Air Traffic Data Center Tests Begin

page 28

electronics

A McGRAW-HILL PUBLICATION APRIL 8, 1960 PRICE SEVENTY-FIVE CENTS

Triggering Underwater Cameras

Creative Microwave Technology

Published by MICROWAVE AND POWER TUBE DIVISION, RAYTHEON COMPANY, WALTHAM 54, MASS., Vol. 2, No. 1

RAYTHEON "M"-TYPE BACKWARD WAVE OSCILLATORS

Electronically tunable at high power levels for a wide range of microwave applications

Where extensive frequency mobility is required, the efficient crossed-field, "M"-type backward wave oscillator is highly versatile. Introduced more than eight years ago, it has been perfected by Raytheon and is now being economically mass produced. Hobbing of the slow-wave structure, a Raytheon-developed technique, assures precision construction necessary for consistently reproducible performance from tube to tube.

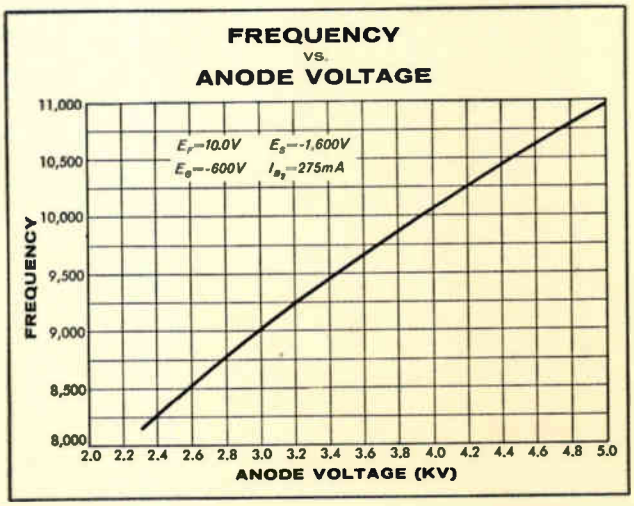
Typical of the "M"-type BWO's available from Raytheon is the QK-634A, an X-band tube which features all ceramic-and-metal construction for reliable operation under extreme environmental conditions.

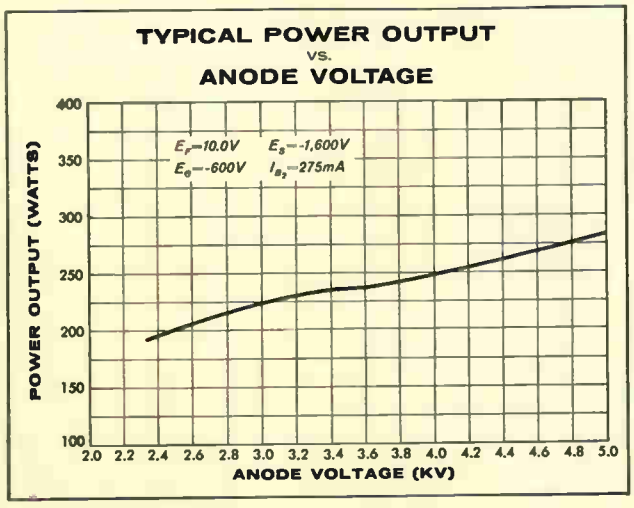
The QK-634A has a nominal power output of 200 to 250 watts and is electronically tunable over its entire frequency range. Precise determination of the radiated spectrum is accomplished by adjusting the voltage applied to either the anode or the sole. Amplitude modulation is also accomplished electronically. Small and compact, the QK-634A can be mounted in any position.

QK-634A Backward Wave Oscillator

Typical Operating Characteristics--QK-634A

Frequency Range	8,150 to 11,000 Mc
Power Output	150 watts (min.) 200 to 250 watts (nom.)
Output Flange	Mates with UG40A/U modified for clearance holes
Tuning Sensitivity	1.0 Mc/V





Other unclassified BWO's in this series include the QK-625 and QK-659, which cover the 2,500-4,450 Mc band.

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RAYTHEON

You can obtain detailed application information and special development services by contacting: Microwave and Power Tube Division, Raytheon Company, Waltham 54, Massachusetts

A LEADER IN CREATIVE MICROWAVE TECHNOLOGY

electronics

APRIL 8, 1960

A McGRAW-HILL PUBLICATION
Vol. 33 No. 15

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Issue at a Glance

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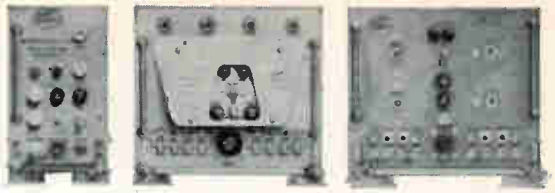
Engineering

Departments



Just three of these broad-band pulse receivers will cover the entire 45 to 10,750 Mc spectrum—and with sensitivities that approach those of narrow-band super-heterodyne equipment. They're ideal for intercept and analysis of pulse signals...a substantial improvement over conventional crystal video receivers...and just one of many accomplishments by an adroit team of specialists—Granger Associates.

In a little over three action-packed years, this organization has built an impressive record of problem-solving in such areas as microwave tube applications, high power applications of negative grid tubes, pulse systems, wide-band antenna systems, back-scatter and meteor-scatter propagation and precipitation static noise reduction.

Their secret? An astonishing ability to convert knowledge of theory into practical hardware—right now. G/A invites your inquiries—either to solve your radio equipment problem or to consider your application as a member of its growing staff.

Specifications for Granger Associates Broad-band Pulse Receivers (System consists of Models 301, 302 and 303 shown above)

Frequency range:	*Simultaneous reception of all frequencies from 45 Mc to 10,750 Mc in nine bands*
Typical tangential sensitivity	*— 85 dbm (at 100 Mc) — 65 dbm (at 10,000 Mc)*
Input Impedance:	*50 ohms. Type N female connector for each band*
Output:	*Video amplifiers provide an approx. logarithmic compression over 50 db of r-f input range. Output of each channel is separately available for video analysis, and—in stretched form—for recording.*
Blanking:	*Provision is included for blanking.*
Design Features:	*Video amplifiers and their power supplies are completely transistorized. Modular construction, with MIL type components and hardware.*
Power requirements:	*Rack mounted—109 to 121 V ac, 50 to 800 cps Airborne—109 to 121 V ac, 360 to 800 cps.*
Packaging:	*Airborne—in ATR cases with shock tray. Rack-mounted for standard 19" relay racks.*

WIDE OPEN PULSE RECEIVERS FROM GRANGER ASSOCIATES

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New LAMBDA Regulated Power Supplies

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CONVECTION COOLED

GUARANTEED FOR 5 YEARS

- **Convection cooled—no internal blowers to wear out**
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- **Excess ambient thermal protection**
- **Fast transient response**
- **Special, high purity foil, hermetically sealed long-life electrolytic capacitors**
- **Hermetically sealed transformer designed to MIL-T-27A**
- **Remote sensing and DC vernier**

New LAMBDA LA Series Condensed Data

DC OUTPUT:

(Regulated for line and load)

MODEL	VOLTAGE RANGE[1]	CURRENT RANGE[2]	PRICE
LA50-03	0-32 VDC	0- 5A	$395
LA50-03M	0-32 VDC	0- 5A	$425
LA100-03	0-32 VDC	0-10A	$510
LA100-03M	0-32 VDC	0-10A	$540

[1] The output voltage for each model is completely covered in four steps by selector switches plus vernier control and is obtained by summation of voltage steps and continuously variable DC vernier as follows:

MODEL	VOLTAGE STEPS
LA 50-03, LA 50-03M	2, 4, 8, 16 and ±2 volt vernier
LA100-03, LA100-03M	2, 4, 8, 16 and ±2 volt vernier

[2] Current rating applies over entire output voltage range

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

Transient Response: Line or Load: Output voltage is constant within regulation specifications for step function line voltage change from 100-130 VAC or 130-100 VAC or for step-function load change from 0 to full load or full load to 0 within 100 microseconds after application.

Ripple and Noise: Less than 1 millivolt rms with either terminal grounded.

AC INPUT:

100-130 VAC, 60± 0.3 cycles[3]

[3] Well within standard commercial power line frequency tolerances in the United States and Canada.

OVERLOAD PROTECTION:

Electrical: Magnetic circuit breaker front panel mounted. Special transistor circuitry provides independent protection against transistor complement overload. Fuses provide internal failure protection. Unit cannot be injured by short circuit or overload.

REMOTE SENSING:

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

PHYSICAL DATA:

Size: LA 50-03 . . . . 5¼" H x 19" W x 14⅜" D
LA100-03 . . . . 7" H x 19" W x 14⅜" D

Panel Finish: Black ripple enamel (standard). Special finishes available to customers specifications at moderate surcharge. Quotation upon request.

Send today for complete data

LAMBDA ELECTRONICS CORP.
11-11 131 STREET • COLLEGE POINT 56, N. Y. • INDEPENDENCE 1-8500

LA-1

electronics
April 8, 1960 Vol. 33, No. 15

Member ABP and ABC

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CROSSTALK . . .

FAR EAST CLOSE-UP. Electronics industry executives don't have to be told Japan is in our business. But they do want to know more —much more—about what makes the Japanese electronics industry tick. So do we. That's why Associate Editor Leary is in Japan this very minute gathering material that will appear in a special report in our May 27 issue.

He is traveling up and down the islands talking to executives, engineers and production workers . . . asking the questions you'd want to ask, and filing stories. Chances are you read the one he filed last week, "Japanese Production Workers: A Close-up." This week, Leary hits the mark again. See p 32. And watch for the May 27 complete wrapup.

FACTS ON FACSIMILE. By the end of this year an experimental system to be operated by the U. S. Post Office will attempt to demonstrate the feasibility of transmitting mail by facsimile.

This is only one sign of the growing interest in facsimile communications. The techniques of "fax"—while actually dating back to the 1860's—are coming into new prominance under pressure of the high-speed requirements of today's electronic age. Facsimile use has been firmly established in crime detection, weather reporting and other non-consumer areas.

The next step: public facsimile networks which will allow John Doe to step into the nearest telegraph office and have a drawing, a layout or any other information that can be placed on a sheet of paper, flashed to any remote destination.

For a roundup by Associate Editor Emma on the trends and facts of todays facsimile systems, turn to p 51.

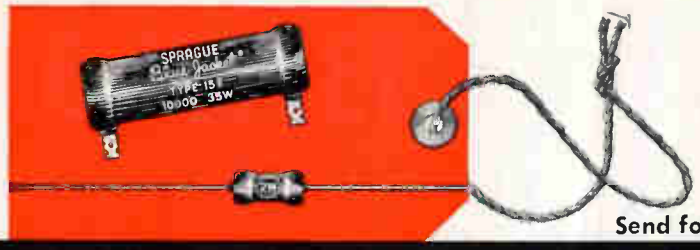
Coming In Our April 15 Issue . . .

PROJECT TIROS. When the Tiros weather satellite went into orbit around the earth, it was tracked automatically by a specially-converted antenna at Ft. Monmouth, N. J., (ELECTRONICS, p 51, Nov. 13, 1959). The antenna is designed to lock onto the satellite and track it while receiving meteorological data on the 216-260 telemetry band.

Next week, H. E. O'Kelley of Radiation Inc. in Melbourne, Fla., reveals details of the feed that allows automatic tracking at low angles. Designed to overcome the twofold problem of changes in the polarization characteristics of the satellite carrier signal and periodic blind spots in the telemetry coverage, the feed employs orthogonal probes to produce circular polarization and prevent loss of target signals. A spinnng dielectric lens simplifies the conical scanning and provides tracking error signals which control the antenna positioning servos.

O'Kelley is director of Radiation's RF Division and the man in charge of converting the Ft. Monmouth antenna. His 10 years' experience in radar and communications include an associate professorship in electrical engineering at Alabama Polytechnic.

TRANSISTOR AMPLIFIERS. Present drift transistors yield video amplifier bandwidths greater than those readily attainable with conventional vacuum-tube pentodes. In our next issue, J. C. de Broekert and R. M. Scarlett of Stanford Electronics Laboratories describe the use of shunt feedback networks around each stage to reduce the overall gain at low frequencies, trading gain for bandwidth. According to the authors, this results in an amplifier that is particularly simple compared to its vacuum-tube counterpart. As an example, they describe the design of an amplifier with 50-db gain and over 100-Mc bandwidth.



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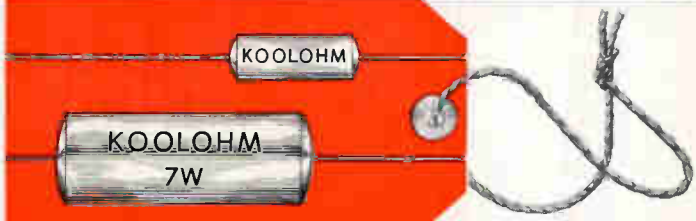

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What have the British been doing in electrical and electronic equipment?

(And in everything else?)

See their newest developments at the British Exhibition, June 10-26, at the New York Coliseum.

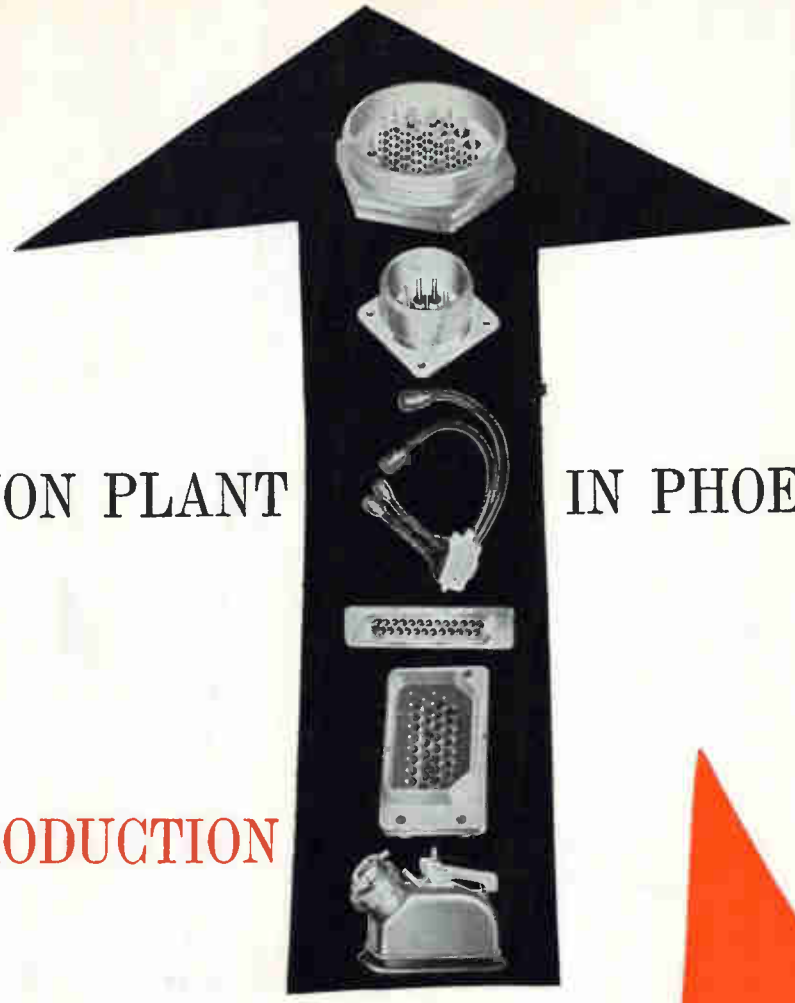
The past few years have been a period of spirited activity in British business, science and industry. New ideas, products and services are flourishing.

Now the best of these achievements will be displayed in a gigantic Exhibition in New York, under the patronage of Her Majesty Queen Elizabeth II and the President of the United States.

It will be a spectacle in the grand manner. (Nearly *twice* as big as the recent Russian show.) A vast number of British firms will show their newest, proudest wares. Executives of the exhibiting companies will be on hand to answer your questions—or talk business.

And the Exhibition will not lack its lighter side. You'll go sight-seeing in the London Arcade, see British films, quaff honest ale in a pub. The British like their fun.

Plan to come. You will find it an absorbing event and a profitable one.



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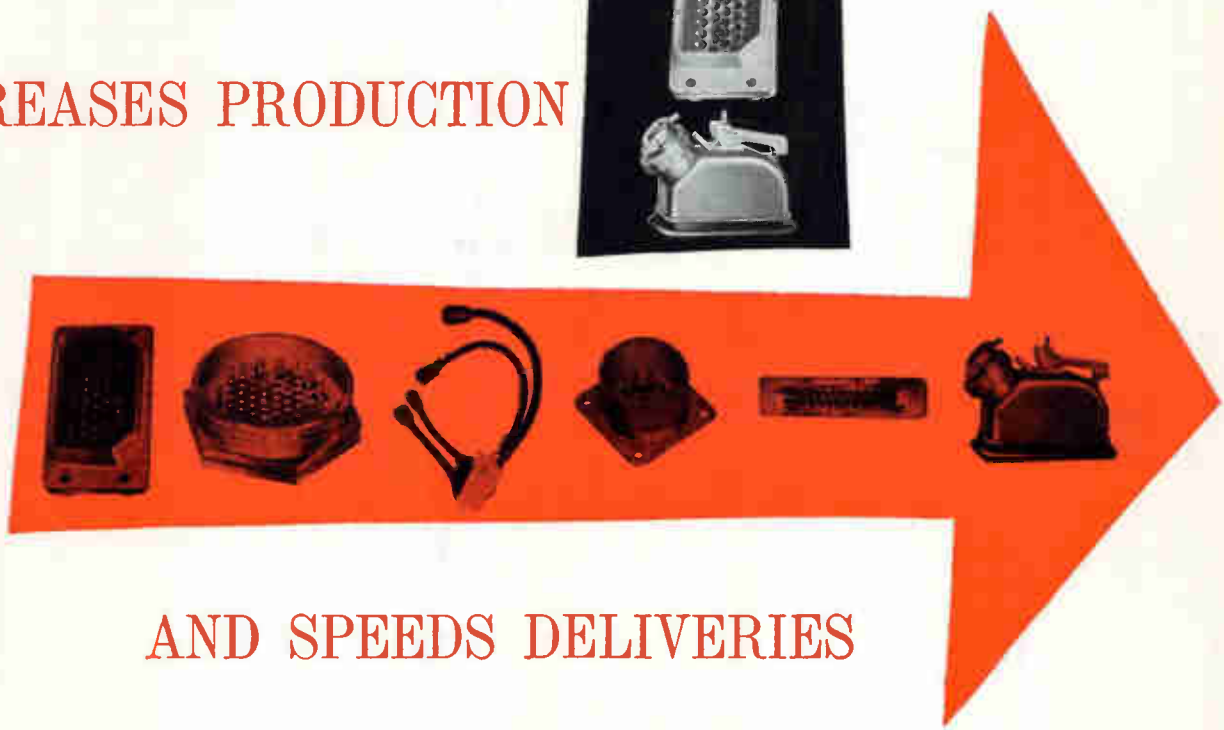
INCREASES PRODUCTION



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Yes...you now get faster deliveries—increased production—better service for all Cannon plug/harness systems, umbilical plugs, and hermetically sealed "Canseal" plugs! The manufacture of these specialized lines has been streamlined by combining in one location every phase of their engineering, manufacturing, and testing. And the new 68,000-sq. ft. Phoenix facility has plenty of room to grow—is staffed with experienced Cannon personnel to give you complete service. This new plant reflects our continuing effort to anticipate expanding technology...is another of many reasons why you should consult the first name in plugs...why you should always consult Cannon for all your plug requirements.

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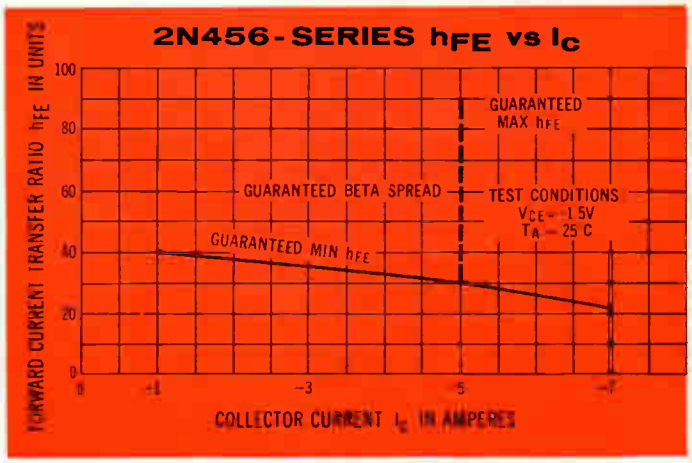
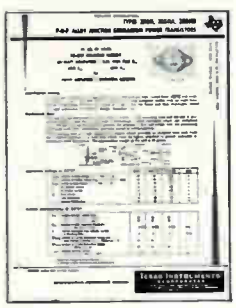


TI gives you design leadership in quality germanium power transistors

INCREASED BETA THROUGH HIGH-EFFICIENCY EMITTER

Emitter efficiency can be improved by increasing the ratio of resistivities between the emitter and base region. For example, when a 10 ohm-centimeter resistivity germanium wafer is used as the base material, it is advantageous to have less than a .01 ohm-centimeter resistivity emitter regrowth region. Since initial doping of the germanium crystal establishes base resistivity, the ratio can be changed only by varying the emitter material. TI utilizes an emitter material that results in a lower emitter resistivity and an increased emitter efficiency, plus providing the higher beta at high currents.



Optimum reliability for all TI germanium power transistors is assured by . . . 100% testing . . . 100% temperature cycling . . . 100% hermetic seal testing . . . continuous and intensive quality assurance program. Write on your company letterhead for germanium power transistor specifications.

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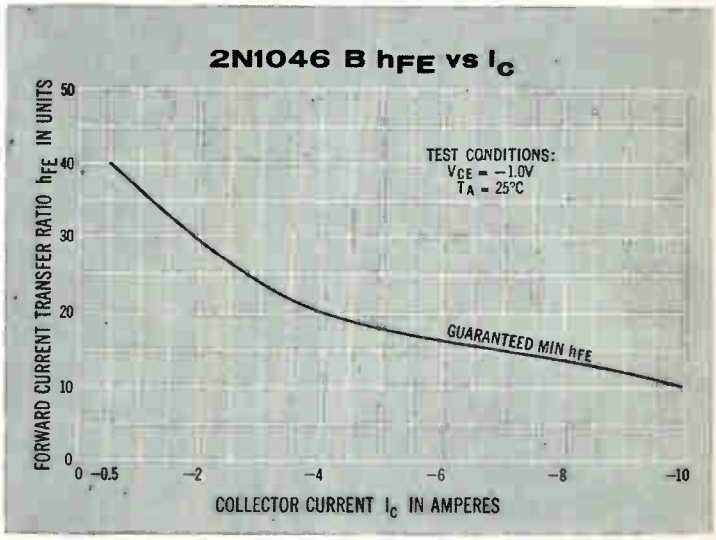
MANIUM POWER TRANSISTORS

New high current 2N1046-A-B give you high frequency/dissipation/voltage with high beta!

New TI 2N1046B germanium power transistors give you 10 amp I_C with typical 18 mc f_T* . . . 130 volt BV_{CBO} . . . guaranteed beta of 10 at 10 amp I_C . . . 30 watt dissipation . . . high frequency/high current operating characteristics. The 2N1046 series alloy-diffused P-N-P transistors provides maximum reliability for your core driving, hi-fi amplification, and other high frequency power applications.

f_T* *Frequency at which common base current gain of the device is unity.*



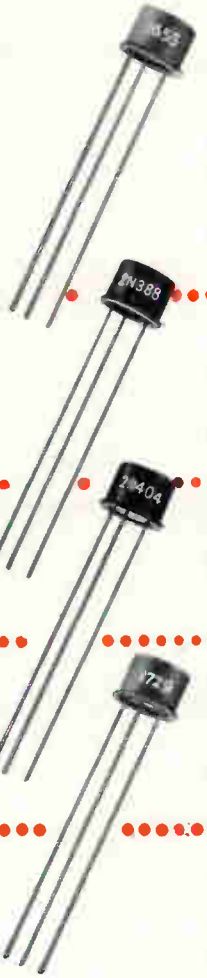
Call on your nearest TI distributor or sales office for immediate delivery of TI germanium power transistors including the 1-amp 2N1038 series and the 3-amp 2N1042 series power transistors.

TI GERMANIUM POWER TRANSISTOR CHARACTERISTICS AT 25°C

Type	Dissipation at 25°C watts	Collector to Base Voltage-v max	Collector to Emitter Voltage min BV_{CEO}	Emitter to Base Voltage-v min BV_{EBO}	Collector Current Amps max	h_{FE} @ I_C min	h_{FE} @ I_C max	Collector Reverse Current I_{CO} max ma	Collector Reverse Current I_{CO} max v	Typ R_{CS} @ I_C ohms	Internal Cutoff Frequency avg f_T
2N456A	50	−40	−20	−20	−7	30 @ 5a	90	−0.5	−20	0.040 @ 5a	430 kc
2N457A	50	−60	−30	−20	−7	30 @ 5a	90	−0.5	−30	0.040 @ 5a	430 kc
2N458A	50	−80	−40	−20	−7	30 @ 5a	90	−0.5	−40	0.040 @ 5a	430 kc
2N1021	50	−100	−50	−20	−7	30 @ 5a	90	−0.5	−50	0.040 @ 5a	430 kc
2N1022	50	−120	−50	−20	−7	30 @ 5a	90	−0.5	−60	0.040 @ 5a	430 kc
2N511	80	−40	−20	−30	−25	20 @ 10a	60	−2	−20	0.025 @ 10a	260 kc
2N511A	80	−60	−30	−30	−25	20 @ 10a	60	−2	−30	0.025 @ 10a	260 kc
2N511B	80	−80	−40	−30	−25	20 @ 10a	60	−2	−40	0.025 @ 10a	260 kc
2N512	80	−40	−20	−30	−25	20 @ 15a	60	−2	−20	0.033 @ 15a	280 kc
2N512A	80	−60	−30	−30	−25	20 @ 15a	60	−2	−30	0.033 @ 15a	280 kc
2N512B	80	−80	−40	−30	−25	20 @ 15a	60	−2	−40	0.033 @ 15a	280 kc
2N513	80	−40	−20	−30	−25	20 @ 20a	60	−2	−20	0.038 @ 20a	300 kc
2N513A	80	−60	−30	−30	−25	20 @ 20a	60	−2	−30	0.038 @ 20a	300 kc
2N513B	80	−80	−40	−30	−25	20 @ 20a	60	−2	−40	0.038 @ 20a	300 kc
2N514	80	−40	−20	−30	−25	20 @ 25a	60	−2	−20	0.040 @ 25a	350 kc
2N514A	80	−60	−30	−30	−25	20 @ 25a	60	−2	−30	0.040 @ 25a	350 kc
2N514B	80	−80	−40	−30	−25	20 @ 25a	60	−2	−40	0.040 @ 25a	350 kc
2N1038	20	−40	−30	−20	−3	20 @ 1a	60	−125μa	−20	0.150 @ 1a	8.0 kc $f_{\alpha e}$ min
2N1039	20	−60	−40	−20	−3	20 @ 1a	60	−125μa	−30	0.150 @ 1a	8.0 kc $f_{\alpha e}$ min
2N1040	20	−80	−50	−20	−3	20 @ 1a	60	−125μa	−40	0.150 @ 1a	8.0 kc $f_{\alpha e}$ min
2N1041	20	−100	−60	−20	−3	20 @ 1a	60	−125μa	−50	0.150 @ 1a	8.0 kc $f_{\alpha e}$ min
2N1042	20	−40	−30	−20	−3	20 @ 3a	60	−125μa	−20	0.167 @ 3a	8.0 kc $f_{\alpha e}$ min
2N1043	20	−60	−40	−20	−3	20 @ 3a	60	−125μa	−30	0.167 @ 3a	8.0 kc $f_{\alpha e}$ min
2N1044	20	−80	−50	−20	−3	20 @ 3a	60	−125μa	−40	0.167 @ 3a	8.0 kc $f_{\alpha e}$ min
2N1045	20	−100	−60	−20	−3	20 @ 3a	60	−125μa	−50	0.167 @ 3a	8.0 kc $f_{\alpha e}$ min
2N1046	30	−100	−50	− 1.5	−10	40 @ 0.5a		−1	−40	0.500 @ 1a	15 mc min
2N1046A	30	−140	−50	− 1.5	−10	20 @ 4a		−1	−40	0.125 @ 4a	15 mc min
2N1046B	30	−140	−50	− 1.5	−10	10 @ 10a		−1	−40	0.050 @ 10a	15 mc min

NON-SECRET

USN·USAF·SAC standards are met by SYLVANIA TRANSISTORS



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

SYLVANIA-2N388 meets all requirements of MIL-T-19500/64 (NAVY). Originated by SYLVANIA, this NPN unit is designed and controlled specifically for computer applications where reliability, high gain and rapid switching capabilities are needed.

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

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

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

SYLVANIA

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CIRCLE 10 ON READER SERVICE CARD

BUSINESS THIS WEEK

Microminiaturization Plus High-Thrust Boosters May Put U.S. Ahead of Soviets in Space Research

Continuing company announcements of newly available microminiature devices and circuits, underscored by displays at last month's IRE show, now strongly suggest that the so-called missile gap may have been —for the longer pull in space research—a blessing in disguise. The reason: Lack of high-thrust rockets as the space era began forced rapid microminiaturization to make the best of the limited propulsion capability available.

This trend has a larger meaning beyond just catching up with the Russians and dollars for our industry. **As larger U. S. boosters are developed, it is conceivable that the headstart in microminiaturization which this country now has will permit American scientists to "leap-frog" far ahead of the Soviets in actual space research.**

Last week T. Keith Glennan, administrator of the National Aeronautics and Space Administration, in comparing the U. S. position in the space exploration field with that of the USSR, declared:

"It is reasonable to assume that the Russians can move more rapidly from concept, to drawing board, to the construction and launching of payloads because they are not limited by the weight restrictions we are experiencing. I suspect . . . that they can avoid the time-consuming business of miniaturization, optimum packaging, and other weight-saving practices."

Some observers now believe this Soviet advantage could be nullified by the sheer volume of instruments on later U. S. boosters. They think the Soviets must run hard in the electronic miniaturization field to remain in close contention with the U. S. in space research as the Saturn and Nova projects develop. Operational Saturn is expected before the end of 1964; Nova, with a thrust of 6 to 12 millon pounds, is expected sometime after 1965.

Two Americans Tour USSR Research Facilities As Guests of Science Academy's Vice Chairman

Two Americans who just toured a score of Soviet research facilities have come away impressed by the scale of scientific education and research in the Soviet Union. Richard S. Leghorn, president of Itek Corporation, Waltham, Mass., and J. B. Wiesner, director of the Research Laboratory of Electronics at MIT, visited the USSR as the personal guests of A. V. Topchiev, vice chairman of the USSR Academy of Science.

Among the facilities they visited in Moscow were the Moscow University physics department, Lebedev Physics Institute, Radio Technical Institute, the Low Temperature Laboratory at Moscow University, Institute of Automatics and Telemechanics, and Viniti—the All-Union Institute of Scientific and Technical Information.

The Americans were struck by the prestige enjoyed by Soviet scientists. **"There is no doubt," remarked Leghorn, "that this is a science and research oriented society."** The two were impressed by the quantity and quality of teaching facilities and laboratory equipment for the university physics department's thousands of students. **"It's as good or better than anything I have seen anywhere including MIT," says Wiesner.**

In Leningrad the Americans visited the Semiconductor Institute, Electromechanical Facility and the Physics Technical Institute. They also toured facilities in Kiev, Tbilsi and Stalingrad.

Experimental Receiving System for Use With Passive Satellites Shows Promise

Experimental progress towards transoceanic communication by means of passive earth satellites was reported last week by Bell Telephone Laboratories.

The experiments used a narrow-beam-width highly-directional horn-reflector antenna with low noise pickup from the surrounding terrain, coupled to a low-noise traveling wave maser that amplifies only in the forward direction. This combination, says BTL, "has a lower noise temperature than any complete receiving system ever demonstrated" and it "measures noise generated in the atmosphere with a precision never before obtained."

BTL says such a low-noise system could also extend the range or increase the bandwidth of telemetering gear aboard space vehicles.

In experiments with the horn-reflector antenna pointed straight up, overall input temperatures as low as 17.6 degrees K were observed at 5.65 Kmc.

ELECTRONICS NEWSLETTER

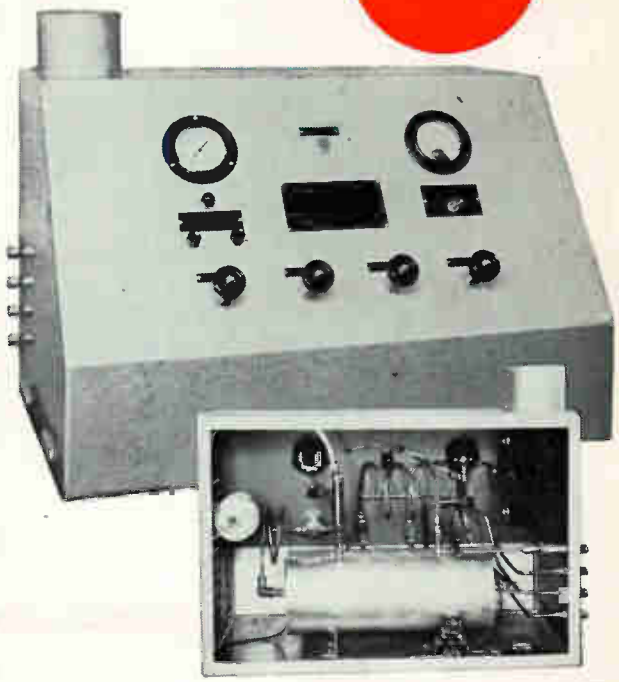
Nuclear bomb alarm system being installed for the Air Force by Western Union will go into operation on the East Coast by May 1, 1960. USAF, which considers the system an extension of SAGE, is leasing it for $2 million a year, including maintenance. System is designed to positively identify atomic explosions of any magnitude and will relay information to display centers. WU says the system can be extended to cover 100 possible targets all over the country in 120 days.

Basic detection units can recognize the thermal radiation wave shape of a nuclear flash. The detector uses silicon photocells and is fast enough, except for a direct hit, to report a nuclear explosion before arrival of the destructive blast wave.

Carbon monoxide use for frequency standards is being studied at the National Company, Melrose, Mass. Basic research now underway aims at making use of the frequencies associated with the change of rotational states of the diatomic CO molecule.

