 2	+27.5	+37.8	− 7.3
Line 3	+26.5	− 2.1	− 2.7
Line 4	+23.4	+20.6	+29.3

Conclusions

To make the system operational, provision for automatic control of phase of the transmitters and an easy method of adjusting individual transmitter loading should be provided.

Dummy load used with the combiner was composed of four 650-foot lengths of 3x No. 10 Copperweld wire stretched eight inches above ground and spaced 20 feet. These strands, when connected two in multiple to each side of the 600-ohm dummy-load line from the combiner, furnished a load with 1.2 swr and on several occasions dissipated over 200 kw. It did not matter much if the ends of the lines were open or grounded as little power got that far. It was possible to touch the dummy antenna lines near the ends even with 200 kw being dissipated.

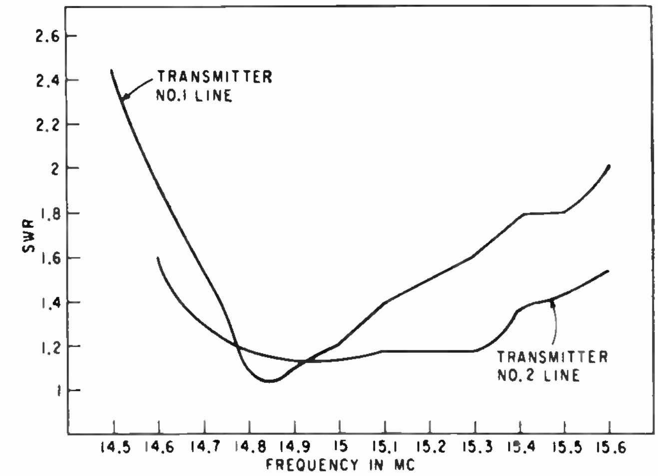

FIG. 4—Standing-wave ratio against frequency characteristics of four-transmitter combiner measured on transmission lines No. 1 and 2

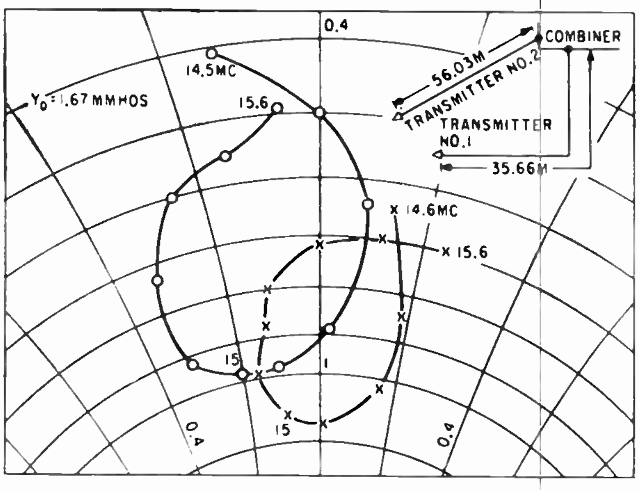

FIG. 5—Smith chart showing admittance against frequency measurements on combiner. Open-dot curve transmission line No. 1; checked curve transmission line No. 2

Finding Radio-Frequency Interference Levels

Here's how to estimate intermodulation products imposed on a transmitted frequency by an interfering transmitter

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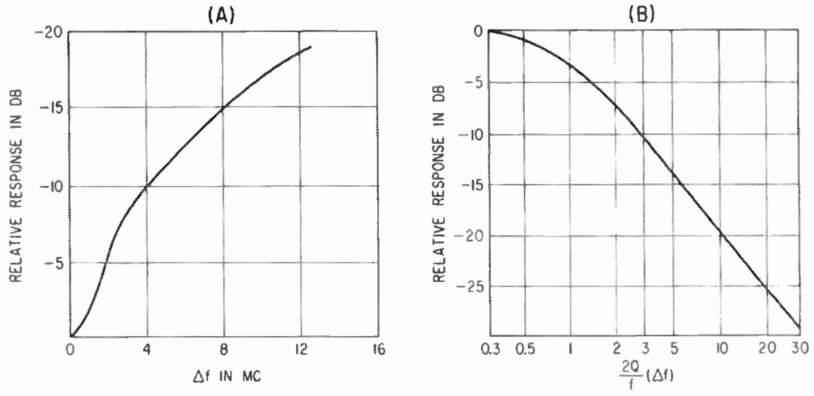

FIG. 1—Curves used to obtain S_f, the rejection factor. Frequency response of output tank (A); and universal Q-factor (B)

WHEN TWO transmitters operate on frequencies relatively close together and there is enough mutual coupling, intermodulation results. The products of intermodulation constitute a serious waste of r-f spectrum. Their existence prohibits the use of these frequencies by receivers in the general area and in many cases, contaminate these channels at great distances from the transmitters.

Reducing Intermodulation

Suggested methods for reduction of r-f intermodulation are usually based on reducing the amplitude of the interfering signal reaching the output tank of the power amplifier. These methods are geographical separation, frequency separation and use of highly selective elements in the transmission line.

Geographical separation is not always possible, and is seldom practical in military applications. Doubling of the intervening distance for each 6-db improvement could rapidly lead to the need for additional frequencies to provide communications between transmitter sites. Providing frequency separation with large guard bands is also a poor solution since this reduces the usable spectrum. While the use of selective filters in the transmission line is an ideal answer from the point of spectrum utilization, it complicates the transmitter and where high power levels are present, may introduce more distressing problems in other areas.

To a great degree, r-f intermodulation can be "designed away" in a power amplifier. A number of papers have described the problem of r-f intermodulation and have demonstrated the frequency pattern of the products.[1-2] One paper describes a method of predicting intermodulation-product levels is based on extrapolation from measured conversion levels.[3] However, in order to "design away" r-f intermodulation susceptibility it is desirable to be able to deal with the parameters determining intermodulation magnitudes.

Intermodulation Process

In describing this process let us consider the products generated in a single transmitter by a neighboring transmitter. Call the neighboring transmitter the interfering transmitter. Call the transmitter being examined the interfered transmitter.

Let A be the frequency of the interfered transmitter. Let B be the frequency of the interfering transmitter and let B be lower than A by Δf.

The products generated in the tank of A are $A - 2B$, $2A - 3B$, $3A - 4B$, $4A - 5B$, etc. and $2A - B$, $3A - 2B$, $4A - 3B$, $5A - 4B$, etc.

Here, for example, $2A - B = A + \Delta f$, and $3A - 2B = A + 2\Delta f$.

Only the lower of the side band pairs are considered since the upper frequencies are well out of the pass band of transmitter A.

Consider the tank circuit of a vacuum tube amplifier to contain a number of frequencies (even though the tank impedance is optimum for only one of these frequencies), each having an amplitude at least an order of magnitude greater than some interfering signal whose frequency is close to the natural frequency of the tank. Such an interfering signal will amplitude-modulate all these frequencies, producing equal side bands regardless of the amplitude of the signals being modulated. Modulation introduced on the main-carrier frequency is not of consequence since the resulting side bands ($A + B$, $A - B$) are well out of the pass band of the tank response. The side bands falling close enough to the natural tank response to be considered are $2A - B$, $3A - 2B$, etc. and $A - 2B$, $2A - 3B$, etc. Since the harmonics of the relatively minute interfering signal decrease rapidly in level with increase in order, the third order side band, $2A - B$, is predominant and of primary consideration.

Modulation is produced by the interfering signal appearing on the plate of the tube. Since this interfering frequency is close to the carrier frequency of the interfered transmitter, assume that the interfering signal is transformed and coupled in the same degree as the carrier. The amplitude of the signal reaching the plate of the output stage is reduced by the selectivity of the tank as is the $2A-B$ product in being transmitted to the antenna. Amplitude of the side band (determined without correction for tank selectivity) depends on the levels produced by interfering frequencies centered around B which approach the carrier frequency. The amplitude of the side tones is independent of the signal amplitude being modulated as long as the modulating signals are of small amplitude compared to the modulated signals. Where amplitudes are comparable, significant higher-order side bands will result and the conversion factor for the third-order product will decrease since a significant portion of the modulating energy must be diverted to the higher order tones.

If the antenna of transmitter A is isolated from transmitter B by a space loss of M, then the power delivered into the transmission line of A due to B is $P_c = P_b - M$. The generated intermodulation product has a power level

$$P_r = P_b - M - (C + S_t)$$

at the output transmission line of transmitter A. The conversion loss of the modulation process is described by C. Term S_t is the rejection of the incoming signal plus the rejection of the intermodulation-product frequency due to the selectivity of the amplifier tank circuit. Thus the parameters describing the intermodulation characteristics of a transmitter are C and S_t. Since the intermodulation-product frequency considered is equal to $A + \Delta f$ and B frequency is equal to $A - \Delta f$, S_t can be expressed as twice the attenuation offered to either frequency by the selectivity of the loaded tank circuit (with symmetrical selectivity).

If a small signal of amplitude e_i is coupled into the output transmission line of a transmitter, the voltage transformed into the output tank of the amplifier is e_{pi}, where

$$e_{pi} = e_i \times (R_L/R_t)^{1/2} \qquad (1),$$

where R_t is the transmission-line impedence and R_L is the source resistance of the transformed voltage, e_{pi}. In defining R_L, we account for the losses encountered by the interfering signal due to plate efficiency and tank losses. Therefore,

$$R_L = \text{Power Out}/(I_p)^{1/2} \qquad (2).$$

The degree of amplitude modulation is dependent on the amplitude of the interfering signal and the modulation characteristic of the tube. In any vacuum tube the operating point is in constant motion but an average value for the modulation characteristic will furnish a reasonably accurate parameter. A suitable value for the dynamic plate resistance, r_p, may be obtained by taking the inverse of the dynamic conductance i_p/e_p averaged over 360 deg of the fundamental signal. Thus, the total usable sideband power is

$$P_s = (e_{pi})^2/r_p + R_L \qquad (3).$$

Since, in the modulation process, the lower side tone can account for only half of this power, the power of the $2A—B$ product, P_c, is expressed

$$P_c = (e_{pi})^2/2\,(r_p + R_L) \qquad (4).$$

From Eq. 1,

$$P_c = (e_i)^2\,R_L/2\,(r_p + R_L)\,R_t \qquad (5).$$

The conversion factor K, which is the ratio of the output sidetone power to the interfering signal

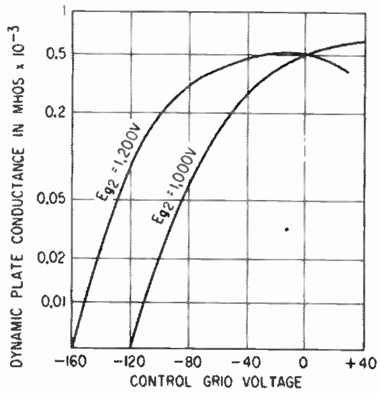

FIG. 2—Dynamic plate conductance of the 2029 tetrode

Table I—Power Amplifier K Values

Δf (mc)	S_t (db)	K (db) (calculated)	K (db) (measured)
2	8	24.1	23.2
3	17	33.1	35.8
5	24	40.1	40.5
10	33	49.1	49.6

power expressed in db, is therefore

$$K = 10 \log \left[\frac{(e_i)^2 R_L/2(r_p + R_L)R_t}{(e_i)^2/R_t} \right] - S_t \qquad (6).$$

or more simply,

$$K = 10 \log\,[R_L/2\,(r_p + R_L)] - S_t$$

The process of r-f intermodulation by an interfering signal in a klystron can also be analyzed by this method. The value of r_p, however, must be determined by the power relations of a beam passing through a modulating gap. These relationships have been adequately described in the literature and expressions to relate the impedance of the beam in the gap to the d-c beam parameters can be utilized.[4]

Determination of S_t

The value of S_t is most simply derived by measurement of the output-tank selectivity. Power output is measured with the output tank tuned to some center frequency while the grid circuit and driving frequency are tuned over a band around this frequency in discrete steps. If the grid drive is made equal for all measurements then the comparative response at each step is the ratio of the output power to the center-frequency power. A curve of such a response is shown in Fig. 1A. The value of S_t at any frequency is twice the value of this power ratio, which is expressed in db. This curve can be calculated but the accuracy required does not normally warrant the effort.

In general, the Q of a loaded tank circuit can be measured or calculated and used to determine S_t for each frequency separation by referring Q to a universal response curve for a single tuned circuit (Fig. 1B). When computing intermodulation conversion for various tube parameters, it is important to measure or compute the loaded Q under each operating condition since this will vary Q considerably. However, an approximate extrapolation from a single Q measurement generally gives good accuracy. Extrapolation can be made on the basis of power output and plate current by assuming that the d-c plate current is a reasonable measure of tank-circuit energy. Since $Q \propto$ tank-circuit v-a/power output,

$$Q_1/Q_2 \propto [(I_{p1})^2/P_{o1}]/[(I_{p2})^2/P_{o2}].$$

This relationship permits using an already-determined parameter, R_L, so that $Q_2 = Q_1\ (R_{L1}/R_{L2})$. The factor $2Q/f$ is computed and response can be determined from Fig. 2 for each value of Δf. The value of S_t is, then, twice the attenuation of the calculated response.

Dynamic Plate Resistance

The dynamic plate resistance, r_p can best be evaluated graphically. Once operating parameters of the tube are established, instantaneous values of plate current over a complete r-f cycle can be tabulated. The E_p—I_p curves of the tube are then consulted and a value of dynamic plate conductance is computed for each value of plate current. The reciprocal of the average plate conductance equals r_p.

In a tetrode, where the slope of the E_p—I_p curves is nearly constant over the entire plate voltage swing, a plot of dynamic conductance as a function of plate current can be easily derived, as in Fig. 2. This facilitates more rapid computation where intermodulation characteristics are examined under various operating conditions.