Palladium Diffusion Purifier removes all impurities from commercial cylinder hydrogen

CHEMICAL DIVISION



The Engelhard Palladium Diffusion Purifier is used to remove all impurities from commercial cylinder hydrogen. This includes such impurities as oxygen, nitrogen, argon, water vapor, hydrocarbons and any others found in commercially bottled hydrogen.

The hydrogen purity achieved is, without question, the highest obtainable—no trace of impurities are detectable in the purified gas, by any known method.

Electrical circuit interlocks prevent palladium and hydrogen contacting at 150°C to form beta phase Pd-H2 system which is brittle and impervious. Impurities are not permitted to accumulate within the palladium tubes. Impurities are bled off continuously with a small hydrogen stream which is vented to a hood or a small burner. A check valve located in the pure product line prevents back flow into the tubes.

The Engelhard Hydrogen Palladium Diffusion Purifier is now manufactured in standard sizes for flowrates from 5 scfh up to 1000 scfh. Larger sizes are custom built to meet customer's requirement. Write for literature and price list.

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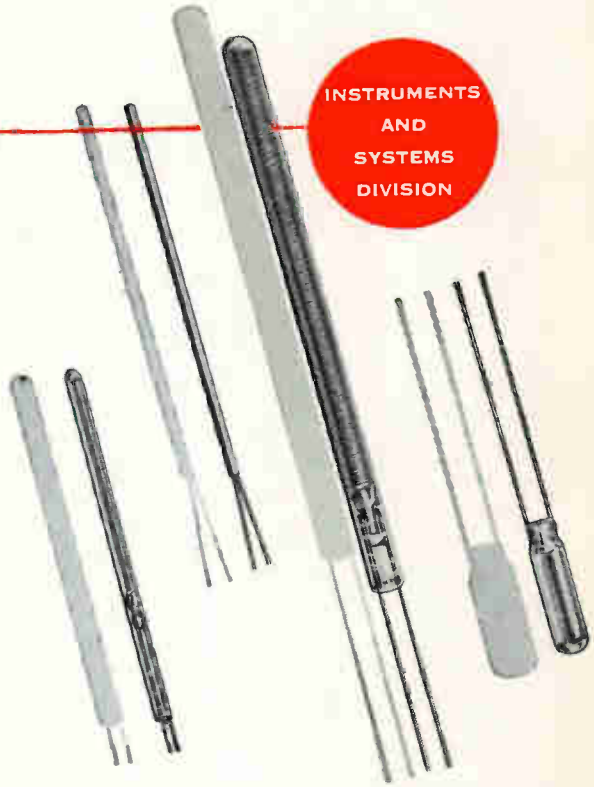
CIRCLE 268 ON READER SERVICE CARD

These platinum precision resistance spirals measure temperature by change in electrical resistance.

INSTRUMENTS AND SYSTEMS DIVISION



Here are ideal components for both accuracy and reliability in temperature measuring or controlling equipment. They have an accuracy of ± 0.1°C.

Three types are available in a full range of sizes. A glass enclosed series affords high precision for temperatures between −220°C and +500°C. Spirals are obtainable as standard products having a resistance of 25, 50 or 100 ohms. The variation in diameters, lengths, etc., are numerous.

High temperature spirals in which suitable ceramic replaces the glass are also available. These are used for measuring temperatures up to 750°C. The accuracy of the ceramic spirals is only slightly less than that obtainable from the glass spiral, but still superior to thermocouples in stability. For extremely precise temperature measurements, a laboratory standard resistance thermometer is available.

Although most spirals are supplied directly to the user as components, we also provide a fabrication service and supply spirals in metal sleeves or other constructions as required. Send for complete literature.

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EAST NEWARK, NEW JERSEY

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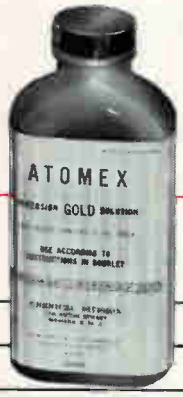

gold plating for electrical and electronic components

Atomic Number	79
Atomic Wgt.	197.20
Crystal Structure	Face center cubic 4.07A°
Density	20°C = 19.3 G/CM³
Melting Point	1063°C
Specific Resistance	13.2 OHMS/MILL/FOOT
Thermal Conductivity	0.71 c g s UNITS (20°C)
Coef. Linear Expansion	14.2 Micro Inches /°C (20°C)
Hardness	Rockwell 15 T Scale = 24
Tensile Strength	P.S.1 x 1000 = 18
Magnetic Susceptibility	.15 x 10^{-6} C.G.S. Units (18°C)

Recently, the use of gold electroplates have been extended to many new functional applications especially in the field of electronics where the tarnish resistance and low electrical resistivity of gold are most useful. A complete line of precious metal plating solutions for both decorative and functional purposes are available from stock.

ATOMEX is a 24K gold immersion solution that permits the deposition of a thin, dense, uniform layer of 24K gold on printed circuits and metallized plastics by means of a simple bath. Atomex deposits gold by Ionic displacement—it is the first practical gold immersion solution containing no free cyanide. The Atomex deposit is more permanent and less expensive than electroplating of comparable thickness. Costly analytical control is unnecessary. Write for literature.

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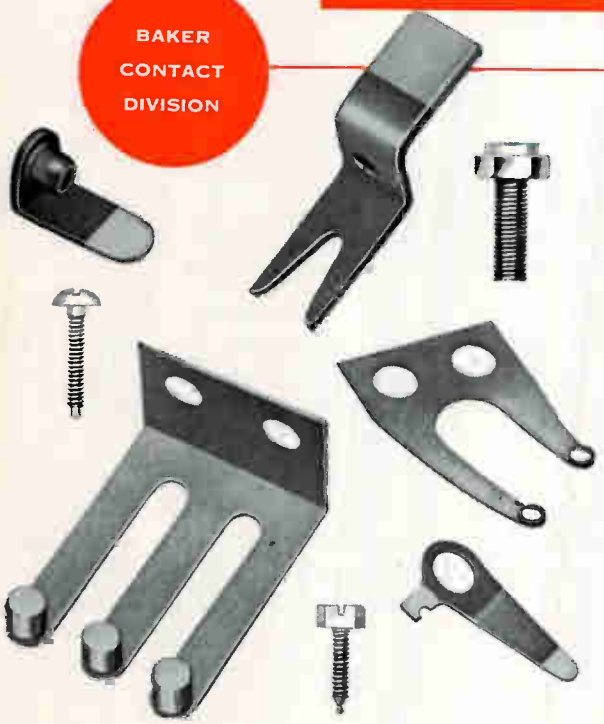

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For high-reliability and long operating life, precious metal contacts in pure or alloyed forms of silver, platinum, palladium and gold are very definitely indicated. These contacts provide unmatched high resistance to atmospheric corrosion, deformation, arc erosion, binding and metal transfer. Baker precious metal contacts are supplied as wire, rod, sheet and in a complete line of fabricated forms. Facilities are also available for manufacture to your specifications. Write for Baker Contact catalog.

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CIRCLE 271 ON READER SERVICE CARD

WASHINGTON OUTLOOK

THE AIR FORCE has unveiled plans to scale back spending in fiscal 1960 and 1961 by some $673.1 million, then beef up other projects by $424 million over the two-year period. The service originally wanted to boost other projects by some $679.5 million, but the Secy. of Defense forced a hold-down on the move.

What the Air Force wants to do is cut back $381 million in its Bomarc-B anti-aircraft missile program and some $274.2 million from its Sage (Semi-Automatic Ground Environment) electronic network to control both manned fighter planes and anti-aircraft missiles. An additional $7-8 million would be trimmed from other projects.

In addition to cutting production money on the Bomarc program, four of the 12 Bomarc bases would be eliminated. They are at Paine, Wash., Adair, Ore., Vandenberg, Calif. and Travis, Calif. All of these bases are currently under various stages of construction.

All eight of the underground control centers of the Sage system would be scrapped. The only site that has been named for these centers is White Horse Mountain, N. Y.

Set for an increase of funds is the Atlas ICBM program. The Air Force wants to add $126 million for 12 more missiles and launching pads. They would go at bases now located at Lincoln, Neb., Saline, Kan., Omaha, Neb., Abiline, Tex., Plattsburgh, N. Y., and Roswell, N. Mex.

Some $27 million will be used to speed up development of the Air Force's solid-fueled Minuteman ICBM missile. And $42.5 million will be used to step up construction of the second and third Ballistic Missile Early Warning (BMEWS) bases at Clear, Alaska, and northern England.

An additional $60 million would be pumped into the Air Force's space projects—Midas, Samos, and Discoverer. The "Century Series" jet fighter-interceptor aircraft program would get an increase of $134 million; the GAR-9/ASG-18 program would get an addition of $15 million; surveillance programs would be increased by $16.9 million.

Reason for making the shift in funds, the Air Force says, is because of "substantial changes in its air defense and strategic programs." Observers see the change as just another step toward the shift to ballistic missiles both in weaponry and detection systems. It is well known, too, that the Bomarc-B missile, which has a stepped up range of 400 miles over the earlier 200-mile range Bomarc-A series, has had serious test difficulties. To date, the Air Force has pumped close to $2 billion into the program.

- **Rapidly expanding need for radio communications** in the oil industry is worrying the National Petroleum Council. The group has just issued a report reviewing current uses, anticipating future needs, and making eight recommendations on what might be done to ease pressure on the spectrum space.

  The petroleum industry currently has an investment of about a quarter billion dollars in privately-owned electronic communications facilities of all kinds, plus what it spends for commercial communications. The industry complains that while common carriers traditionally oppose development of private systems, they cannot really supply the oil industry with the communications it needs.

  A key recommendation of the council's radio committee is that the Secretary of the Interior prepare studies of the industry's use of radio and radar every two or three years. It also recommends increasing coordination among government agencies dealing with oil communications.

  Congressional efforts to straighten out the spectrum mess this year have bogged down. A projected House study has been written off for this year.

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TEMCO'S DC TO DC POWER CONVERTER

■ Based on a unique method of non-dissipative voltage regulation, Temco's DC to DC power converter leads the field in accuracy and efficiency within its size and weight. This one small unit (3.5″ x 5.9″ x 2.2″ — weight 3 pounds) provides a 250, 150 and 5 volt DC power supply. High efficiency — 70% at full load — is combined with extremely accurate voltage regulation. It meets or exceeds the 250, 150 and 5 volt power requirements of most telemetry systems. ■ Designed and developed by Temco Electronics, this DC to DC converter offers major advantages both to the military and to industry. It can be furnished with other output voltages for use in airborne flight testing and a multitude of space age applications. Particularly, it is representative of Temco's advanced techniques and capabilities, and its increasing leadership in the field of electronics. For further information, write or call today. ■ Many excellent engineering and scientific positions are now open in this and other Temco programs. We invite your inquiry.

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If America should be attacked . . . from bases around the world Strategic Air Command bombers, tankers and surface-to-surface missiles will rise to action. Minutes only will be available.

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As systems manager, International Electric Corporation is developing and will turn over to SAC a world-wide electronic combat control system, an integrated complex of electronic subsystems. The system, employing digital techniques and equipment, will transmit, process and display information on a global basis . . . with only seconds involved.

Engineers whose interests lie in systems engineering, data processing and communications will find in this long-term project exceptional opportunity to exercise creative competence and individual initiative. For details of engineering assignments write B. J. Crawford, Director of Technical Staffing.

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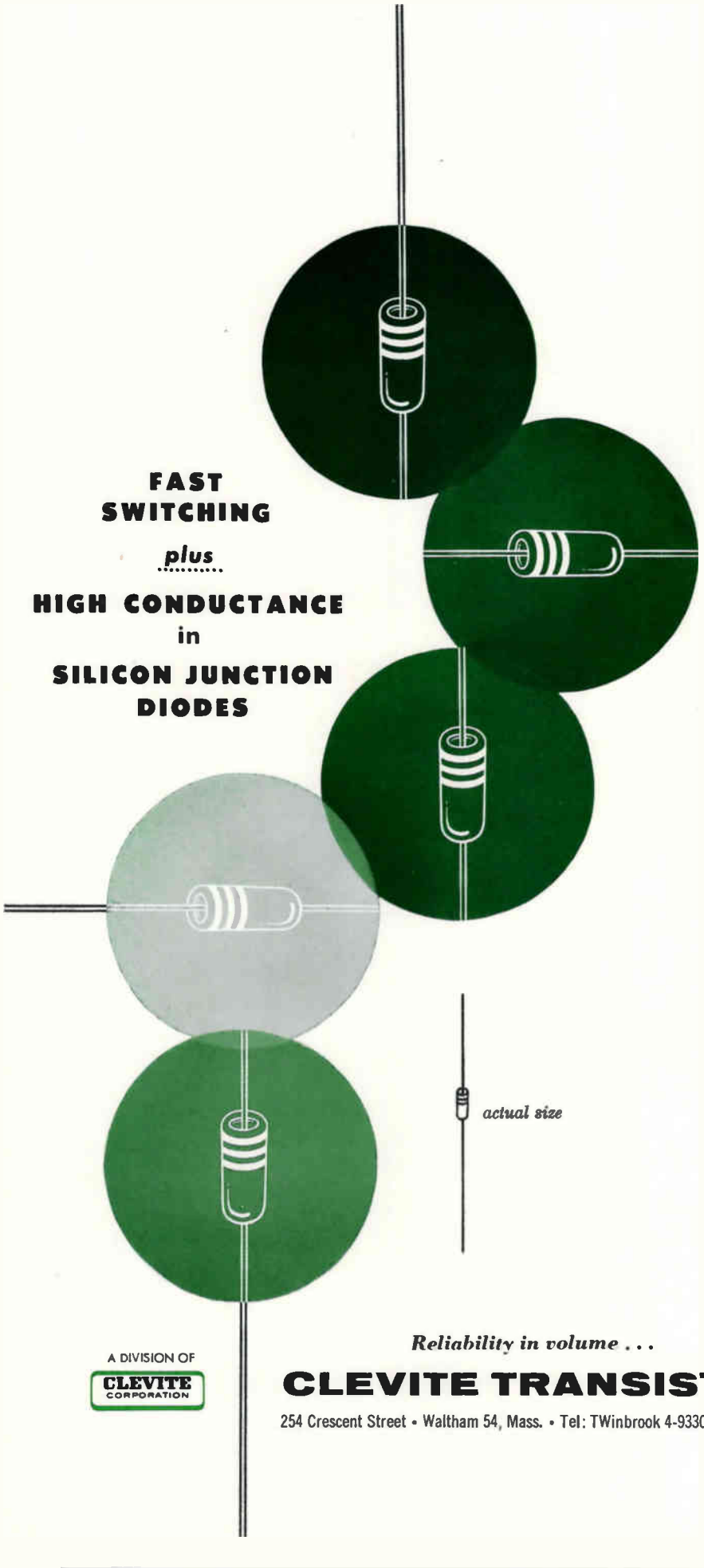
FAST SWITCHING
plus
HIGH CONDUCTANCE
in
SILICON JUNCTION DIODES



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SWITCHING TYPES

New circuit possibilities for low impedance, high current applications are opened up by Clevite's switching diodes. Type CSD-2542, for example, switches from 30 ma to −35v. in 0.5 microseconds in a modified IBM Y circuit and has a forward conductance of 100 ma minimum at 1 volt.

Combining high reverse voltage, high forward conductance, fast switching and high temperature operation, these diodes approach the ideal multi-purpose device sought by designers.

GENERAL PURPOSE TYPES

Optimum rectification efficiency rather than rate of switching has been built into these silicon diodes. They feature very high forward conductance and low reverse current. These diodes find their principal use in various instrumentation applications where the accuracy or reproduceability of performance of the circuit requires a diode of negligible reverse current. In this line of general purpose types Clevite has available, in addition to the JAN types listed below, commercial diodes of the 1N482 series.

MILITARY TYPES

JAN

1N457	MIL-E-1/1026
1N458	MIL-E-1/1027
1N459	MIL-E-1/1028

Signal Corps

1N662	MIL-E-1/1139
1N663	MIL-E-1/1140
1N658	MIL-E-1/1160
1N643	MIL-E-1/1171

All these diodes are available for immediate delivery. Write now for Bulletins B217A-1, B217A-2 and B217-4.

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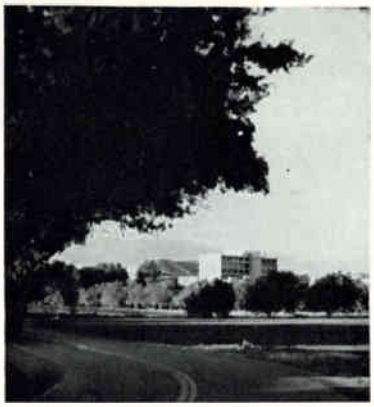
CIRCLE 19 ON READER SERVICE CARD



At The Ramo-Wooldridge Laboratories... integrated programs of research & development of electronic systems and components.

The new Ramo-Wooldridge Laboratories in Canoga Park provide an environment for creative work in an academic setting. Here, scientists and engineers seek solutions to the technological problems of today. The Ramo-Wooldridge research and development philosophy places major emphasis on the imaginative contributions of the members of the technical staff. ■ There are outstanding opportunities for scientists and engineers. *Write* Dr. Richard C. Potter, Head, Technical Staff Development, Department 21-E.

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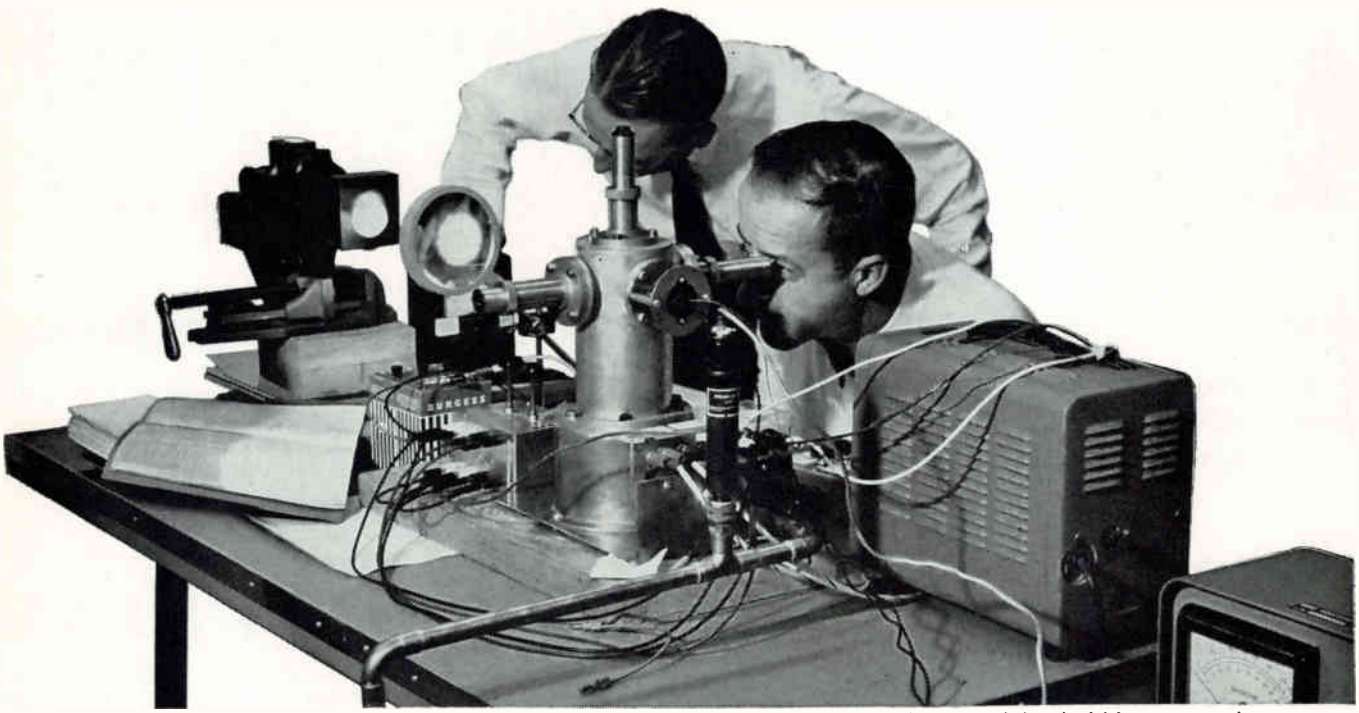

An electron device permits scientists to study the behavior of charged dust particles held in suspension.

Admiral Sales Up 17 Percent

ADMIRAL CORP. announces consolidated net sales of $199,605,609 for 1959, a rise of 17 percent over the $170,777,126 reported for 1958. Net income last year was $4,108,450 or $1.71 a share. In 1958 it was $1,357,017 or 57 cents. Provision for all taxes—federal, state, local and foreign—amounted to $18,957,811 or $7.88 cents a share.

• **General Transistor Corp.,** Jamaica, L. I., reports net sales of $10,278,585 for the year ended Dec. 31, 1959, an increase of 50 percent over 1958. Net income after taxes was $537,306—19 percent under 1958. Company president Herman Fialkov said this was due to several factors including problems arising from multiplant semiconductor operations and losses incurred in magnetic head and intercoupler operations. Plans for consolidation of activities in a new plant now under construction are expected to cut future losses of this nature, he said.

• **Sprague Electric Co.,** North Adams, Mass., announces largest sales and net profits for 1959 of any year in company history. Sales rose to $56,351,571 last year from $43,193,717 in 1958. Net profit went to $3,502,328 from $1,761,719. Net earnings per share were $2.61 in 1959, $1.41 in 1958. Dividends totaled $1.20 per share in cash plus 2 percent in stock.

• **Ampex Corporation,** Redwood City, Calif., reports sales of $46,271,000 for the first nine months of the company's present fiscal year. This is an increase of 72 percent over the $26,829,000 reported in the same period of the previous year. Net income rose 100 percent in the same interval, going from $1,219,000 to $2,446,000. Earnings per share were $1.02 based on shares outstanding before the 3-for-1 stock split which became effective Feb. 1, 1960.

• **Sonotone Corp.** reports sales and earnings at record highs, with net profits up 41 percent. Sales for 1959 reached a record $24,756,708, up 15 percent over 1958 sales of $21,513,064. Net earnings were $1,132,302, up 41 percent over 1958 profits of $800,473. The 1959 earnings were equal, after preferred dividends, to 96 cents per common share on 1,148,287 shares outstanding at the end of 1959, as compared with 71 cents per share on 1,070,169 shares outstanding at the end of 1958.

• **Allied Control Co.,** New York, announces net sales for 1959 rose to $11,083,664, compared with $9,755,173 for 1958. Net income was $444,721, down from $531,207 in 1958. Earnings per share totalled $1.88 in 1959, $2.11 in 1958.

• **Ironrite, Inc.,** Mt. Clemens, Mich., producer of home automatic ironing equipment, announces the acquisition of **Warren Mfg. Co.,** Littleton, Mass., producer of telephone, teletype and telemetering equipment. This transaction follows by 5 months Ironrite's acquisition of **Dielectric Products,** Raymond, Me. for 124,078 shares of common stock.

25 MOST ACTIVE STOCKS

WEEK ENDING MARCH 25

	SHARES (IN 100's)	HIGH	LOW	CLOSE
Int'l Tel & Tel	1,338	38½	35½	38½
Ampex	1,177	37⅞	34¾	36⅛
Burroughs	1,004	33⅝	29⅝	32⅛
RCA	959	69⅛	66⅛	68½
Gen Tel & Elec	860	79¾	73⅝	79
Avco Corp	829	14½	13½	14¼
Waltham Precision	705	3¼	2¾	3¼
Gen Electric	678	90½	86¾	89⅞
Litton Ind	601	74⅜	68¼	73⅜
Philco Corp	550	35	33⅛	34⅝
Reeves Sndcrft	534	9¼	8¼	8¾
Westinghouse	478	51	49¼	50⅜
Siegler Corp	393	37½	35½	35¾
Dumont Labs	354	8⅝	7⅛	8½
Texas Inst	323	186⅝	170¾	186⅝
Zenith Radio	311	106⅝	99½	105
Reliance Elec	302	57	55⅛	56½
Amphenol Borg	293	42⅜	38	42⅜
Collins Radio	279	59⅜	56⅝	58⅝
Transitron	269	47⅝	45⅛	46½
Gen Inst	257	28¼	26⅞	27¾
Univ Controls	248	15	13¾	13⅞
Raytheon Mfg	245	45¼	43⅝	43⅞
Varian Assoc	240	46⅞	44⅛	46¼
Int'l Bus Mach	234	441	423	440

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.

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CHOOSE HUGHES SILICON RECTIFIERS

With over 100 different JEDEC types available, Hughes offers you one of the industry's largest selections of stud mounted and top hat silicon rectifiers. And with their hermetically sealed, corrosion resistant packages, these rectifiers give you maximum reliability!

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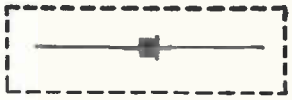
For export write: Hughes International, Culver City, California.



PIGTAIL TOP HAT SILICON RECTIFIERS

E.I.A. Number	*PIV*
1N536	50
1N599	50
1N599A	50
1N1217	50
1N440B	100
1N530	100
1N537	100
1N600	100
1N600A	100
1N1100	100
1N1218	100
1N601	150
1N601A	150
1N1219	150
1N441B	200
1N531	200
1N538	200
1N602	200
1N602A	200
1N1101	200
1N1220	200
1N442B	300
1N532	300
1N539	300
1N603	300
1N603A	300
1N1102	300
1N1221	300
1N443B	400
1N533	400
1N540	400
1N604	400
1N604A	400
1N1103	400
1N1222	400
1N444B	500
1N534	500
1N605	500
1N605A	500
1N1104	500
1N1223	500
1N445B	600
1N535	600
1N547	600
1N606	600
1N606A	600
1N1096	600
1N1224	600
1N1225	700
1N560	800
1N1226	800
1N561	1000

STUD MOUNTED SILICON RECTIFIERS

E.I.A. Number	*PIV*
1N607	50
1N607A	50
1N340	100
1N338	100
1N349	100
1N348	100
1N347	100
1N253	100
1N608	100
1N608A	100
1N609	150
1N609A	150
1N336	200
1N337	200
1N346	200
1N345	200
1N254	200
1N610	200
1N610A	200
1N334	300
1N335	300
1N344	300
1N343	300
1N611	300
1N611A	300
1N332	400
1N333	400
1N342	400
1N341	400
1N255	400
1N612	400
1N612A	400
1N613	500
1N613A	500
1N256	600
1N614	600
1N614A	600
1N562	800
1N563	1000

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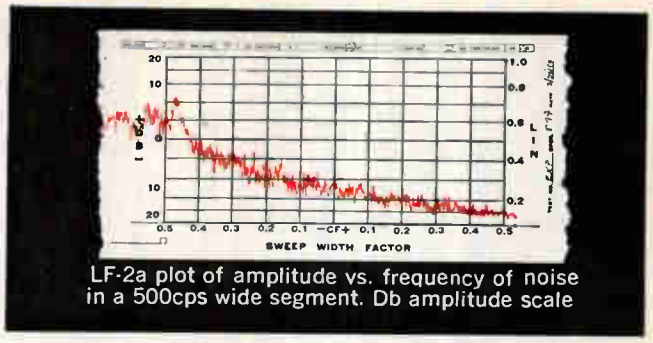

LF-2a plot of amplitude vs. frequency of noise in a 500cps wide segment. Db amplitude scale

Panoramic Subsonic Spectrum Analyzer

MODEL
LF-2a
0.5 cps. to 2500 cps.

EXCLUSIVE FEATURES:

- **Adjustable scan widths—2 cps to 500 cps**
- **10 second "quick look" on external scope**
- **Exceptional adjustable resolution (selectivity): 0.1 cps to 20 cps**
- **Low cost** • **Easy to use**

Unusually flexible and versatile, the economical Model LF-2a automatically separates and measures the frequency and amplitude of discrete or random signals between 0.5 and 2500 cps . . . and displays these data on either an integral chart recorder or external scope.

More application requirements are satisfied by providing analyses of spectrum segments—as narrow as 2 cps, as wide as 500 cps—plotted over the **full width** of a calibrated 12" x 4½" chart record. A calibrated tuning control enables rapid selection of the center frequency of the spectrum portion of interest. Frequency selectivity—or resolution—is independently adjustable from 0.1 cps to 20 cps for more accurate detection and measurement of either closely spaced discrete signals or noise.

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Among the LF-2a's many proven uses are: • **Vibration and Acoustic Analysis** • **Random Waveform Studies** • **Power Spectral Density Analysis** • **Medical Investigations** • **Servo Analysis** • **General Low Frequency Waveform Studies**

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dependable CERTIFIED SPECIFICATIONS for accurate data

SUMMARY OF SPECIFICATIONS:

Frequency range: 0.5 cps to 2500 cps in two operating modes:
X1.0—Linear segments 500, 100 or 20 cps wide, centerable between 0 and 2250 cps
X0.1—Linear segments 50, 10 or 2 cps wide, centerable between 0 and 225 cps
Sensitivity: 10 mv to 100v for full scale deflection
Amplitude scales: Linear and 2 decade log
Chart size: 12" length, usable width 4½"
Resolution: 0.1 cps to 20 cps in 11 steps
Sweep Rates: One scan in 10 seconds, and 1, 2, 4, 8 or 16 minutes; also may be scanned in 1, 2, 4, 8, or 16 hours (optional)
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0.5 cps/hr. in X1.0 mode
Input Impedance: 5 megohms
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Optional: LF-2aM, with automatic frequency advance after each scan interval provides unattended analysis from 0.5-2000 cps.

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MARKET RESEARCH

Microwave Components Survey

MICROWAVE COMPONENTS form one of the electronics industry's "hot" markets. Component manufacturers have long needed a guide for estimating markets for individual microwave components, but very little information has been available in the past.

Commerce Department's Business and Defense Services Administration now helps meet this need with its recently issued Microwave Components study which deals with 1958 production and related data.

$300 Million in 1958

BDSA estimates the total microwave components market in 1958 at $300 million. This estimate includes the following sub-totals (all in million $):

Microwave tubes	$108
Microwave antennas	$95
Microwave components covered in survey	$92
Other (mixer crystals, etc.)	$5

No figures later than 1958 were reported by the government agency. But follow-up visits made in late 1959 revealed that last year's output levels were substantially above those of 1958 and indicated 1960 would bring further expansion.

Products covered in the survey include: wave guides and fittings, transitional and motional devices, microwave switches, reactive and dissipative devices, hybrids, microwave test and measuring devices.

Survey was made among 96 microwave component manufacturers who reported 1958 shipments worth $68,446,000, of which $54,198,000 (or 80 percent) was for military use. Ferrite component shipments amounted to less than six percent of all microwave component shipments, $3,776,000. Military share of ferrite shipments was $2,635,000.

Although survey return of shipments from the 96 manufacturers added up to $68.5 million, BDSA estimated the total 1958 market for components covered in the survey at $92 million.

Difference of approximately $25 million represents agency estimate of non-reported shipments. This non-reported figure includes $13 million for "captive" output, $7 million of research and development and $3 million from missing firms.

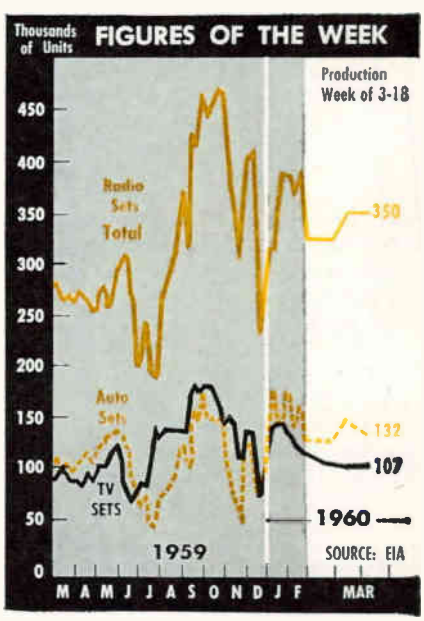
Survey also shows shipments for 43 individual microwave components, in units and dollars, along with average prices. Unfortunately the survey-makers were unable to make estimates of the national markets for individual products. Listed are only the total shipments reported by the 96 participants.

Nevertheless, the figures reported should be of considerable value to anyone doing market planning in the microwave area. The figures are not reported in this column because of the volume of detail. However, the complete report may be obtained from the Superintendent of Documents, Washington 25, D. C. Price: 10 cents.

Additional Material

In addition to shipment statistics, the report contains much additional material on the economics of microwave manufacturing. Here is an example:

Average sales per employee was $10,500, while the average floor space required for each employee was 226 sq ft.



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These are just a few of the very real applications for the Cubic Talking Meter, made possible by 16 channels of voice information available at command programmed by fine Cubic Digital instrumentation or any source of electrical impulse.