From the standpoint of intermodulation suppression, the primary characteristic to be considered in the tube type to be used as final amplifier is the dynamic plate resistance. For this reason, a tetrode is highly recommended as a final amplifier.

In evaluating an amplifier for its intermodulation susceptibility, the effects of the conduction angle should be carefully examined. The dynamic plate resistance increases as the conduction angle is decreased. This shows that an intermodulation susceptibility improvement could be achieved with very hard class

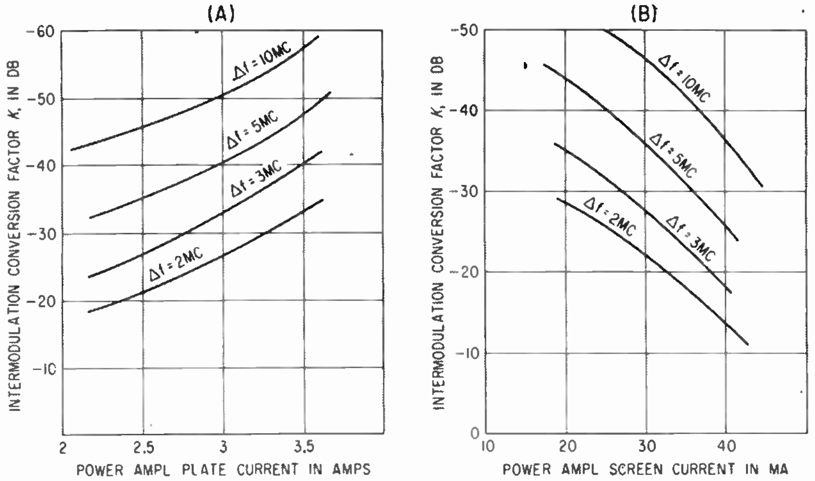

FIG. 3 —Intermodulation-conversion factor, K, plotted against plate current (A) and screen current (B)

C operation. However, decreased conduction will decrease the loaded Q of the tank, since closer coupling to the output transmission line will be required. Lower Q reduces the side tone attenuation offered by the tank selectivity and increases R_L. Both of these results will increase intermodulation susceptibility.

Thus, an amplifier should be examined to determine the best region of operation. Optimum conduction angle may fall anywhere between zero and 360 deg. Optimum operational parameters may represent a considerable compromise on other operational requirements. A desirable intermodulation characteristic must be evaluated with respect to the operational environment of the amplifier. Very slight variations of parameters and tuning procedures can greatly help.

A power amplifier with a 2029 tetrode in the output stage was examined for intermodulation properties by the method described above. The amplifier delivers 20 kw over the 225 mc to 400 mc range and has the capability for a-m or f-m. In its a-m mode, a class-C intermediate power amplifier stage is plate modulated and the final stage is operated as a class-B linear stage. Table I shows the calculated intermodulation-conversion values for a number of frequency separations compared to the measured values for each separation. These calculated values were determined by Eq. 1 through 6 and a measured amplifier.

Analysis of this output stage indicated that improvement in intermodulation susceptibility required a larger conduction angle than the normal 180 deg. of class-B operation. The intermodulation-conversion parameter for a 10-mc separation was computed to be 40 db for class-C operation and 55 db for class-AB operation.

The 2029 tetrode has a large dynamic plate resistance even when operating in the class-AB region. Thus improvement of increased plate resistance with a smaller conduction angle is greatly outweighed by the decrease in tank selectivity. It is likely that overall improvement through class-C operation comes only with a triode stage.

Increasing the conduction angle increases the tank Q for an amplifier stage since the ratio of tank volt amperes to output power is increased. A plot of the change in intermodulation conversion resulting from this effect for a tetrode amplifier is shown in Fig. 3A.

The effect of driving a tetrode plate into the region of screen potential is shown in Fig. 3B. Screen current is used as an indication of depth of plate swing.

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Computing Transistor Switching Dissipation

By DONALD W. BOENSEL, Member of Technical Staff, Space Electronics Corp., Glendale, Calif.

An important problem in using transistors as switches is to determine maximum performance as a function of parameters such as load power, switching frequency and ambient temperature. In any case, collector junction temperature usually dictates maximum performance. Factors contributing directly to a rise in junction temperature are components of dissipated power resulting from such imperfect switch characteristics as OFF leakage current, ON saturation resistance, and nonzero turn-on and turn-off times.

To calculate transistor switching dissipation, assume that a generalized switching circuit may take the form shown in Fig. 1A and that the idealized output voltage and current waveforms are adequately represented by those shown in Fig. 1B. The subsequent analysis assumes the following: input dissipation is negligible; R_{sat} is determined by I_+ and load current V_c/R_L; turn-on and turn-off times (δ) are related to I_+' and I_-'; input peaking transients essentially reach completion regardless of drive frequency.

Also assume that $R_L \gg R_{sat}$, $I_{co(max)} \ll V_c/R_L$,

$$\beta = \alpha_o(1 - \alpha) = \beta_o'(1 + S/\omega_\beta)$$

$$I_{co}(T_j) = I_{co(25C)}2^{K_L(T_j - 25)}$$

The thermal resistance from collector junction to ambient consists of ρ_d (the resistance from junction to heat sink), and ρ_s (the resistance from sink to ambient). For most applications, the sum of these, ρ_t, can be treated as constant. Thus

$$T_j = T_{amb} + \rho_t P_c \quad (1)$$

Average collector dissipation per cycle is given by the sum of four components. This expression

$$P_c = \frac{1}{\Delta}(E_{on} + E_{off}) + \frac{V_c I_{co}(T_j)}{2} + \left(\frac{V_c}{R_L}\right)^2 \frac{R_{sat}}{2} \quad (2)$$

assumes that Δ, the period of the excitation, is much greater than the sum of δ_{on} and δ_{off} and that the drive is symmetrical (*off* interval = *on* interval). Energies dissipated during turn-on and turn-off are E_{on} and E_{off} respectively.

In any switching circuit designed to achieve reasonably efficient operation, input peaking is used to improve switching times; this condition means that $\beta_o I_+'$ and $\beta_o I_-'$ are $\gg V_c/R_L$.

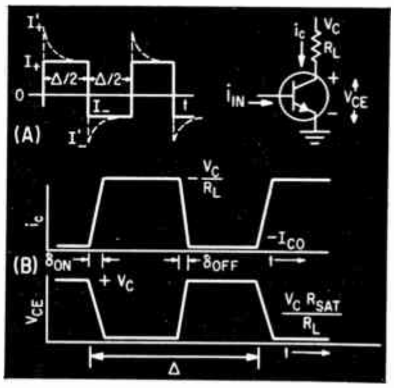


FIG. 1—Switching circuit (A) and assumed output waveforms (B)

Table I—Symbols

R_{sat}	saturation resistance
I_+	steady-state *on* base current
I_+'	peak turn-on current
I_-'	peak turn-off current
I_{co}	reverse saturation current
β_o	l-f common-emitter gain
S	$j\omega$, at the frequency of β
ω_β	beta cutoff f in rad/sec
T_j	collector temp in deg C
T_{amb}	ambient temp in deg C
K_L	0.07 for Ge, 0.11 for Si
ρ_t	deg C/w
P_c	collector power dissipation, w
P_L	peak load power, w

Thus transition times are

$$\delta_{on} \simeq [(V_c/R_L)/(\beta_o I_+')](1/\omega_\beta) \quad (3A)$$

$$\delta_{off} \simeq [(V_c/R_L)/(\beta_o I_-')](1/\omega_\beta) \quad (3B)$$

During transitions, therefore, collector current and voltage can be represented by simple linear time-varying expressions. For turn-on

$$i_c = [(V_c/R_L)/(\delta_{on})]t \quad (4A)$$

$$v_{ce} = V_c(1 - t/\delta_{on}) \quad (4B)$$

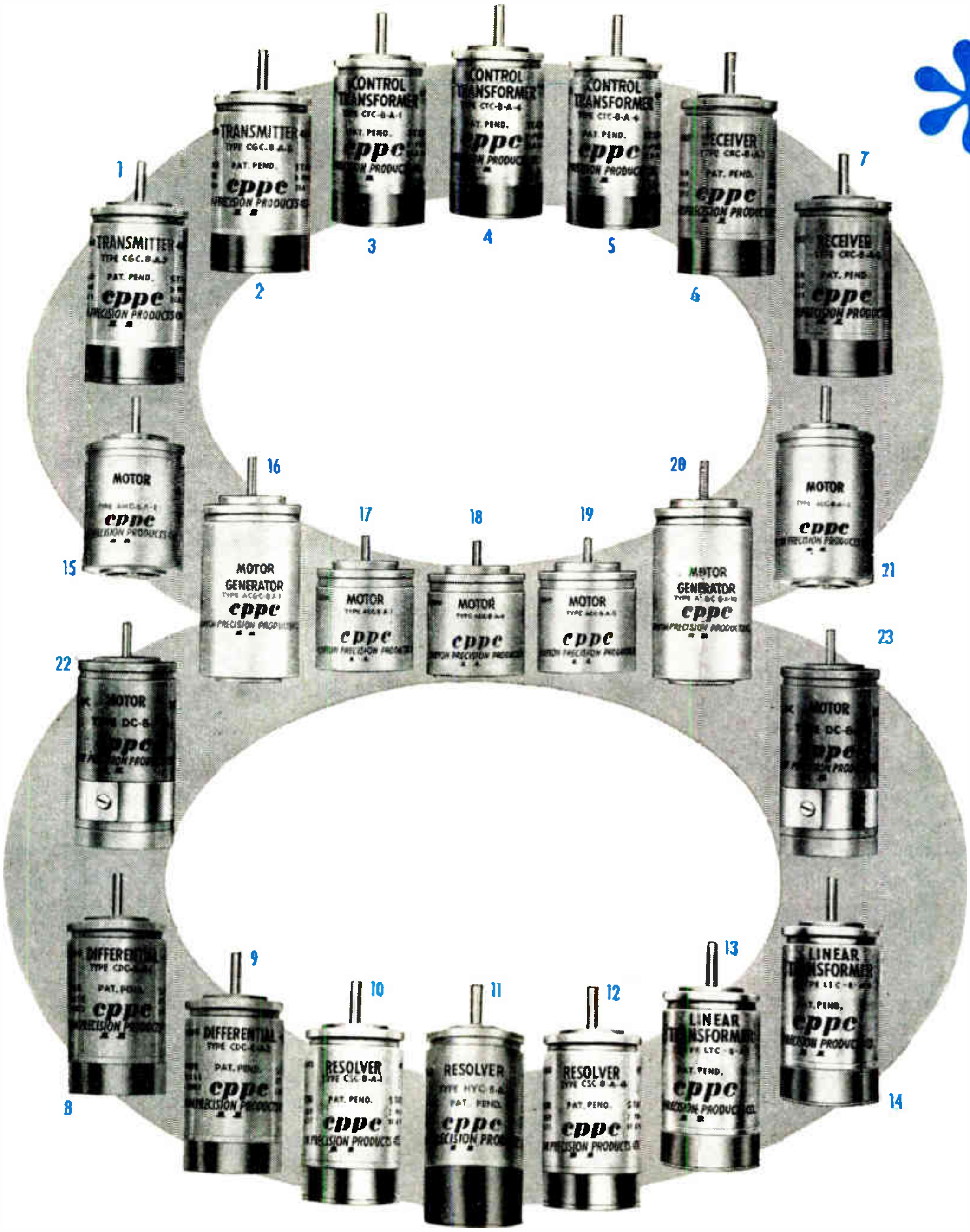
For turn-off:

$$i_c = (V_c/R_L)(1 - t/\delta_{off}) \quad (5A)$$

$$v_{ce} = (V_c/\delta_{off})t. \quad (5B)$$

When integrated over the transition intervals, Eq. 3, 4 and 5 lead to

$$E_{on} = [V_c^3/(6R_L^2\omega_\alpha)]/I_+'$$



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$$E_{eff} = [V_c^3/(6R_L^2\omega_\alpha)]/I_-'$$

where $\omega_\alpha = \beta_o\omega_\beta$ is the normal alpha cut-off frequency in radians/sec.

Although there are a number of possible combinations of knowns and unknowns in Eq. 1, it is practical to treat only one representative set. One important situation is determining the trade-off between operating frequency and load power. A particularly convenient form of Eq. 1 for such a determination is

$$T_j = T_{amb} + [\rho_t P_L^2(K_1 f + K_2) + K_3 2^{K_L(T_j - 25)}] \quad (6)$$

where

$$K_1 = [(1/I_+') + (1/I_-')][\rho_t/6V_c\omega_\alpha] \quad (7)$$

$$K_2 = \rho_t R_{sat}/2V_c^2 \quad (8)$$

$$K_3 = \rho_t V_c I_{co}(25C)/2 \quad (9)$$

and variables are in v, amp, ohms, deg C radians/sec and cps.

Ordinarily, either a maximum junction temperature is specified for a particular device or a lower temperature limit is chosen for safety or reliability so that T_j is known. This, of course, also determines $I_{co}(T_j)$. Although it is apparent from Eq. 6, 7, 8 and 9 that V_c can be optimized to give a maximum fP_L, such a consideration is beyond the scope of this treatment. It will therefore be assumed that some arbitrary V_c is known, allowing calculations of K_1, K_2, and K_3.

The nomogram is an aid in calculating the bracketed terms in Eq. 6. Scales (1), (2), and (3) are used to find $K_3 2^{K_L(T_j-25)}$ and scales (3), (4), and (5) to find $P_L^2K_2$. The product $P_L^2K_1f$ is found with scales (5), (6), (7), (8), and (9). Although the product scales (3) and (9) have been limited to temperature terms from 1 to 100 C, scaling can be used to accommodate different P_L^2 or f ranges. Specifically for an n-decade increase in P_L^2, multiply (5) by 10^n and (6) by 10^{-n}. For an m-decade increase in f, multiply (8) by 10^m and (6) and (7) by 10^{-m}.