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- Product identified with crystal for field survival analysis

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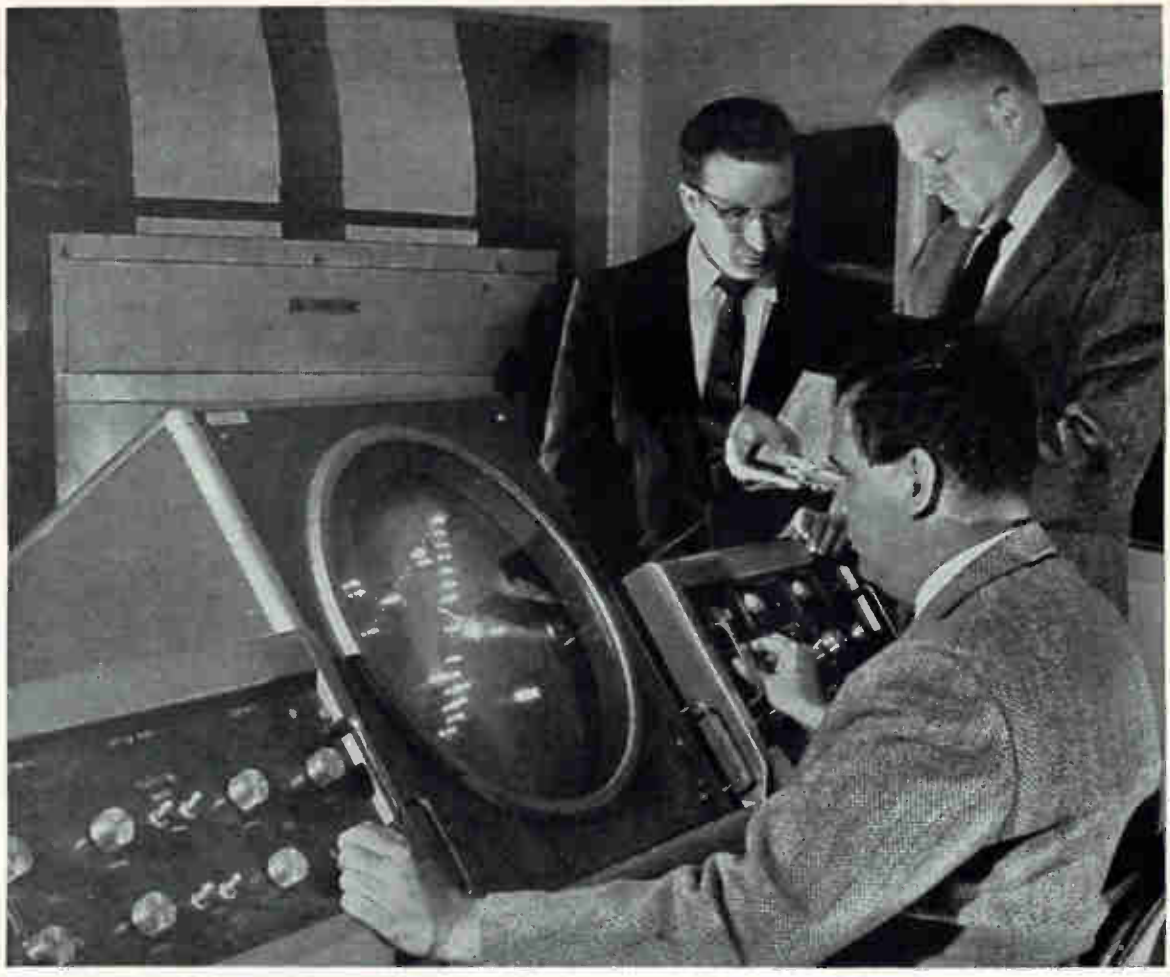


Charactron display in NAFEC's computer laboratory shows movements of 50 simulated aircraft

Air Traffic Data Center Tests Begin

Present simulation tests will gradually phase into live information service for New York. Data central is expected to cost $67 million by 1963

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

FIRST experimental use of a data processing central in connection with the nation's air traffic control problems is underway in the form of limited-scale simulation of the New York traffic center. By the end of this year government researchers expect to phase into a "substantial simulated operation."

At least two live data center test phases are in the early planning stages but the live tests themselves are not expected to start before next year. The plans—necessarily indefinite because an air traffic control system must be evolved on the basis of step-by-step development and testing—nevertheless indicate that steady progress is being made in 1960 towards solving the most serious problems of jet-age air traffic control.

The work of planning, developing and testing the data-handling and associate systems goes on near Atlantic City, N. J., at the National Aviation Facilities Experimental Center (NAFEC) of the Federal Aviation Agency's Bureau of Research and development. The data center project is the biggest single one NAFEC has right now.

E. R. Quesada, administrator of the Federal Aviation Agency, says the data processing central will be available for regular use in the New York area in 1963. The system will be installed later in Chicago, Los Angeles, Washington and Miami.

The FAA has committed about $8 million in fiscal 1960 funds to the data processing central, bringing the total committed to date to $22 million. The agency expects to spend $15 million on the DPC in each of the next three years—for a total of $67 million by 1963.

Following New York center simulation tests, according to present plans, the DPC will be tested live initially as an enroute traffic center controlling the planes flying to and from New York through a designated sector around Atlantic City.

Next step will be to test the system's capability for fulfilling a more complex function: the handling of traffic making the transition from enroute control to New York terminal control.

GPL Is Contractor

Data Processing Central project is being carried out for the Federal Aviation Agency by the GPL division of General Precision, Inc. Two other divisions, Librascope and Link, are working under GPL, as are associated contractors Tasker Instrument Corp. and Stromberg-Carlson Co.

GPL says the proposed New York area system will: receive 735 flight plans per hour; store 1,100 flight plans simultaneously; print and distribute 2,665 flight progress strips every hour; update 10,000 strips per hour; transmit 368 flight plans and 2,168 updates per hour to adjacent centers.

Solid-State Computers

Four solid-state Librascope computers are expected to form the heart of the data processing central. One will handle enroute data, another transistion/terminal data and a third will be for standby use and data reduction. Function of the fourth computer is not yet clear; it is believed that a tie-in with military SAGE system is being considered. An analog computer might be added to the system later, depending on future studies. One computer has been delivered so far to NAFEC.

GPL says the computer stores 256,000 words of eight characters on 16 magnetic drums, each containing 16,000 words; it performs 31 distinct operations. The machine now at NAFEC uses a Flexowriter input and a paper tape readout. It is understood that a magnetic tape system is under development, and is expected to be ready next fall.

The enroute part of the data processing central, to be used in the first live air traffic data-handling test, has five principal functions:

1. Flight plan processing and distribution. A Fliden (flight identification) unit receives initial flight plan data for entry into the computer and also prints out the individual flight strips previously done manually by controllers.

2. Conflict prediction. The computer checks all data for the enroute area to see if any flight strip contains information that would put the plane it represents in conflict with any other. A conflict means more than a collision course; it arises whenever one plane encroaches upon the assigned airspace of another. Right now, the computer at NAFEC generates a Hughes Charactron display of simulated aircraft movements for a controller. An additional detailed display is expected to be available eventually to provide the controller with alphanumeric data on topography, direction, height and speed.

3. Updating. If a plane doesn't stick to its flight plan along the enroute sector for some unexpected reason, the controller can use his keyboard to correct the information in the computer. A scanning device finds the original flight strip, then a print head strikes out the old information and adds the new data.

4. Bright display. Several approaches to a bright display visible in broad daylight that would tie in to the computers are being considered at NAFEC.

Future: Data Exchanges

5. Flow control. It is envisioned that in the case of flights covering more than one DPC sector, there will be exchanges of flight data between data processing centrals in each sector along the flight route starting with the original flight plan. For example, data on a Los Angeles to New York flight would be known all along the proposed route at take-off time.

At least one key unit for transition/terminal control, a sequence console, has already been developed by Link. It is in use at NAFEC in current experiments as a visual readout device.

Antenna Experiments In Fall

THIS WEEK progress is reported on another project in the complex program FAA is pushing to solve the air traffic control problems of the 1970's.

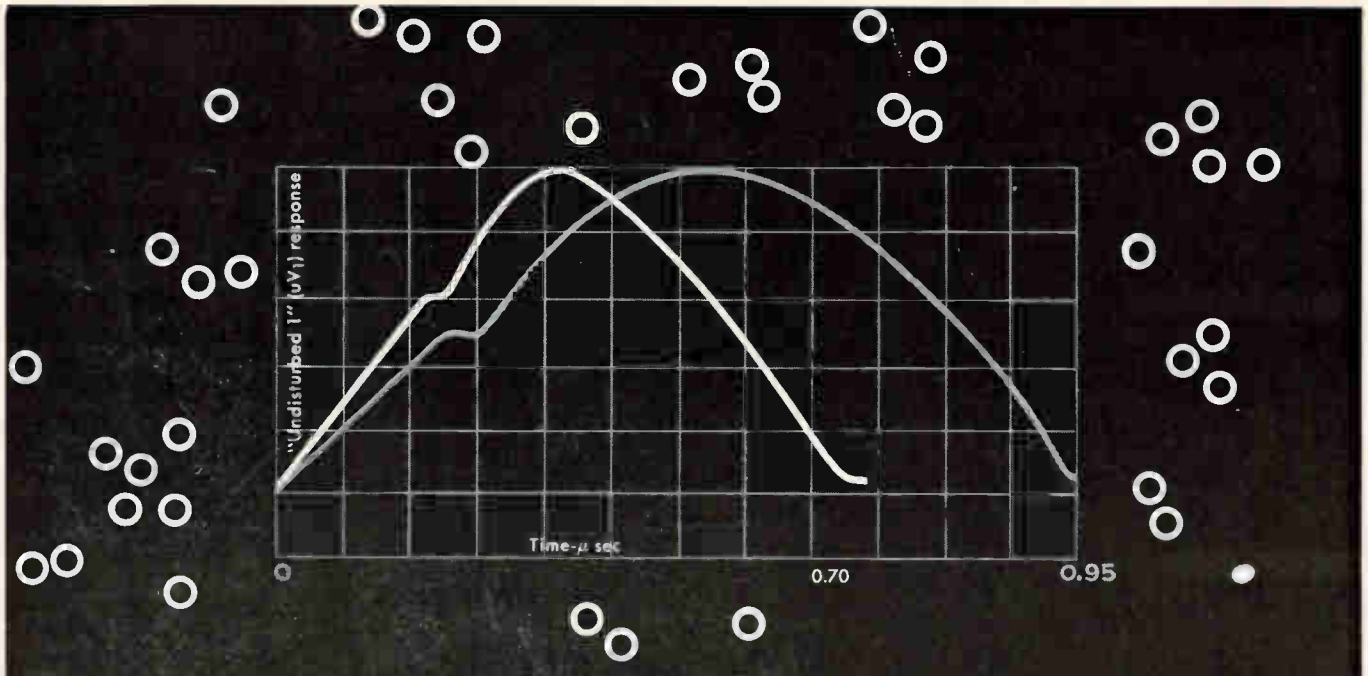
The W. L. Maxson Corp., New York City, which last year received a $1.7 million development contract for a 3-D Air Height Surveillance Radar (AHSR-1), reports it will deliver the first sub-section of the antenna to the National Aviation Facilities Experimental Center.

The antenna will be 160 ft high and 45 ft wide on each of its three sides. Sub-section just completed is a 9-ft by 42-ft panel, one of 15 for each side. Completion of one complete sail covering 120 degrees is expected by next fall. At that time it is expected that experiments using 32 of the 132 low-noise receivers eventually to be installed will get underway.

Besides providing azimuth coverage of 360 degrees, the passive S-band height-finder radar will give elevation coverage from half a degree above the horizon to 40 degrees. The AHSR will receive energy bounced off aircraft by a conventional ASR (airport surveillance radar). It is designed to provide azimuth range and altitude of planes out to a surveillance range of 50 miles, and to resolve two aircraft at the same range and azimuth that are separated by 1,000 ft in altitude. The AHSR and the ASR, one-half mile apart, will be linked by microwave.

Each of the 120-degree azimuth sector fixed antenna arrays will consist of 1,056 elements aimed at a particular angle in space. Accuracy is −500 ft at maximum range, equivalent to the ASR's 50 to 75 mile range.

The system is designed to handle up to 20 targets in the same azimuth "capsule" (the sky area covered by one antenna element), or two targets in the same azimuth-range "capsule" (at the same azimuth and within minimum separation distance).



Another major addition to the RCA Ferrite Line

NEW RCA MEMORY CORE

Switches in 0.7 μsec

RCA Ferrite line now offers a choice of memory cores with faster switching times or reduced power requirements

RCA's new memory core 227M1 (XF-4138) with 0.7 μsec switching time, now opens up a wide choice of design possibilities for military and commercial computers. With the announcement of this new core, RCA now offers:

- 227M1 (XF-4138) for fast switching
- 226M1 (XF-4028) for *reduced* power requirements with *increased* operating margins
- 224M1 (XF-3018H) for standard coincident-current memory applications

See chart for comparative operating characteristics. These cores are part of RCA's comprehensive line of ferrite cores, transfluxors, and other magnetic memory and switching devices.

Systems Engineering Service

Your local RCA Field Representative is prepared to furnish a completely coordinated service, including transistor, ferrite, and memory-systems application assistance. Call him today. For technical literature on RCA Ferrite cores and memory devices, write RCA Commercial Engineering, Section D-19-NN-2, Somerville, N. J.

NOMINAL OPERATING CHARACTERISTICS AT 25°C

Type	New Feature	Size	Full Driving Current (Im) (ma)	Partial-Write Current (Ipw) (ma)	Pulse Rise Time (t_r) (μ sec)	Switching Time (t_s) (μ sec)	Response "Undisturbed 1" (uV_1) (mv)	Response "Disturbed 0" (dV_2) (mv)
226MI (XF-4028)	Lower Drive	.050"x.030"x.015"	400	200	0.2	0.95	85	10
224MI (XF-3018H)	Present Standard	.050"x.030"x.015"	500	250	0.2	0.95	75	8.5
227MI (XF-4138)	Faster Switching	.050"x.030"x.015"	500	250	0.2	0.70	105	13

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- **ONLY ONE POTENTIOMETER** needed for DC Standardization — other wattmeters need two standards, multiplying costs . . . and errors.
- **READ-OUT VERSATILITY** — can actuate remote indicators, digital meters; drive strip-chart recorders, integrators; used in parallel or alone.

With the development of its Model 1483 Electronic Wattmeter, Weston now brings to AC and DC power measurement a degree of accuracy which extends even beyond the traditional accuracy of Weston's indicating type dynamometer wattmeters. With quick, precise operation, the Model 1483 provides a low impedance DC output that can be measured by present day highly accurate techniques. Truly, here's a new concept in quality and capability.

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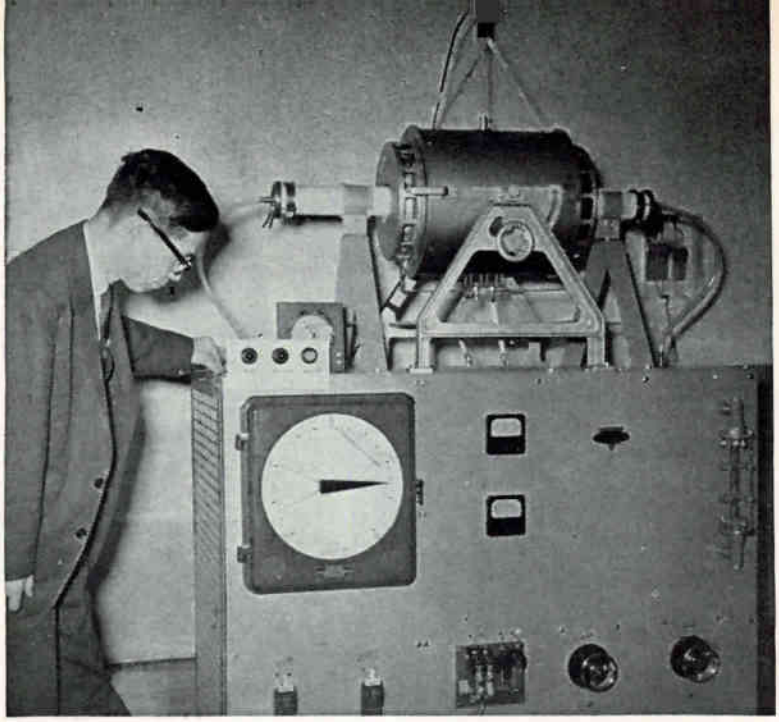
Origin Electric, one of the smaller Japanese componentmakers, exchanges power diodes for technical assistance

By FRANK LEARY

Associate Editor



Engineering director Nakagawa adjusts silicon refining furnace designed by Origin to purify its silicon

American, Japan Firms Reach Accord

TOKYO — Typical of the recent trend toward cooperation between Japan's fast-growing electronics industry and the U. S. technology is the agreement for technical assistance between Raytheon Mfg. Co. and Origin Electric of Tokyo. The two firms have reached agreement on contract terms, and the agreement is now up for approval by the Japanese Finance Ministry.

Seeks Techniques

The agreement will provide Origin with design and production techniques for silicon and germanium diodes, and will be a barter exchange in that some or all of the contract price will be repaid in kind. Origin will apply Raytheon's techniques to the manufacture of power diodes for the Massachusetts company, supplementing Raytheon's line of communications diodes.

The technical-assistance agreement must be approved by the Finance Ministry here, which passes on all international contracts under which either critical goods or currency leaves the country. The ministry has, in the past, tended to be more favorably disposed toward barter-type agreements which do not involve outflow of currency.

Origin president Yasutaro Goto told ELECTRONICS that there was no formal plan involving financial investment in his firm by Raytheon. The small Japanese company (600 employees) is presently capitalized at 132 million yen, about $370,000 at current exchange rates, and is planning a stock split in the near future. At that time part of the stock may be bought by Raytheon.

Some 35 percent of the stock in Origin is currently held by its employees. At one time, the firm was entirely employee-owned, but as capital requirements grew it became necessary to bring in outside capital from insurance companies and the Mitsui Bank.

Diode Manufacturer

Origin was founded by Goto in 1938, and in its early days concentrated on the manufacture of selenium rectifiers and resistance furnaces. In 1956, the company began to make germanium power diodes, becoming the first firm in Japan to build high-current diodes. A 48,000-amp system was installed for a large Japanese chemical works, for example, and many of the power systems used by telephone central exchanges here are of Origin manufacture.

Silicon diodes have been under development for only about a year, and it was to hasten its entry into this field that Origin decided to contract for technical assistance with Raytheon.

Power-Supply Systems

Prior to the war, the company made only components, but since 1945 it has developed and produced complete power-supply systems. Some of the inductive components required in these systems are manufactured by Origin, including saturable reactors and some heavy-duty transformers. Much of their separate component production is for the 300-v rectifier systems in television receivers, and for the line rectifier in telephone receiver units.

Silicon is currently imported from the U. S., but the New Japan Nitrogen Co., of Osaka, is now making sample lots of high-quality silicon. Origin's research head, T. Nakagawa, figures that Japan may soon be in the position to export silicon of the required quality to the U. S. market.

Research at Origin is mostly in the applied field, with a small amount of basic investigation into materials. Seventy percent of Origin's employees are high-school and

college students at night; of these, the college men are mostly electrical engineering students, so that the R&D attitude permeates the entire plant. Nakagawa himself applied his doctoral research to the semiconductor field and was one of the first scientists in Japan to win his doctor's in this field.

The firm is heavily engineering-oriented, with 100 of the employees holding degrees in engineering. Only a small proportion of the workers are women—about 20 percent—and these are concentrated in the small-component assembly areas.

Origin's products are now almost exclusively merchandised in Japan, but inquiries have come in from some of Japan's traditional markets in southeast Asia and from the Near East. The firm is also investigating the feasibility of trading in the U. S. market.

Another technical assistance agreement, going in the other direction, is now under government

Origin makes many of its high-power transformers for incorporation into its power systems

scrutiny in New Delhi. A Bombay firm, the Automatic Electric Devices Co., has negotiated the agreement with Origin to speed its production of semiconductor diodes. The Indian firm had previously negotiated an agreement for plant design and advice from a German firm, found the results unsatisfactory, and came to Origin after inspecting the Japanese firm's techniques and facilities. At first, the Bombay company will build selenium diodes, then expand into germanium and silicon devices as the techniques become available to Origin from Raytheon.

NEW, UNIQUE RCA 5-KW FM TRANSMITTER UTILIZES 4CX5000A CERAMIC TETRODE

RCA has recently developed a unique new 5-KW FM transmitter which utilizes the new technique of multiplexing. This provides simultaneous transmission of two or more program channels on the same RF carrier to meet increased demands of FM stations for additional program services.

The PA stage of the new BTF-5B transmitter is composed of a single Eimac 4CX5000A ceramic tetrode, which produces the 5000-watt output. This tetrode offers high power gain and excellent stability to assure faithful transmission of the broadband multiplex signals.

That's why the 4CX5000A was the logical choice of discriminating RCA engineers. Its many exclusive ceramic design features help to make possible this conservatively rated, high power, air-cooled transmitter.

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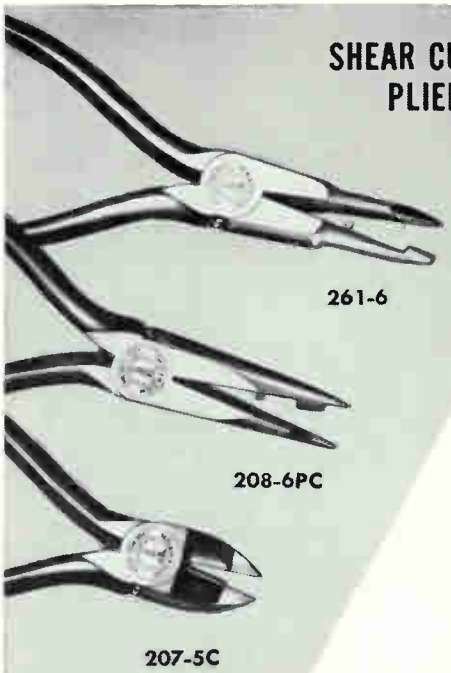

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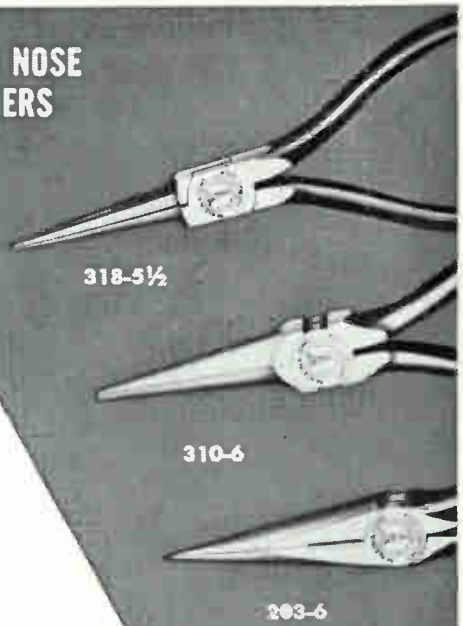
207-5C

LONG NOSE PLIERS

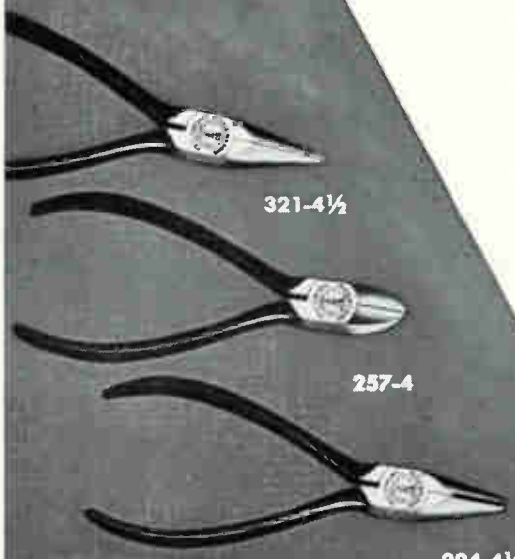


318-5½

310-6

203-6

MIDGET PLIERS

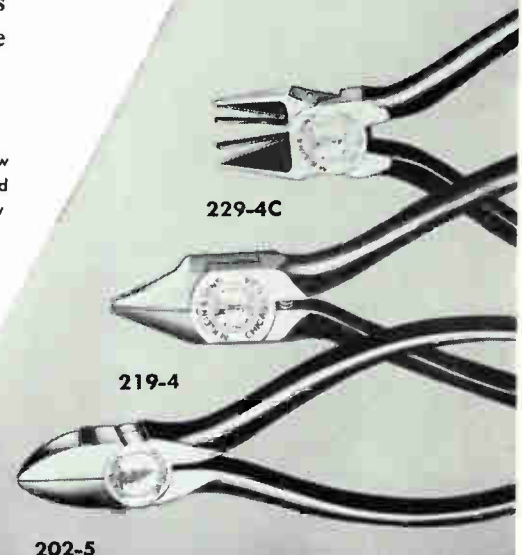


321-4½

257-4

224-4½

OBLIQUE CUTTERS



229-4C

219-4

202-5

In the rapidly growing field of electronics, there is an increasing need for highly specialized pliers. While you're using a plier designed to do a particular job, not only is assembly speeded up but better performance is assured.

Our own engineers, working with electronic manufacturers, have developed many pliers that serve the specialized needs of this field.

On this page are shown a few of the many pliers available in the complete Klein line.

WRITE FOR CATALOG

If you do not have a copy of the new Klein Catalog 103A illustrating and describing Klein Pliers, write for a copy It will be sent without obligation.

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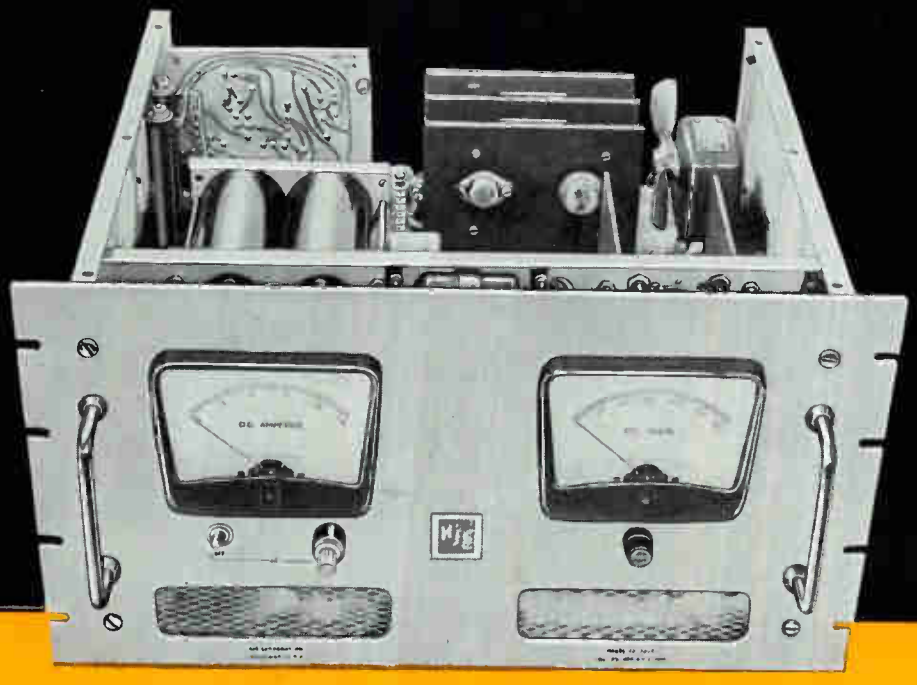
. . . for premium applications in the commercial field



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NJE offers its distinguished line of Transistorized Solid State Power Supplies — high quality units specifically designed for premium applications in the commercial field. Every NJE Solid State Power Supply is built with MIL-T-27A style hermetically-sealed transformer and reactors, wire-wound resistors, and the highest quality components available.

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- RUGGED
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Model	Output DC Voltage	Output DC Amps	RMS Ripple	Regulation Line*	Regulation Load*	Panel Height	Depth	Price
SS-32-3	0-32	0-3	1 MV	±0.015% or ±1 MV	±0.03% or ±2 MV	5¼	14½	$540
SS-32-10	0-36	0-10	1 MV	±0.015% or ±1 MV	±0.03% or ±2 MV	8¾	17½	695
SS-32-20	0-32	0-20	1 MV	±0.015% or ±1 MV	±0.03% or ±2 MV	12¼	17½	990
SS-10-10	0-10	0-10	0.5 MV	±0.015% or ±1 MV	±0.03% or ±2 MV	5¼	17½	575

* Whichever is larger

9 other models available from stock, subject to prior sale. Quantity discounts available.

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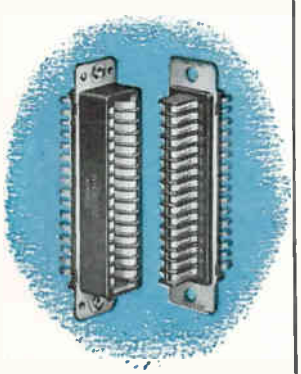
improved ribbon contacts can't "set", have extended mating range

Since the development of Blue Ribbon connectors by AMPHENOL in 1946, the unique, ribbon-like spring contacts that are the heart of these connectors have undergone continuing design improvements. Here are some examples of present efficiency: Blue Ribbon contacts can't be "set" or overstressed; they provide full-range electrical mating action with no intermittant contact action even under extreme vibration; a double-stub design effectively secures the contact in the dielectric; gold-over-albaloy plating withstands 500 cycles of mating without galling; mating force requirements have been reduced to ½ pound per contact.

Today, AMPHENOL Blue Ribbons are the optimum rack & panel connector for such applications as computers, recorders, monitors and other equipments in both commercial and military systems. Blue Ribbon reliability has proved to be outstanding.

availability

The Blue Ribbon family is large—5 different types in 8 to 32 contacts plus 50 contact circulars. Miniaturized Micro-Ribbons are also available for applications where space is a factor. Blue Ribbons have been adapted to many special needs, with the AMPHENOL Engineering Department offering continuing consulting service in the design of custom connectors based on the unique Blue Ribbon principle.



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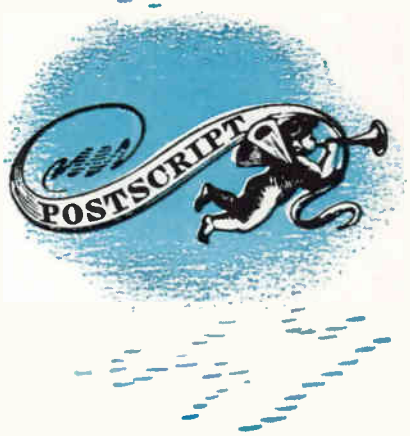


BLUE Ribbons® are available from Authorized AMPHENOL Distributors -at Factory Prices!

AMPHENOL DISTRIBUTOR DIVISION
Amphenol-Borg Electronics Corporation
BROADVIEW, ILLINOIS

Small Computers: Big Business

Increased attention to the computer needs of little companies is sparking market growth, as well as research for new machines and new uses

AMONG LATEST TRENDS in computer developments is the push by manufacturers for equipment suited to the needs of small businesses.

To bring this about, increasing emphasis is being placed on reducing cost and size and making operation easier.

Small Beginnings

An example of this is Royal McBee's 910 computer introduced a few weeks ago. The device resembles an ordinary electric typewriter.

The system is actually a sequence-controlled computer which automatically performs billing operations. The typist prints the customer's name and address on the billing form, adds the quantity and description of the merchandise involved. The computer does the rest.

A stored program control is brought into action by depressing a keyboard switch. The resultant process automatically prints all extensions of the given information—such as subtotals, grand totals, taxes, discount rates.

Replaceable plug boards allow changes of instructions from one type of job to another in minutes. The equipment sells for $6,500, operates from standard current.

Also reflecting this approach is IBM's series 50 equipment. A basic system can be installed for about $270 a month.

Equipment consists of a card punch to record data, a sorter to arrange information and an accounting machine to print results.

An expanded series might consist of all the basic machines plus a reproducing punch to punch data automatically, a calculating punch to process data automatically and an automatic collator.

In reporting on the series 50 equipment, IBM says a "significant number" of customers have field-converted their equipment to faster speeds of the new models. Customers say the advantages of increased processing capacity far outweigh the additional cost, once a small firm has learned to work with the equipment. Some idea of relative price difference may be had from the $225 monthly rental paid for the series 50 accounting machine and the $405 charged for the standard IBM equivalent.

As a rule, once a company has begun using computers, new uses for the equipment come into being. A company originally using a machine to handle payroll and accounts receivable functions, may decide to perform sales analysis, cost accounting or some other operation with the computer. This usually brings about a need for more machine time, usually met by installing high-speed equipment.

Aimed at the market for such expanded needs of small business is a computer that accepts data in random order and automatically updates any affected records in a single sequence of operation.

Designed by Royal Precision Corp., and designated the RPC-9000, this new computer was designed to handle business functions. Information can be entered into the machine from paper tape, punch cards or through a typewriter keyboard forming part of the system.

The internal operating memory of the computer consists of nine blocks of magnetostrictive delay lines capable of storing 432 instructions or 72 twelve-character words.

External memory is stored in endless magnetic tape loops. Each loop can store up to 1 million alphanumeric characters.

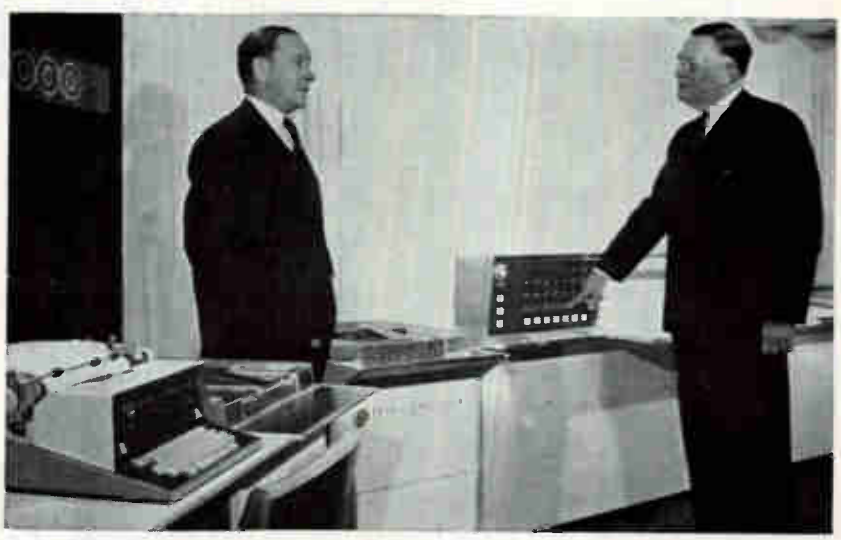
The entire basic system requires 150 sq ft of floor space, operates from standard current.

It sells for $120,000, leases for $2,450 a month.

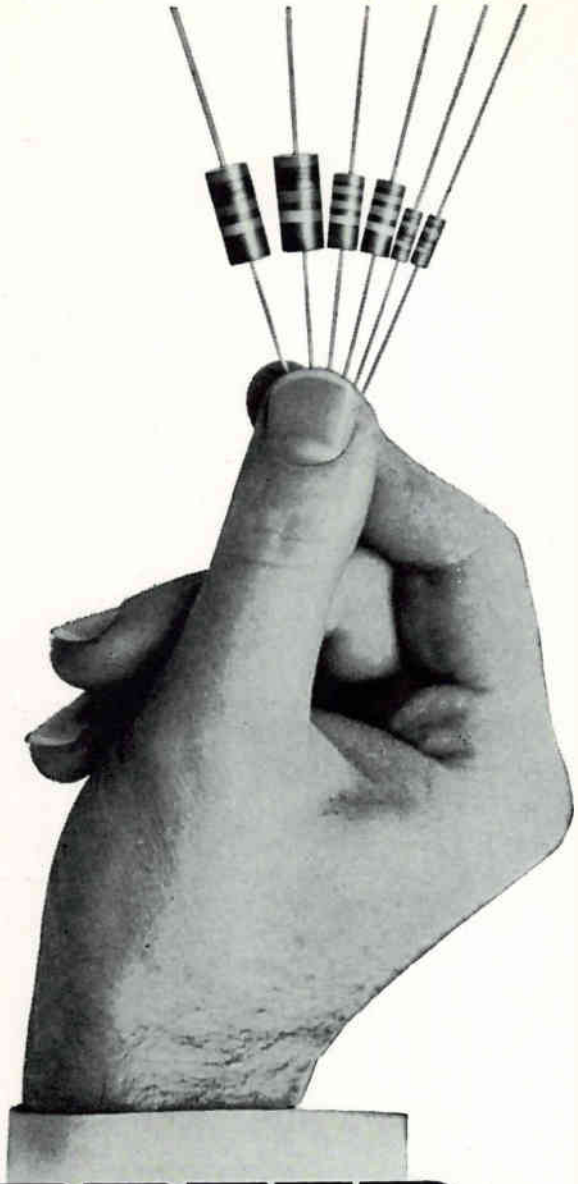
Other Approaches

In the small business category is Bendix Aviation's G-15. A basic unit in this class costs about $49,500, rents for $1,485. Additional equipment, such as gear to produce and read punch cards, provide magnetic tape read-in and read-out and handle data in the other common computer forms, would raise the lease cost to about $3,800. The G-15 provides a 2,160-word storage on magnetic drum.

Burroughs Corp. reports about 200 of its series E-101 computers in the field. These lease for about $1,000 a month, sell for about $38,000. They have a magnetic drum storage of 220 12-digit words and can operate from paper tape or punch cards.



Small business computer RPC-9000 is discussed by P. M. Zenner (right), president and F. P. Ryan, executive vice president, of Royal McBee Corp.



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You're sure to find the sizes and types you want in Speer's complete line of 1/2-, 1- and 2-watt fixed composition resistors, which meet or exceed the requirements of specifications MIL RII and RS 172. The fast, efficient service for which Speer has gained a wide reputation can also help *you* eliminate costly production delays. So next time, specify Speer! *Speer now offers these new sizes:*

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			Nominal Diameter	Nominal Length	Wire Size	Nominal Length
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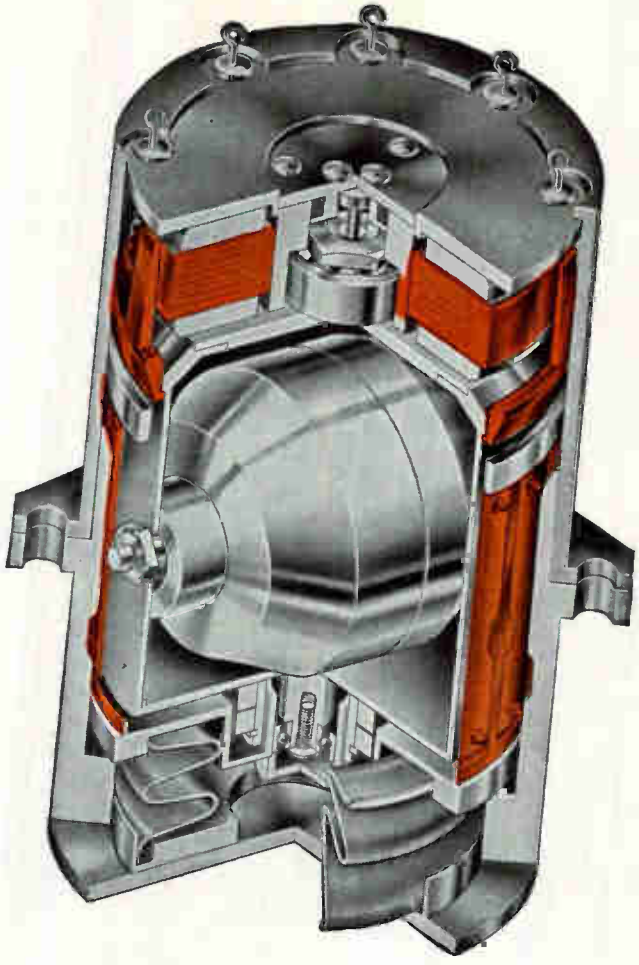
SR 1	RC 32	1	.225	.562	#18	1½
SR 2	RC 42	2	.312	.688	#17	1½

Other Electronics Divisions of Speer Carbon Company
Jeffers Electronics, Du Bois, Pa.
Onondaga Electronics, Syracuse, N. Y.

Speer Resistor Division
Speer Carbon Company, Bradford, Pennsylvania

Ketay 2" floated rate gyro controls damping from −54° to +74° C.

...saves space, weight, wattage and wear



Ketay has been successful in developing a floated rate gyroscope with a unique bellows and spring fingers system which compensates for temperature changes. Fluid viscosity is allowed to change freely, while the damping gap is controlled instead. This ingenious shear damping principle offers true "second order performance." No heating is required from −40° to + 74° C.

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TYPICAL RG 20 SPECIFICATIONS

Rate (deg/sec)	±30
Natural Frequency	25 cps (min)
Size	Diameter 2" Length 2⅞"
Damping (Ratio to Critical) over temperature	.07 ±0.2
Spin Motor	115V Line to Line 3φ 400 cps
Pickoff Type	Inductive
Excitation	26 VRMS 400 cps
Sensitivity (v/deg/sec)	0.2
Threshold (deg/sec)	0.06
Weight	1¼ lbs. (max)

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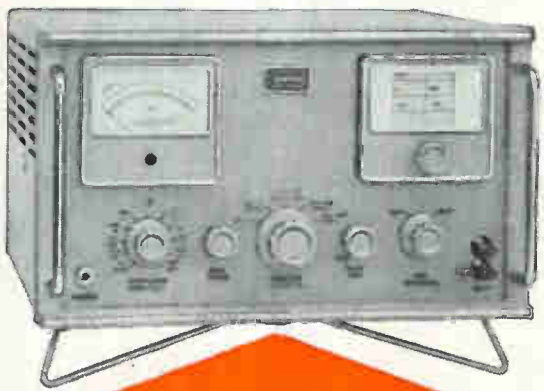

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Flat VTVM feature

Sierra Model 125A

FREQUENCY SELECTIVE VOLTMETER

Model 125A is an all-new vacuum tube voltmeter incorporating features of several previous Sierra instruments in one compact, high-performance instrument.

Covering the frequency range of 3 to 600 KC, this new voltmeter has both narrow and wide selectivity settings plus a flat voltmeter position. This triple mode measurement capability makes the Model 125A an extremely versatile instrument for carrier measurements, wave analysis and general laboratory use. Brief specifications are listed at the side. For full information and demonstration, call your Sierra representative or write direct.

SPECIFICATIONS

Frequency Range
Tunable Mode: 3 KC — 600 KC
Flat Mode: 1 KC — 600 KC

Measurement Range
Tunable Mode: -90 dbm to + 32 dbm
Flat Mode: -30 dbm to + 32 dbm

Selectivity
Narrow: down 3 db 125 cps off resonance
down 45 db 500 cps off resonance
Wide: down 3 db 1.25 KC off resonance
down 45 db 5 KC off resonance

Construction
Modular with etched glass epoxy circuit boards

Data subject to change without notice

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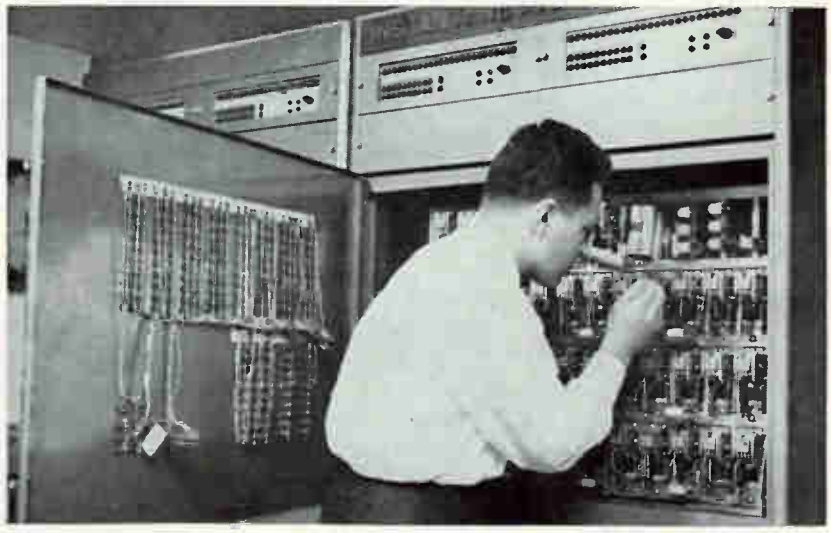
Nielsen OKs New Rating

Latest service covers 17 metropolitan counties, gives minute-by-minute reports on 7 channels



Relay panel of instantaneous tv checking system is inspected by a Nielsen engineer. System links 300 sample homes with central office

SIX-MONTH SHAKEDOWN of an electronic system for checking tv viewing habits in the metropolitan New York area was completed last week.

The system was designed by the engineering department of A. C. Nielsen, market research specialists, at the firm's Chicago facilities, and placed in operation last October.

Presently, the Nielsen-designed equipment is installed in 279 television sets in five boroughs of New York City, eight counties in New Jersey and four in New York State.

Called the Instantaneous Audimeter, the system operates on information obtained in the viewer's home. The home unit is small enough to be put in a closet or beneath a piece of furniture and connected by wire to the television receiver.

In cases where a home to be sampled uses a portable television set, the survey firm supplies output jacks at electrical outlets in rooms where the set is used. These jacks are then connected by wire to the home unit.

In operation, the home unit makes a continuous check of the television set to determine whether it is turned on and, if so, to what channel. The unit is connected by leased telephone lines to an information center in the company's Lexington Ave. offices.

From the information center, all home units are scanned once a minute. Information collected by scanner units is punched on paper tape and recorded simultaneously by automatic printer. Each 15 minutes the composite returns of all sets are automatically totaled and printed as a separate figure from the individual subtotals.

At the same time, a light display shows engineers the response condition of each unit, one at a time. Included in the central office equipment are circuits to permit checks of trunkline voltage, forward resistance, back resistance, and to test for failure of any unit due to excessive atmospheric moisture.

Nationwide Plans

The New York Audimeter system represents the first commercial operation of its type made by Nielsen. A pilot instantaneous system was placed in operation in Chicago in 1957. From it information was gained to make the New York network possible.

Nielsen planners say they may eventually have a nationwide instantaneous system but point out

System

the many aspects of broadcast operations that must first be studied.

For one thing, time zone differentials and broadcast delay patterns limit the speed with which individual programs can be rated.

For another, cost of the service must meet the need for speed on the part of broadcast stations, network owners and others using the survey.

As a possible intermediate step, however, a market-by-market system has been given consideration. One company official points out that specifics for multi-city operations will be announced following completion of discussions with clients who have indicated an interest in conducting fast "popularity" or "test" ratings to supplement national tv audience figures.

The Nielsen system is the second instant rating service to be installed in New York. Also in operation is the Arbitron system (ELECTRONICS, p 34, Oct. 3, '58), designed to link seven cities to the New York offices of the American Rating Bureau. The ARB equipment was produced by Taller & Cooper.

Warning Device

Light sensor in automatic bomb alarm system now being installed at strategic cities and military bases in the U.S. is triggered by light only from nuclear blasts. Since light travels faster than shock waves, the device will warn civilian and military leaders before it is destroyed. Developer Western Union will get about $2 million a year for providing and maintaining the entire national system

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This Space Electronics issue is another in the many services offered members of the IRE. Non-members of the Institute of Radio Engineers, however, are invited to reserve a copy of this vital report by returning the coupon below, today.

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"Photon Propelled Space Vehicles," by D. C. Hock, F. N. McMillan, and A. R. Tanguay, Radiation, Inc.

"Interplanetary Navigation," by G. M. Clemence, USN Observatory

"Navigation Using Signals from High Altitude Satellites," by A. B. Moody, USN Hydrographic Office

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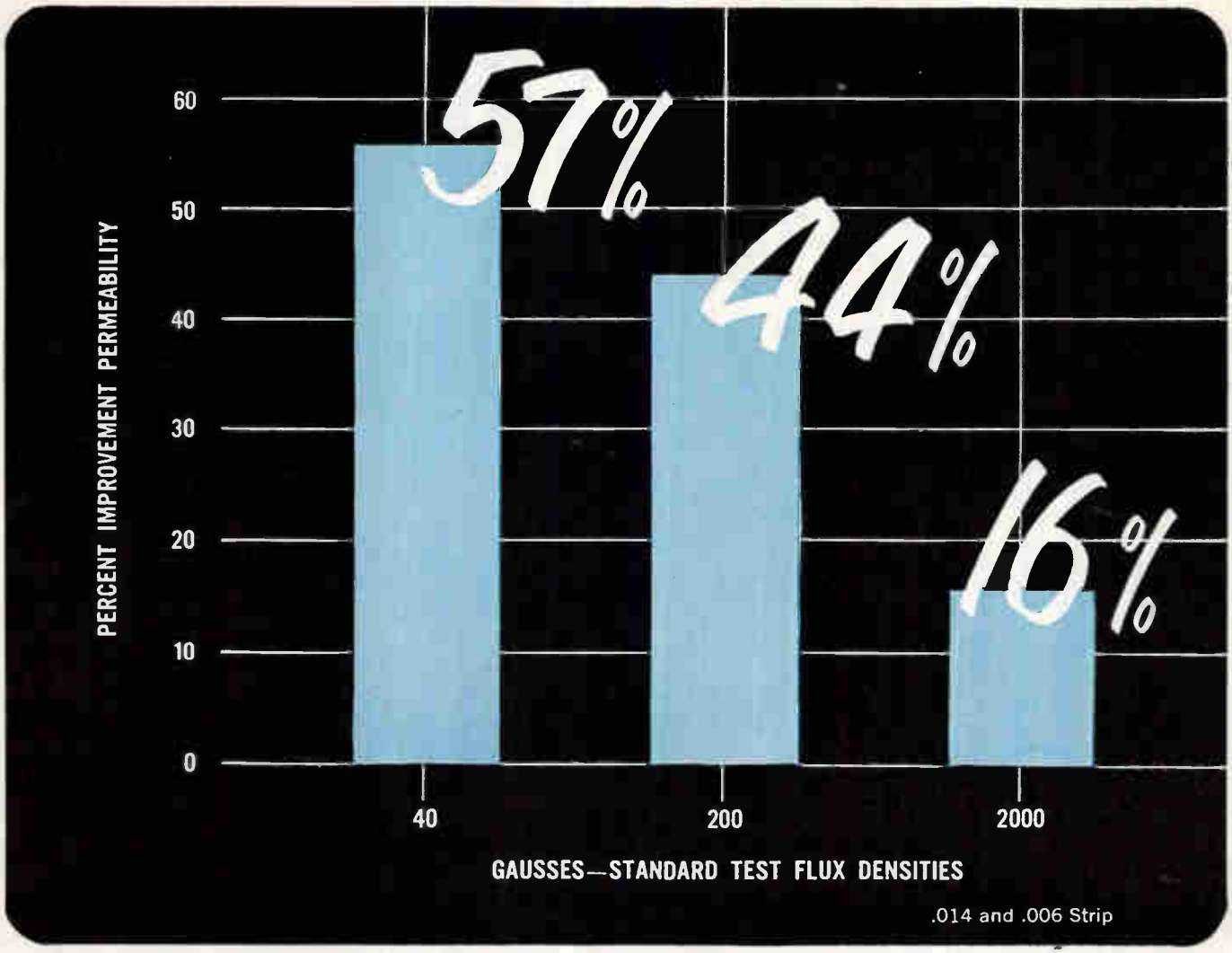

Greater permeability for Allegheny Ludlum's AL-4750...and it's *guaranteed*

promises more consistency, higher predictability for magnetic cores

AL-4750 nickel-iron strip now has higher *guaranteed* permeability values than ever before. For example, at 40 induction gausses AL-4750 now has 57% higher permeability than in the past, using the standard flux density test.

This greater permeability means better consistency and predictability for magnetic core users . . . and allows careful, high performance design.

This improvement in AL-4750 is the result of Allegheny Ludlum's continuing research on electrical alloys and nickel-bearing steels. Moly Permalloy has been similarly improved in permeability. A-L constantly researches silicon steels, including A-L's well-known grain-oriented silicon, Silectron, and other magnetic alloys.

Complete facilities for the fabrication and heat treatment of laminations are available at Allegheny Ludlum. And A-L's technical know-how guarantees you close gage tolerance, uniformity of gage throughout the coil and minimum spread of gage across the coil-width.

If you have a problem on electrical steels, laminations or magnetic material, call A-L for prompt technical assistance. Write for blue sheet EM-16 for complete data on AL-4750. *Allegheny Ludlum Steel Corporation, Oliver Building, Pittsburgh 22, Pa. Address Dept. E-4.*

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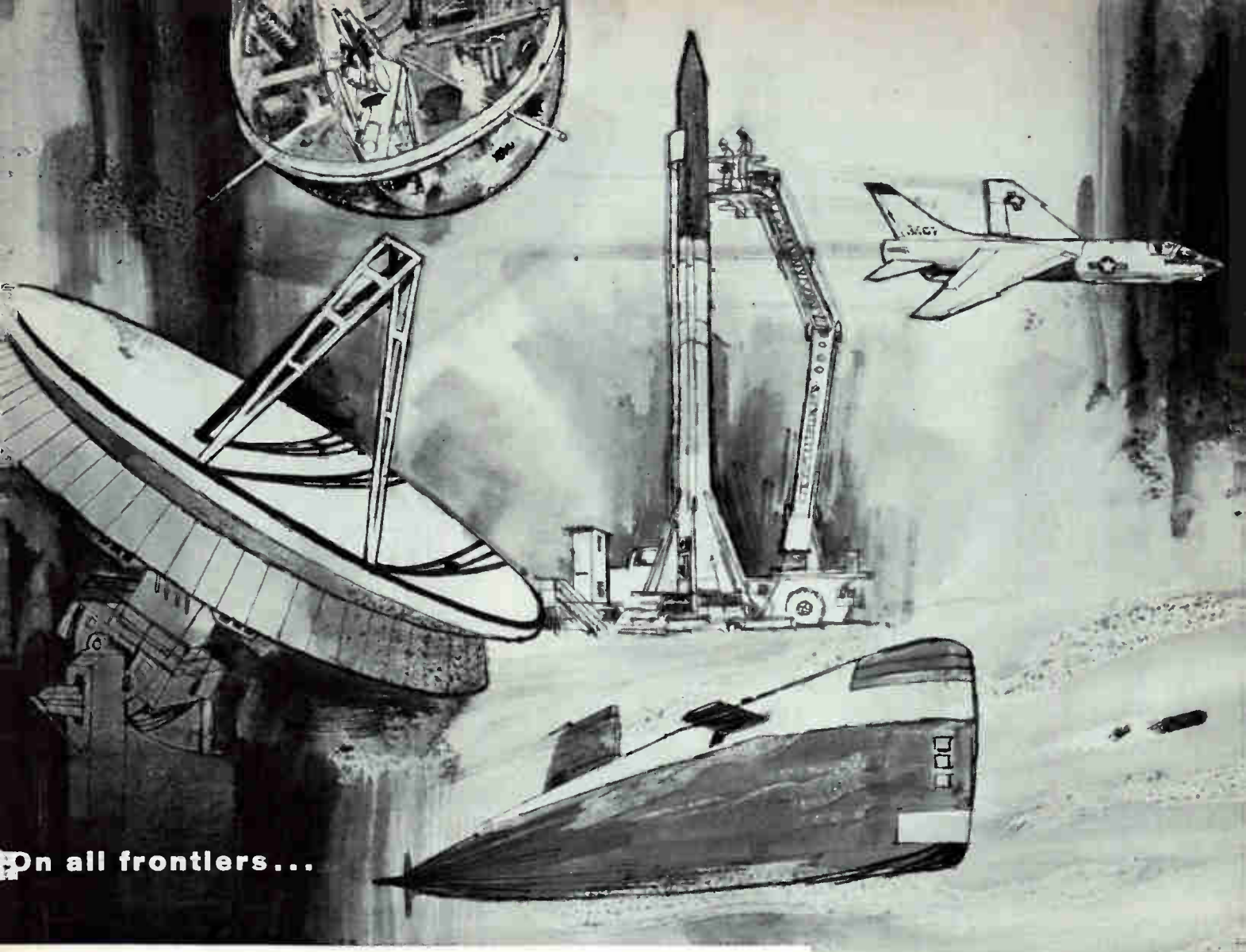

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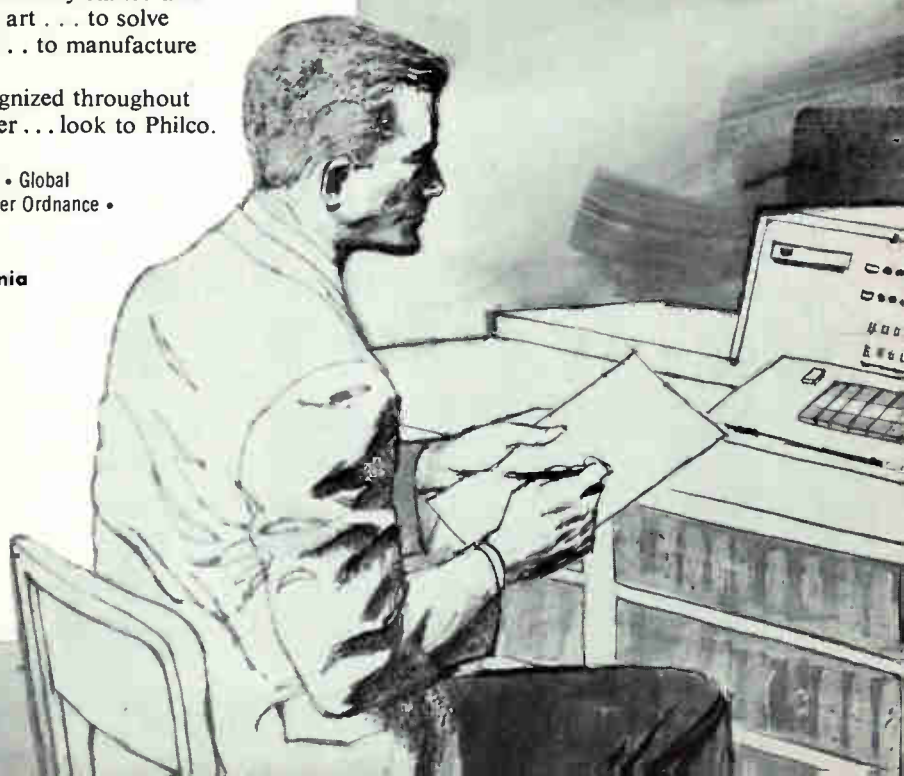

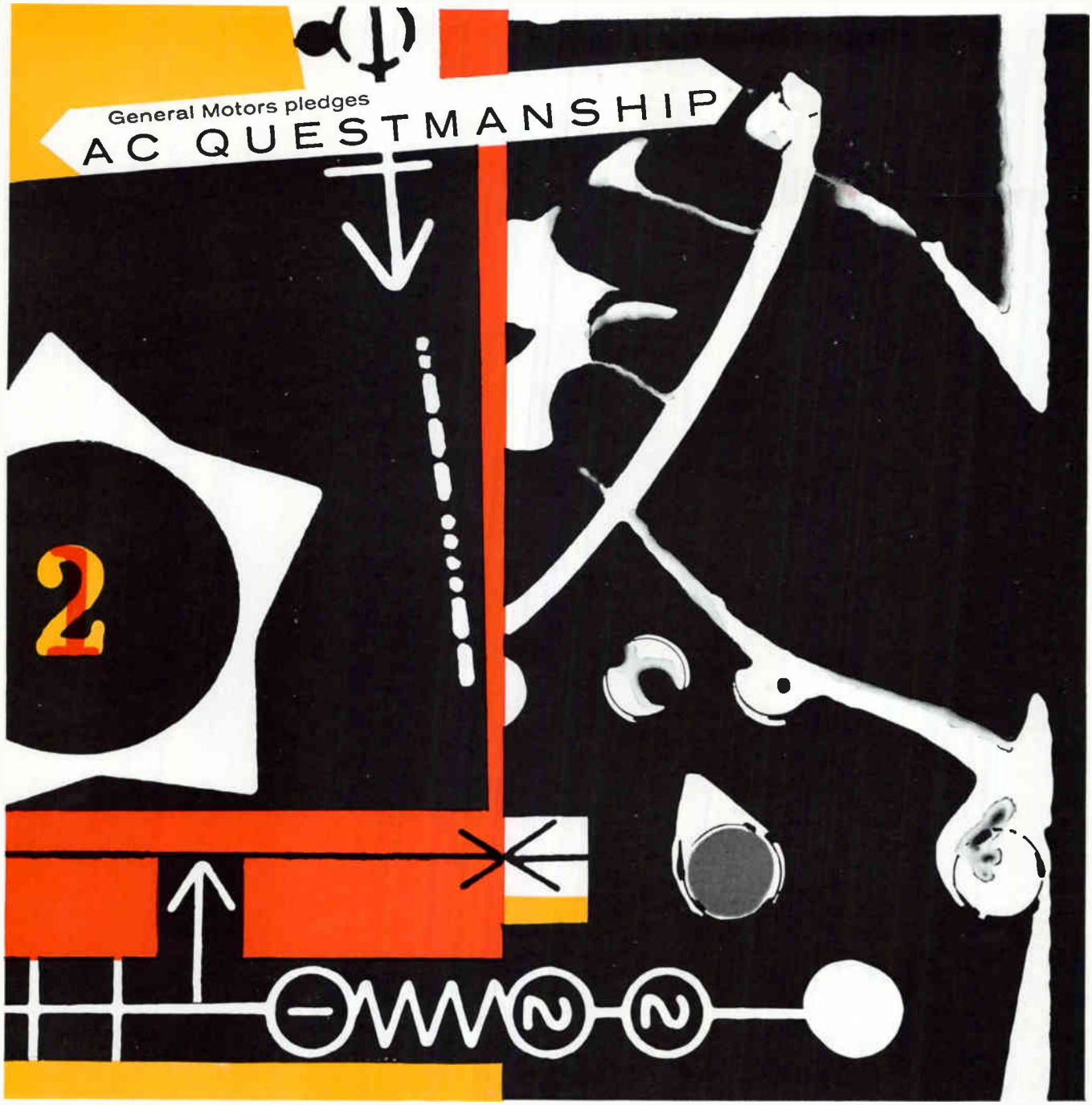

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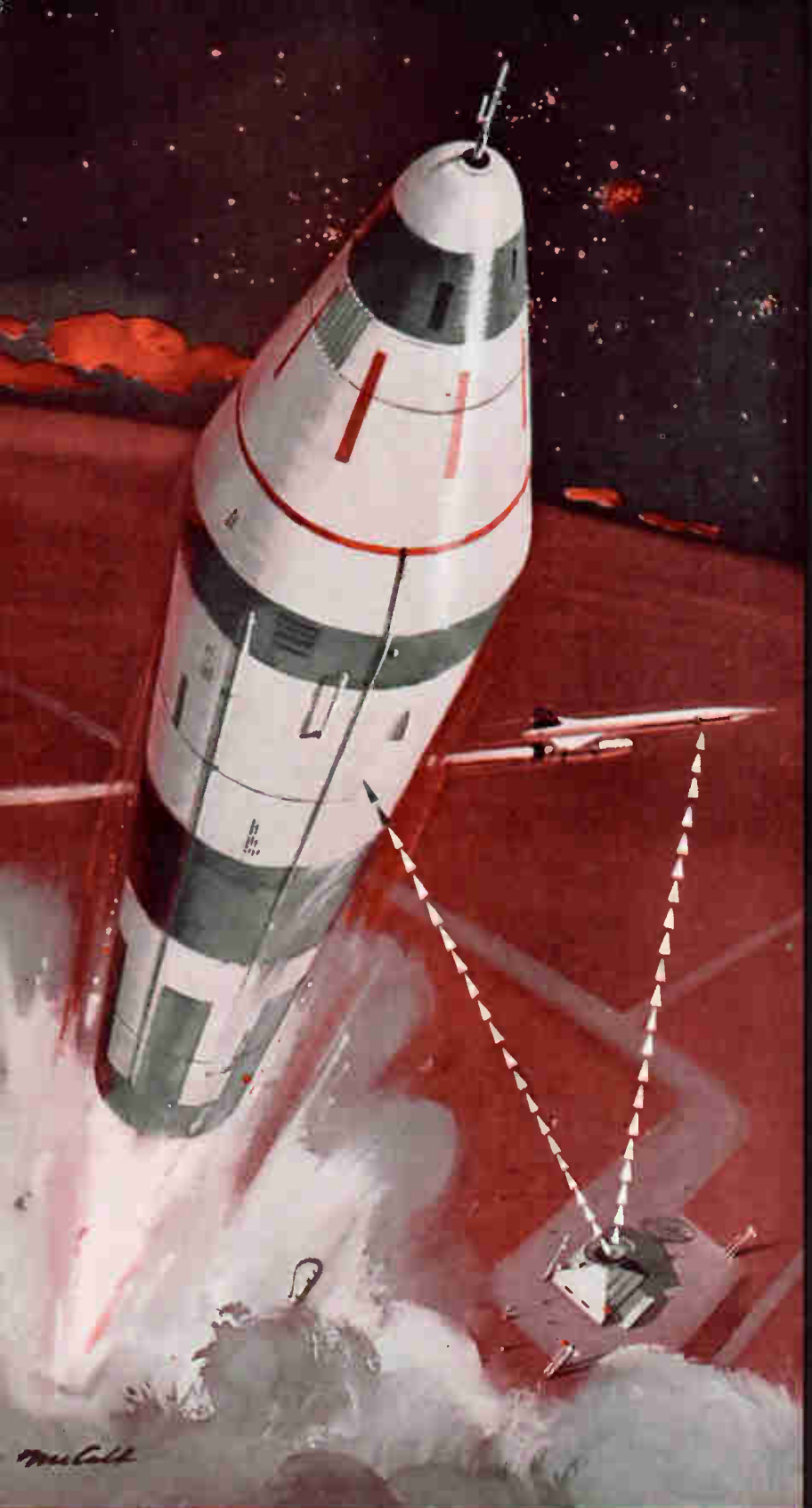


New from Crosley...

miniaturized

Command Receivers for missiles and drones

To meet the critical need for high-density packaging in missiles, Avco's Crosley Division has developed new miniaturized Command Destruct Receivers that weigh only three pounds.

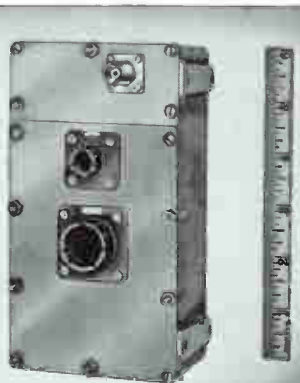
Their task: To receive and act upon instruction from the ground to destroy a missile that has gone out of control.

In the Command Destruct configuration for range safety and similar applications, the miniaturized Command Receiver has four channels incorporating a decoder, to provide a secure link between the ground station and missile.

For high-performance drones and decoys, there are similar miniaturized Command Receivers that employ a 12-channel network. These receivers will actuate control surfaces, direct engine operation, and open a recovery parachute—all by radio-conveyed ground instruction.

Today Avco/Crosley Command Receivers are standard equipment on most of the nation's missiles. And by meeting the most severe environmental and operational requirements they have proved themselves for the future.

For more information, write to Vice-President, Marketing-Defense Products, Dept. E-CR, Crosley Division, Avco Corporation, 1329 Arlington Street, Cincinnati 25, Ohio



New Crosley Command Receiver is about the size of a kitchen match box.

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CIRCLE 50 ON READER SERVICE CARD

Equipment such as this in use at New York Telephone Co.'s Binghamton office reflects growing importance of facsimile business

Facsimile Research Spreads

Increasing 'fax' use shows need for faster transmission and—something new—privacy

PUBLIC FACSIMILE transmission rescued a New York aircraft designer this week when he needed immediate approval of an engineering change drawing from a California factory. Within minutes the drawing was sent across the continent, checked and flashed back.

Prior to this year, this would not have been possible.

Until Dec., 1959, public facsimile available on the same basis as telegram service, existed only between N. Y., Chicago and Washington, D. C.

Last December, spurred by the small but active interest of users, Western Union decided to extend to Los Angeles and San Francisco.

37,000 Firms Invest

In the matter of private systems, manufacturers tell ELECTRONICS that uses are limited only by the ingenuity of customers. At present some 37,000 U. S. companies have invested in desk-top facsimile systems operating in closed circuit.

Under close scrutiny at present is the possibility of transmitting mail by facsimile. The U. S. Post Office department has already conducted experiments in a system between Battle Creek, Mich., and Washington, D. C., with equipment supplied by Stewart Warner and others.

Next in line will be a system being built under contract by International Telephone and Telegraph Corp. It will link two major post offices as yet undesignated.

A major challenge to researchers on this post office system will be the development of what the contract terms a "sanctity system". Basic to the transmission of mail is the requirement that privacy of communication be maintained. Details on avenues researchers will pursue are not yet available. Hopes are high for an adequate solution, however, in view of the possible target date of late this year for completion.

Present equipment takes about 6 minutes to produce final copy at the receiving terminus on an ordinary letter-size sheet of paper. With the processing of bulk mail, this speed will not be adequate.

Present equipment can produce faster copies only by operating on bandwidths wider than those available in ordinary voice-type communication channels. A Western Union spokesman told ELECTRONICS of sending an entire page of the New York Times in two minutes by facsimile some years ago. This of course, was done at an enormous expense in bandwidth.

The goal of researchers in the immediate future will be the development of systems able to operate at higher speeds without going to wider bandwidths.

MEETINGS AHEAD

Apr. 11-13: Space Conference, Engineering Technology, AIEE, Baker Hotel, Dallas, Tex.

Apr. 11-14: Weather Radar Conference, American Meteorological Society and Stanford Research Institute, San Francisco.

Apr. 12-13: Protective Relay Engineers, Annual, A&M College of Texas, College Station, Texas.

Apr. 12-13: Electronic Data Processing, IRE, ARS, Hotel Alms, Cincinnati, O.

Apr. 12-13: Static Relay Symposium, USA Signal R&D Lab, Hexagon Auditorium, Ft. Monmouth, N. J.

Apr. 18-19: Automatic Techniques, Annual Conf., ASME, IRE, AIEE, Cleveland-Sheraton Hotel, Cleveland.

Apr. 19-21: Active Networks & Feedback Systems, International Symposium, Department of Defense Research Agencies, IRE, Engineering Societies Bldg., N. Y. C.

Apr. 20: Quality Control Clinic, ASQC, Univ. of Rochester, Rochester, N. Y.

Apr. 20-22: Medical Electronics, National Conf., PGME of IRE, Shamrock-Hilton Hotel, Houston, Tex.

Apr. 20-22: Southwestern IRE Conf. & Electronics Show, SWIRECO, PGME of IRE, Shamrock-Hilton Hotel, Houston, Tex.