As an example of using the nomogram, consider the following problem.

A silicon transistor has $\omega_\alpha = 10^6$, I_{co} (25 C) = 1 ma, β_o = 100, R_{sat} = 0.1 ohm and ρ_t = 2 deg/w. Maximum T_j is 95 C and maximum ambient is 55 C. Determine the maximum average switched power obtainable from a 28-v supply at 100 kc with I_+' and I_-' limited to 1 amp apiece. Solving Eq. 7, 8 and 9

$K_1 = 2.4 \times 10^{-7}$, $K_2 = 1.3 \times 10^{-4}$ and $K_3 = 3 \times 10^{-2}$.

As shown by the dotted lines on Fig. 2, for

$$T_{jmax} - 25 = 70\text{ C}, \quad K_3 2^{K_L(T_j-25)} = 7\text{ C}.$$

Since K_2 is extremely small in this case, assume that it makes a negligible contribution to junction temperature. The maximum contribution of $P_L^2K_1f$ is obtained from

$$P_L^2K_1f \leq T_j - T_{amb} - K_3 2^{K_L(T_j-25)}$$
$$\leq 70 - 55 - 7 \leq 8.$$

The settings on scales (6), (7), (8), and (9) reveal that the maximum attainable power = $(3 \times 10^3)^{1/2}$ = 55 w, or an average load power of 27.5 w.

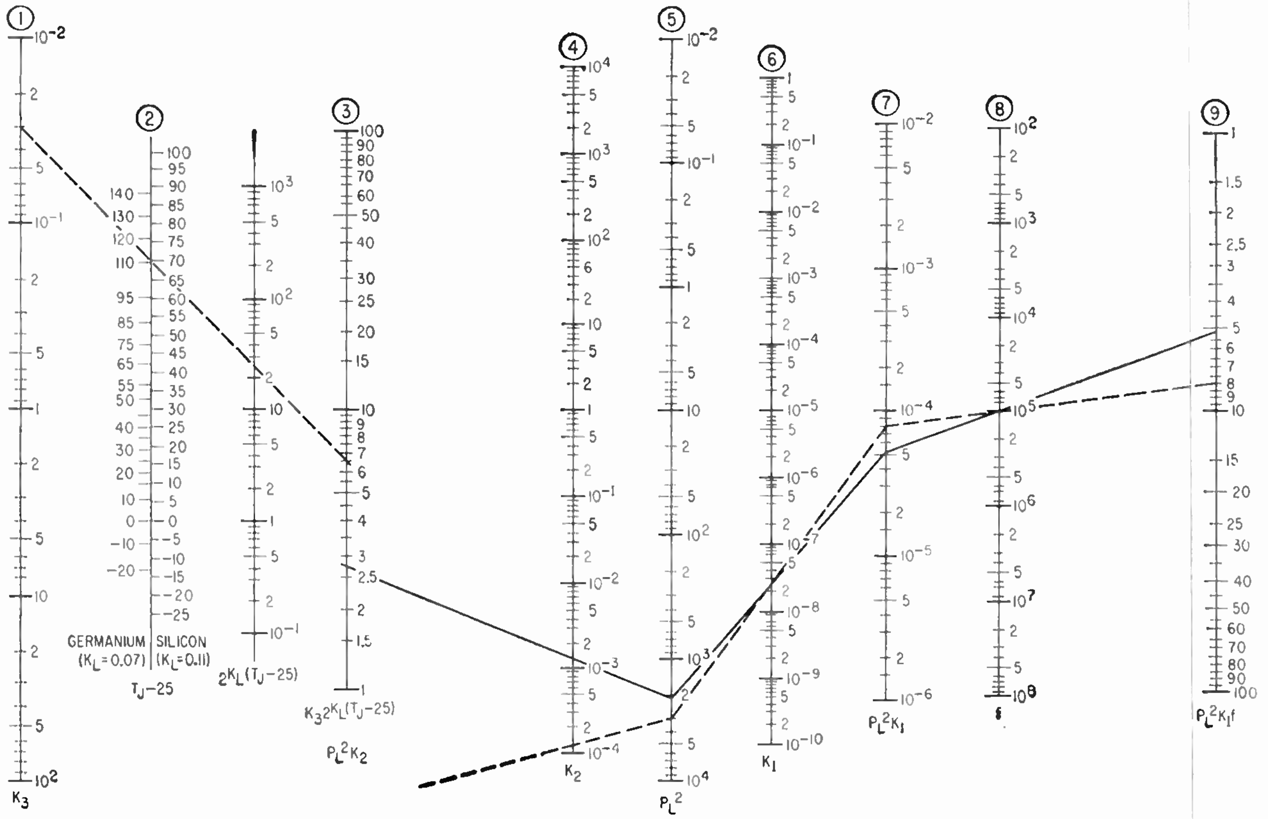


FIG. 2—Solid lines are for same problem shown by dotted lines, with R_{sat}=1 ohm

Switching System Uses Photo Memory

EXPERIMENTAL electronic telephone-switching system uses photographic plates in its permanent memory. The plates are exposed and developed automatically.

The permanent memory, developed at Bell Telephone Laboratories, stores such data as directory information and instructions for the electronic switching system. The information is in the form of thousands of clear dots on an otherwise opaque photographic area 2 in. sq. Seventeen areas are combined to make up a complete photographic plate, and the memory is comprised of four such plates.

Spot Scanner

The spots of clear and opaque film are scanned by a crt and focused by a system of lenses. Movement of the beam is controlled by an electronic and optical positioning system accurate enough to pick out on each area a particular spot location.

The flying-spot store contains over two million bits of information and can read out a 68-bit word every 2½ microseconds.

The moving beam is focused through an objective lens onto the photosensitive area. The spot scans the image area and stops briefly at positions where a spot exposure is desired. The photographic emulsion is slow enough not to be exposed by the passing of the beam alone, but requires the lengthened exposure of the pause.

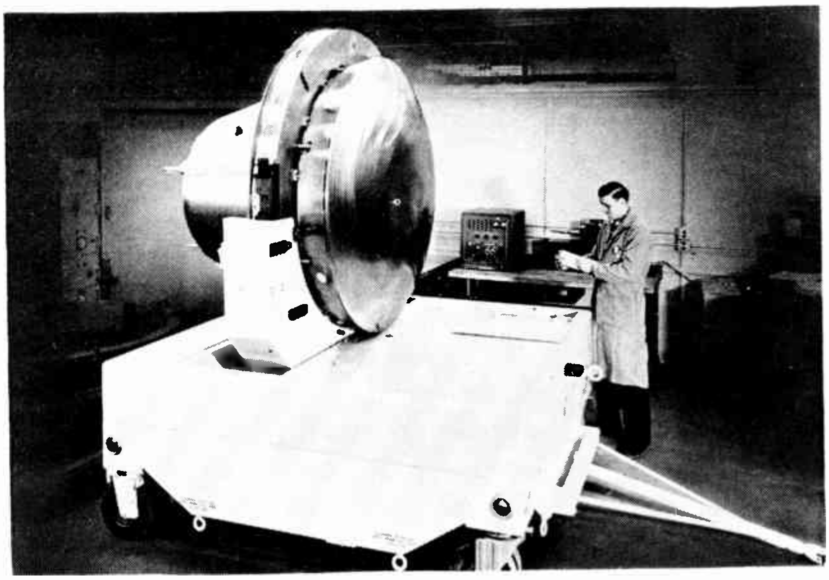
Each of the seventeen small areas on a plate is exposed individually, in sequence, while the others are covered by shutters. Automatic control allows an entire plate, containing 550,000 spot positions, to be exposed in less than three minutes.

After exposure, the plates are withdrawn from the memory unit in a dust and light-proof container and inserted into the automatic processor for developing and fixing. Two of the plates can be processed simultaneously.

Once the plates are in the processor, they are automatically dipped into one tank after another, depending on a predetermined schedule. As many as fifteen steps may be involved in a typical reversal processing schedule, and appropriate dwell times are set to allow proper processing.

After developing, reversal and fixing operations have been completed, the plates are rinsed and dried in filtered air, and delivered back into their container for reinsertion into the memory unit.

Instrument Balances Nose Cones



Weight and center of gravity locator developed by Dynametrics Corp. will be used for field evaluation of re-entry vehicles. To avoid disintegration of nose cones from shock and 15,000 F temperatures, re-entry attitude is determined from locator readouts of weight and center of gravity along roll, pitch and yaw axes

Adding Zener Diodes Stabilizes Pulses

By RONALD L. IVES, Palo Alto, Calif.

CONTROL and timing pulses transmitted over long capacitively isolated lines are often degraded. The initially sharp pulses become damped oscillations. This difficulty is most serious when prf is an integral multiple of resonant frequency of the transmission circuit.

Results of the line's affects are shown in Fig. 1A, in which the pulse has degenerated into a damped oscillation. In extreme cases, it may resemble that of Fig. 1B. If the trigger point of the receiving device is set at h, it will respond twice for each single pulse transmitted. This two-stepping is commonly eliminated by careful adjustment of receptor sensitivity.

Eliminating Oscillations

Experiments with a number of troublesome pulse-transmission circuits showed that a reverse diode eliminated the reverse-polarity waves. Additional work showed that a Zener diode, connected as in Fig. 2, not only eliminated the damped oscillations, but also regulated pulse height very

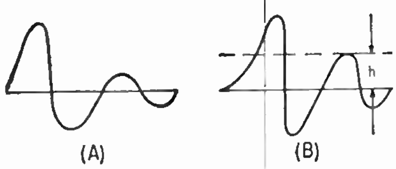


FIG. 1—Pulses transmitted over long capacitively isolated lines may come out as damped oscillations (A) or even exceed trigger level h at (B) of pulsed circuit

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satisfactorily. In practice, resistor R in Fig. 2 is the circuit resistance. Zener diode voltage is chosen to be slightly greater than optimum operating voltage of the receptor.

A circuit receiving a pulse shaped as in Fig. 3A is equipped with a Zener diode stabilizer. Result is a pulse shaped as in Fig. 3B with a maximum level equal to the Zener voltage and damped oscillations reduced to an almost undetectably small amplitude. Critical adjustment of receptor sensitivity is no longer necessary to prevent double-stepping, and overall performance through a wide range of prf's is greatly improved.

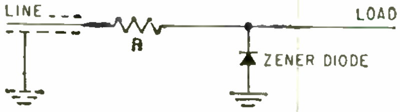

FIG. 2—Zener diode eliminates damped oscillations and regulates pulse height

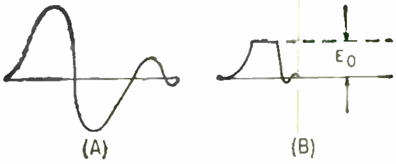

FIG. 3—Adding Zener diode to line producing pulses as shown at (A) results in pulses as shown at (B)

Direction-Finding Vans Are Used by Germans

IMPROVED equipment for locating radio interference has been developed in Germany. The Radio-Interference Branch of the German Federal Post Office is using interference-detecting vans.

Directional antennas mounted on the vehicles can be rotated at speeds up to 120 rpm (normal speed is 80 rpm). Receiving apparatus provides a frequency-panorama display and azimuth direction on crt's.

The relatively high rotation speed of the antennas and the possibility of making observations while on the move minimize the effects of spurious reflections of the signal being observed. An adjustable clipping circuit eliminates signals caused by secondary lobes.

In operation, information regarding the instantaneous direction of the antenna is transmitted in the form of a three-phase signal to the direction-finding receiver by a rotating-field device. A special circuit converts this signal to a four-phase signal to obtain a display on the screen in the direction corresponding to that of the antenna.

Persistence of the fluorescent screen is sufficient for normal antenna rotation speeds. A marker pulse indicates, on the frequency panorama, the frequency to which the direction finder is tuned.

In practice, a rapid change of bearing indicates the vehicle is passing close to a source of interference, which can then be fixed by the standard technique.

Automatic Neutron Activation Analysis

CHEMICAL analysis through neutron activation analysis has been made automatic by Shell Development Co. The new technique permits routine analysis in minutes of almost any material, such as metal alloys, plastics, ores and chemical compounds. Similar analyses by conventional techniques may take hours or even days.

Also, through neutron activation analysis, samples need no preparation and are left undamaged.

The test is based on the fact that no isotopes have identical gamma radiation and half life. By exposing a sample to neutron activation from a Van de Graaff accelerator and measuring gamma rays emitted with a spectrometer, radiochemists can identify and measure elements in the sample.

Neutron activation analysis has been used before but not where no chemical steps are needed.

Already technicians are doing routine analyses for 25 elements in various materials. The only apparent limitation to the technique is the classification of elements with a half life too short or too long for spectroscopic measurement.

The highly sensitive analytical technique can detect trace quantities as low as one part in 100 million. Type of analyses made thus far have been determining foreign materials present in plastic samples, number and kind of minerals present in crude oil from the well and foreign elements in catalysts used in petroleum-processing.

Space-Travel Generator: How it Works

A SMALL MOLDED QUARTZ generator, now in an aerosciences laboratory in Philadelphia, may be one solution to a major problem of extended space flight: How to create a power source that would supply a space vehicle with the current necessary for radio communication, electrical propulsion, light, heat and air conditioning; and keep within size, weight and efficiency specifications.

Successfully operated by General Electric's Missile and Space Vehicle Department, a working unit was developed less than a year after the company began studying the concept. The concept has been dubbed magnetohydrodynamics, or MHD.

What's MHD?