Apr. 26-28: Airlines Electronic Maintenance Meeting, Aeronautical Radio, Inc., Hollywood Roosevelt, Los Angeles.

Apr. 30: Sferics and Thunderstorm Electricity, Amer. Geophysical Union, Amer. Meteorological Society & U. S. Nat. Comm. of URSI, National Science Foundation, Wash., D. C.

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

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

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

Swift, sure
DISTORTION READINGS

-hp- 330B/C/D Distortion Analyzer

20 cps to 20 KC

Measure distortions as low as 0.1%
Measure noise on voltages as small as 100 μv
High sensitivity, high stability
Wide band 20 db gain amplifier
Oscilloscope terminals; built-in VTVM

-hp- 330B Distortion Analyzer is a basic instrument universally used to measure total audio distortion, voltage level, power output, gain, total AM carrier distortion, noise and hum level and audio signal frequencies.

Model 330B consists of a frequency selective amplifier, a regulated power supply and a VTVM. The amplifier operates with a resistance-tuned circuit to provide almost infinite attenuation of the fundamental while passing harmonic frequencies at normal gain. Negative feedback minimizes distortion and insures uniform response and stability. The VTVM is used to set the load and measure the value of harmonic voltages, thus providing a direct reading of total distortion. The VTVM may also be used separately.

For FM broadcasters, *-hp-* 330C is offered. Similar to 330B, this instrument has a meter with VU ballistic characteristics meeting F.C.C. requirements and a VTVM frequency range of 10 cps to 60 KC.

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SPECIFICATIONS

Distortion Measurement: 20 cps to 20 KC.

Dial Calibration Accuracy: ±2% full range.

Elimination Characteristics: Reduces fundamental frequency more than 99.9%.

Accuracy: ±3% full scale at distortion levels of 0.5%.

Sensitivity: Distortion levels of 0.3% are measured full scale. Accurate readings on 0.1% levels.

Input Impedance: 200,000 ohms, 40 μμf shunt.

Required Input: 1 v RMS.

Voltmeter: Nine 10 db ranges, 0.03 to 300 v. Full scale sensitivity all ranges.

Noise Measurement: 300 μv full scale. Coverage 10 cps to 20 KC.

Oscilloscope Terminals: 75 db max. gain from AF input to terminals.

Price: *-hp-* 330B, $410.00 (cabinet), *-hp-* 330C, $440.00 (cabinet), *-hp-* 330D, $500.00 (cabinet), (Rack models $15.00 less).

Data subject to change without notice.
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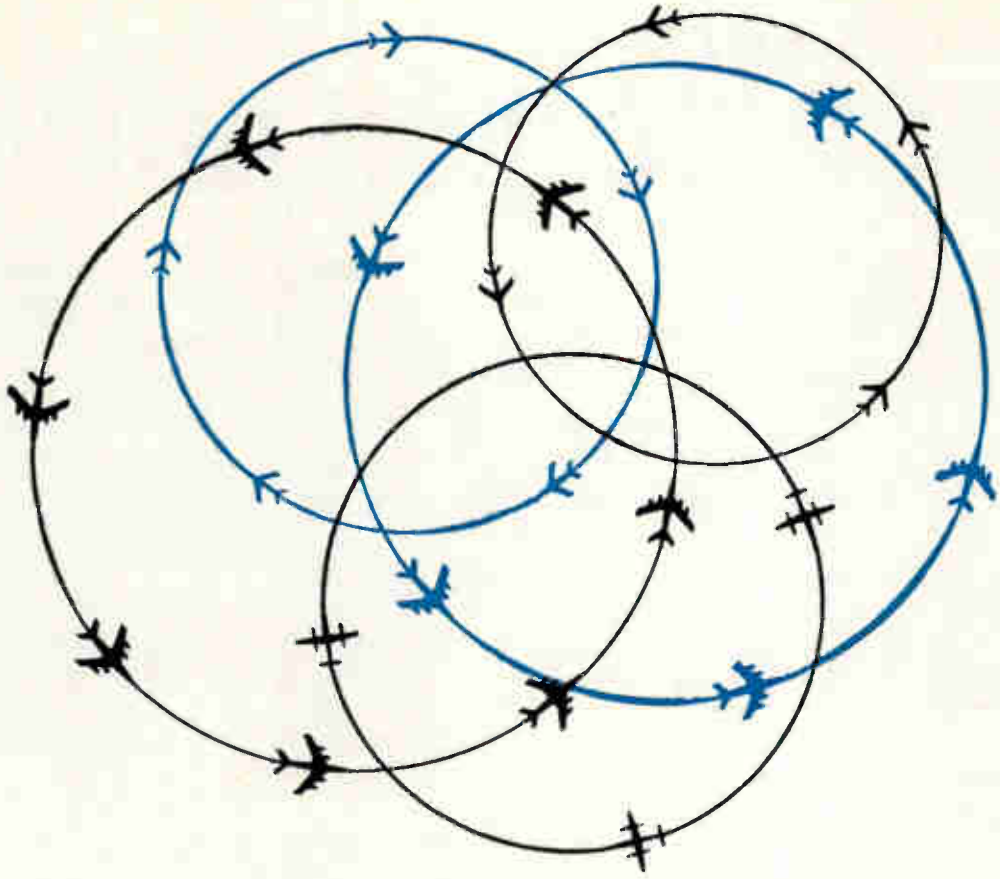
hp now has a 200 KC 'scope for $435! Seen it?



Volscan juggles 24 aircraft with AMP Programming

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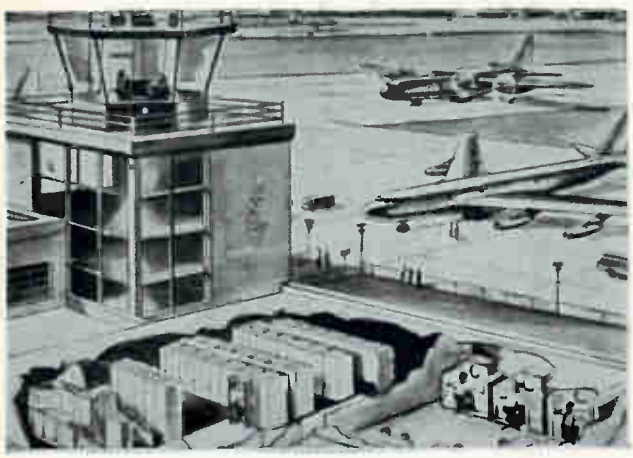

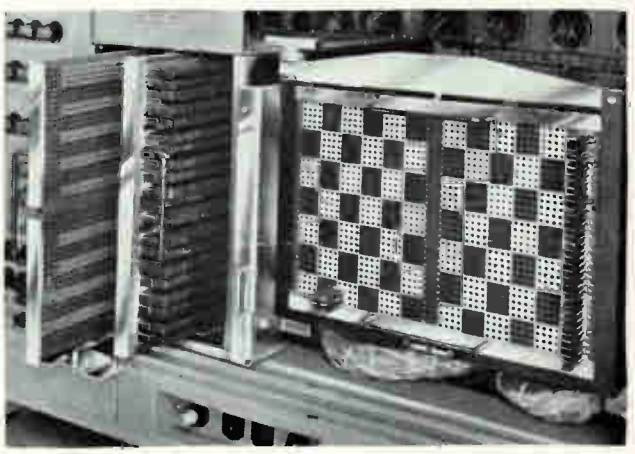

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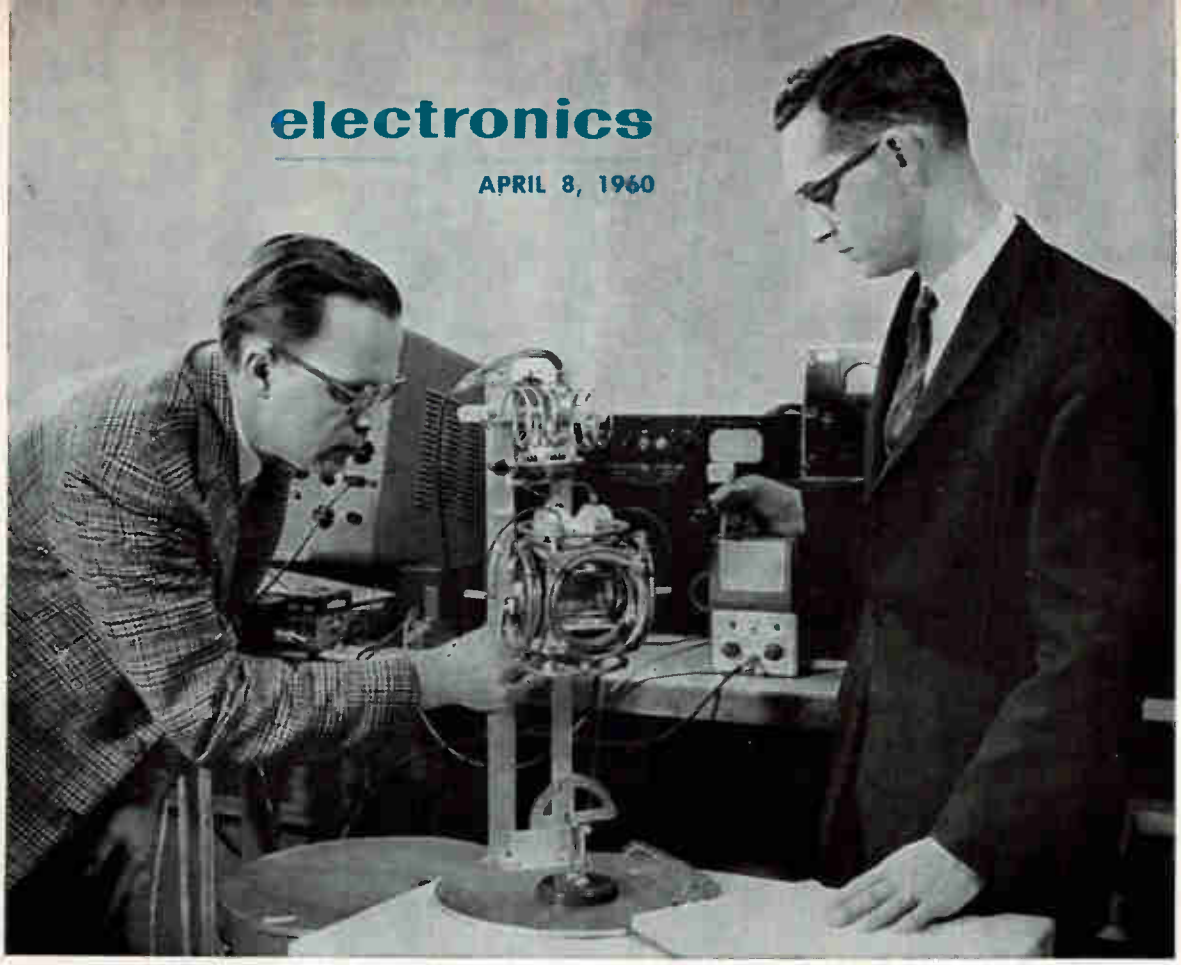


During a test run, the lamp-cell rig is enclosed by container at lower left. Spectral lamp is mounted above absorption cell. Although coil pairs can produce two mutually perpendicular fields, only one pair is used in Fig. 1 setup

Magnetometer System for Orientation in Space

Optical-electronic system is sensitive to variations in intensity and direction of magnetic fields. Electronic portion of system senses output of light absorption cell which responds to orientation in space

By H. E. DeBOLT,
Defense Products Div., Fairchild Camera and Instrument Corp., Syosset, N. Y.

ONE METHOD of controlling the attitude of a space vehicle is to line up one axis of the vehicle in the direction of the earth's magnetic field. At distances greater than 10,000 miles from the earth, this method requires measurement of magnetic-field direction at very low intensities. The system to be described can detect field components smaller than 0.01 gamma—an intensity that permits direction measurement at distances greater than 50,000 miles from the earth.

METHOD USED—The system is shown in Fig. 1. Light from a spectral lamp excites atoms in an absorption cell, increasing their energies. A square-wave voltage (50 to 70 cps) which produces a field perpendicular to the direction of spectral light, makes the absorption-cell output sensitive to its surrounding

magnetic field. This field is produced by supplies 1 and 2, which simulate the earth's magnetic field that exists in space. When tested, the system is placed in a shielded container which nullifies the earth's magnetic field.

A light detector senses changes in light absorption and signals the circuits of the system, which produce correcting changes of space-vehicle attitude.

OPTICAL PUMPING—The technique used in exciting the atoms of the absorption cell is called optical pumping. With this technique, optical energy of an appropriate wavelength pumps atoms of helium in the cell preferentially into certain energy states.

Quantum theory explains optical pumping. This theory states that an atom can exist in only certain discrete energy levels. Figure 2A shows a partial energy-level diagram for helium. The heavy horizontal lines identified by n numbers indicate energy levels. When an atom undergoes a transition between two of these energy levels it either emits or absorbs a photon. The ensemble of photons emitted by many atoms undergoing identical transitions constitutes a sharp spectral line.

Not all transitions betwen pairs of energy levels are allowed and various selection rules govern the permitted transitions. These selection rules are equally operative for transitions from higher to lower levels (emission), or from lower to higher levels (absorption). The lines which interconnect various levels show interlevel transition possibilities and their numbers indicate the wavelength of the corresponding photons.

Transitions always take place between one column of energy and an adjacent column, never within the same column. Each column contains atoms of identical electron-orbit momentum.

There are two groups of energy states of the helium atom, the parhelium and the orthohelium. Optical transitions between these two groups cannot take place.

In the parhelium group of atoms, the two electrons around the helium nucleus are always oriented with their intrinsic spins—and consequently, their magnetic moments—pointed in opposite directions. Therefore, the atoms of this group exhibit no magnetic characteristics, except a weak diamagnetism. The magnetic field in a space filled with a diamagnetic gas is less than would be obtained in free space with identical magnetomotive forces.

In the orthohelium group of energy states, the two electrons in the helium atom have their spins and magnetic moments always pointed in the same direction. Orthohelium atoms tend to line up parallel to an applied magnetic field. Thus, orthohelium is paramagnetic. The magnetic field in a space filled with a paramagnetic gas is greater than would exist in free space with identical magnetomotive forces.

Figures 2A and 2B do not show all details of orthohelium energy levels and transitions. Figure 2B shows more details of the lowest levels of the ^3S and ^3P columns of the orthohelium group than Fig. 2A.

The distinction between the columns of Fig. 2A is that atoms included in columns S, P, D or F have 0, 1, 2, or 3 units, respectively, of total electron orbital angular momentum. The various n levels correspond to electron shells that may surround the nucleus; a helium atom in an $n = 2$ level has its electrons orbiting closer to its nucleus than an atom in an $n = 3$ level. Thus the lowest level of the ^3S column is designated 2^3S, where the first number of the term refers to the atom's n level.

Except for the ^3S column, each level of the other columns has three components. These components are the three allowed orientations of the electron-spin directions relative to the direction of the electron-orbit angular momentum. Figure 2B shows the three components of the lowest energy level of the ^3P column.

The lowest energy level in the ^3S column is metastable. A metastable energy state is one which cannot lose its energy by radiation and which cannot be reached from a lower energy level by absorbing radiation. It is possible to excite helium gas in a gas discharge and obtain a sufficient concentration of metastable orthohelium to make use of its characteristics. The metastable state has a sufficiently long life time (about 1 msec) to be useful for measurement. It is the metastable state that is optically pumped, in the absorption cell.

The spectral line of 10,829 A coming from the spectral lamp excites metastable-state atoms to 2^3P, the lowest group of energy levels in the ^3P column. Atoms remain in their excited 2^3P states for about 10^{-8} sec, and then return to the 2^3S level, radiating energy. The three components of 2^3P are very close together. Two of these components are so close together that the spectral lines of radiation emitted when atoms go back to the 2^3S level overlap; these components are 2^3P_1 and 2^3P_2 (Fig. 2B). Line widths between 2^3P and 2^3S levels represent approximate relative strengths of emission lines.

EFFECT OF MAGNETIC FIELD—When a magnetic field is applied, the 2^3S level separates into three different energy levels. The sketch enclosed by the circle in the ^3S column (Fig. 2B) indicates this separation. Separation of these levels is much smaller than the separations of the three components of the 2^3P level, whose separations are shown for zero-magnetic-field conditions. The separation between adjacent components of the 2^3S level is equivalent to a photon with a frequency of 2.8 Mc for a magnetic field of one gauss. This characteristic may be used to measure the intensity as well as the direction of the magnetic field.

For a 2^3S atom in the maximum-energy state, the $m = +1$ state, the two electrons around the helium atom are oriented in such a direction that they generate a magnetic field opposing the field in which the atom is located. The lowest-energy 2^3S atom, the $m = -1$ state, has its electron magnetic field pointing in the same direction as the magnetic field in which the atom is located. The m = 0 level refers to an electron orientation in which the magnetic field

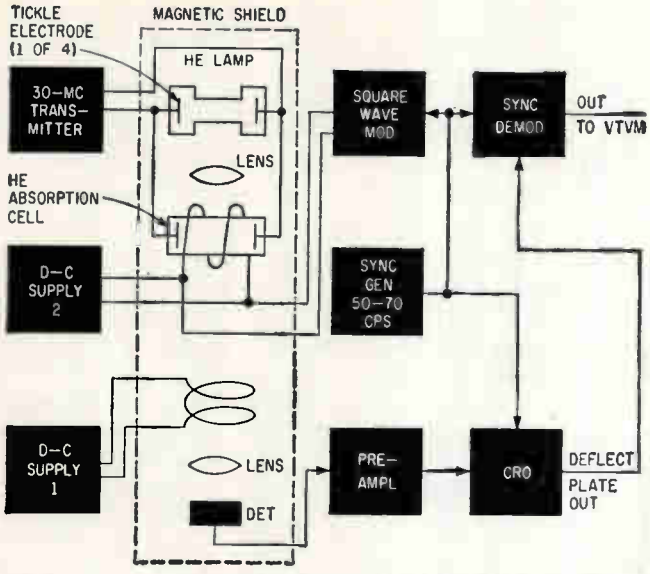


FIG. 1—Magnetometer system. Lamp and cell each have two tickle electrodes

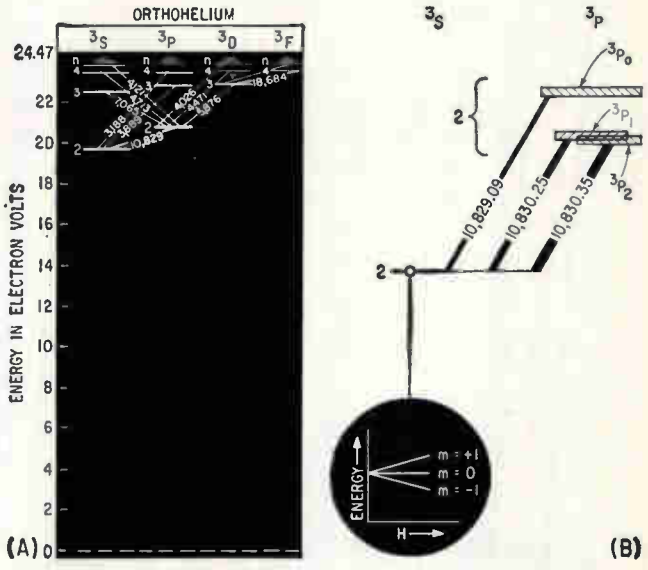


FIG. 2—Orthohelium energy levels (A); the lowest S- and P-column levels are shown in finer detail in (B)

of the electrons is at right angles to the surrounding magnetic field. These three states are the only possible energy states of the 2^3S energy level.

Superscript 3, which precedes the letters *S*, *P*, *D*, and *F* of the orthohelium orbital-momentum columns, indicates that three spectral lines are emitted in transitions between levels or that levels consist of three components.

PUMPING CYCLE — The optical pumping cycle takes place in three steps (Fig. 3). In the first step (Fig. 3A), an atom in one of the three magnetic substates of the 2^3S level absorbs a light photon, and rises to the 2^3P_2, 2^3P_1, or 2^3P_0 state. The probabilities for absorption of light are different for the three magnetic substates of the 2^3S level, as discussed below.

The second step (Fig. 3B) is mixing in the 2^3P level. Collisions between atoms can cause mixing among the three states of the 2^3P level, since the energy of motion of the atom is greater than the energy of separation. An atom excited to the 2^3P level collides with another atom about 100 times.

Third step is the return to the 2^3S level by the emission of radiation. These three steps take about 10^{-8} sec. Since atoms excited to the 2^3P state mix, return of an atom to either of the three magnetic substates of the 2^3S level is equally probable.

PROBABILITIES—Figure 4 shows absorption and population probabilities of 2^3S substates for various magnetic-field and a-c excitation parameters. Size of the circles at the end of the magnetic-substate lines indicates relative absorption and population probabilities of atoms in the substate levels. These circles are not drawn to scale.

When the light and magnetic-field directions are colinear, the probability of absorption of 10,829-A light is highest for the middle state. Without a perturbing field, the relative number of atoms in the middle substate would be lower than the other two

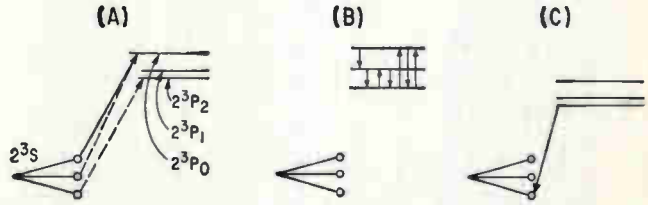


FIG. 3—In the optical-pumping cycle, S-level atoms absorb photons (A), are excited to P level (B), and emit photons in returning to S level (C)

1 MAGNETIC-FIELD ANGLE WITH LIGHT	2 RELATIVE ABSORPTION PROBABILITY	3 RELATIVE POPULATION (NO EXCITATION)	4 RELATIVE POPULATION (RESONANCE EXCITATION)
0° (COLINEAR)			
90°			
55°			

FIG. 4—Optical pumping effects on the lowest S-column level

states (column 3); more middle-state atoms would be excited to the 2^3P level than high or low-state atoms. When optical pumping reaches equilibrium, the gas would be somewhat more transparent to 10,829-A light than at the start of pumping, since more atoms would be in the high and the low substates, which have less light-absorption probabilities

than the middle substate.

Application of a weak resonant field (2.8 Mc per gauss) equalizes the relative populations of the atoms in the three substates of the 2^3S level (column 4). Thus the gas becomes more absorbent of 10,829-A light. This effect can be used to control an oscillator at the resonance frequency of 2.8 Mc per gauss by circuits which sense the frequency at which this increase in absorption takes place.

When the angle between the magnetic field and the light beam is 57 deg, the absorption probability is the same for all three energy substates of the 2^3S level. Thus the 57-deg direction is equivalent to having light pass through the absorption cell in all directions, a condition that does not produce a pumping or orientation effect. Figure 5 shows the relative effectiveness of the optical pumping for various directions of the magnetic field with respect to the light direction.

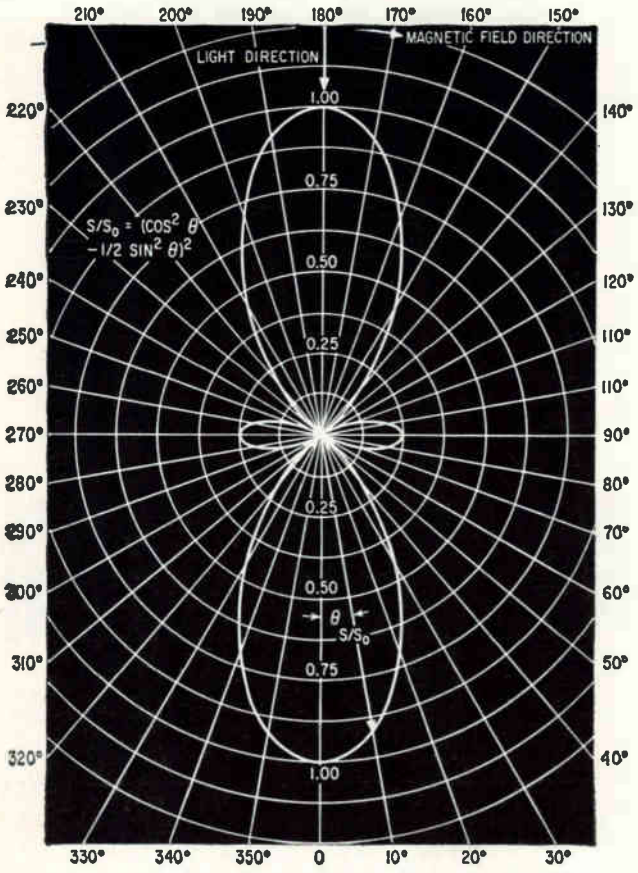


FIG. 5—Theoretical optical-pumping effectiveness (S/S_0) plotted against light-magnetic field angle

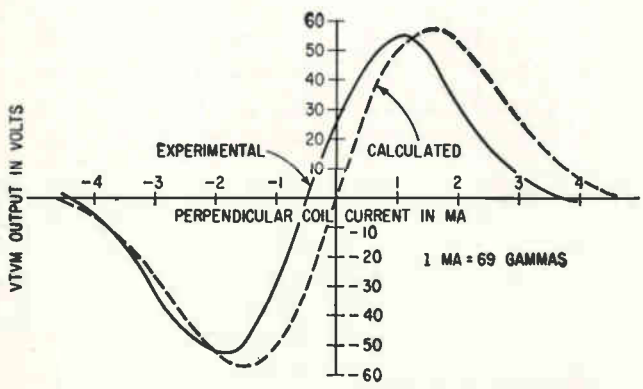


FIG. 6—Output as a function of perpendicular-field strength

SYSTEM FUNCTIONING—In Fig. 1, an r-f oscillator drives the helium lamp and helium absorption cell. Oscillator frequency is higher than the resonance frequency used to excite the helium absorption cell (2.8 mc/gauss).

Light from the lamp is collimated by a lens system and passed into the absorption cell. After passing through the absorption cell, the light is refocused on a photosensitive detector which is sensitive to the pumping light. Supply 1 supplies a magnetic field that is colinear to the light path. Supply 2 supplies a field that is perpendicular to the light path. The square-wave modulator also supplies a perpendicular field along the same axis as the field contributed by supply 2.

Supplies 1 and 2 simulate components of the earth's magnetic field; the earth's magnetic field in the vicinity of the test setup is nullified by shielding the absorption cell.

The square wave of excitation (50 to 70 cps) modulates the direction of the resultant total magnetic field. If the earth's magnetic field and the light are colinear the resultant total magnetic field direction deviates the same angle from the light direction for positive and negative portions of the square wave. As shown in Fig. 5, the relative absorption would then be the same, and no light-intensity modulation would be sensed at the detector input.

If the earth's field is not colinear with the light, the square wave produces a greater angle between the total field and the light when it is one polarity and a smaller angle when it is the opposite polarity. Absorption is now different for one polarity, and modulation of the light is detected by the photosensitive cell. This modulation is amplified and displayed by the cro.

The cro output is synchronously rectified. The synchronous rectifier is controlled by the supply that drives the square-wave modulator. The attitude of a space vehicle could be controlled to the null of the magnetometer output.

RESULTS—Figure 6 shows the vtvm output. Deviation between the curves is due to the small amount of residual field existing in the container of the system. The colinear-field strength is 160 gammas and the square-wave modulation field produces about 69 gammas in the same direction as the perpendicular field produced by d-c supply 2. Current from supply 2 is indicated on the abscissa.

Alkali-metal spectral lamps and absorption cells have been used, rather than helium in some experiments. Alkali pumping-effectiveness null occurs at 90 deg.

Work was performed under subcontract 214-362070 with G. E. Missile and Ordnance Systems Dept. under prime contract AF 04(647)-269.

Credit is acknowledged for the work of Dr. P. A. Franken and Dr. F. D. Colegrove.

Measurement of Diode Switching Characteristics

Behavior of computer diodes when handling steep-edged, short-duration pulses is investigated. Sampling oscilloscope permits study of diode recovery times down to 500 picoseconds

By W. S. ECKESS and P. G. DUCKER, Pacific Semiconductors, Inc., Culver City, Calif.

WHEN a semiconductor diode is switched from a conducting state to a nonconducting state (reverse bias), a transient occurs known as reverse-recovery.[1] This transient time is of major concern because it limits the maximum computer speed (clock rate). When a diode is switched from a nonconducting state to a conducting state (forward current), there occurs a phenomena known as forward-recovery. Although this forward-recovery characteristic is not as important in most computer circuits, there are applications such as core drivers and high speed switching where a fast forward-recovery time is required.

Using a very fast rise time mercury relay pulse generator and a sampling oscilloscope that has an equivalent bandwidth of greater than 1,000 Mc, measurements of forward and reverse recovery times are described.[2]

Circuit Description

Forward current in the diode under test (see Fig. 1) is established by the battery B_1, and resistors R_1, R_2, and R_3. The impedance of the current supply is shunted to ground by C_1.

Reverse voltage applied to the circuit has a rise time of <0.4 nanoseconds (1 nanosecond $= 10^{-9}$ sec) and a pulse width of 50 nanoseconds. The prf is 120 cps. The pulse generator supplying this pulse has a source impedance of 50 ohms. Reverse voltage appears across the series loop consisting of R_2 and R_3 and the diode under test. Read-out voltage is taken from across load resistance R_3, and fed to the oscilloscope, which has a rise-time of <0.4 nanosecs and input impedance of 50 ohms.

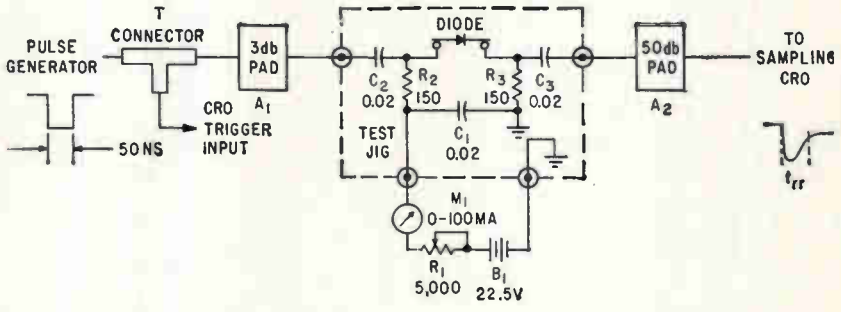


FIG. 1—Negative input-pulse cuts off diode current and oscilloscope displays diode recovery-time

The circuit time constant is the product of the loop resistance and capacitance. For this circuit the driving or source resistance is 50 ohms and the load resistance is 50 ohms; therefore, the loop resistance is 100 ohms. Loop capacitance is a function of the circuit layout and the diode capacitance. Since semiconductor diodes have a nonlinear capacitance which varies as a function of the voltage across the diode, the diode capacitance measured at zero volts is assumed to be most representative of the actual capacitance during the switching period. Loop capacitance measured at the test circuit output terminals with a diode inserted in the test clips having a capacitance of 4 pfs at zero volts is 8 pfs. Therefore the circuit time constant is 0.8 nanoseconds.

Limitations affecting the actual reverse recovery time of the diode under test are switching time, oscilloscope rise time and circuit time-constant. The combined rise time of the oscilloscope and mercury relay pulse generator was measured to be 450 picoseconds, and the circuit time constant was calculated from values of loop resistance to be 800 picoseconds.

This circuit offers the advantage of simplicity over other reverse recovery testers. In addition the circuit simulates the actual conditions

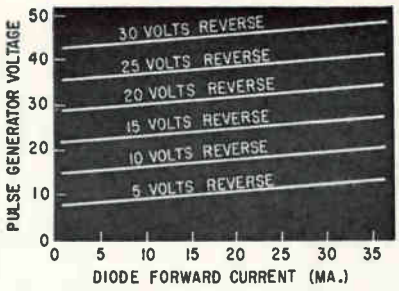
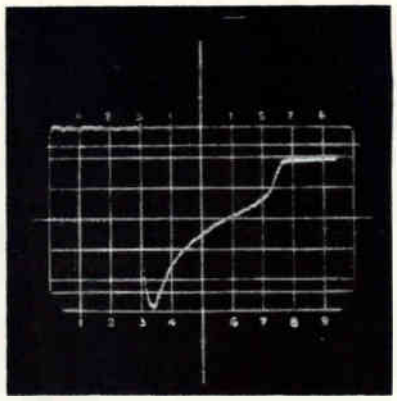


FIG. 2—Colibration of sampling oscilloscope for reverse recovery meosurements



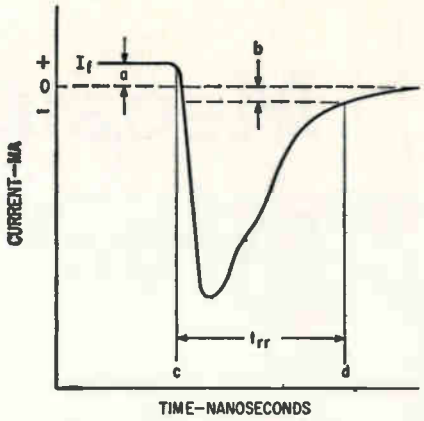


FIG. 3—Reverse-recovery woveform. Forward current (a), reverse current (b), start of switching (c), end of switching (d), reverse recovery time (t_{rr})

that computer diodes will be subjected to in computer circuits, namely, switching from a specified forward current to a specified reverse voltage and recovery to the required resistance level. Method B of MIL-S-19500B (Para. 60.1.11.2) which is the military standard for reverse recovery time measurements of less than 0.3 microseconds does not offer the computer designer the above advantages. The switching conditions of this standard is from a specified forward current to an equal reverse current. Reverse-recovery-time is defined as the time required for the reverse current to decrease to $\frac{1}{10}$ the specified reverse current. These conditions are not practical in terms of the computer designer's needs.

Measurements

It is necessary to overcome the d-c voltage drop across R_s before the diode is switched to a reverse voltage. In Fig. 2, curves have been drawn of the pulse-generator voltage amplitude necessary to switch the diode from the forward current to a specified reverse voltage. The loss of attenuator A_1 (3 db) is considered for this calibration curve. Switching from 20 ma to −15 volts would require a pulse amplitude of 25 volts.

A photograph of a typical reverse-recovery waveform is shown in Fig. 3. Forward-current magnitude is labeled and is measured in centimeters. Since this current is accurately known, its amplitude can be used to calibrate the oscilloscope. The zero current or infinite impedance level is determined by observing the steady state level after the diode has recovered to its static reverse bias leakage. Because of the extremely small loop resistance, small load capacitance and very fast rise-time of the pulse generator and oscilloscope, very large values of peak inverse currents are typical. Peak reverse currents of 70 to 100 ma have been measured when switching from 5 ma to −10 volts. This compares to typical values of 2 or 3 ma peaks for the same switching conditions using the JAN 256 Reverse Recovery Tester. Obviously, cathode followers or shunt diodes are not required to remove the forward current.

Usually, reverse-recovery-times of very fast switching diodes are specified to low resistance levels or high reverse-current values. Typical values are 2,500 to 5,000 ohms or 5 ma to 1.0 ma. As shown in Fig. 4, it is very difficult to measure to higher resistance values than 4,000 ohms.

Important features of the oscilloscope are a built-in clamp and a digital output. In Fig. 5 the reverse recovery waveform clamped at a specified level is given. By connecting a counter to the digital output, the exact number of sampling pulses occurring below the clamp level can be counted. Since the number of samples per unit time is known, the reverse recovery time can be read directly or punched on tapes or cards. This is an important advance in the automatic testing of semiconductor diodes.

Forward Recovery

When a computer diode is switched abruptly from its steady state (no forward bias) to some forward current, and then back to its initial state, there occurs a phenomenon generally known as forward recovery. Response of silicon computer diodes to constant current, one ampere, 300 nanosecond-duration-pulses is described.

A mercury switch pulse generator provides the positive pulse described above. This circuit is illustrated in Fig. 6. The pulse is fed through a 3 db pad (to terminate generator) to the recovery fixture. The diode is then switched into its forward state for the duration of the pulse. The resulting waveform is attenuated through a 50 db pad and fed to the oscilloscope.

Waveform Analysis

Referring to Fig. 7, the resultant waveform can be analyzed for a relatively fast silicon computer diode: an initial voltage peak with a rise-time of approximately 5 nanoseconds (E_1); an exponential decay to the steady state forward voltage drop of this diode (E_2); a very fast voltage drop, with a fall time of approximately 1 nanosecond, when the forward driving pulse is turned off (E_3); a slight decrease of voltage (E_4); and a final voltage decay to zero.

The initial voltage E_1 peaks up higher than the steady state value because of the unmodulated bulk resistance of the diode. Conductivity modulation then sets in and reduces this peak to the steady-state voltage value E_2, corresponding to the magnitude of the current input pulse. When the driving current is turned off, the voltage drops to a level, E_3, dependent upon the minor-

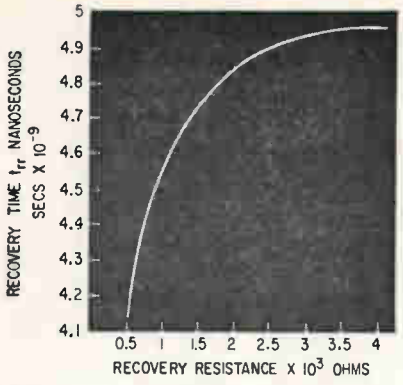


FIG. 4—Relationship between reverse-recovery-time and diode reverse-recovery resistance

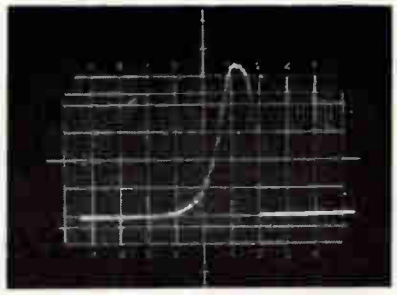


FIG. 5—Oscilloscope permits waveform to be clamped to any selected voltage level. Digital counter automatically counts the number of sampling pulses between the rising and falling edges of the wave at its intersection with the clamping level

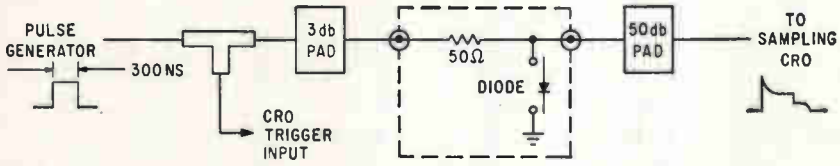


FIG. 6—Forward recovery time is measured for application of a short positive pulse

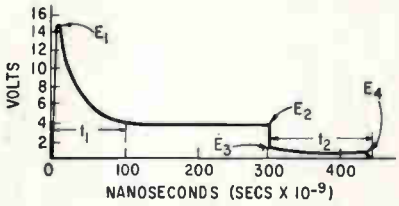


FIG. 7—Detailed response curve for low capacitance silicon diode. Input is 300 nanosecond pulse, and ampere amplitude

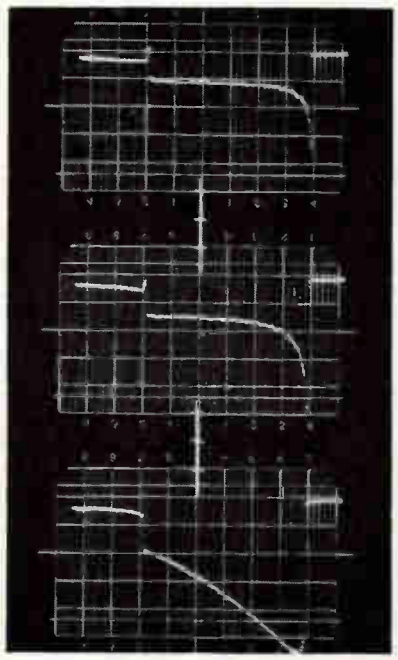


FIG. 8—Forward response of fused silicon diodes. Diodes range in recovery time from slow (upper graph) to extremely fast (lower graph)

ity carrier storage in the diode which, during this period, acts like a voltage source. This voltage drops off only slightly to E_1 until the current supplied by the diode is limited solely by the diode minority carrier storage and recombination rate. It then decays to zero considerably faster, completing the cycle. The length of time of voltage maintenance after the driving pulse turns off (t_2) is therefore a function of both loop resistance and minority carrier lifetime within the diode itself.

The forward recovery time is denoted by t_1 in Fig. 7, while time t_2 is associated with the reverse recovery time. In Fig. 8, photographs of slow, fast and extremely fast forward recovery diodes are shown. The slow diode (top) does not recover to the steady state condition before the termination of the 300 nanosecond pulse and the magnitude of E_1 in Fig. 8 (top) is higher than that of E_1 in Fig. 8 (middle) and 8 (bottom). The faster diodes show larger voltage peaks and faster recovery. In all three cases the stored charge (t_2) remained the same.

Rectification Efficiency

At frequencies above 2 Mc the rectification efficiency of silicon computer diodes drops off sharply. Since recovery times have been associated with rectification efficiency, an attempt was made to find correlation between the two. It was found that rectification efficiency was correlatable with the area under the forward-recovery curve, between the limits 0 and t_1 (see Fig. 7).

A graph of this relationship is shown in Fig. 9A where the area under the curve is expressed in coulombs. It should be emphasized that these measurements were made with a 1 ampere driving pulse, thus accounting for the high storage values. The rectification efficiency measurements were made in the standard 100 Mc, 2 v rms circuit, with $R_L = 5{,}000$ ohms, and $C_L = 20$ picofarad.

Correlation (or lack of correlation) between reverse recovery time and rectification efficiency is shown in Fig. 9B. These measurements were made using diodes having the same capacity and forward conductance. Investigations were made to determine if correlation between rectification efficiency and diode characteristics could be established. Only the forward transient storage seemed to give any degree of correlation.

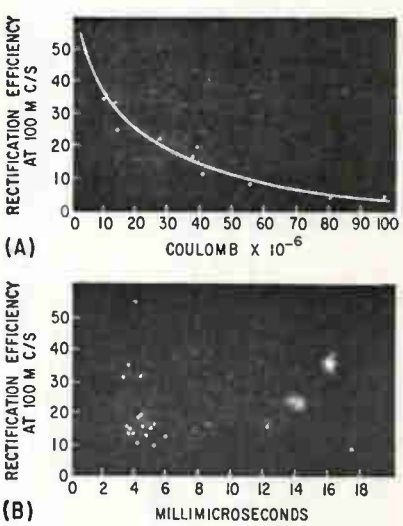


FIG. 9—Relationship between rectification efficiency and forward transient storage (A), and rectification efficiency versus reverse-recovery time (B)

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(2) William E. Bushor, Sample Method Displays Millimicrosecond Pulses, ELECTRONICS, 32, No. 31, July 31, 1959.

Instrumentation for

Underwater camera's electronic flash and film-rewind circuits control picture taking at depths up to 6 miles below the surface

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IN THE MIDST of all the effort to go outward into space, a small group of scientists is making dramatic advances in another unexplored region—the vast area of the earth underneath the seven seas. Oceanographers are acutely aware that much less is known about the bottom of the ocean than the surface of the moon.

By exploring the bottom of the ocean with sounding lines and sonar pulses, oceanographers have begun to acquire a knowledge about its general features. Now, man stands ready to penetrate to the bottom of the ocean and to explore its depth with his eyes. Bathyscaphes will make it possible to conduct detailed surveys of the ocean bottom.

During bathyscaphe dives, cameras will do most of the looking for those aboard and will augment their observations.

Exploration by Camera

In selecting the photographic equipment he will use during exploration, the oceanographer working from a surface ship must choose between motion-picture and still cameras. The motion-picture camera provides the more powerful medium in terms of continuous event coverage but requires great amounts of light, large quantities of film, and complex camera mechanisms. On the other hand, even though the still camera offers better optical resolution when larger film is used, it does not have the advantage of continuous coverage. Hence, the underwater-camera operator, who cannot see the subject or the scene to be photographed, must select the moment to operate the shutter. This disadvantage is offset in some measure by stereo camera arrangements and color film, which add greatly to the information presented by still photographs.

An ideal system with either stills or motion pictures would consist of a television camera fixed to the underwater camera. The operator could sit on board his surface ship with a pushbutton in his hand, view the screen and wait for the subject and camera angle to suit his fancy. Systems such as this have actually been used.

Principal disadvantage is in the electrical connection that is required between the tv camera and the surface viewing station. At the time of this writing, use of tv cables more than 1,000 ft long presents almost insurmountable electrical and mechanical problems. The tremendous weight of long cables and the powerful winching equipment required to reel in the cable rule out the use of tv viewing equipment at great depths.

Since the camera must be operated blindly, it is advisable to use an automatic cycling camera. If the still, or motion-picture camera is capable of taking many photographs there is a good chance that some of the frames will record data of value.

The electronic-flash system of lighting, compared to the incandescent method, is particularly efficient since the light is on only when the shutter is open.

Camera System

The camera and light source are housed in two separate pressure-resistant cylindrical steel containers connected by an electric cable. No electric cable to the surface is required since the apparatus is battery-powered. Camera cores withstand pressures up to 17,500 psi, equivalent to a depth of 6 miles.

The magazine cover shows the camera system and its rig. It comprises two cameras which operate together to produce stereo pairs of photographs, an electronic flash tube, and a battery-powered sonar pinger which produces 12-Kc pulses of acoustic power at one-second intervals. The sonar provides the winch operator with a continuous indication of the camera-to-bottom distance. Using this information, the operator lowers the camera to the correct distance above the bottom for sharpest focus.

The camera shown in Fig. 1 accepts a standard 100-ft, daylight-loading roll of 35-mm film, on which 500 exposures can be made. A shutter is used with a camera case designed for depths up to a mile but is unnecessary at depths beyond 600 ft because of the lack of ambient light. With each picture the camera also records a picture of an internal data chamber in which are displayed a data card, a depth gage, a clock, and other required instruments.

The camera can be wired so that the moment of camera exposure can be controlled by a hand-operated button as in the bathyscape, or by a cam-operated timer motor, or by a bottom-sensing switch. In the bottom-sensing method, the shutter is operated when a switch suspended below the camera touches bottom. The length of the line from which the switch is suspended is ac-

Exploring the Oceans

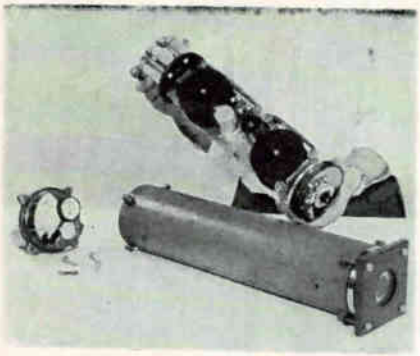

FIG. 1—One of the two cameras shown on THE FRONT COVER. Data taken from panel (left) will be 9-frames distant from photo it identifies

curately measured so that the camera will be in exact focus when the switch touches bottom.

Automatic Cycling

Adjustable, mechanical time-delay switch S_1, (Fig. 2) which is in series with the battery, delays the start of the operating cycle. This delay conserves the film and battery by preventing operation until the apparatus has been lowered to the operating depth. The timer can be preset to delay operation up to two hours. Once S_1 closes, the camera and light source start to cycle automatically and continue to do so for two hours, after which the film supply will be exhausted.

Timing motor B_1 in the light-source casing turns at 5 rpm to drive a cam which momentarily actuates timing switch S_2 every 12 sec. While the timing switch is in position A, current is fed to the various charging circuits in the camera.

Each time switch S_2 drops into position B, three separate circuits operate in the camera. Capacitor C_1 discharges through incandescent data lamp L_1, causing a picture to be taken of the data chamber. Capacitor C_2 discharges through the shutter solenoid and opens the shutter momentarily. Contacts S_3 in the shutter then close, triggering flash tube light source V_1. Capacitor C_3 discharges to ground.

High d-c voltage is obtained for the flash tube from the 6-v battery by a d-c-to-d-c converter (Fig. 2). Alternating current is generated by an oscillator containing transistors Q_1 and Q_2. The 1-Kc output is stepped up to 450 v by toroidal power transformer T_1. Secondary current is rectified to 900 v by four diodes in a voltage-doubler circuit. Because of the high inverse voltage, two diodes in series are used in each leg. Each of the flash tube discharge capacitors C_4 and C_5 becomes charged to 450 v. Because of the series arrangement, they are, in effect, a single 262.5 μf capacitor charged to 900 v. Their energy storage is $(CE^2)/2 = 106$ w-sec.

A charge of about 200 v, which builds up on trigger capacitor C_6, is discharged to ground when synchronizing switch S_3 closes. The discharge generates a high voltage pulse in transformer T_2, triggering the flash tube and causing capacitors C_4 and C_5 to discharge through the flash tube. Flash duration is about 200 μsec.

When the timing motor cam returns S_2 to position A, transistor Q_3 conducts and current flows into the base of Q_4. Transistor Q_4 starts conducting and operating current is applied to film drive motor B_2. This current is transitory, lasting about one second, the time required for the voltage on C_3 to rise to 6 v. During this short period, the film drive motor drives cammed switch, S_4, into position B'. In this position, the film drive motor is connected directly to the 6-v circuit line. The film drive motor advances the film one frame. When the cam moves S_4 back into position A', power is removed from the motor, the film stops advancing, and the operating cycle is complete. Resistor R_1 limits over-travel when current is removed from the motor by its dynamic braking action on the motor.

The battery used is a wet, rechargeable, 6-v, silver-zinc type, which has a 20-amp-hr capacity.

The authors acknowledge the help and comments of many people associated with the development, particularly Lloyd Hoadley, David Owen, J. Brackett Hersey, Richard Backus, George Clarke, John Graham, Edward Thorndike, Allyn Vine, Jacques Y. Cousteau, Andre Laban, Lloyd Breslau, David Cahlander, Thomas Gifft, John Tredwell, Paul Regele, Clif Lilliot, John Sanroma, John Keefe, Vernon MacRoberts, Robert Hopkins, James Baker, Andrew Wollensak, and George Houot.

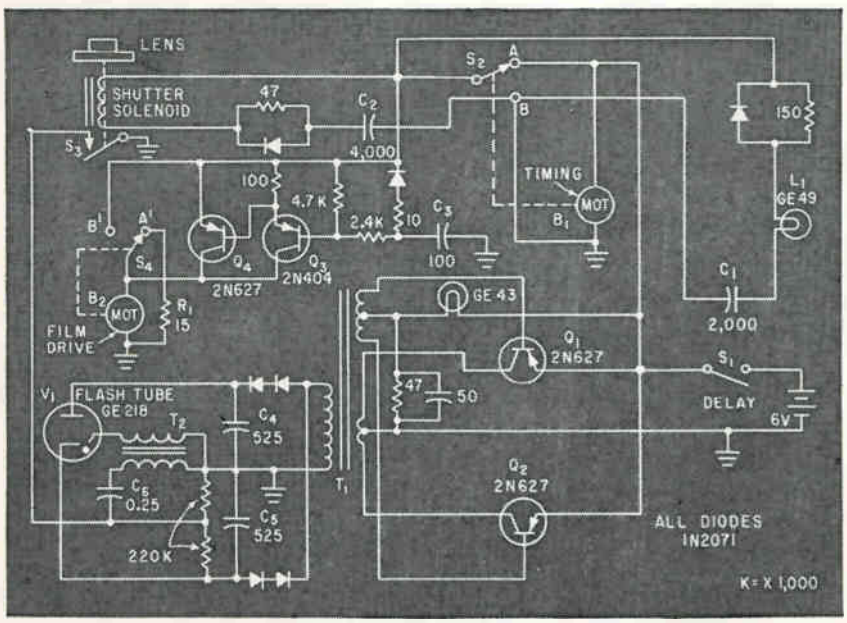

FIG. 2—Automatic-cycling system

Designing Tv Tuners With

Specially developed diffused-base mesa transistors permit design of tv tuners with noise performance equal to that obtained in tube tuners. Complete design procedure for r-f amplifier, mixer and oscillator stages is given

UNTIL RECENTLY, transistors were not used at very high frequencies due to high noise figure and low gain when compared with tubes. This is no longer true and, in fact, we may see the situation reversed in the next few years. The mesa transistors used in the tv tuner described here were developed for tv tuner and i-f applications.

In simplest terms, a tuner can be defined as that part of a receiver which selects the desired frequency from a spectrum and converts it to a fixed lower frequency with minimum degradation in signal-to-noise-ratio and signal fidelity. Gain may be considered secondary if it is sufficient to keep the noise figure independent of the following stages. This is nearly always true in superheterodynes where gain is cheaper at intermediate frequencies.

Also of importance, but not necessarily tied to transistor utilization, are selectivity, oscillator radiation, swr (standing wave ratio) and agc (including overload). Automatic gain control is dependent on transistor parameters but can be enhanced considerably by the circuits. Actually, there is one more requirement which is not covered by this paper: suitable packaging for the tuner. Tuner packaging is an art in itself.

In actual numbers, present-day tube tuners provide the selectivity required with noise figures ranging from 6 to 12 db at 215 Mc. The gain of a tube tuner will vary considerably at 215 Mc, but in general lies between 25 and 40 db. Most tube tuners handle up to 1-v at the input.

The 2N1398 r-f amplifier described is tested to a maximum noise figure of 6 db at 200 Mc, while the mixer, 2N1399, is tested to a noise figure of 7 db maximum at 200 Mc. Typical net gain for the r-f amplifier in a practical circuit is 10 db at 200 Mc, the mixer 12 db at 200 Mc. The minimum noise figure of the r-f amplifier is 4 db at 200 Mc. Thus, with careful design, it is possible with mesa transistors to equal the noise performance of today's best tube tuners.

Automatic gain control can be made to equal or exceed present tube design, but overload still represents a problem. At a signal level approximately equal to the d-c base-to-emitter voltage (V_{BE}) transistor overload occurs. For germanium, V_{BE} is in the neighborhood of 0.2 volts. Forward, rather than reverse agc will sometimes enhance overload handling capability, but the order of improvement is small compared to what would be desirable. An input attenuator still remains the most effective method of handling very large signals.

H-F and Design Parameters

The parameters of interest can be divided into two categories: general high-frequency and design. General high-frequency parameters, such as $r_b'C_c$ product, f_α and f_{max} determine the gain capabilities of a transistor, while knowledge of r_b' and h_{fe}, is necessary for noise analysis. These parameters are useful to the designer in making a preliminary evaluation of the transistors. The measurement of $r_b' C_c$ is easy, and a simple test set is shown in Appendix 1.

The low-frequency common base forward current transfer ratio, α_o, can be measured by conventional test gear but f_α, the frequency at which $|\alpha|$ has decreased 3 db, is harder to ascertain. A high-frequency transfer bridge such as the GR1607A can be used to measure f_α directly. However, a somewhat simpler method is based on the fact that f_α is related to f_T (the frequency at which $|h_{fe}|$ becomes 1) by $f_\alpha = Kf_T$ where K is a factor which is usually between 1.2 and 2. The multiplying factor, K, depends upon the amount of drift field and, hence, the excess phase shift in the transistor. For transistors with no drift field (alloy transistors) the factor is 1.2. For the diffused-base mesa transistor K is approximately 1.9, so that $f_\alpha \cong 1.9\ f_T$.

The parameter f_T is determined by measuring $|h_{fe}|$ at 100 Mc and multiplying by 100, the frequency of measurement. Measurement of h_{fe} is covered in Appendix 2. From these parameters f_{max} and power gain at frequency f, is computed: $f_{max} = \sqrt{\alpha_o\ f_\alpha/8\pi\ r_b'C_c}$ or PG = 20 log (f_{max}/f) db. Thus a transistor with an f_{max} of 1,000 Mc would have a gain of 14 db at 200 Mc and approximately 40 db at 10 Mc. The gain expression is approximate for frequencies much less than f_{max}.

The last high-frequency parameter that is of interest here is the noise figure. This may be computed from the following formula from Neilson[2]:

$$F = 1 + \frac{r_b'}{R_g} + \frac{r_e}{2R_g} + \left[1 + \frac{1}{1-\alpha_o}\left(\frac{f}{f_\alpha}\right)^2\right] \times [R_g + R_b' + r_e]^2/2\,h_{FEO}r_eR_g$$

where R_g is generator impedance; f = frequency under consideration; $r_e \approx 25/I_E$ = 25/emitter current in ma; r_b' = high frequency base resistance, see Appendix 3; and h_{FEO} =d-c common emitter current gain (d-c β). The above formula shows reasonable agreement with actual noise measurements made with a noise diode from a 75 ohm source at 200 Mc.

Design Parameters

Once the short-circuit current gain of a particular transistor con-

Mesa Transistors

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figuration is known, the only additional design parameters necessary are the input and output impedances. These may also be used to compute the gain more accurately. (See Appendix 4.)

As a general rule, it is much easier to measure short-circuit impedances than open-circuit impedances at higher frequencies and, thus, the following will be used in design calculations:

r_{oep}, C_{oep}—Parallel equivalent output impedance, input short circuited.
r_{iep}, C_{iep}—Parallel equivalent input impedance, common emitter output short circuited.
r_{ies}, C_{ies}—Series equivalent input impedance, common emitter, output short circuited.
r_{ibp}, C_{ibp}—Parallel equivalent input impedance, common base, output short circuited.
r_{ibs}, C_{ibs}—Series equivalent input impedance, common base, output short circuited.

These parameters can be measured with such instruments as the Boonton RX Meter, Wayne-Kerr VHF Bridge, or General Radio Transfer Bridge. They closely approximate circuit conditions where the circuit is neutralized or where the input or output loads are such that the effect of transistor feedback is small. Above 100 Mc, it is recommended that input impedance be measured with the GR1607 Transfer Bridge, or an RX meter with coaxial adapter. Below 100 Mc, RX meter adapters can be used.

The critical design parameters used in the following are controlled by the transistor manufacturer. Methods for determining these parameters are given in Appendix 5. Design procedure for the three tuner stages—r-f amplifier, mixer, and oscillator—will be given now.

For an r-f amplifier, Fig. 1, two configurations are possible: common-emitter or common-base. The neutralized common-emitter stage will give less gain than the unneutralized common-base stage at channel 13. However, for a given set of parameter variations, the common-emitter stage will give less spread in total gain. The noise figure of both configurations is exactly the same.

Step 1—Select operating point: The current gain, h_{fe}, rises continuously up to about 7 ma, while the output impedance drops quickly. This gives a plateau of constant gain for a region lying between 0.5 and 2.0 ma emitter current (Fig. 1C). Noise figure is also minimum in this region. Therefore, an operating point of 1.5 ma will be selected. The collector supply voltage is usually determined by factors other than the tuner and will ordinarily be between 6 and 12 volts.

Biasing resistors are selected on the basis of the stability factor desired. A stability factor of 3 is satisfactory for operation to 60 C. The emitter resistor of a common base r-f stage should be large compared to the input impedance to avoid excessive signal loss. Base bias is not shown for this stage since it is derived from the agc system. Where agc is applied to the common emitter r-f stage, an r-f choke is used to connect to the agc source.

Step 2—Input Circuit: In the procedure which follows, and for the interstage and oscillator, a channel 13 (215 Mc) design will be shown since this is generally the most difficult. However, each channel is a separate design problem with different tuned circuits and transistor parameters. It is at this point that the transistor input and output impedances at 215 Mc are measured by the transfer bridge or RX meter. At 215 Mc, r_{ies} is about 40 ohms and r_{ibs} about 25 ohms. Typical values for c_{ies} and c_{ibs} are 35 pf and 0.012 μh, respectively.

There are a large number of in-

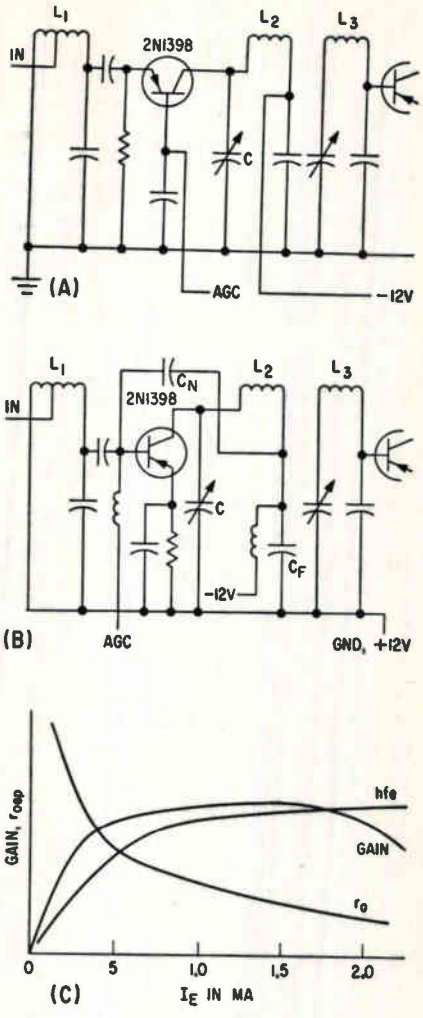


FIG. 1—Common bose (A) and common emitter (B) connection for 215 Mc r-f amplifier. Transistor charocteristics (C)

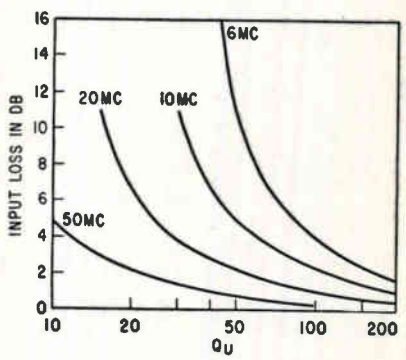


FIG. 2—Relotion between input loss ond unloaded Q for chonnel 13 varies with input bandwidth

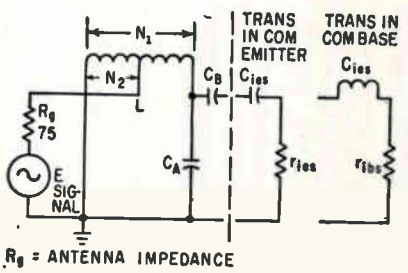


FIG. 3—Input network for r-f amplifier

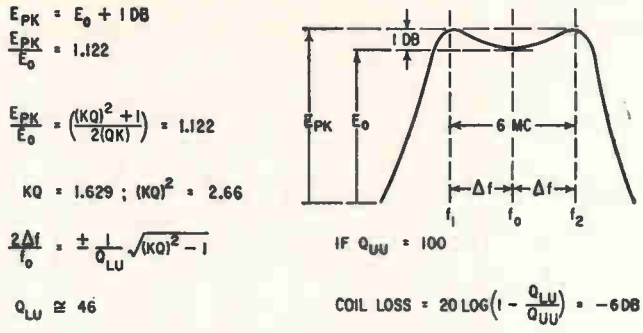


FIG. 4—Interstage network bandpass suitable for channel 13

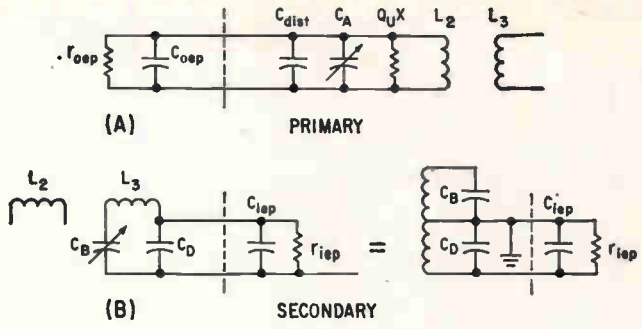


FIG. 5—Equivalent circuit of interstage network

put configurations possible, but usually the one which gives the greatest convenience in switching is used. Turret and switch type tuners, therefore, usually utilize different types of circuits.

The input bandwidth must first be determined. Considering selectivity alone an input bandwidth of 6 Mc would seem desirable; however, this would require a loaded Q (Q_L) of 36, and would necessitate using a high unloaded Q (Q_U) to keep input losses down. Input losses add directly to the noise figure, and it would be best to keep these losses to 1 db or less. Figure 2 shows calculated input circuit-loss versus unloaded Q for several bandwidths.

In a practical tuner it may not be possible to realize unloaded Q's of more than 100. If we use the 1 db loss criterion, the input bandwidth must be in the order of 20 Mc. We may now proceed with the design shown in Fig. 3.

Given: Frequency, f_o = 215 Mc.

C_A = 25 pf. This is selected to be as large as possible and is determined by the tuner construction.

L = 0.002 μh, the inductance to resonate 25 pf at 215 Mc

R_g = 75 ohms, Bandwidth, BW = 20 Mc

Unloaded Q (Q_U) of coil = 100

Loaded Q (Q_L) of input circuit = $f_o/BW = 215/20 = 10.8$

Calculate the circuit reactance, X

$$X = \frac{1}{\omega C} = \frac{1}{2\pi(215\times10^6)25\times10^{-12}} \cong 30 \text{ ohms}$$

Calculate the generator and load resistances (R_g' and R_L') referred to the total tank circuit as shown in Appendix 6.

$$R_g' = R_L' = 2X\frac{Q_U Q_L}{Q_U - Q_L} = 2(30)\frac{(100\times10.8)}{(100-10.8)} = 720 \text{ ohms}$$

Calculate tap point for antenna: $N_1/N_2 = \sqrt{R_g'/R_g} = \sqrt{720/75} \cong 3$. This assumes $k = 1$. Tap can be moved up slightly to compensate for k being less than 1.

From GR-1607 transfer bridge: $r_{ibe} = 40$ ohms; $C_{ibe} = 35$ pf; $r_{ibo} = 25$ ohms; $C_{ibo} = 0.015$ μh, (input is inductive).

Calculate coupling capacitor, C_B

$$X_{CB} = \sqrt{R_L'\,r_{ibe} - (r_{ibe})^2} = \sqrt{720(40) - (40)^2} = 168 \text{ ohms}$$

$$C_B = \frac{X_{CB}}{2\pi f_o} \cong 4.7 \text{ pf, for common-emitter stage}$$

$$X_{CB} = \sqrt{R_L'\,(r_{ibe})^2 - (r_{ibe})^2} = \sqrt{720(25) - (25)^2} = 132 \text{ ohms}$$

$$C_B = \frac{X_{CB}}{2\pi f_o} \cong 5.6 \text{ pf, for common-base stage.}$$

Since $C_{ibe} >> C_B$, its effect can be ignored.

Where the input impedance is inductive, the procedure is the same except C_B must be increased slightly to give X_{CB} the correct magnitude.

The noise figure can be reduced about 0.5 db by mistuning the input circuit on the high side and by adjusting the input so as to allow the transistor to look back into an impedance slightly greater than its own input impedance. The transistor may also be operated directly from a 75 ohm antenna with negligible loss in gain, but a vswr of about 1.8 will result. Where the higher vswr is not objectionable, this method is satisfactory. For the diffused-base mesa transistor the best noise figure and gain each are obtained with almost exactly the same source impedance.

Step 3—The Interstage Coupling Network: The interstage coupling network is usually double-tuned, since it is here that the tuner must obtain most of its image rejection. A neutralized common-emitter stage requires some provision for neutralization from this network. Inductor L_2 (Fig. 1b) may be tapped, but a simpler neutralization method is to select a capacitor C_F for the low-impedance end of L_2 such that the series resonance frequency of L_2 and C_F is considerably lower than that of L_2 in parallel with C_{total}, where C_{total} is total effective parallel capacitance across the inductance. The voltage across C_F will then approach a 180 degree lag with respect to the collector voltage. If C_{total} is 5 pf, C_F should be about 25 pf. Then, if C_c, the capacitance to be neutralized, is 1 pf, $C_N = (25/5)\ (C_c) = 5(1) = 5$ pf.

Figure 4 shows a bandpass characteristic which could be considered suitable for channel 13. Using the equivalent circuit in Fig. 5, we may now compute the parameter values of the transformer for a common emitter (or common base) stage.

(a) Primary

Given: Q_{LU} = 46 = Loaded, uncoupled Q, from Fig. 4; Q_{UU} = 100 = Unloaded, uncoupled Q; r_{oep} = 5000 ohm (from RX meter); c_{oep} = 1.5 pf (from RX meter).