Magnetohydrodynamic power generation extracts electric current from the motion of an ionized gas, heated to about 5,000 F, and passed through a magnetic field. The process utilizes the same classic electrical phenomenon found in steam turbo generation: voltage is created when a conductor is moved through a magnetic field.

Heart of the power generator for space vehicles is contained in the small unit held in operator's right hand. This molded quartz unit will be mounted between the hollow graphite cylinders, on table in foreground, and will be secured in the steel casing between the magnetic poles

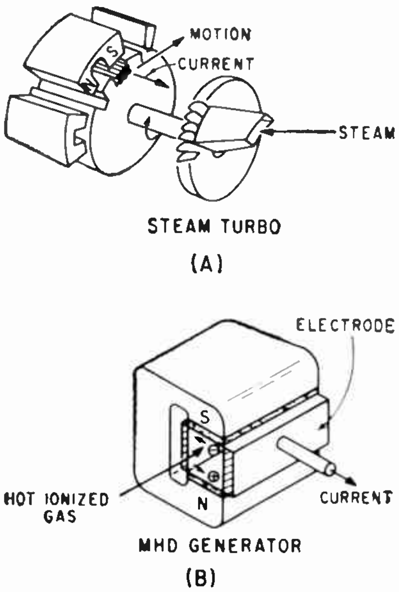

FIG. 1—In a conventional steam turbo (A) voltage is created when the copper wire spins through a magnetic field. The same effect is created in the MHD power generator (B) by directing a hot ionized gas through the magnetic field

In the steam turbo, Fig. 1A, the conductor is usually copper wire that is spun through a magnetic field by a turbine. In the MHD power generator, Fig. 1B, a very hot ionized gas such as superheated air, used as the conductor, is directed through the magnetic field where current is drawn off by electrodes. Here no moving parts are involved. The energy contained in a high temperature air plasma, consisting of ionized atoms and electrons, is converted directly into electrical energy. Lack of moving parts, high operating temperatures and compact parts mean that this type of generator has potential for great reliability.

Closed and Opened Systems

The high temperature air plasma used as the conductor may be obtained from an arc or burner. In the GE development, a huge electrical arc, jumped between two points, heats the air to around 5,000 F. When this plasma passes through a magnetic field in the direction shown in Fig. 1B, the conducting gas cuts lines of force and generates voltage within the gas. The electric power is extracted from the flow of electrons.

Magnetohydrodynamic power can be used in a closed system, Fig. 2A, where thermal power sufficient to heat and move the conductor gas could be provided by solar energy or a fusion device. The closed system could be used on extended space flights. In an open-cycle system, Fig. 2B, rocket exhausts could provide the current needed for short-time jobs on space vehicles that did not otherwise have sustained power requirements. Rocket motors now provide from one to three second operation, sufficient for example, to provide power to transmit a tv image from a space vehicle that has been placed on the moon.

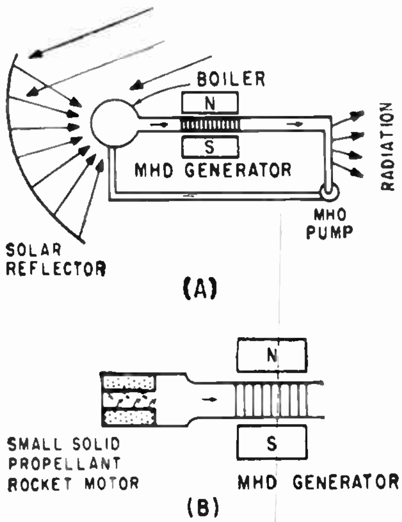

FIG. 2—A closed system for generating power might use a solar reflector (A) and the gas could be recycled. An open system, (B), would use the intermittent power provided by the exhaust gases of a rocket motor

This week, in a discussion with Leo Steg, manager of the GE Aerosciences Lab., ELECTRONICS learned several significant facts about the development. The unit could feed an auxillary power unit; could be used as an intermittent power source; or as a stationary power generator, the unit could be used as

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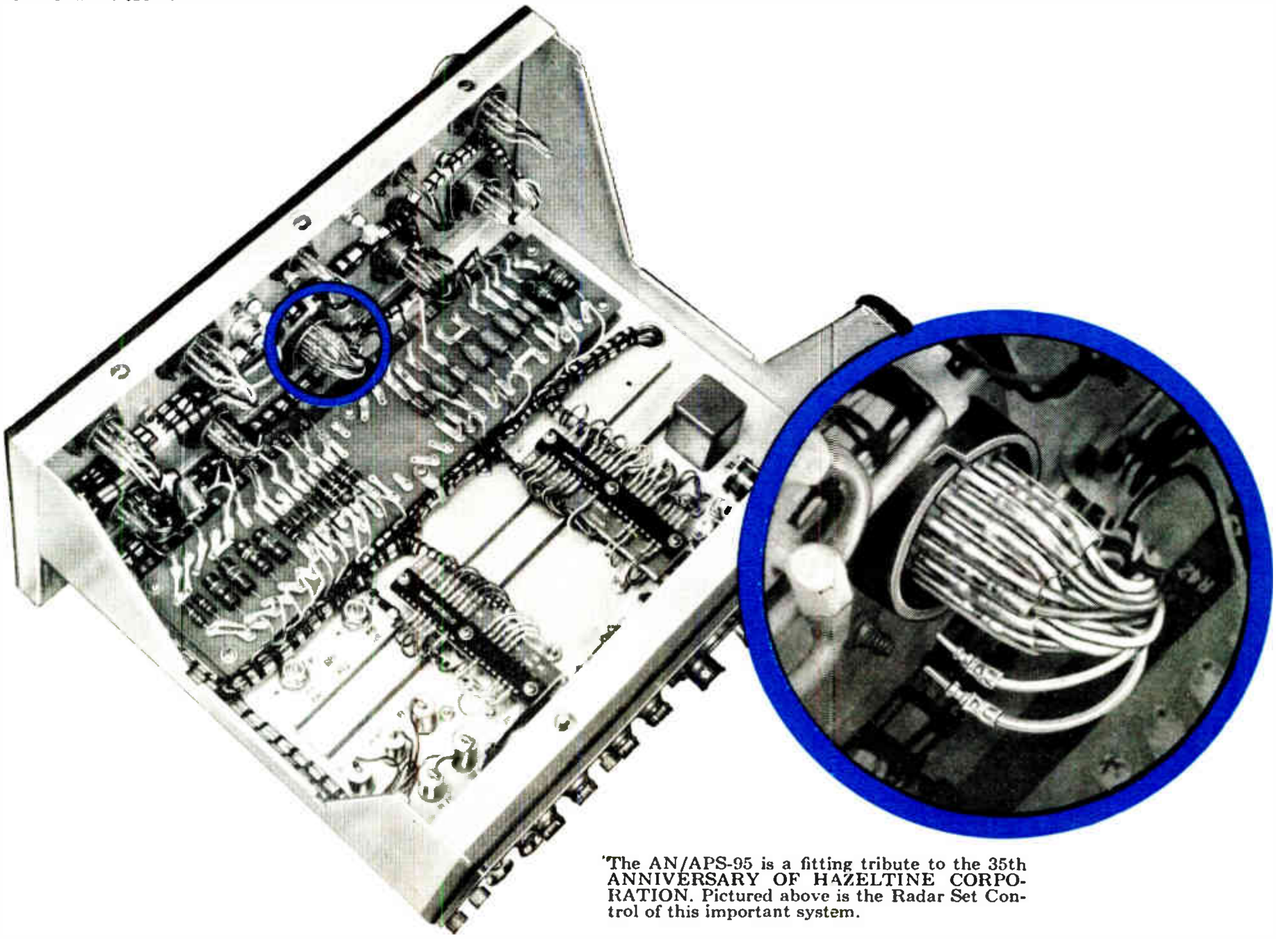

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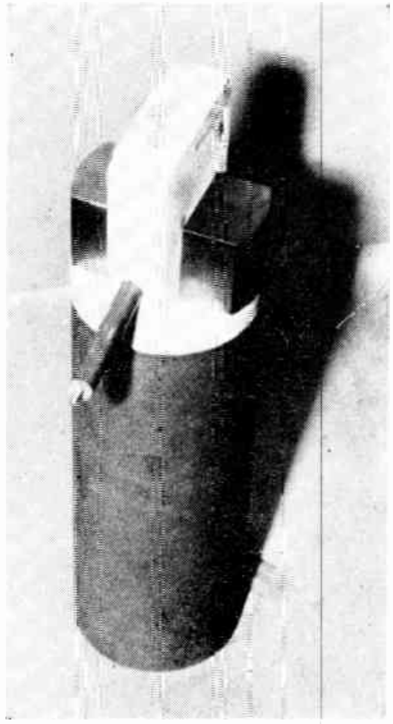
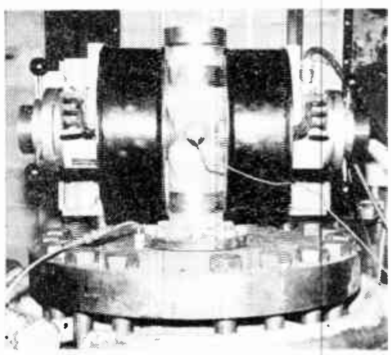


The white section, mounted on the graphite cylinder, is the molded quartz unit. The hollow cylinder directs hot ionized gases into the narrow channel of the generator. Metal blocks, flush against the sides of the generator, are the pole pieces that carry the magnetic field to the sides of the generator channel. The slender stick extending from the narrow side of the generator is a graphite electrode

a topping device. That is, gas from the MHD source could be used as an input to a conventional stationary power plant.

The technique will require considerable development and time before it may be applied practically to stationary power generation. According to Steg, the major problems now fall into these areas: materials, air flow control, and how to bring the temperature down. George Sut-

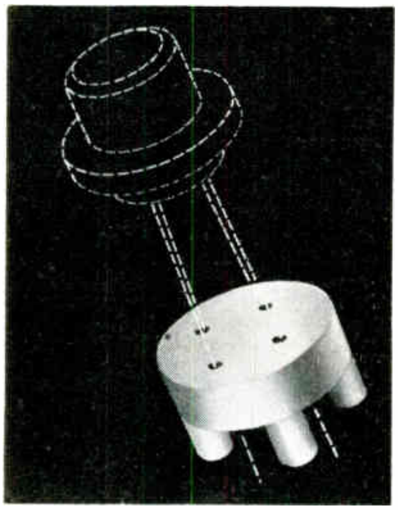


Cylinder containing generator is flanked by poles of an electromagnet. Current is extracted from the gas flow by electrodes on either side of the cylinder ton, project engineer for MHD at the Aerosciences Laboratory, and John McGinn and Willard Sutton, principal scientists concerned with the experiment also stated that refinement of the power source, development of high temperature materials and consideration of weight factors are the next steps in MHD for space power.

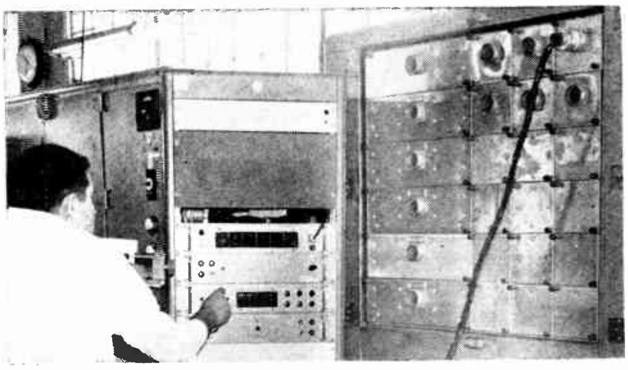
In tests made with the MHD unit, approximately one kilowatt of electrical power was obtained for a period of five seconds. In principle, a MHD generator can operate continuously by controlling gas flow.

Two years ago, scientists at the GE Research Laboratory announced the development of a thermionic converter for direct conversion of heat energy into electrical energy. Last year, the Company confirmed that they were working on chemical fuel cells that will be used for generation of electric energy.

Mounting Transistors



Injection-molded plastic transistor mounting pads, shown above, are designed to eliminate difficulties incurred in mounting transistors on etched circuit boards. The pads provide stable mounting for all Jetec 12 and 30 transistor cases. An air space protects the transistor from heat damage during soldering, and prevents entrapment of moisture at the base of the transistor. The pads are being made by Regan Plastics Corp., Glendale, California. Three designs are offered.



Modified environmental chamber and drawer-like fixtures permit automatic test measurements on as many as 2,000 components. Technician is using digital ohmmeter with automatic scan and printer

Component test fixtures are prepared on assembly line. Similar line is used to load components. Fixturing techniques save time, permit maximum utilization and versatility of environmental test equipment

Modular Fixtures Speed Testing

MODULAR FIXTURES permit environmental tests to be made on components with minimum handling, maximum use of environmental equipment and automatic methods of introducing electrical test conditions and gathering data.

The modular fixtures illustrated here, devised and used by United States Testing Co., Inc., Hoboken, N. J., are of two types: those used in environmental test chambers and those used on mechanical stress testers.

A chamber fixture is shown in Fig. 1 and the large photos. Each fixture holds an everage of 50 components enabling a single large chamber to hold approximately 2,000 components of various types.

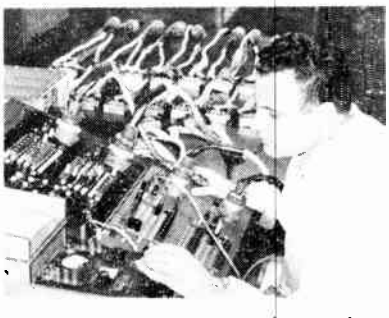
Insulated mounting posts with phosphor bronze contacts are fixed on an aluminum base plate. The end plate is 2.5 inches of pressed asbestos sheathed in aluminum. Shielded high temperature wire connections to the posts are harnessed under the base plate and brought to a gang connector in the end plate.

Environmental chamber doors are replaced with horizontal aluminum bars, drilled and threaded at intervals to provide 36 modular spaces. Openings not in use are closed with blank end plates. End plates are snugged in place with screw fasteners for rapid insertion or removal of fixtures and blank plates.

Electrical inputs required for tests are supplied through a patch board and a cable which plugs into the gang connector. From the patch board, another cable connects various test and data sampling instruments (Fig 2). Measurements may be made on each component individually, or in combination. Test circuits may be built into, or introduced through, the panels.

Preliminary and post-environmental tests are performed while the components are mounted in the

Patch panel at left is used to set up test conditions. Measurements will be made with equipment that automatically prints out data for each component in a fixture



Patch panel used in testing relays. Relays in background are still mounted in mechanical stress test fixtures which hold 4 relays each

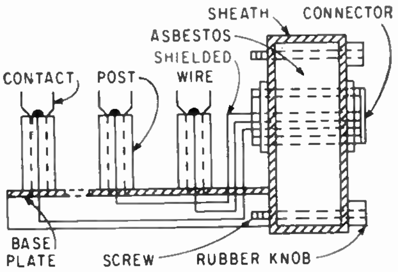


FIG. 1—Cross-sectional view of fixture used in test chamber

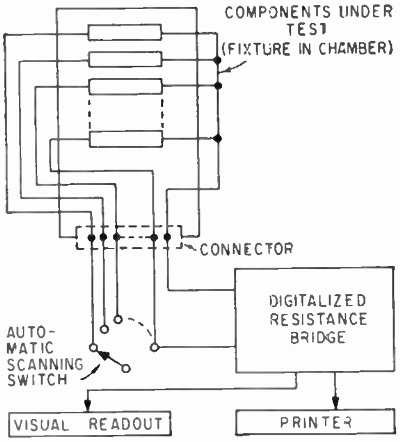


FIG. 2—Setup for automatically measuring group of components in chamber

OFFICIAL U.S.A.F. PHOTO
of the Atlas lift-off
at Vandenberg A.F.B.
on September 9, 1959.
This was the first official
firing by SAC crew to
test operational capability.

Many significant achievements will be added to those already recorded in the chronicles of military and scientific space technology. Many important milestones in the conquest of space will be passed. None, however, will surpass the realization of America's operational capability in Intercontinental Ballistic Missiles. The threshold of this phase of our national defense was passed on September 9, 1959, with the historic launch of an Atlas by a Strategic Air Command crew at Vandenberg Air Force Base, California. Measured by any standard no event could have been more timely... more rewarding.

Five years ago the free world had no functional ballistic missile rocket engines, no guidance systems, no nose cones, no tracking stations, no launching pads, no trained missile squadrons. Today all those who have contributed to this present state of operational reality may take justifiable pride.

In this effort, Space Technology Laboratories is also proud of its privilege in performing the functions of systems engineering and technical direction for the Air Force Ballistic Missile Division, in close and continuing cooperation with the Air Force Ballistic Missiles Center, Strategic Air Command-MIKE, and such major associate contractors as: Convair, a Division of General Dynamics Corp., for airframe, assembly and test; General Electric Co., and Burroughs Corporation for radio guidance; Arma, a Division of American Bosch Arma Corporation, for all-inertial guidance; Rocketdyne Division, North American Aviation, Inc., for propulsion; General Electric Co., for re-entry vehicle; and Acoustica Associates, for propellant utilization.

All have worked in concert, with vigor and dedication to the objective of providing the nation with this fundamental addition to its defense capability.

SPACE TECHNOLOGY LABORATORIES, INC.

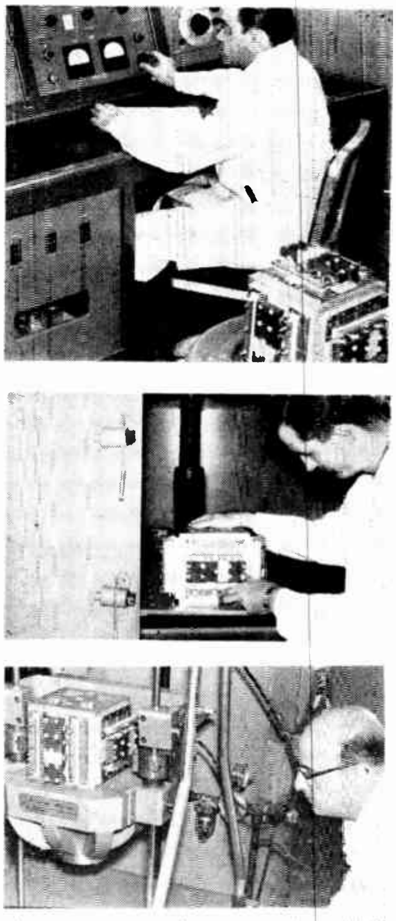
P.O. BOX 95004, LOS ANGELES 45, CALIFORNIA same fixture. Fixtures can be set up and loaded in advance, enabling test preparations to be made in an orderly, assembly-line fashion.

Additional lots of components can be inserted in the chambers without opening large doors and disrupting conditions. As long as environmental levels do not conflict, several different lots of components can be tested for varying time periods. High temperature cabling is not necessary. Test instrumentation can be designed for maximum versatility.

A similar principle is used for vibration, shock and acceleration testing fixtures. However, the number of components carried is generally less and fixtures can not be as standard because of such considerations as fixtures resonance.

The basic fixture is a cast magnesium cube with interior cavities to meet resonance and wiring requirements. Components are mounted on plates. The plates are screwed to the cube. The assembly is weight-balanced and tested for resonance before use.

Large components are mounted directly on the plates. If components are mounted by lead wires, leads as well as the component bodies are clamped between thick phenolic strips on the plate. Tracks are milled in the plate so the strips can be adjusted to various component widths. The leads of small or axial lead components are fixed to phenolic strips with glue (dissolvable, for later removal) and notched phenolic board is clamped tightly over the component bodies.



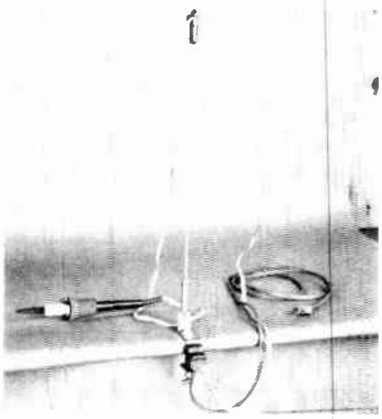
Plates containing large capacitors (held under notched phenolic plates) are mounted on 5 sides of magnesium cube. The cube assembly is mounted on a vibration tester (top), acceleration tester (center) and a shock machine

The same cube is then used on any of the mechanical environment equipment. Components also remain on the plate throughout pretests and post tests.

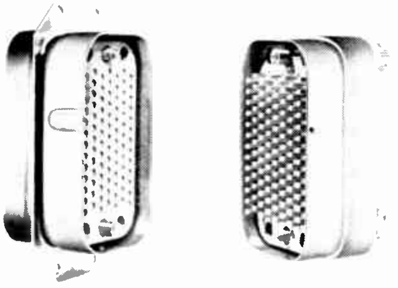
Homey Solution to Soldering Snag

SOLDERING IRON can be prevented from burning its own cord by using an ironing cord holder available at department stores. The cord holder is a rod attached to a flexible spring so it can bend in any direction. The bench clamp also contains an outlet for an extension cord.

Another advantage of the holder is that when soldering in delicate areas, the cord does not rest on the hand and hamper free movement of the iron. This idea was submitted by Ralph Rinaldi, of Theta Instrument Corp., Saddle Brook, N. J.



On The Market



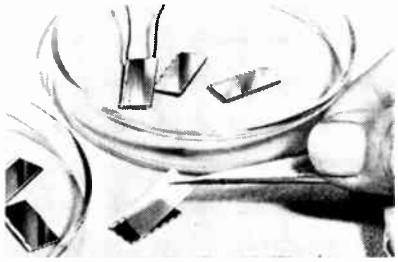
Miniature Connectors up to 104 contacts

AIRBORN CONNECTORS, INC., 2618 Manana Drive, Dallas 20, Texas. Miniature rectangular environmental connectors feature stainless steel shells, precision molded sealing gaskets, high strength glass-fiber filled diallyl phthalate moldings and permanently lubricated stainless steel jackscrews to exceed requirements of MIL-C-8384 and to mate with existing MS types under this spec. Closed entry beryllium copper contacts pass MIL-C-5015 test prod damage test. Connectors have been tested up to 200,000 ft. Qualification test data available.

CIRCLE 301 ON READER SERVICE CARD

Silicon Solar Cells glass-topped

INTERNATIONAL RECTIFIER CORP., 1521 E. Grand Ave., El Segundo, Calif. Silicon solar cells for space vehicles incorporate an extremely thin, optically-coated coverglass and provide optimum reflection properties and high thermal emissivity. The coverglassed cells are capable



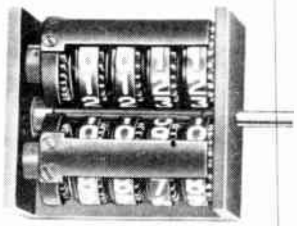
of providing (1) reduced cell temperature and higher efficiency through increased radiative thermal emissivity; (2) protection of cell surface from micrometeorite bombardment and abrasion; (3) reflection of that portion of the solar spectrum not effective in solar cell electrical conversion; and (4) furnishing an antireflection surface to improve the transmission of desired radiation.

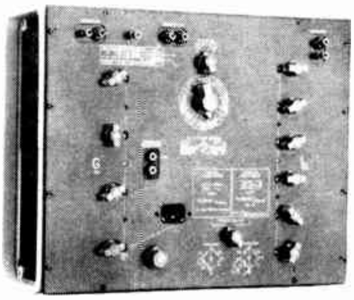
CIRCLE 302 ON READER SERVICE CARD

Dual Bank Counter high-speed

DURANT MFG. CO., 1912 North Buffum St., Milwaukee 1, Wisc. Dual bank instrument counter adds and subtracts simultaneously. A long life, high speed line of instruments, the counters are designed for use in navigation and tracking equipment, machine tools and all digital readout equipment, where plus and minus or North and South readings are needed. Standard models are available in hundreds of variations, applicable to most instrument specifications.

CIRCLE 303 ON READER SERVICE CARD





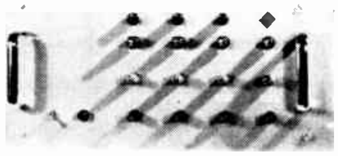
Inductance Bridge high-resolution

GENERAL RADIO CO., West Concord, Mass., announces type 1632-A high-resolution (six-figure) inductance bridge with a basic direct-reading accuracy of 0.1 percent, designed for the precise measurement of either the series or the parallel components of two-terminal grounded inductors, at audio frequencies, over a wide range of inductance from milliμh to 1,111 henries. Its high accuracy and sensitivity make it suitable for standardization measurements. An in-line digital read-out for inductance and conductance and absence of a sliding balance makes possible rapid precision measurements.

CIRCLE 304 ON READER SERVICE CARD

Power Supply transistorized

MID-EASTERN ELECTRONICS, INC., 32 Commerce St., Springfield, N.J. Model 154 features four regulated outputs in standard 19-in. relay rack unit. Three d-c outputs and



one a-c output are provided for simultaneous operation: 200 v d-c at 50 ma; 100 v d-c at 50 ma; −50 v d-c at 5 ma; and 6.3 v a-c at 5 amperes, all regulated within 0.25 percent. Input power is 105-125 v 60 cps. Ripple is 0.01 percent, recovery less than 50 μsec.

DELCO RADIO

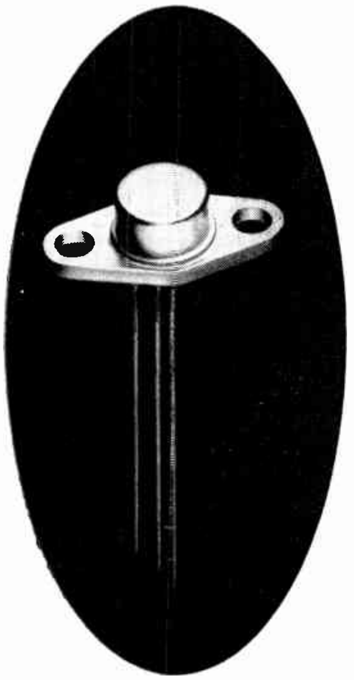
POWER TRANSISTORS

Unsurpassed Performance, Widest Applications, Military Types

Delco Radio has a complete line of germanium power transistors

HIGH POWER—The conservatively rated 15 ampere stud-mount series leads the field with improved collector to emitter voltages, low saturation resistances, and diode voltage ratings measured at 85°C. The JAN 2N174, MIL-T-19500/13A, and the commercial 2N174 are leaders in the switching versions of this series. Headed by the 2N1100 and including the new 2N1412, other transistors in the Delco Radio high power family have equally impressive performance characteristics.

MEDIUM POWER—The new 5-ampere series in the JEDEC TO3 case includes the 2N1168 and 2N392 for high power gain in low distortion linear applications. The 2N1011 (MIL-T-19500/67 Sig.C), 2N1159, and 2N1160 for higher voltage switching applications complete this series. • The low diode leakage 2N553 series, also in the JEDEC TO3 case, is rated up to 4 amperes. Usage of this series is growing rapidly in a variety of applications—especially in regulators. The 2N297A (MIL-T-19500/36A Sig.C) and the 2N665 (MIL-T-19500/58A Sig.C) are produced from this type, making with the above a comprehensive line for military applications.