Using expression derived in Appendix 7, calculate

$$C_{total} = \frac{Q_{UU}}{\omega r_o\left(\frac{Q_{UU}}{Q_{LU}} - 1\right)} = \frac{100}{5000\left(\frac{100}{46} - 1\right)(2\pi)(215\times10^6)} \cong 13\text{pf.}$$

Then L = 0.04 μh, the inductance to resonate with C_{total} at 215 Mc. $C_A = C_{total} - (C_{dist} + C_{oep}) = 13 - (2 + 1.5) = 9.5$ pf. C_A may then be a 4.7 pf fixed capacitor plus a 1 – 8 pf trimmer. Bandpass shape in Fig. 4 is used to determine $KQ_{LU} = 1.629$. Also, $K = KQ_{LU}/Q_{LU} = 1.629/46 = 0.035$. Letting L_2

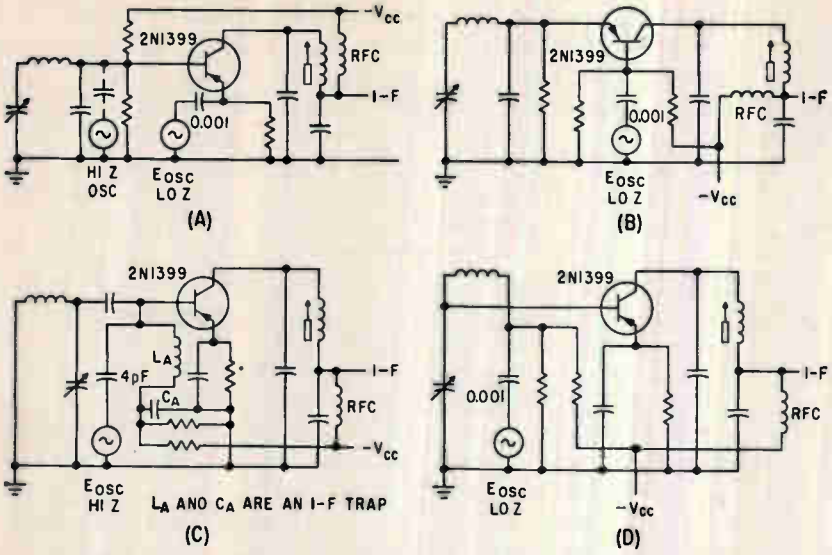
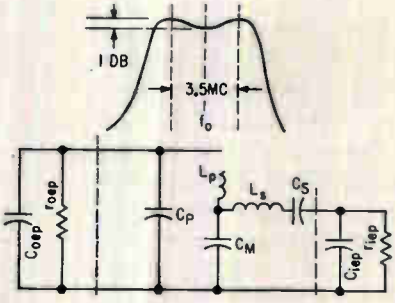


FIG. 6—Possible mixer connections include: signal in base, oscillator in emitter or base (A); signal in emitter, oscillator in base (B); signal and oscillator in base, emitter grounded (C); and signal and oscillator in base in series, emitter grounded (D)

$BW_{pk-pk} = 3.5$ Mc, $Q_{UU} = 70$
$f_o = 43$ Mc, Let $Q_1 = Q_2$
$KQ = 1.629$; same as interstage

$$Q_{LU} = \frac{f_o}{BW_{pk-pk}} \sqrt{(KQ)^2 - 1}$$

$$= \frac{43}{3.5} \sqrt{2.66 - 1} \cong 15.5$$



(a) Primary

$r_{oep} = 20{,}000$ ohms, $C_{oep} = 1.5$ pf } RX Meter Data at 43 Mc

$$C_{total} = \frac{Q_{UU}}{r_o \left[\frac{Q_{UU}}{Q_{LU}} - 1\right] \omega} = \frac{70}{20{,}000 \left[\frac{70}{15.5} - 1\right] 2\pi \times 43 \times 10^6}$$

$= 3.7$ pf and $L_p = 3.7$ μh

$C_p = C_{total} - (C_{oep} + C_{dist}) = 3.7 - (1.5 + 2) \cong 0$
Omit C_p

(b) Secondary

$r_{iep} = 200$ ohms $\quad Q_{input} = \omega C_{iep} r_{iep} = 0.55$
$C_{iep} = 10$ pf $\quad (Q_{input})^2 = 0.3$

$$r_{ies} = \frac{r_{iep}}{1 + Q^2} = \frac{200}{1.3} \cong 153 \text{ ohms}$$

$$C_{ies} = C_{iep} \frac{(1 + Q^2)}{Q^2} = 10 \frac{(1.3)}{.3} = 43 \text{ pf}$$

$$C_{total} = \frac{1}{\omega r_{ies} Q_{LU}} = \frac{1}{2\pi 43 \times 10^6 \times 153 \times 15.5} \cong 1.6 \text{ pf}, \quad L_s = 8.8 \text{ μh}$$

$C_{total} \ll C_{ies}$; therefore, $C_s = 1.6$ pf
$KQ = 1.629$, $Q = 15.5$, $\therefore K = 0.105$

$$C_M \cong \frac{\sqrt{(C_{pri\ total})\ (C_{sec\ total})}}{K} \cong \frac{\sqrt{3.7(1.5)}}{0.105} \cong 20 \text{ pf}$$

$$\text{Efficiency} = \left(1 - \frac{Q_{LU}}{Q_{UU}}\right)^2 = \left(1 - \frac{15.5}{70}\right)^2 = -2.2 \text{ db}$$

FIG. 7—I-f transformer design equations used

$= L_2 = 0.042$ μh, then $M \cong K\sqrt{L_1 L_2} = 0.35\ (0.042) \cong 0.00149$ μh. Adjust spacing between L_2 and L_3 for M and proper bandpass.

If we wish to have equal primary and secondary Q's, then r_{iep} of the mixer must be transformed to equal r_{oep} of the r-f amplifier. A tap on L_2 would accomplish this, but a pi section (or capacitance split) match is better since one less switch contact is required. Figure 5B shows such a network.

(b) Secondary, Fig. 5B

Let $C_{total} = 13$ pf (same as primary); $L_3 = 0.042$ μh (same as primary); $C_B = C_{total} = 13$ pf.

Assume common-emitter mixer and convert transistor input parameters from series equivalent to parallel equivalent.

$$r_{iep} = r_{ies}(1 + Q_T^2) = r_{ies}[1 + (1/\omega C_{ies} r_{ies})^2] = 40\ [1 + 0.25] \cong 50 \text{ ohm}$$

$$C_{iep} = C_{ies} Q_T^2/(1 + Q_T^2) = 35 \times 0.25/1.25 \cong 7 \text{ pf}$$

Where Q_T is the Q of the transistor at its input. Calculate

$$C_D = C_{total} \sqrt{r_{oep}/r_{iep}} = 15\sqrt{5{,}000/50} = 150 \text{ pf}$$

The effect of C_{iep} can be ignored since C_{iep} is considerably less than C_D. To reduce oscillator transmission back through the network, C_D may be changed to a network to put a transmission zero near the oscillator frequency.

If the r-f stage is connected common-base, the output impedance for the r-f transistor is negative at 215 Mc. This impedance is not easy to measure since it depends not only on the internal gain of the transistor, but also upon the feedback capacitance. In practice a design based on a positive output impedance may be used if the secondary loading is increased by decreasing C_D. This adjustment can best be accomplished by empirical methods.

In theory, a double-tuned circuit driven by a negative resistance generator could be designed to have a large gain-bandwidth product. However, if a large increase in gain is realized, the circuit becomes critical to adjust, and small load changes may bring on instability. When the increase in gain is about equal to the coil loss (6 db), the circuit ordinarily will be unconditionally stable with the controls

which are placed on transistor parameters.

Mixer

To perform the function of mixer efficiently, a transistor must have the following characteristics: good gain at the intermediate frequency; good emitter-base diode characteristics; and low emitter-base transition capacitance (C_{te}).

The diffused-base mesa transistor has all these characteristics. The gain at 43 mc is 25-30 db, and the diffused-base structure has an efficient emitter with good diode characteristics. Transition capacitance is also low making the transistor useful well into the uhf region.

When a transistor is to function as a mixer, the signal and oscillator voltages are introduced between the emitter and base. Whether the emitter or base is grounded is largely a matter of the designer's choice since, insofar as transistor mixing action is concerned, both connections are the same. Therefore, the oscillator and signal voltages may be both injected at the base or emitter or to either individually.

Maximum gain is obtained when the emitter-base diode is reverse biased by the oscillator voltage for a small fraction of a cycle. This corresponds to an injection level of 0.1 to 0.2 volts rms. Also, since the diode is reverse biased for only a short period, the input impedance of a mixer is close to that of an r-f amplifier.

D-c operating point for a mixer is a compromise between i-f gain and detection efficiency. The 2N1399 mesa transistor gives best gain with an emitter current of 1.0 to 1.5 ma. A few possible mixer configurations are shown in Fig. 6. Whichever configuration is used, it is always important to keep the i-f impedance low at the emitter and base terminals to reduce i-f degeneration. The necessity for neutralization is also removed. The tapped input coil and capacitive split accomplish this automatically, but where a small capacitor is used for impedance matching (Fig. 6C) an i-f trap (L_A C_A) must be used. In general, the Q of the trap should be less than that of the i-f transformer which follows it, so that the trap itself will not become a part of the bandpass circuit. The example in the final circuit (Fig. 9) is that of Fig. 6A with signal and oscillator both connected to the base.

Since the first i-f transformer is usually included in the tuner, one type will be shown here. It should be understood that the design is not intended to give a desirable total i-f response, since it comprises only two poles in the overall i-f system. The unloaded Q of the transformer is not critical as in the r-f stage, and a value of 70 is typical for an economical design. Figure 7 shows the computation for a transformer with combined parallel and series tuning. The parallel-series type is desirable since it uses low impedance coupling and is adaptable to situations where the tuner must be located remotely from the i-f amplifier.

Oscillator

The choice of oscillator circuit is considerably simplified by the fact that the common-base transistor connection is usually regenerative at high frequencies. With some added external feedback capacitance between emitter and collector, dependable oscillation is assured. The circuit shown in Fig. 8 is typical.

The most effective method of controlling the oscillator power in a circuit such as this is by varying the d-c emitter current. An oscillator with an emitter current of 1.5-2 ma can supply about twenty times the 100-300 microwatts required by the mixer. The emitter and base resistors shown give a stability factor of approximately 2 which is satisfactory for operation to 65 C. As in the common-base r-f amplifier, the emitter resistor is made large enough to prevent shunting of the signal path. The signal at the base of the oscillator should have a good low inductance path to ground such as provided by a feed-through type capacitor.

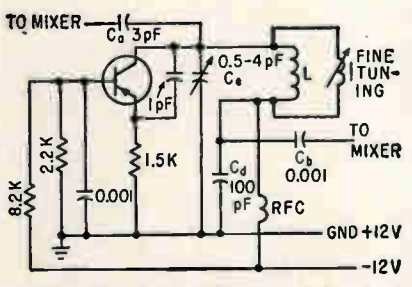


FIG. 8—Oscillator circuit shows typical component values

Mixer injection voltage may be taken from the oscillator in several ways. If the voltage is injected to the mixer at the same point as the signal, high-impedance feed from the oscillator collector via a small capacitor (C_a) is to be preferred. Where oscillator voltage injected into a separate element is desirable, the voltage may be taken from the bottom of L via C_b. Capacitor C_d determines the oscillator voltage and is also a low impedance path for the i-f voltage in the mixer.

Exact values for C_a and C_d must be selected by trial and error since residual circuit reactances play considerable part in determining the actual voltage at the mixer. The values shown in Fig. 8 are typical. Note that an r-f choke in series with the d-c supply is necessary where C_d is used to obtain the injection voltage. The trimmer capacitance C_e is used to compensate for the small variations in the total capacitance across L. In order that L may be a reasonable size C_e should be as small as possible. The circuit shown will have a total capacitance across L of about 6 pf, so that L = 0.063 μh at 257 mc.

Fine tuning may be obtained with either capacitance or inductance. Variable capacitance is, perhaps, easier to construct mechanically, but variable inductance gives a constant incremental frequency, Δf, for the tuning, which is desirable. For a 3 percent tuning range, Δf = 6.75 Mc. Then the required change in L would be $(1.03)^2 = 1.06$ or 6 percent.

A 2:1 change in inductance is obtained easily with a sliding core coil.

Let $L_{fT}/L_{tank} = N$; and P = percent tuning ratio = 1.06 = $[(f + \Delta f)/f]^2$ when L_{fT} = minimum inductance of fine tuning inductor. Then $N = (p - 2)/2\ (1 - p) = (1.06 - 2)/2\ (1 - 1.06) = 8$ and $L_{fT} = 8\ (0.063) = 0.504$ μh minimum and 1.008 μh maximum. The tank inductance must now be increased slightly to make up for the shunting effect of the fine tuning.

Conclusion

The complete tuner for channel 13 is shown in Fig. 9. In this article an attempt has been made to emphasize those aspects of design that are peculiar to transistor

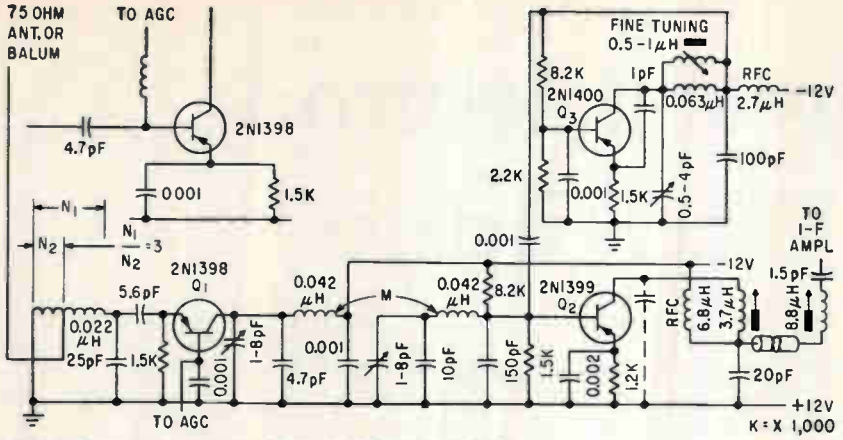


FIG. 9—Complete tv tuner shows coils for channel 13

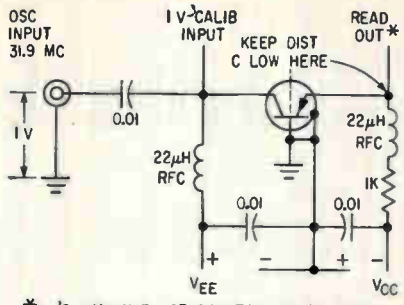


FIG. 10—Test set for $r_b'C_c$ uses calibrated input

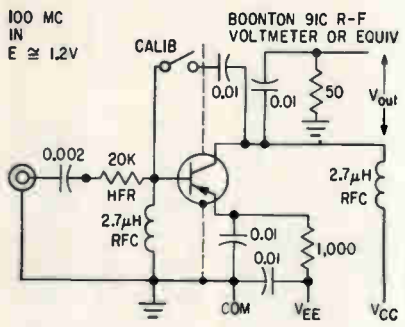


FIG. 11—Test set used to find h_{fe}

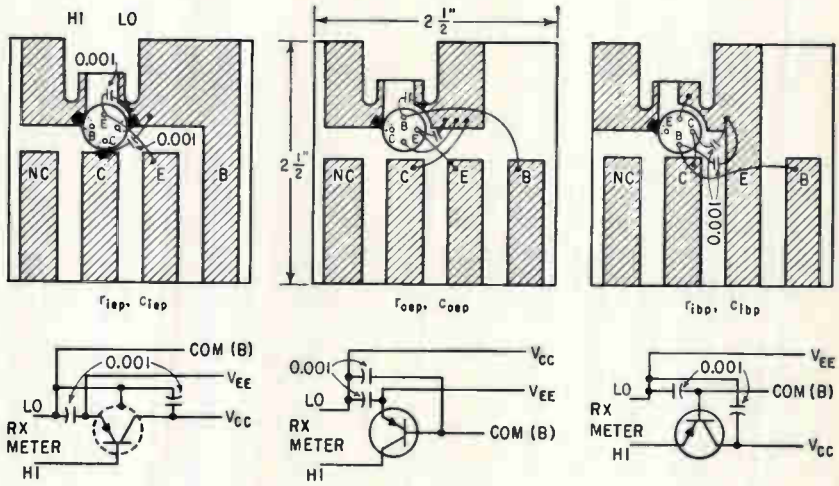


FIG. 12—Jigs and circuit used to measure short-circuit impedances below 100 Mc

utilization. Areas of transistor utilization which have been described previously have been intentionally by-passed. Traps, baluns, and other refinements do not differ from tube counterparts and have been omitted. The tuner described has a noise figure of 6-8 db on channel 13 and a gain of 22 db. A similar design for channel 2 will have a noise figure of 5 db and a gain of 35 db.

APPENDIX

(1). $r_b'C_c$ Product; $h_{rb} \cong j\omega r_b'C_c$
Test set shown in Fig. 10. Separate 31.9 Mc oscillator and r-f voltmeter required. Oscillator may be transistorized and self-contained.

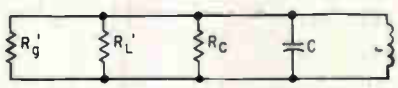
(2). h_{fe} at 100 Mc
Test set shown in Fig. 11. Separate 100 Mc oscillator and r-f voltmeter required. Oscillator may be transistorized and self-contained.

(3). r_b' referred to base input
(a) Measure $r_{ie} = R_e\ (h_{ie})$ with General Radio 1607A transfer bridge at 100 Mc, or
(b) Measure r_{iep} at 100 Mc with RX Meter and jig shown in Fig. 12. Convert to series equivalent
$r_b' = r_{ie} = r_{iep}/[1 + (\omega C_{iep} r_{iep})^2]$

(4). MAG (maximum available gain) $\cong h_f^2[r_{op}/4[r_{ip}/(1 + r_{ip}C_{ip})^2]]$

(5). (a) r_{oep}, C_{oep}, r_{iep}, C_{iep}, r_{ibp}, C_{ibp}
Use RX meter and jigs shown in Fig. 12.
GR-1607A bridge
(b) C_c, the capacitive component of the reverse transfer admittance, common emitter.
Measure C_{oep} at 100 Mc or greater. $C_c \approx C_{oep}$.

(6). Derivation of expression for generator and load impedances referred to the total tank circuit where $Q_{unloaded}$, Q_{loaded}, and capacity are given.



R_g' = Generator resistance referred to total tank circuit.
R_L' = Load resistance referred to total tank circuit.
R_c = Coil loss resistance referred to total tank circuit.
$Q_U = \omega C R_c$, $R_c = Q_U/\omega C = XQ_U$,
$Q_L = \omega C R_T$, $R_T = Q_L/\omega C = XQ_L$.
Where $R_T = R_{total} = 1/(1/R_c' + 1/R_g' + 1/R_L')$ and $X = 1/\omega C$.
Let the generator and load be matched ($R_g' = R_L'$). Then, $R_T = 1/(1/R_c + 2/R_g')$ and $R_g' = 2R_TR_c/(R_c - R_T) = 2(Q_LX)(Q_UX)/(Q_UX - Q_LX) = 2XQ_LQ_U/(Q_U - Q_L)$.

(7). Derivation of expression for total tuning capacity of a circuit where Q_U (Q unloaded), Q_L (Q loaded), and load resistance are known.

R_g = load resistance
R_c = coil loss resistance (Q_UX)
$Q_L = \omega C R_g R_c/(R_g + R_c)$,
$Q_U = \omega C R_c$
Then, $Q_L/Q_U = R_g/(R_g + R_c)$ and $R_c = r_o(Q_U Q_L - 1)$ also $R_c = Q_U/\omega C$
Therefore, $Q_U/\omega C = r_o(Q_U/Q_L - 1)$ and $C = Q_U/[\omega r_o(Q_U/Q_L - 1)]$

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Super-Power Electron Tube for UHF Band

Long-range radar for missile detection and intercontinental television are some of the applications foreseen for this uhf ceramic-metal tube which has a maximum usable frequency above 600 Mc

By GEORGE FLYNN, Associate Editor

WITH A PEAK RATING of five million watts, RCA's latest super-power tube will be used to explore some of the newest areas in communications. Intercontinental tv is one application where the tube is likely to be applied; scatter transmission for a world-wide communication system is another possible use. At the same time, some of the more conventional uses of r-f energy will be affected by the availability of greater power in a smaller package.

Only a little larger than an office typewriter, the A-2346 will deliver 300 Kw of continuous power at frequencies up to 450 Mc, and a peak of 5 megawatts in pulse operation. The power dissipation per unit active area of the tube is higher than and is perhaps exceeded only by some high-power transistors.

Maximum usable frequency of the device is above 600 Mc but full-scale tests have not been completed. Although plate efficiency of the tube at 600 Mc is nearly 60 percent, its power handling ability at this frequency is expected to be less than at 450 Mc.

The new tube was developed at RCA's Lancaster plant for the Air Force and the Rome Air Development Center, Griffis Air Force Base, Rome, New York. Specific military applications of the device are still classified but it is known that the tube will be used in high-power, long-range radar. Since the range of a radar set is proportional to the fourth root of the radiated power, the output stages of the largest radar sets have used the largest available tubes in parallel and push-pull parallel. There are, of course, many practical problems in paralleling tubes and the practice cannot be extended without limit. The problems are complicated at high frequencies because of inter-circuit capacitance, inductances and voltage ratings.

Some of the other uses for the tube will be in particle accelerators, r-f induction heating, and hard-tube pulse modulators.

Construction Principles

A design based on adding more and more similar elements in a parallel or repetitive manner is not in itself a bad or an inelegant solution of an engineering problem. Room and street lighting, for example, are familiar uses of the technique.

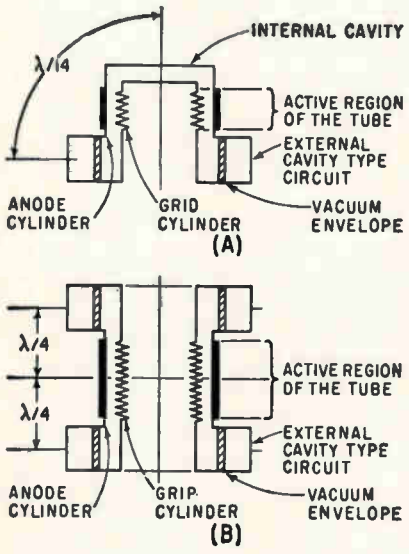


FIG. 1—Single-ended tube geometry (A), has the disadvantage that maximum voltage does not occur across the active region of the tube. Double-ended construction (B), allows both power density and size to be increased

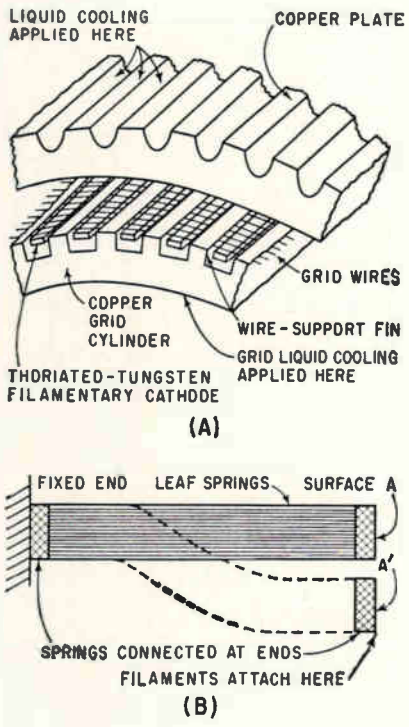


FIG. 2—Basic geometry integrates 96 triodes into one cylindrical structure (A). Pantographic element (B), supports filaments and prevents bowing and arching. Surfaces A and A' are essentially parallel Close-up of grid structure

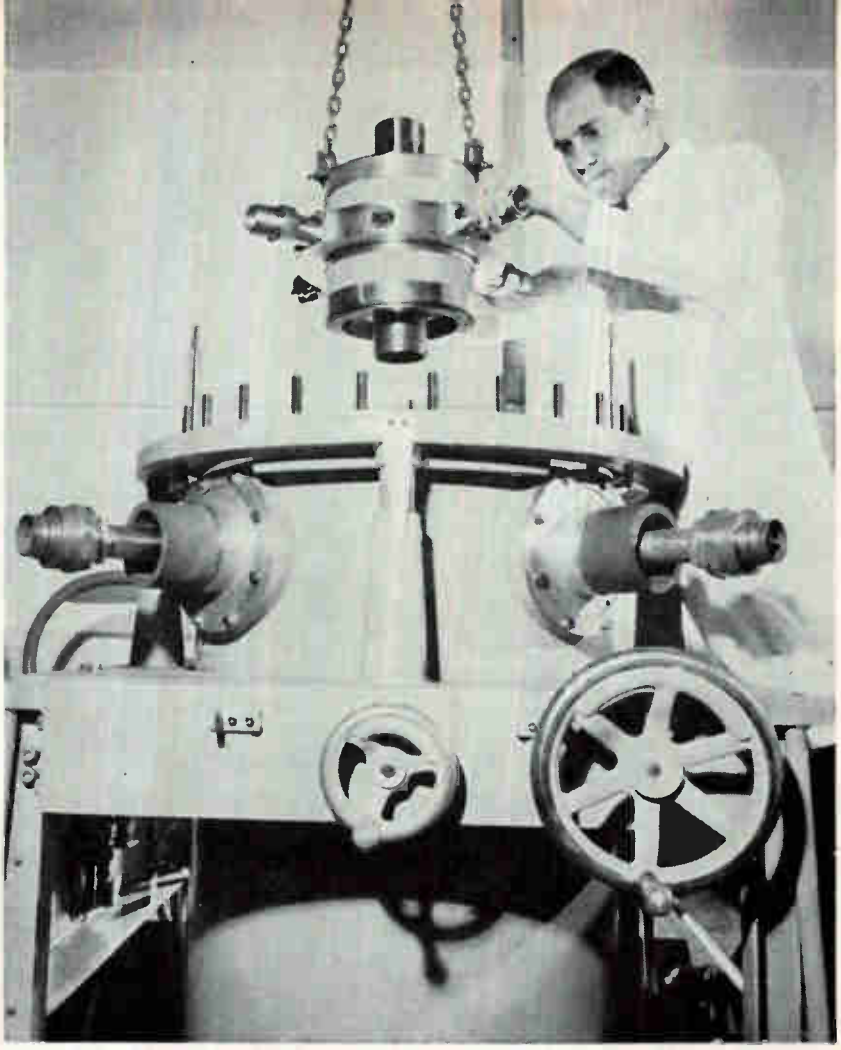
Construction of the A-2346 is based on the same idea of parallel elements, but in this case 96 basic triode elements are combined and integrated into the final tube.

Another important design concept was to consider the tube as a double-ended device. The advantage gained by this approach is that the diameter of the basic structure can be increased without regard to phase relations within the tube itself. In a single-ended structure, these internal phase relations limit the maximum basic diameter—because of the unavoidable internal cavity formed between grid and plate—and thus the power handling ability. These ideas are illustrated in Fig. 1. A limitation on the double-ended structure is the possible development of circumferential spurious modes, a limitation that may be lifted when the mechanism of suppression for this type of mode is better understood.

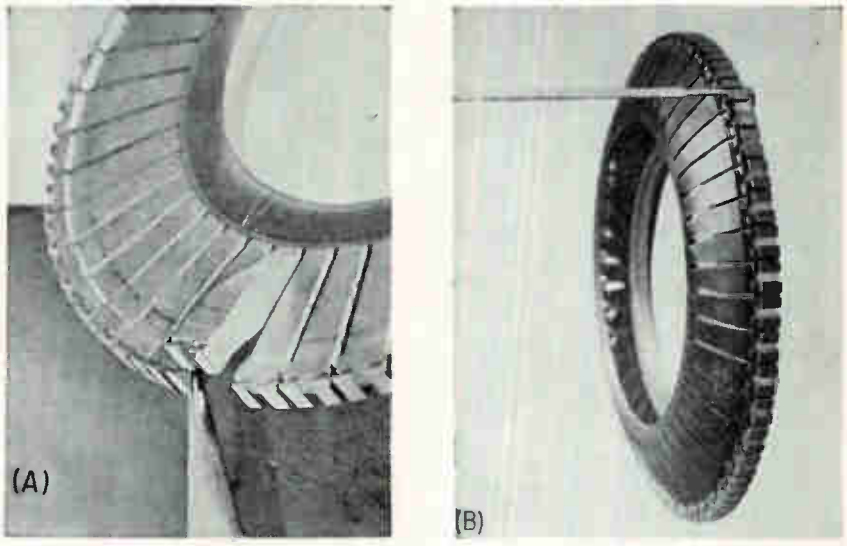
Mechanical details of the structure of the tube are shown in Fig. 2A, which illustrates how the 96 basic triodes are combined and integrated into the final tube. The first step is to combine all the anodes into one copper tube that surrounds the grid-cathode structure. The grids have also been integrated into one water-cooled structure, with the grid wire wrapped around a precisely machined copper support, at a pitch of 72 turns per inch. When the grid wire is in place, the grid support structure is subjected to a mechanical rolling operation which mashes the copper groove edges down over the grid spiral. Intimate contact between grid wire and support is thus obtained, and the grid stays at a low temperature.

Also shown in Fig. 2A are the directly-heated, thoriated-tungsten cathodes. Since filament heating current is 7,000 amperes at 4 volts, each of the 96 filament rods carries about 73 amps. As the filaments heat up they undergo a certain amount of expansion which cannot be eliminated. The expansion must be taken up, while at the same time the spacing between grid and cathode cannot be allowed to change significantly. A pantographic member is therefore used as the filament support. The structure, shown in Fig. 2B consists of a number of thin chrome-copper leaves in parallel but gold-bonded at both ends. As the spring effect takes up the expansion of the filament, the face of the pantographic structure remains parallel to its original position. Bowing or arching of the filament is prevented and the amount of lateral movement is so small as to be negligible, particularly after operating temperature is reached.

In final assembly, ceramic bushings are installed over the active elements. An interference fit between



The A-2346 tube is being lowered into a test chamber. Cavity type resonant circuits are built into the chamber which is part of the circuit of Fig. 3



Pantographic element greatly extended (A). Cathode-filament support ring with one of the 96 filamentary cathode strands in place (B)

the ceramic bushings and the special tool steel mounting hoops make a vacuum tight seal.

Large power tubes are usually water cooled and the A-2346 is no exception. Cooling electron tubes with water has been common for many years and no special problems developed when the technique was applied to the new tube.

Test Circuit

Once the tubes have been assembled and degassed, they are tested in the circuit of Fig. 3. The circuit uses cavity resonators in a grounded grid configuration. Because of the high voltages used in the test, the keying circuits are operated at the plate potential of the tube under test. Plate voltage of 35 Kv is applied in pulses 10- to 2,000-μsec wide through a development type switch tube. Peak plate current during the 5-megawatt output test is almost 300 amp.

All high power tubes are subject to occasional internal flashovers. A typical protection circuit is shown in Fig. 4. If an arc develops in the protected tube, the heavy cathode current will develop a high voltage across R_k. This voltage feeds back through C_1 and fires the thyratron, effectively grounding the power supply. At the same time, an overload relay is energized to trip the main a-c circuit breaker.[1, 2] In the test circuit of Fig. 3, an ignitron replaces the thyratron.

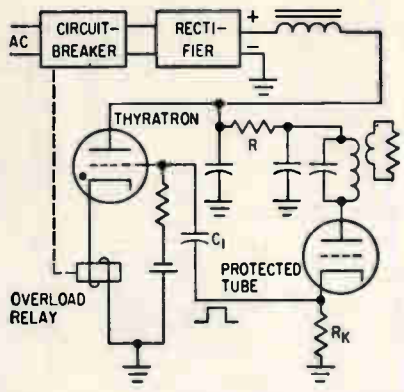


FIG. 4—Simplified circuit for protecting power tubes

If a fault develops, not only is the power supply grounded but any test pulse is immediately ended. Pulse information to the switching tube circuits is transmitted by radio link and thus some of the problems of insulating for approximately 40 Kv are eliminated. Of the test circuit itself, the largest element is the 300-μf capacitor of the 40-Kv power supply. An entire room is used to house the many individual units that are required to meet the requirements.

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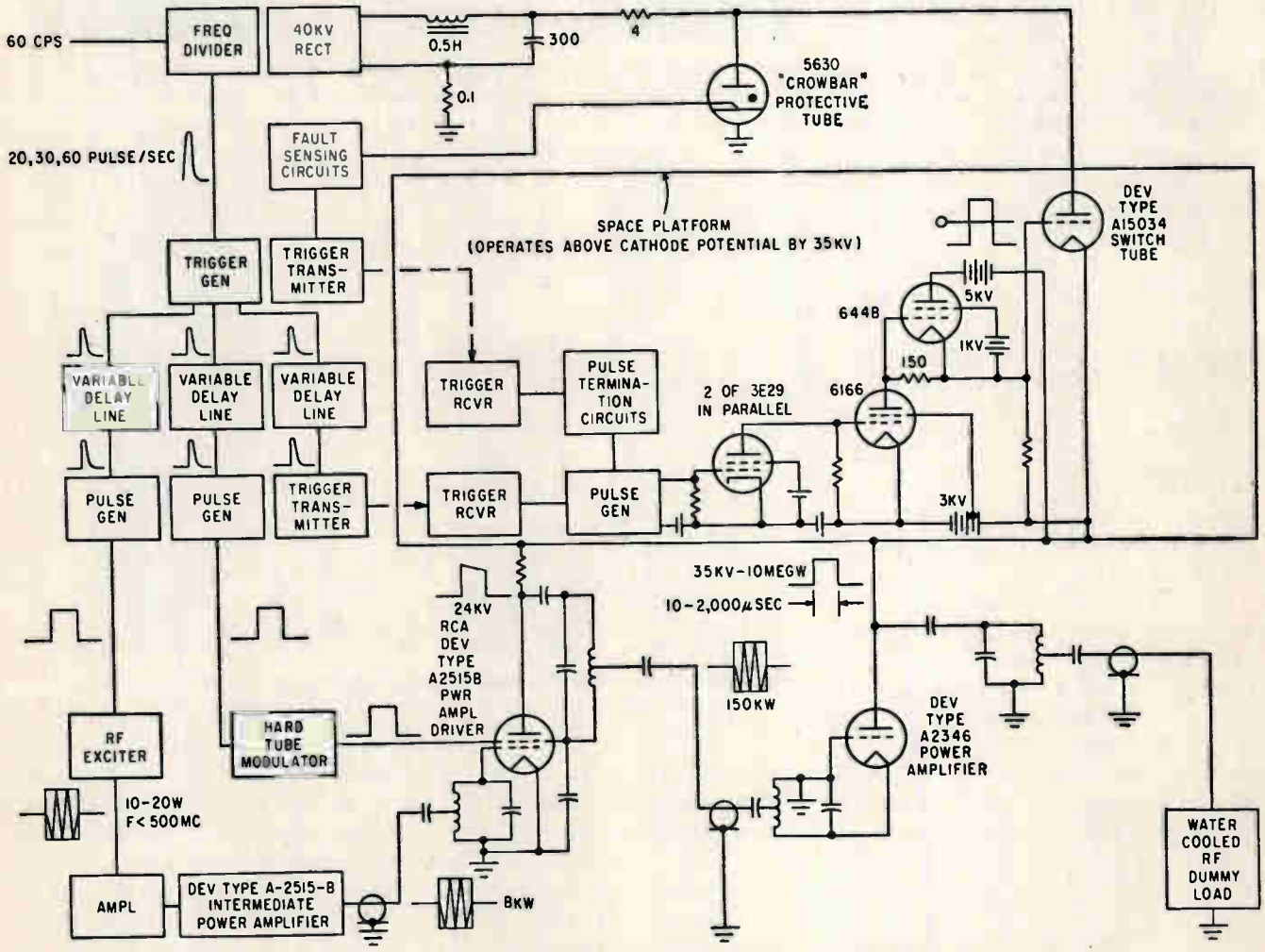

FIG. 3—Test circuit for development tube. Ignitron crowbar circuit will ground the power supply in less tron 5 μsec

Insuring Stability in Time Delay Multivibrators

Silicon and Zener diodes improve performance of conventional germanium-transistor circuit. Timing network is isolated during timing interval

By **PAUL E. HARRIS,** Defense Systems Laboratory, Syracuse University Research Corporation, Syracuse, N. Y.