MINIATURIZED MIGHT—The new 2N1172 is a mighty mite for a wide variety of usages where the modified JEDEC 30 package, on a functioning miniature diamond base, permits dissipation up to two watts at 70°C.

Write today for engineering data or personal applications assistance in getting these readily available, *proved* transistors to work in your most exacting requirements.

DELCO RADIO

DIVISION OF GENERAL MOTORS, KOKOMO, INDIANA

BRANCH OFFICES

Newark, New Jersey
1180 Raymond Boulevard
Tel: Mitchell 2-6165

Chicago, Illinois
5750 West 51st Street
Tel: Portsmouth 7-3500

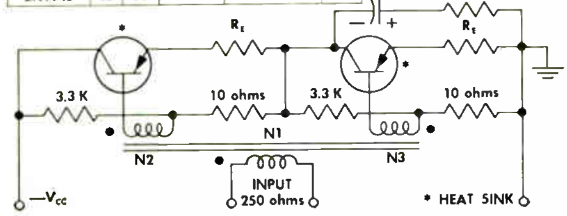
Santa Monica, California
726 Santa Monica Boulevard
Tel: Exbrook 3-1465

Your best combination of I_{CBO}-R_{CS}-V-PLUS HIGH BETA ...TI germanium power transistors!

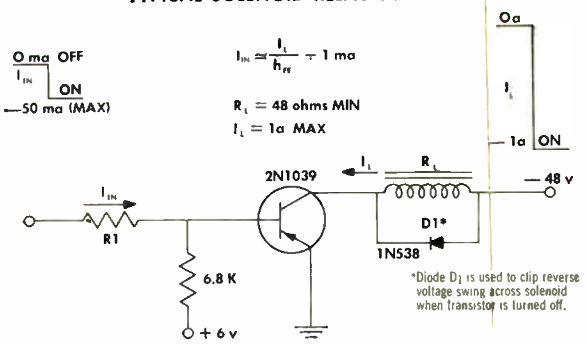
TYPICAL AUDIO AMPLIFIER 10 WATTS OUTPUT

TRANSISTOR	V_{cc} volts	R_L ohms	Efficiency %	Distortion % at P_o=10w	R_k ohms
2N1042	35	10	58	2.7	1
2N1043	55	25	57	1.8	2.5
2N1044	70	40	56	1.6	4
2N1045	85	60	53.5	1.6	6

Transformer: N1:N2:N3 = 1:1:1 To Minimize Cross-Over Distortion the Coils Should be Bifilar Wound.



TYPICAL SOLENOID RELAY DRIVER



*Diode D1 is used to clip reverse voltage swing across solenoid when transistor is turned off.

20-w power transistors:

switching circuits • relay drivers • audio and pulse amplifiers

ACTUAL SIZE

TI 2N1042 series alloy-junction transistors **guarantee** 20 w dissipation at 25°C with voltage ratings of —40, —60, —80, and —100 v. You get guaranteed 20-to-60 beta spread at —3 amps and low 0.16 ohm saturation resistance at the —3 amp maximum collector rating.

1.25-w power transistors:

medium speed switching circuits • relay drivers • low-power audio and pulse amplifiers

ACTUAL SIZE

TI 2N1038 series alloy-junction transistors **guarantee** 1.25 w dissipation in moving free air at 25°C with voltage ratings of —40, —60, —80, and —100 v. **Guaranteed** 20-to-60 beta spread at —1 amp and low 0.2 ohm saturation resistance assure reliable performance.

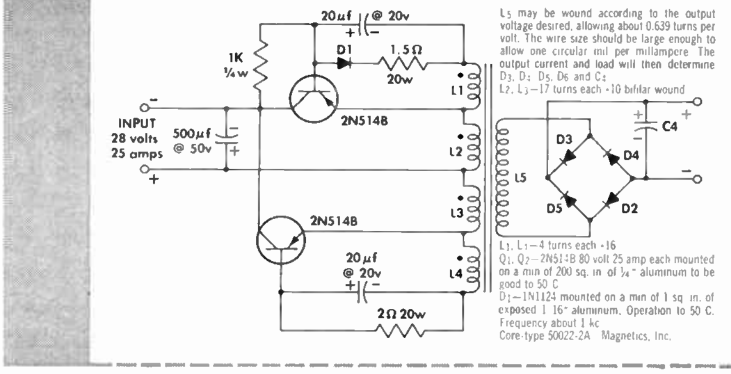
TI GERMANIUM POWER TRANSISTOR CHARACTERISTICS AT 25°C

Type	Dissipation at 25°C Watts	Max Collector Voltage Volts	Max Collector Current Amps	h_{FE} min	h_{FE} max	Collector Reverse Current I_{CO} max	Typical Saturation Resistance R_{CS} Ohms
2N456	50	—40	—5	10 @ —5a	50	—2ma @ —40v	0.048
2N457	50	—60	—5	10 @ —5a	50	—2ma @ —60v	0.048
2N458	50	—80	—5	10 @ —5a	50	—2ma @ —80v	0.048
2N511	80	—40	—10	10 @ —10a	30	—2ma @ —20v	0.025
2N511A	80	—60	—10	10 @ —10a	30	—2ma @ —30v	0.025
2N511B	80	—80	—10	10 @ —10a	30	—2ma @ —40v	0.025
2N512	80	—40	—15	10 @ —15a	30	—2ma @ —20v	0.025
2N512A	80	—60	—15	10 @ —15a	30	—2ma @ —30v	0.025
2N512B	80	—80	—15	10 @ —15a	30	—2ma @ —40v	0.025
2N513	80	—40	—20	10 @ —20a	30	—2ma @ —20v	0.025
2N513A	80	—60	—20	10 @ —20a	30	—2ma @ —30v	0.025
2N513B	80	—80	—20	10 @ —20a	30	—2ma @ —40v	0.025
2N514	80	—40	—25	10 @ —25a	30	—2ma @ —20v	0.025
2N514A	80	—60	—25	10 @ —25a	30	—2ma @ —30v	0.025
2N514B	80	—80	—25	10 @ —25a	30	—2ma @ —40v	0.025
2N1021	50	—100	—5	10 @ —5a	30	—2ma @ —100v	0.08
2N1022	50	—120	—5	10 @ —5a	30	—2ma @ —120v	0.08
2N1038	1.25	—40	—1	20 @ —1a	60	—125µa @ —20v	0.2
2N1039	1.25	—60	—1	20 @ —1a	60	—125µa @ —30v	0.2
2N1040	1.25	—80	—1	20 @ —1a	60	—125µa @ —40v	0.2
2N1041	1.25	—100	—1	20 @ —1a	60	—125µa @ —50v	0.2
2N1042	20	—40	—3	20 @ —3a	60	—125µa @ —20v	0.16
2N1043	20	—60	—3	20 @ —3a	60	—125µa @ —30v	0.16
2N1044	20	—80	—3	20 @ —3a	60	—125µa @ —40v	0.16
2N1045	20	—100	—3	20 @ —3a	60	—125µa @ —50v	0.16
2N1046	35	—80	—3	20 @ —3a	160	—1ma @ —40v	0.9

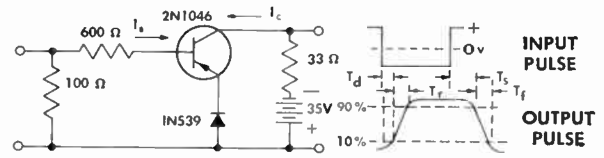
germanium and silicon transistors
silicon diodes and rectifiers
*tan*TI*cap* solid tantalum capacitors
precision carbon film resistors
sensistor silicon resistors

TEXAS

DC-TO-DC POWER CONVERTER 630-WATT OUTPUT AT 90% EFFICIENCY



TYPICAL SWITCHING CHARACTERISTICS



TYPICAL SWITCHING TIMES		
T_d	Delay Time	0.3 µsec
T_r	Rise Time	0.7 µsec
T_s	Storage Time	1.2 µsec
T_f	Fall Time	0.5 µsec

TEST CURRENTS

I_{B1} (Turn-on Current) = — 30mA

I_{B2} (Turn-off Current) = + 30ma

I_C (Collector Current) = — 1A

ACTUAL SIZE

10 to 25-amp switchers:

high current switching applications

TI 2N511 series alloy-junction transistors **guarantee** collector currents of **—10, —15, —20, and —25 amps** in —40, —60 and —80 v ratings. All units provide low 0.025 ohm saturation resistance and typical switching times at 25°C of 12.5 µsecs (t_{on}) and 8.0 µsecs (t_{off}).

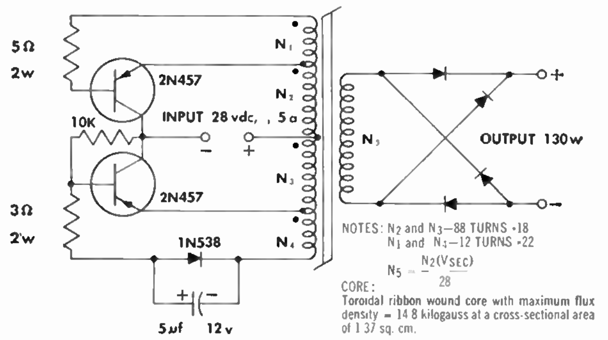
ACTUAL SIZE

high power/high frequency switchers:

computer core drivers • deflection circuits • light weight converter applications

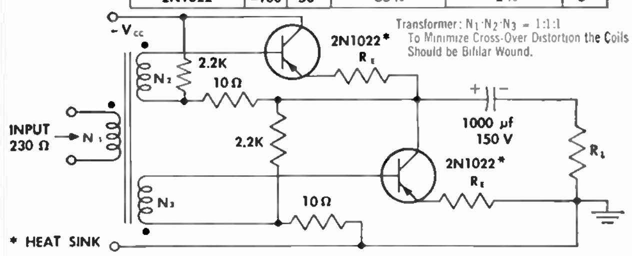
TI 2N1046 alloy diffused transistors combine high power, high frequency and high voltage performance in a single package. **Guaranteed** 35-w dissipation, collector breakdown voltage to —80 v, and low 0.75 ohm saturation resistance with **12 mc** typical alpha cutoff insure reliable operating characteristics.

TYPICAL DC TO DC POWER CONVERTER



TYPICAL 20 WATT AMPLIFIER POWER GAIN = 23 db

TRANSISTOR	V_{cc} V	R_E Ω	EFFICIENCY	DISTORTION 20 WATTS	R_L Ω
2N1021	-80	30	66%	2%	3
2N1022	-100	50	66%	2%	5



ACTUAL SIZE

high beta power amplifiers:

audio amplifiers • current switchers • power converters

TI 2N456 series alloy-junction transistors with **guaranteed** 50-w dissipation, **—40, —60, and —80 BV_{CBO}** ratings and less than 0.048 ohm saturation resistance provide optimum performance characteristics.

ACTUAL SIZE

high voltage power converters:

audio • servo • power applications

TI 2N1021 and 2N1022 alloy-junction transistors **guarantee** maximum operating voltages of **—100 v and —120 v** respectively, low 0.08 ohm saturation resistance, and typical betas of 60 at —1 amp, 23 at —5 amps. You get **guaranteed** collector reserve current of —2 ma maximum at full rated voltage.

Check the specifications at left for the unit most suited to your particular requirements.

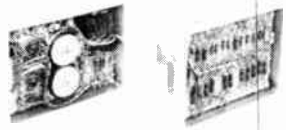
INSTRUMENTS
INCORPORATED
SEMICONDUCTOR-COMPONENTS DIVISION
13500 N. CENTRAL EXPRESSWAY
POST OFFICE BOX 312 · DALLAS, TEXAS

Write on your company letterhead *to your nearest TI sales office* **describing your application for specific details on TI products.**

CIRCLE 93 ON READER SERVICE CARD

and overshoot less than 1.0 percent of voltage setting. Price is $495.

CIRCLE 305 ON READER SERVICE CARD



Control System airborne type

AIRBORNE ACCESSORIES CORP., 1414 Chestnut Ave., Hillside 5, N. J. Key development in a new airborne control system is a contactorless control package consisting of standardized control boxes into which are plugged unitized transistorized or magnetic preamplifier and power amplifier sub-systems. Circuitry for each sub-system is mounted in a compact chassis and by means of a quick connect-disconnect plug, any of the several units can easily be slid in or out of the control box in seconds. Thus, amplifiers drive motors ranging up to 200 w, or control any physical response in relation to a variable stimulus as sensed by the transducer.

CIRCLE 306 ON READER SERVICE CARD

Potentiometer 4-w power rating

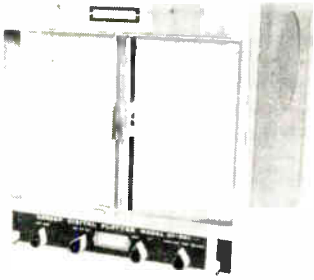
CLAROSTAT MFG. CO., INC., Dover, N. H. A power rating of 4 w at 40 C, derated to zero at 135C, is attained in the type 45 wire-wound potentiometer of new construction yet in the 1½ in. diameter size. The new construction is suitable for ohmages from 1 to 10,000, linear, and compatible with resistance wire sizes and contact pressures well within the limits for satisfactory rotational life. Resistance tolerance of ±10 percent or closer. One tap only at 50 percent ±2 percent of resistance, at any position electrically. Other features: 300 deg mechanical and electrical rotation, 280 deg effective: 1.2 to 6 oz/in. torque.

CIRCLE 307 ON READER SERVICE CARD

Capacitors
metallized Mylar

WESCO ELECTRICAL AND MFG. CO., 27 Olive St., Greenfield, Mass. The 26MM metallized Mylar capacitors offer an economical method of obtaining an equivalent for a hermetically sealed capacitor. Temperature range is − 55 C to + 125 C with no de-rating. Applications are d-c filters, military airborne electronic equipment and many other electronic circuits where size, weight and environmental conditions are major factors.

CIRCLE 308 ON READER SERVICE CARD



Digital Plotter
wide applications

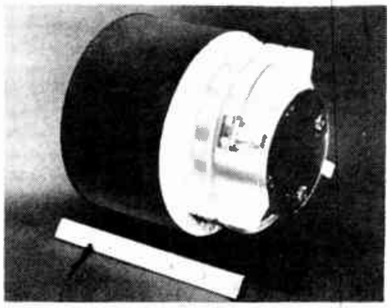
THE GERBER SCIENTIFIC INSTRUMENT CO., 89 Spruce St., Hartford, Conn. Model GP-1 digital plotter consists of (1) two high-speed servo systems which position a printing mechanism according to the binary coded X and Y input signals, (2) two digital-to-analog converters, one each for the X and Y signals, (3) a plot and computer acknowledge circuit and (4) power supplies. The plot and computer acknowledge circuit actuates the printing solenoids after the printing mechanism has been properly positioned by both the X and Y servo systems. Model GP-1 can be supplied to accept X-Y data in any normally used digital format such as binary, decimal, binary coded decimal, or analog.

CIRCLE 309 ON READER SERVICE CARD

Phase Detectors
selenium

GENERAL ELECTRIC CO., Semiconductor Products Dept., Lynchburg, Va., has a line of miniature selenium double diodes whose most common use is in tv receivers as horizontal phase detectors. Type 6GD1 is a series connected voltage doubler; 6GC1 has a common cathode with center tap; 6GX1 has a common anode with center tap. The devices have a forward current rating of 0.5 ma at 2.0 v d-c; reverse current rating of 5.0 μa at -20 v d-c; and are rated for operation in an ambient temperature of 187 F. The double diodes have 1½ in. leads which may be clipped off for printed board installation or hand crimped to suit other mechanical requirements.

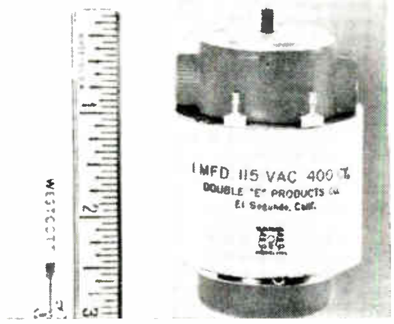
CIRCLE 310 ON READER SERVICE CARD



Delay Lines
lightweight

RAMO-WOOLDRIDGE, a division of Thompson Ramo Wooldridge Inc., P.O. Box 90534 Airport Station, Los Angeles 45, Calif. These low-loss, wideband, compactly packaged microwave delay lines weigh only 25 oz and can replace more than 100 ft of coaxial cable each. They employ a light weight ceramic material with a high dielectric constant that will greatly reduce the total weight and cubic content of packaged units. The S-band helical microwave delay line provides a time delay of 0.1 μsec for signals nominally in the 2.2 to 4.2 kmc range.

CIRCLE 311 ON READER SERVICE CARD



Phasing Capacitor
400 cycle

DOUBLE "E" PRODUCTS CO., 208 Standard St., El Segundo, Calif. New phasing or motor starting capacitor features a "donut" or "wedding ring" type mounting configuration for fractional h-p motors. Model 5992 is rated at 1 μf 115 v a-c 400 cycle, for operations from −65 F to 400 F. Unit has 1 1/4 in. i-d with 1/4 in. to 3/8 in. thickness and is 1/2 in. long with conveniently located terminals and/or wire leads, and is available for other various size o-d motors.

CIRCLE 312 ON READER SERVICE CARD

Coaxial Plugs
solderless

CANNON ELECTRIC CO., P.O. Box 3765, Terminal Annex, Los Angeles 54, Calif. The Crimpee, a completely solderless r-f coaxial plug, may be used in mobile communications equipment, television master antenna sets, and other equipment. It is readily interchangeable with Military PL-259 plugs and mates with the SO-239. It is available for five cable sizes: RG-8/U, 9/U, 11/U,

CIRCLE 97 ON READER SERVICE CARD

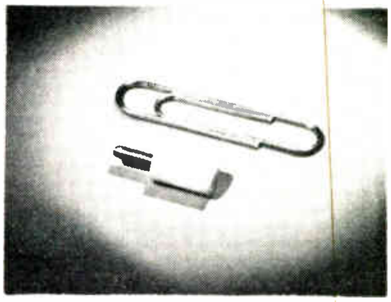
58/U and 59/U. Crimpee can be assembled in minutes by crimping the cable braid between two concentric ferrules, which are placed over the cable jacket. Once crimped into place the connection will not come loose or pull apart.

CIRCLE 313 ON READER SERVICE CARD

Power Converter transistorized

WEBSTER ELECTRIC CO., Racine, Wisc. Model 2D12 transistorized power converter is compact, easily regulated and has no moving parts. It can convert 12 v into 250 v d-c, has automatic overload protection, weighs only 12 oz. and is 2 in. high by 2 in. deep by 4½ in. long.

CIRCLE 314 ON READER SERVICE CARD



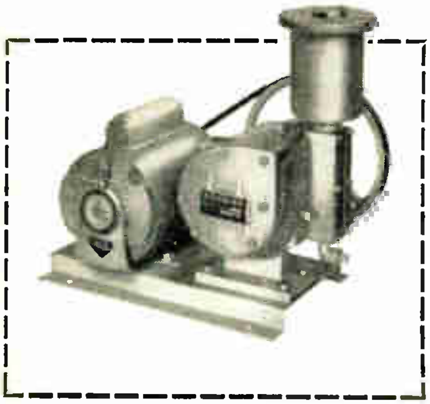
Subminiature Plug redesigned unit

SEALECTRO CORP., 139 Hoyt St., Mamaroneck, N. Y. Type PR-300 plug or probe is a redesigned version that provides smoother insertion and withdrawal in corresponding Press-Fit jacks. The in-line plug takes the stripped wire end to the very tip of the probe where it is neatly soldered without interfering with the ready insertion or withdrawal.

CIRCLE 315 ON READER SERVICE CARD

Glass-Bonded Mica high-temperature

ELECTRONIC MECHANICS, INC., 101 Clifton Blvd., Clifton, N. J., has developed Mykroy 20-7 for 1,100 F continuous operation. It can be molded to extremely tight tolerances and with excellent dimensional stability. It is white in appearance, hard, and has specific gravity of 2.4. Volume resistivity at



1,100 F is greater than 1 megohm and is greater than a million megohms at room temperature. This non-moisture absorbing insulator will find wide application for molded-in thermocouple devices, high temperature feed through bushings, relay spacers, and coil forms.

CIRCLE 316 ON READER SERVICE CARD

Transistor military-type

Bendix Aviation Corp., Red Bank Division, Long Branch, N. J. Designed to meet MIL-T-19500/36A (Sig C), the 2N297A transistor can be used in numerous military applications such as missiles and supersonic aircraft. It also has many applications to high current switching, audio amplification, voltage regulators, power supply circuits and power oscillator circuits. Maximum collector voltage rating is 60 v and maximum collector current rating, 5 amperes. It will readily dissipate 35 w at 25 C and 10 w at 75 C.

CIRCLE 317 ON READER SERVICE CARD

Monitor Amplifier high-power

Fairchild Recording Equipment Corp., 10-40 45th Ave., Long Island City 1, N. Y. Model 680 compact monitor amplifier provides the recording and broadcast industries with a flexible amplifier having a conservatively rated output of 80 w, but capable of reproducing peaks in excess of 250 w. A meter actuated by pushbuttons on the front panel to check output tube, plate current, static and dynamic balance assures a continuous degree of high performance. Input and output connections are free of ground eliminating crosstalk and ground loop problems.

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CIRCLE 101 ON READER SERVICE CARD

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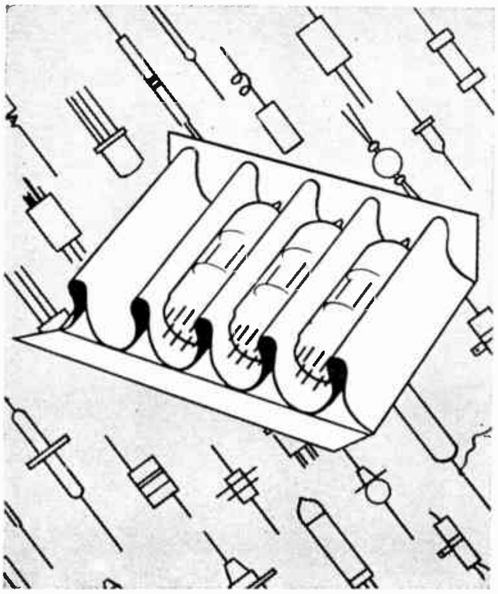

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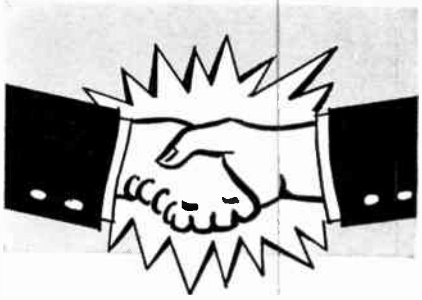

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CIRCLE 212 ON READER SERVICE CARD

Literature of

MICROWAVE FERRITE COMPONENTS. Ferrotec, Inc., 217 California St., Newton, Mass. Included among the microwave ferrite components outlined in a 4-page short form catalog are resonance isolators, circulators, switches, tee circulators, phase shifters and modulators.

CIRCLE 325 ON READER SERVICE CARD

FIXED WAVEGUIDE ATTENUATORS. Waveline Inc., Caldwell, N. J., has available a bulletin covering a series of fixed waveguide attenuators that feature broadband accuracy and rugged design. Prices are included.

CIRCLE 326 ON READER SERVICE CARD

BASIC CIRCUITS. Automatic Electric Co., Northlake, Ill. "Basic Circuits" is a 32-page booklet designed to serve as a guide to determine the availability of a circuit and its components.

CIRCLE 327 ON READER SERVICE CARD

SERVO COMPONENTS. Vernitron Corp., 136 Church St., New York 7, N. Y. An illustrated brochure contains specifications on control and torque synchros and resolvers, as well as information about the company and its personnel.

CIRCLE 328 ON READER SERVICE CARD

SILICON CONTROLLED RECTIFIER. International Rectifier Corp., El Segundo, Calif. A recent issue of *Rectifier News* contains an introduction to the Thyrode, a 20 to 200 v, 10 ampere rated silicon controlled rectifier.

CIRCLE 329 ON READER SERVICE CARD

HIGH-VACUUM PUMP. Ultek Corp., 920 Commercial St., Palo Alto, Calif., announces a leaflet describing a small permanent-appendage electronic high-vacuum pump identified as the UlteVac series 110.

CIRCLE 330 ON READER SERVICE CARD

FACILITIES BROCHURE. Sony Corp., 351 Kitashinagawa-6, Shinagawa-Ku, Tokyo, Japan, has prepared a well illustrated booklet introducing its products, such as tape recorders, transistors and transistor radios. It shows the various branches of the factory

where the products are being manufactured.
CIRCLE 331 ON READER SERVICE CARD

WIDE RANGE OHMMETER. Mid-Eastern Electronics, Inc., 32 Commerce St., Springfield, N. J. A two-page bulletin gives application data and specifications on the model 701 wide range ohmmeter.
CIRCLE 332 ON READER SERVICE CARD

MICROWAVE EQUIPMENT. Lel, Inc., 380 Oak St., Copiague, L. I., N. Y. Catalog No. 96 provides 22 pages of information on microwave receiver front ends, r-f, i-f and twt amplifiers, telemetering preamplifiers, noise test sets, and beacons.
CIRCLE 333 ON READER SERVICE CARD

AIRBORNE CONTROL SYSTEM. Airborne Accessories Corp., 1414 Chestnut Ave., Hillside 5, N. J. A 4-page bulletin contains charts, characteristics tables and photos of a new airborne control system.
CIRCLE 334 ON READER SERVICE CARD

PROTECTIVE SURFACE COATINGS. Columbia Technical Corp., 61-02 Thirty-First Ave., Woodside 77, N. Y., announces a 20-page brochure entitled "How To Use Protective Surface Coatings In Electronic Applications."
CIRCLE 335 ON READER SERVICE CARD

POLYETHYLENE MATERIALS. Union Carbide Plastics Co., 30 E. 42nd St., New York 17, N. Y. Issue No. 109 of *Kabelitems* lists requirements of new ASTM tentative specification D-1248-58T for polyethylene molding and extrusion materials.
CIRCLE 336 ON READER SERVICE CARD

COAXIAL CABLE. Times Wire and Cable Co. Inc., Wallingford, Conn. A complete engineering data and coaxial cable selection chart is now available.
CIRCLE 337 ON READER SERVICE CARD

TANTALUM CAPACITORS. U. S. Semiconductor Products, Inc., 3536 W. Osborn Road, Phoenix, Ariz. Bulletin TS-11-58 covers a line of hermetically sealed solid electrolyte tantalum capacitors.
CIRCLE 338 ON READER SERVICE CARD

TANTALUM . . . *After 37 Years Our Most Important Product*

GLEN RAMSEY, Vice President Fansteel Metallurgical Corporation and General Manager of Rectifier-Capacitor Division, displays (in right hand) porous tantalum anode he developed in 1936—the achievement which made today's miniature tantalum capacitors possible. One of the early applications of this anode was in a Fansteel surge arrester (shown on desk). Left hand holds present day tantalum capacitors.

There have been few developments in the past century that have been of more benefit to science and industry than the discovery by Fansteel of a method for producing tantalum commercially.

Our scientists have continued through the years to work on ways to improve tantalum and ways to use it. The development of the tantalum capacitor is one of the most important "firsts" at Fansteel. Contributing greatly to the age of miniaturization in electronics, the tantalum capacitor is characterized by long life, stability and highest reliability.

In 37 years of tantalum leadership—through research, development, production and application—we have constantly learned more and more about tantalum. Fansteel experience with tantalum and tantalum capacitors adds the extra ingredient to Fansteel Capacitor Grade Tantalum. This experience can't be found in technical literature. And it can't be bought. But we have it, and it is available to you.

There is no short cut to perfection in anything, certainly not in a metal like tantalum. It has taken Fansteel a long time to reach its position of leadership, and we feel that there is still some distance to travel. But we have gone far enough to assure continued supply of Capacitor Grade Tantalum in quantity, and continued improvement in quality. Fansteel Metallurgical Corporation, Rectifier-Capacitor Division, North Chicago, Illinois.

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597

Pickering: ideas to hardware

SYMPHONY to sonar was an easy transition for Norman C. Pickering, vice president and technical director of Avien, Inc., Woodside. N. Y.

His lifelong interest in acoustics provided the common denominator which forms the basis of his competence in instruments—both musical and scientific.

This duality of interest is reflected in Norm's academic record. He holds an EE degree from Newark College of Engineering, a degree from New York's Juilliard School of Music, and has completed studies in advanced physics at Columbia.

Despite the advantage of being a third-generation engineer by following in the footsteps of his father and grandfather, Pickering chose a career in music when schooling was completed.

By 1937 he was playing first horn with the Indianapolis Symphony Orchestra, after having handled several orchestral assignments including playing in the orchestra of the Metropolitan Opera House.

While in Indiana, his engineering background attracted the attention of C. G. Conn, Ltd., the musical instrument company, where he became a key man in the acoustical engineering department. The dual environment of music and engineering led Pickering to design better electronic audio equipment, at first as a hobby, and later commercially.

In 1945, the audio hobby became a commercial reality with development of the Pickering line, including the "Pickering pick-up". This equipment attracted the interest of the major record companies and the success of the venture became a certainty.

Pickering's next move in search of new technical problems to solve was to Avien, Inc., Long Island designers and manufacturers of instrumentation systems in the fields of temperature control, fluid flow measurement, missile checkout equipment, flight operation monitoring, propulsion system instrumentation and undersea technology.

Here again, the double-barrelled approach characterizes Pickering's environment. In discussing the apparently diverse instrumentation required for submarines and aircraft, he points out that both travel in three dimensions and therefore have certain maneuvering problems in common.

Genial Pickering matches his diversified professional life with a similarly diversified personal life. As a resident of Sag Harbor, Long Island, he enjoys boating during the summer and shares his first love, music, with his wife, Juta, who came to America after having escaped from Russian Estonia by traveling on foot to Germany in 1945. Married in 1951, the Pickerings are the parents of boys aged five, four and one.

Norm is a member of the Audio Engineering Society, (he holds membership card No. 4), the American Institute of Physics, the Acoustical Society of America, and was elected this month to Avien's board of directors.

Schauwecker Heads Valor

HARRY E. SCHAUWECKER is the newly elected president of Valor Instruments, Inc., Gardena, Calif. Previously, as director of new products development, he was responsible for the development of the expanding line of transistorized instruments.

Prior to joining Valor, Schauwecker was a transistor specialist at Gilfillan Brothers Inc. and Bell Telephone Laboratories. A lecturer in engineering at UCLA, he has taught an advanced course on transistor applications for several years.

Franklin Institute Honors Researchers

GROWING IMPORTANCE of electronics in the world of science is demonstrated by the number of scientists honored by this year's Medal Day ceremonies, held late last month at the Franklin Institute, Philadelphia. All three winners of the Cresson Medal, oldest of the Institute's awards, were from electrical engineering fields, as were one of two Longstreth medalists, one of five Wetherill medalists, and both winners of the prized Ballantine Medal.

Franklin Medal, highest Institute award, went to Cornell University's Hans Bethe for contributions to theoretical physics. It was Bethe's ruminations on thermonuclear processes in the sun that led to the development of manmade thermonuclear fusion and the hydrogen bomb.

Winners of the Cresson Medal were John Hays Hammond Jr., president and treasurer of Hammond Research Corp., Gloucester, Mass., for remote radio control of moving vehicles; Henry C. Harrison, independent consulting engineer of Port Washington, N. Y., for matched impedance principles in electromechanics; and Irving Wolff, research v-p of RCA Laboratories, Princeton, N. J., for contribution to radio, radar and electronics.

Jacob Rabinow, president of Rabinow Engineering Co., Washington, won one of the Longstreth Medals for development of a magnetic fluid clutch; the other went to David M. Potter, president of Potter Aeronautical Corp., Union, N. J., for a balanced rotary flow meter.

The Potts Medal was awarded to chemist George W. Morey of the U. S. Geological Survey for development of a rare-earth oxide glass. The Henderson Medal was awarded to the Electromotive division of General Motors for work in the field of diesel-electric locomotives.

Clarence Zener, director of Westinghouse Electric's research laboratories, won a Wetherill Medal for his contributions to the field of solid-state physics. The other Wetherill Medals went to Linde Co.'s Robert B. Aitchison for developing a jet-piercing process for mining and quarrying; and for work in gas chromatography as applied to biochemistry, to two Englishmen, A. T. James and A. J. P. Martin, and one Scot, R. L. M. Synge.

The Clark Medal went to George Oberfell of Phillips Petroleum, and the Brown Medal was awarded posthumously to the late Hardy Cross for his contributions to structural engineering.

The Clamer Medal went to MIT's Morris Cohen for work in physical metallurgy.

The two Ballantine Medals were awarded to A. Hoyt Taylor, formerly of Naval Research Labs, for his contributions to the science of electronic communications; and to Columbia University's Charles H. Townes for the conception and development of the maser.

Medalists are selected by a group of seventy scientists and engineers from the various sciences and mechanic arts, serving as the Institute's Committee on Science and the Arts.

News of Reps

Murphy and Cota has been appointed sales rep for Filtron, Inc., to cover North Carolina, South Carolina, Alabama, Georgia, Florida and Mississippi.

W. E. Zimmerman Co., electronic manufacturers' rep of Beverly Hills, has opened a new sales office in Palo Alto, Calif.

Ace Electronics Associates, Inc., Somerville, Mass., appoints **O. F. Masin Co.** of Pelham, N. Y., to cover the metropolitan New York area; **Air Equipment Sales Co.** of Dallas, Texas, to handle sales in Texas, Oklahoma, Arkansas and Louisiana.

Electro-Pulse, Inc., Culver City, Calif., manufacturer of precision pulse generating and electronic counting equipment, has appointed **Parrish Electronics** of Denver, Colo., to cover Colorado, New Mexico, Utah, Wyoming, and southeast Idaho.

Representation of Daystrom Transicoil by **E. V. Roberts & Associates**, Los Angeles sales rep firm, has been expanded to include the San Francisco area.

Aladdin Electronics, a division of Aladdin Industries, Inc., Nashville, Tenn., has selected **Technical Services Co., Inc.,** of Phoenix, Ariz., as exclusive rep for Aladdin electronic products in Arizona, New Mexico (including El Paso, Texas), Colorado and Utah.

Clear Beam Antenna Corp., Canoga Park, Calif., appoints two rep firms. **Robert W. Peters Co.,** Cleveland, Ohio, will cover Ohio, West Virginia and eastern Pennsylvania. **Felleisen Associates,** Chicago, Ill., will handle sales in Illinois, Wisconsin, Minnesota, North Dakota and South Dakota.

Appointment of **The Dan Greene Organization, Inc.** of Cambridge, Mass., as sales rep of Howell Instrument Co., Ft. Worth, Texas, has been announced. Rep firm will handle sales in the six New England states.

COMMENT

Stratovision

(Re: Washington Outlook, p 14, Oct. 30; and "Stratovision: New Business," p 42, Nov. 6. . .)

As a school board member, interested in the possible advantages of educational television as probably the most potent aid to education ever invented since the printing press, and in the future and best utilization of the frequency spectrum available for education, I would like to point out that the short-term gains we might make with Stratovision seem to me to be more than offset by the long-term losses of an inefficient use of the spectrum.

It seems quite in order to say that there are far too few frequencies available for the best use of educational television in the long run; so why restrict the long-run picture?

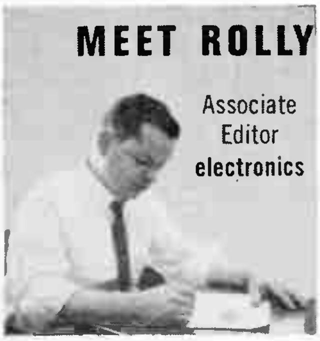
Insufficient information, I believe, confuses the picture; for example, your Oct. 14 notice refers to narrow-banding "half-channel technique" improvement, but does not tell us that the same technique would do a much better job for educational tv when applied to land-based transmitters instead of airborne ones, and that it is not uniquely adaptable to airborne applications.

There are other undesirable features of the proposal. What do we gain from spending millions to put some "canned" tape-recorded lessons into some classrooms, when we could do the same thing at a fraction of the cost with film-recorded lessons covering the same material. This is especially important when we stop to think that most of the schools already have film projectors among their visual-aids equipment, but do not have uhf television sets nor the antenna systems to operate them.

Film recordings could be used now. Airborne tape recording and uhf tv may be a couple years or more off and a few million dollars removed from actuality. Research programs are okay; but I think they should not be billed in a manner that confuses the issue and possibly interferes with active programs that are definitely beyond the experimental stage.

Does not the narrow-band experi-

MEET ROLLY CHAREST



Associate Editor electronics

RESUME:

Charest, Roland J., Boston University, BS in Journalism. Formerly New England editor for **electronics**. Navy sonarman. Writer, reporter, editor for Lynn Item, Boston Globe, Boston Traveler. Won a New England Associated Press (AP) award in 1955 for writing feature articles in the major city newspaper class.

PRESENT OCCUPATION:

Rolly Charest supports Managing Editor Jack Carroll for editorial content accuracy and expediting putting each weekly issue to bed. Rolly reworks headlines for greater readability, is involved in makeup, and helps polish editorial content. Rolly's across-the-board background assures you accuracy in the face of journalistic pressures; articles in this week's issue that could be held over to the next deadline, but are not. The readers' interests come first!

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electronics

A McGraw-Hill Publication • 330 W. 42nd St., New York 36 mentation confuse the issue? Judging from past experience, it would appear to me that standard-band stratovision will be two or three years off for effective use, with another year or so added for the narrow-band experiments to bear fruit.

The opinions of a number of other people are not too different from mine. Advisors to a couple of national groups in allied arts have agreed on the subject. It seemed in order to bring some of these points to your attention . . .

LLOYD P. MORRIS
ELMWOOD PARK, ILL.

Reader Morris documented his case with two sets of notes, which we will hold onto for future reference. We feel that all sides of this case should be aired as completely as possible.

Dr. Esaki & the Planetarium

It was a pleasure to notice Mr. Solomon's kind remarks in the November 6 issue of ELECTRONICS concerning Dr. Leo Esaki's visit to the American Museum—Hayden Planetarium ("Dr. Leo Esaki Goes Touring," p 38, Nov. 6). We try to live up to our worldwide reputation by presenting modern astronomy to the public in a way which is simultaneously informative, interesting and entertaining. In this way we hope we can make anyone's visit to the Planetarium an experience to remember, be he a world-renowned physicist or an inquisitive visitor.

ELECTRONICS often presents interesting information useful to us in the Planetarium's radioastronomy project, and it helps keep us informed on developments in space-age electronics. Your feature reviews are especially good. In particular, I would like to congratulate you on the astronomical review of several months ago ("The Challenge of Space," p 65, Apr. 24). It should prove welcome to those engineers who find themselves suddenly working in this new technological field without a broad background in astronomy.

I am sure your lively journal will keep up the good work.

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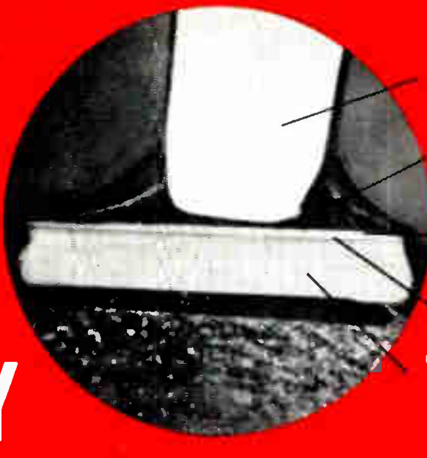

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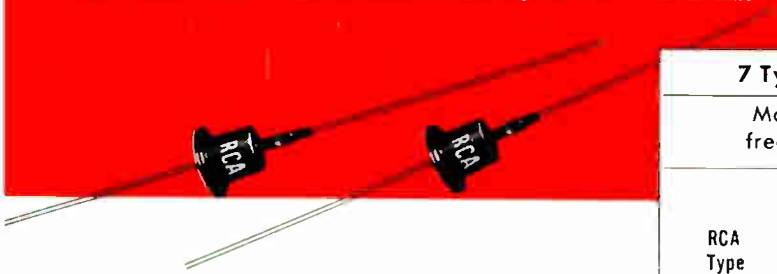

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1N537	100	750	5	400
1N538	200	750	5	300
1N539	300	750	5	300
1N540	400	750	5	300
1N1095	500	750	5	300
1N547	600	750	5	350
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1N440-B	100	750	0.3	100
1N441-B	200	750	0.75	100
1N442-B	300	750	1.0	200
1N443-B	400	750	1.5	200
1N444-B	500	650	1.75	200
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