A PRECISION TIME DELAY is often required in radar and industrial electronics. Obvious applications of this multivibrator are the range gate delay in a doppler radar boxcar circuit and the time delay for an expanded range indicator sweep. An additional family of applications is the generation of gate waveforms.

A conventional transistor monostable circuit has been modified so that its performance is independent of transistor selection and its delay-stability does not vary appreciably with transistor temperature, trigger amplitude and power supply variations.

Tests show that the jitter of the output is less than four nanoseconds over a delay range of 3 to 35 microseconds. With input-trigger variations from 10 to 100 volts, variation in delay is 1.5 percent and a power supply change from 24 to 15 volts causes a delay change of 2 percent. A negative-going output pulse of nine-volt amplitude is obtained, and its steep edges (0.1 microseconds) are retained even when loaded with a 50-pf output capacitance.

Circuit Description

The multivibrator circuit is shown in Fig. 1. Reliability is achieved by introducing several modifications of the conventional monostable multivibrator[1]. Most significant of these modifications is the isolation of the timing network $R_4R_5C_1$ during the timing interval.

In the conventional multivibrator, the junction of C_1 and R_5 is directly connected to the base of Q_2. This connection leads to two difficulties. First, care must be taken not to exceed the base-to-emitter reverse voltage of Q_2. Second, and more disastrous, is the effect of i_{co}, the leakage current between collector and base of Q_2.

This leakage current flows into C_1 in parallel with the desired charging current furnished through R_4 and R_5. Since leakage current varies widely with temperature, relatively large variations in delay can be expected.

Diode D_3 is an extremely high back resistance silicon type. It serves as a voltage discriminator terminating the delay interval whenever C_1 has been charged back to ground potential. During the timing interval, D_3 is reverse biased and effectively isolates the timing circuit from the base of Q_2 and from all other components.

Circuit Operation

In the quiescent state Q_1 is cut off while Q_2 is conducting. The 9-volt Zener diode D_2 is open, allowing the base of Q_1 to remain at or near ground potential. The cathode of diode D_3 is at approximately −1 volt. A current flows through the forward biased diode D_3 to the base of Q_2 and to R_6 causing collector of Q_2 to remain bottomed.

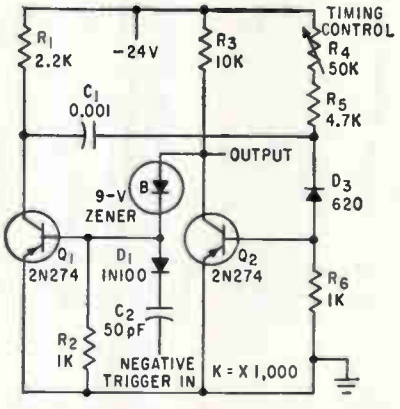

FIG. 1—Zener diode disconnects Q_2 collector from Q_1 base for rapid Q_2 cut-on. High back-resistance diode D_3 prevents collector-base leakage current from altering timing

Application of a satisfactory trigger causes conduction in Q_1. Voltage at the Q_1 collector falls toward ground potential. This voltage step is passed across capacitor C_1 to the cathode of D_3. The effect of this step is to reverse bias diode D_3 and reduce base and collector currents of Q_2 to near zero.

The collector of Q_2 rapidly approaches −24 volts. However, as soon as the collector voltage exceeds the 9-volt breakdown of Zener diode D_2, conduction occurs producing sufficient base current to bottom the collector of Q_1. The trigger is no longer needed to sustain circuit action.

The next phase of circuit operation is the sawtooth voltage runup at the cathode of D_3. That point was driven to a potential of approximately +24 volts by the collector of Q_1. Diode D_3 remains nonconducting and its cathode voltage moves back toward ground potential as C_1 is charged exponentially toward −24 volts by the current through R_4 and R_5.

The delay is terminated when C_1 has charged to a potential sufficient to first-produce forward conduction in D_3. Once conduction begins in D_3, turnoff is regenerative and quiescent conditions are rapidly reestablished.

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(1) J. Millman and H. Taub, "Pulse and Digital Circuits", McGraw-Hill Book Co., New York, p 599.
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Frequency-Independent Current Dividers

By CLINTON L. CONNER, University of Colorado, Denver, Colorado

PARALLEL CIRCUITS, such as that shown in Fig. 1A, act as current dividers. Since the reactive impedances vary with frequency, the current division is not constant as the frequency is changed. But if the proper resonance conditions are met, the circuit can be made independent of frequency. Calculating the ratio of the current in one leg to the total input current:

$$E_1 = i_1 Z_1 = i Z_1 Z_2/(Z_1 + Z_2)$$

$$\frac{i_1}{i} = \frac{Z_2}{Z_1 + Z_2}$$

$$= \frac{r_2 + j(\omega L_2 - 1/\omega C_2)}{r_1 + j(\omega L_1 - 1/\omega C_1) + r_2 + j(\omega L_2 - 1/\omega C_2)} \quad (1)$$

The condition for resonance requires that $\omega L_1 - 1/\omega C_1 = 0$ and that $\omega(L_1 + L_2) - 1/\omega(1/C_1 + 1/C_2) = 0$. If the conditions for resonance are imposed on the circuit in Fig. 1A, then Eq. 1 reduces to a resistance ratio so that

$$\frac{i_1}{i} = \frac{r_2}{r_1 + r_2} = \frac{1/r_1}{(1/r_1) + (1/r_2)} \quad (2)$$

But, is the resonant condition the only method by which we can cause the circuit to act as simple resistance current divider? Let the condition of being independent of frequency be the only initial restriction placed upon the circuit. Assume that $Z_1 = r_1 + j\alpha$ and that $Z_2 = r_2 + j\beta$; then the current ratio becomes

$$\frac{i_1}{i} = \frac{r_2 + j\beta}{r_1 + r_2 + j(\alpha + \beta)} = \frac{r_2 + j\beta}{\left(\frac{r_1 + r_2}{r_2}\right) r_2 + j\left(\frac{\alpha + \beta}{\beta}\right)\beta} \quad (3)$$

If $(r_1 + r_2)/r_2 = (\alpha + \beta)/\beta = N$, then the current ratio will reduce to $i_1/i = 1/N = r_2/(r_1 + r_2)$. The ratio $r_2/(r_1 + r_2)$ is not dependent upon frequency. The other ratio $\beta/(\alpha + \beta)$ is in general dependent upon frequency. If the ratio is rewritten in terms of inductances and capacitances, then

$$\frac{\beta}{\alpha + \beta} = \frac{\omega L_2 - \frac{1}{\omega C_2}}{\omega L_1 - \frac{1}{\omega C_1} + \omega L_2 - \frac{1}{\omega C_2}} = \frac{\omega L_2 - \frac{1}{\omega C_2}}{\omega L_2\left(\frac{L_1 + L_2}{L_2}\right) - \frac{1}{\omega C_2}\left(\frac{1/C_1 + 1/C_2}{1/C_2}\right)} \quad (4)$$

If the condition

$(L_1 + L_2)/L_2 = [(1/C_1 + (1/C_2)]/(1/C_2)$

is imposed upon Eq. 4, then $\beta/(\alpha + \beta) = L_2/(L_1 + L_2) = (1/C_2)/[(1/C_1) + (1/C_2)]$.

The results of the investigation show that the current divider of Figure 1A will respond like a resistance current divider and be independent of frequency if the following conditions are true

$$\frac{1/r_1}{(1/r_1) + (1/r_2)} = \frac{1/L_1}{(1/L_1) + (1/L_2)} = \frac{C_1}{C_1 + C_2} \quad (5)$$

If α and β consist only of inductive reactances, $\beta/(\alpha + \beta)$

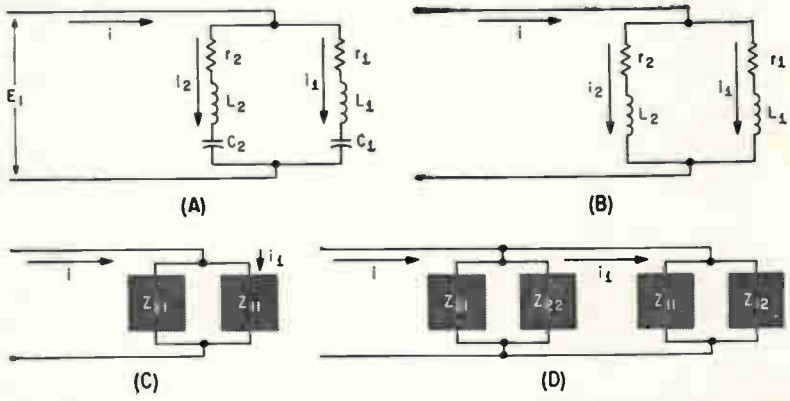

FIG 1—Ratio of current in a branch to total current, i_1/i, can be made independent of frequency. The method can be extended to any number of parallel circuits

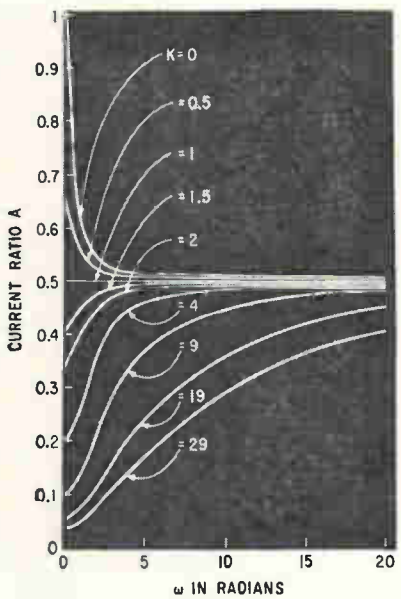

FIG. 2—For the inductance-resistance divider of Fig. 1B, for the condition $r_1 = Kr_2$, the circuit is frequency independent only for $K = 1$

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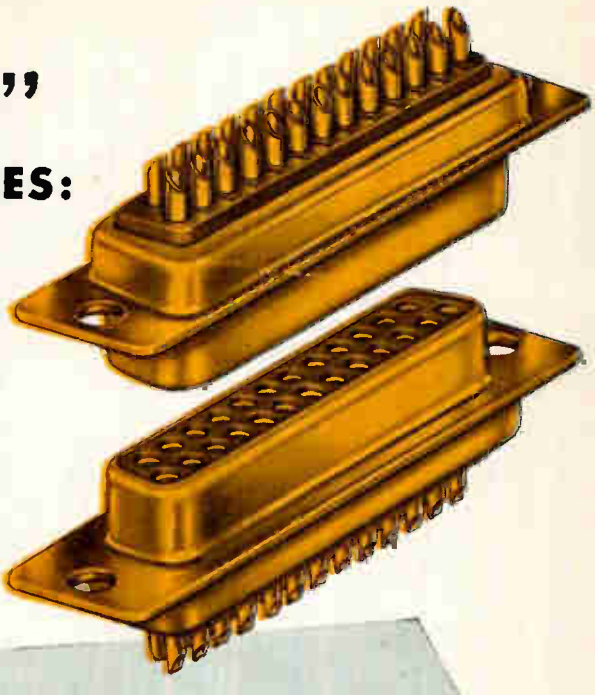

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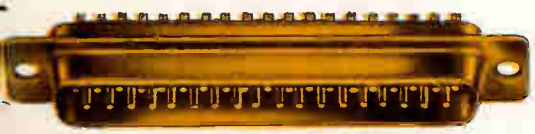
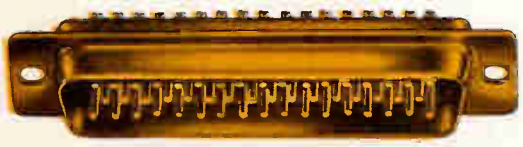
9 CONTACTS

15 CONTACTS

25 CONTACTS



37 CONTACTS



50 CONTACTS

The GOLDEN-D is in addition to the "D" line. It supplements the standard "D" which will continue in full production.

CONTACTS: Miniature socket contacts are closed-entry providing protection against damage by oversized test probes. Pins and sockets are gold plated for high reliability. Wire sizes No. 20 and smaller may be accommodated.

Coaxial contacts, except grounded coax, are designed to permit them to be snapped-in to the insulator after they have been secured to the cables. Contacts are also removable. Both straight and 90° coaxials are supplied. All feature captivated center contacts. Coaxial cables within the range of .067" O.D. to .093" O.D. can be accommodated.

SHELLS: Tooled in all shell sizes common to the "D" line. Nomenclature, used to identify GOLDEN-D sizes, is identical to that for standard D's except that the letter M is added. Thus, standard D's are identified as DA, DB, DC, DD, and DE. GOLDEN-D's are the DAM, DBM, DCM, DDM, and DEM. "M" designates "monobloc." Floating mounting holes are available in all GOLDEN-D shells. These are designated by adding the letter "F" to the shell callout. For example, DAMF.

*Available at a later date.

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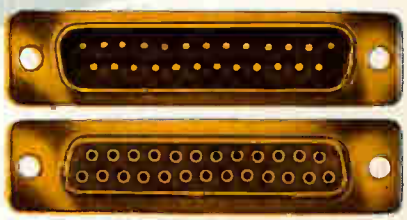

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LAYOUTS

Tooling is complete to provide the GOLDEN-D standard layouts listed below. These layouts are interchangeable with similar patterns used in standard "D's". Thus any GOLDEN-D will mate with any standard "D" of the same shell size and layout.

STANDARD LAYOUTS	COAXIAL LAYOUTS			
	layout	#20 contacts	ungrounded coax. contacts	coble accom.
DAM-15P or S	DAM-3C3P or S	0	3 Rt. Angle	.067"
DBM-25P or S	DAM-A7C2P or S	5	2 Straight	.067"
DCM-37P or S	DAM-A11C1P or S	10	1 Straight	.067"
DDM-50P or S	DBM-A17C2P or S	15	2 Straight	.067"
DEM-9P or S	DBM-21C1P or S	20	1 Straight	.067"
	DBM-13C3P or S	10	3 Straight	.067"
	DCM-27C2P or S	25	2 Straight	.067"
	DEM-5C1P or S	4	1 Straight	.067"

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$= L_2/(L_1 + L_2)$. The condition for the inductance-resistance current divider to be independent of frequency is that

$$\frac{r_2}{r_1 + r_2} = \frac{L_2}{L_1 + L_2} \text{ or}$$

$$\frac{1/r_1}{(1/r_1) + (1/r_2)} = \frac{1/L_1}{(1/L_1) + (1/L_2)} \quad (6)$$

Examining the inductance-resistance current divider as shown in Fig. 1B to determine the meaning of Eq. 6, assume

$$L_1 = L_2 = r_2$$
$$r_1 = Kr_2$$

There is no loss of generality from these assumptions and they are made only to facilitate computation. The current ratio becomes

$$\frac{i_1}{i} = \frac{r_2 + j\omega L_2}{r_1 + r_2 + j\omega(L_1 + L_2)} = \frac{1 + j\omega}{(1 + K) + j2\omega}$$

$$A = \left|\frac{i_1}{i}\right| = \sqrt{\frac{1 + \omega^2}{(1 + K)^2 + 4\omega^2}} \quad (7)$$

A plot of Eq. 7 is given in Fig. 2, where A is the ordinate and ω the absicissa. The plot has been made for several values of K. From Fig. 2 note that only one value, $K = 1$, gives a curve which is constant with frequency. If $K = 1$, then $r_1 = r_2$ and

$$\frac{L_2}{L_1 + L_2} = \frac{r_2}{r_1 + r_2} = \frac{1}{1 + 1} = \frac{1}{2}$$

Having found a method to make the simple parallel-circuit current divider independent of frequency, it can be shown that the same idea can be applied to the compound parallel circuit of Fig. 1D.

$$i_1\left(\frac{Z_{11}Z_{12}}{Z_{11}+Z_{12}}\right) = (i)\frac{\left(\frac{Z_{11}Z_{12}}{Z_{11}+Z_{12}}\right)\left(\frac{Z_{21}Z_{22}}{Z_{21}+Z_{22}}\right)}{\frac{Z_{11}Z_{12}}{Z_{11}+Z_{12}} + \frac{Z_{21}Z_{22}}{Z_{21}+Z_{22}}}$$

From which

$$\frac{i_1}{i} = \frac{Z_{11}+Z_{12}}{Z_{11}\frac{(Z_{12}+Z_{22})}{Z_{22}} + Z_{12}\frac{(Z_{11}+Z_{21})}{Z_{21}}} \quad (8)$$

If we let $(z_{12} + z_{22})/z_{22} = (z_{11} + z_{21})/z_{21}$, Eq. 8 becomes

$$\frac{i_1}{i} = \frac{Z_{22}}{Z_{12} + Z_{22}} = \frac{Z_{21}}{Z_{11} + Z_{21}} \quad (9)$$

Equation 9 is the relationship required for two impedances placed in parallel to form a current divider. From Eq. 5 the relations necessary for a parallel-impedance current divider which is independent of frequency are known. As a result, the relations for the compound parallel-circuit current divider can be written. The relations are

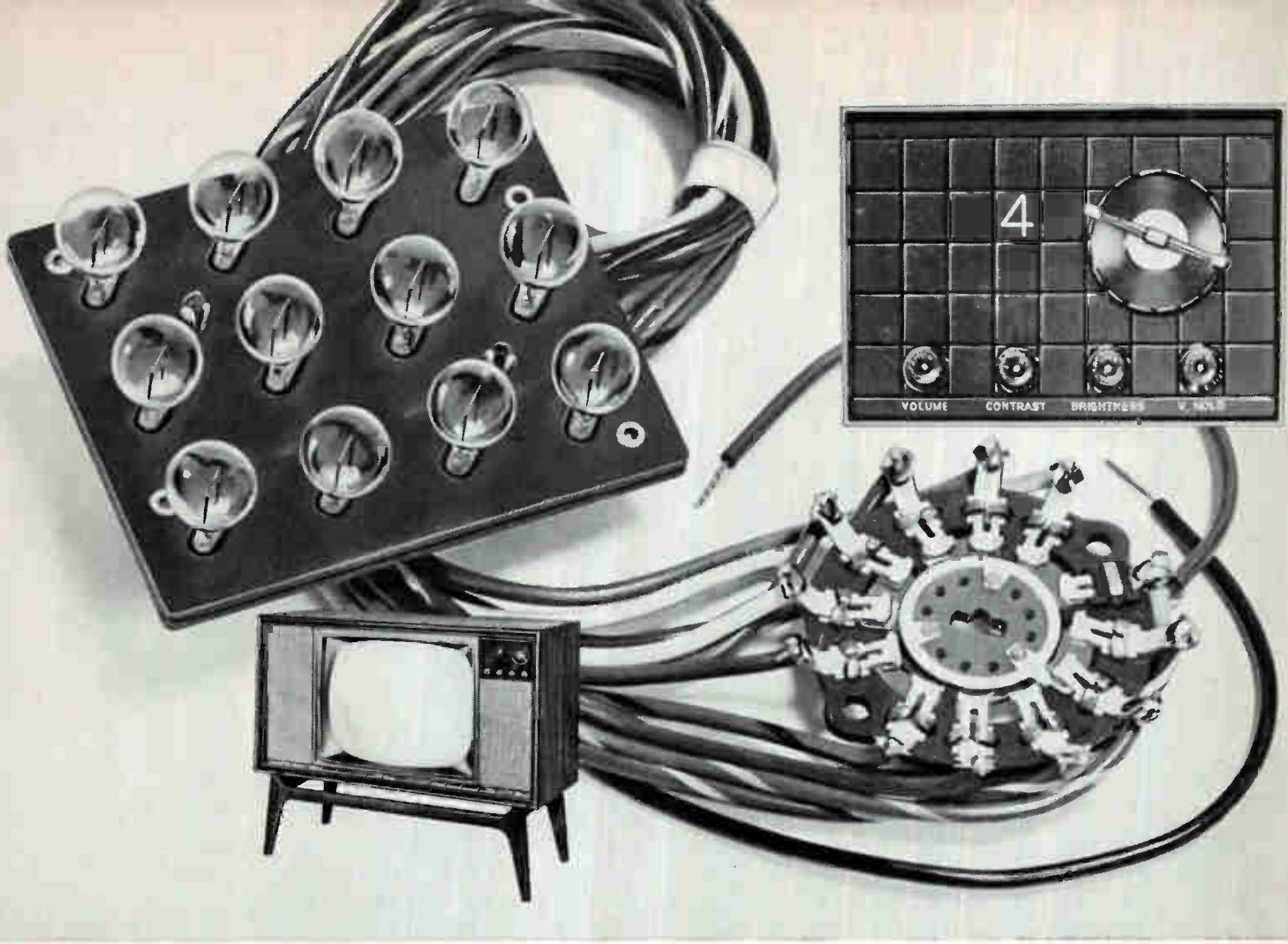
$$\frac{\frac{1}{r_{11}}}{\frac{1}{r_{11}}+\frac{1}{r_{21}}} = \frac{\frac{1}{r_{12}}}{\frac{1}{r_{12}}+\frac{1}{r_{22}}} = \frac{\frac{1}{L_{11}}}{\frac{1}{L_{11}}+\frac{1}{L_{22}}} = \frac{\frac{1}{L_{12}}}{\frac{1}{L_{12}}+\frac{1}{L_{22}}} = \frac{C_{11}}{C_{11}+C_{21}} = \frac{C_{21}}{C_{21}+C_{22}} \quad (10)$$

Having shown that Eq. 10 is valid for a two-branch parallel circuit as shown in Fig. 1C, the same concept can be extended to three double branches in parallel. Then by mathematical induction the case for n double branches in parallel can be proved.

The results which have been obtained are summarized in the table, where some examples are given.

Table I—Parameter Ratios for Frequency-Independent, Four-Branch Current Divider. Use with Fig. ID

Z_{11}	Z_{21}	Z_{12}	Z_{22}	For a current ratio $i_1/i = A$, set A equal to:
r_{11}	r_{21}	$j\omega L_{12}$	$j\omega L_{22}$	$\frac{1/r_{11}}{(1/r_{11})+(1/r_{21})} = \frac{1/L_{12}}{(1/L_{12})+(1/L_{22})}$
$r_{11}+j\omega L_{11}$	$r_{21}+j\omega L_{21}$	$r_{12}+j\omega L_{12}$	$r_{22}+j\omega L_{22}$	$\frac{1/r_{11}}{(1/r_{11})+(1/r_{21})} = \frac{1/r_{12}}{(1/r_{12})+(1/r_{22})} = \frac{1/L_{11}}{(1/L_{11})+(1/L_{21})} = \frac{1/L_{12}}{(1/L_{12})+(1/L_{22})}$
$r_{11}-\frac{j}{\omega C_{11}}$	$r_{21}-\frac{j}{\omega C_{21}}$	$r_{12}-\frac{j}{\omega C_{12}}$	$r_{22}-\frac{j}{\omega C_{22}}$	$\frac{1/r_{11}}{(1/r_{11})+(1/r_{21})} = \frac{1/r_{12}}{(1/r_{12})+(1/r_{22})} = \frac{C_{11}}{C_{11}+C_{21}} = \frac{C_{12}}{C_{12}+C_{22}}$
$j\left(\omega L_{11}-\frac{1}{\omega C_{11}}\right)$	$j\left(\omega L_{21}-\frac{1}{\omega C_{21}}\right)$	$j\left(\omega L_{12}-\frac{1}{\omega C_{12}}\right)$	$j\left(\omega L_{22}-\frac{1}{\omega C_{22}}\right)$	$\frac{1/L_{11}}{(1/L_{11})+(1/L_{21})} = \frac{1/L_{12}}{(1/L_{12})+(1/L_{22})} = \frac{C_{11}}{C_{11}+C_{21}} = \frac{C_{12}}{C_{12}+C_{22}}$
$r_{11}+j\left(\omega L_{11}-\frac{1}{\omega C_{11}}\right)$	$r_{21}+j\left(\omega L_{21}-\frac{1}{\omega C_{21}}\right)$	$r_{12}+j\left(\omega L_{12}-\frac{1}{\omega C_{12}}\right)$	$r_{22}+j\left(\omega L_{22}-\frac{1}{\omega C_{22}}\right)$	$\frac{1/r_{11}}{(1/r_{11})+(1/r_{21})} = \frac{1/r_{12}}{(1/r_{12})+(1/r_{22})} = \frac{1/L_{11}}{(1/L_{11})+(1/L_{21})} = \frac{1/L_{12}}{(1/L_{12})+(1/L_{22})} = \frac{C_{11}}{C_{11}+C_{21}} = \frac{C_{12}}{C_{12}+C_{22}}$



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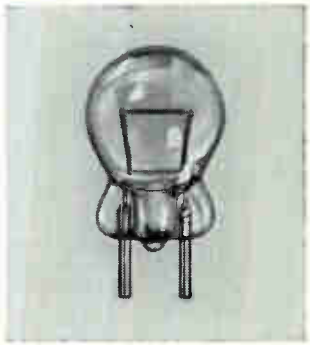

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LONG-RANGE vlf navigation systems may be required to provide increased accuracy. Designers of such systems may be required to consider propagation anomalies at these frequencies. Corrections may be required for variations in factors presently assumed to be constant.

Atmospheric noise generated by lightning and the earth's magnetic field affect vlf navigation systems. To improve these systems, more data is required on the statistical distribution of amplitude, frequency and direction of arrival of sferics.

About 200 individual lightning strokes occur each second somewhere on earth. Each stroke emits an energy pulse with frequencies to above 150 Kc and a maximum between 5 and 10 Kc. This energy is easily detectable at ranges over 3,000 Km. Since lightning is limited to middle latitudes and tends to follow the sun, atmospheric noise has amplitude and directional distributions that are functions of receiver location, time of day and season.

Arctic Stations

Stanford Research Institute operated three stations in the Arctic for the Air Force from Sept. 1958 to Mar. 1959 to collect statistical data about atmospheric noise. They were at Fairbanks, Alaska; Thule, Greenland; and St. Johns, Newfoundland. About 27 miles of 35-mm film recorded sferic data throughout the northern hemisphere.

One conclusion is that characteristics of atmospheric noise are functions of receiver location and lightning location. Thus receivers located farther north were farther from lightning activity and there was less atmospheric noise.

Atmospheric noise data currently in use below about 50 Kc are based on few measurements and a straight-line extrapolation of data at 50 Kc. Actually, at lower frequencies, atmospheric noise level increases.

Reception of sferics was also used to demonstrate two somewhat related anomalies of vlf propagation. The great circle route through Fairbanks and Thule is in Arctic regions, crosses the auroral zone and is near the north magnetic pole. Also, storm centers in Europe and the western Pacific are on this great circle path, providing signals propagated in opposite directions between the two receiving stations.

Spectrum analyses between 3 and 30 Kc were made of sferics propagated in each direction. By comparing amplitudes at each frequency, average propagation attenuation for both directions was obtained. The path is nonreciprocal with the Thule-Fairbanks path apparently containing the anomalies. Similar propagation measurements for a Stanford-Hawaii path agree reasonably well with the Thule-Fairbanks data and with theory. Thus, drastic vlf propagation attenuation anomalies do exist. From the limited data analyzed, propagation seems to be related to the earth's magnetic field.

Operation of the Arctic net indicated another related anomaly. Sferic source locations indicate that vlf propagation over long distances is highly contaminated by all forms of polarization components. Direction-of-arrival data taken at Fairbanks, on NPM, Honolulu, and NLK, Jim Creek, Washington, indicate that this contamination is related to the earth's magnetic field.

Navigation Aids

Doppler radar navigators are being installed in commercial aircraft operating over long-distance routes. These systems are independent of ground radio equipment and nearly independent of propagation medium and noise interference. However, Doppler and other self-contained aids are subject to errors that accumulate with time. Also, in case of failure, the navigator must rely on other aids or on dead reckoning.

Despite recent advances in self-contained aids, there is continuing need for a ground-referenced system sufficiently accurate for calibration and monitoring of other equipment used for long-range navigation. This need may some time be met by navigation satellites operating at vhf. However, at the present time, serious consideration may be given to vlf for long-range navigation.

Designers of vlf navigation systems may be required to consider propagation anomalies. It may be necessary to abondon such assumptions as that velocity of propagation is known and that the propagation path is a great circle.

Contact Monitoring For Vibration Tests

By F. W. KEAR, Lytle Corp., Albuquerque, New Mexico

DEVICES using electrical contacts must withstand specified shock and vibration. Test circuits are required to determine whether the contacts have maintained their normally open or closed condition. Contact failures must be detected quickly (depending on vibration frequency), and a permanent record of test results must be provided.

Test Circuit

The transistorized contact monitor in Fig. 1 was developed for use in such environmental tests. The circuit comprising Q_1 and Q_2 monitors normally open contacts for closure.

If contacts close, voltage on the collector of Q_1 drops to ground level for a time proportional to vibration frequency. During this time, base

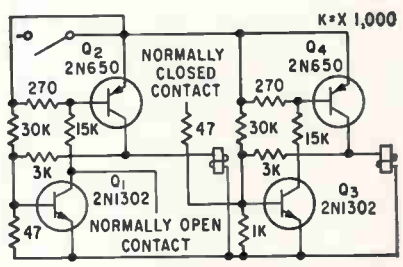

FIG. 1—Duol circuit monitors both normolly open ond normolly closed contocts during vibrotion tests

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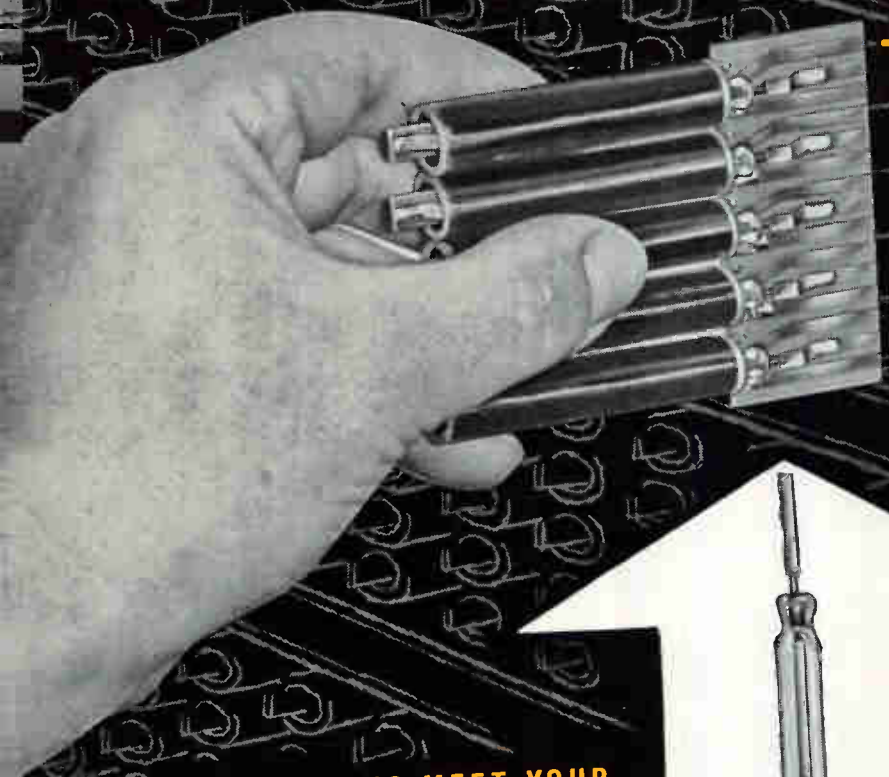
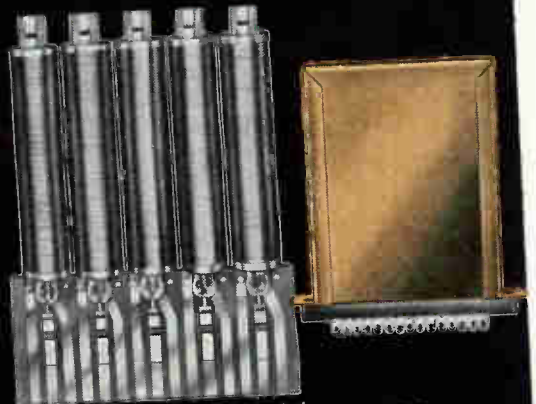
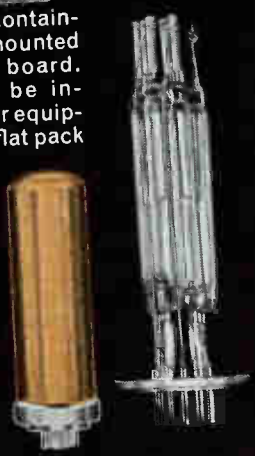


PACKAGED TO MEET YOUR REQUIREMENTS



Here five relays, each containing two switches, are mounted on a printed circuit board. This assembly may be inserted directly into your equipment or enclosed in a flat pack container.



These six switches are clustered to form the core of a single electromagnetic coil, and encased in a cylindrical steel container.

ACTUAL SIZE

Basic element of CLAREED relays is this switch capsule. A pair of magnetically operated contacts is hermetically sealed in an atmosphere of inert gas. The capsule combines extreme simplicity with high reliability and long life. It has excellent low-level characteristics.

CLAREED Sealed Contact Reed relays put you . . . the designer . . . in the driver's seat. They are simple in design, flexible in assembly. They are packaged and mounted to comply with *your* mechanical design configuration . . . even on your own circuit board. CLAREED relays are ideal components for transistor-drive applications, computers, data-processing and other high speed equipment.

Contacts are hermetically sealed in inert gas. Tens of millions of operations are assured since contact contamination is completely precluded. Hundreds of millions of operations are possible when operated up to ½ rated load.

If you use relays, it will pay you to know all about CLAREED . . . an entirely new concept in relay design. Address C. P. Clare & Co., 3101 Pratt Blvd., Chicago 45, Illinois. In Canada: C. P. Clare Canada Limited, Box 134, Downsview, Ontario. Cable Address: CLARELAY. *Send for Bulletin CPC-5.*

CLARE

When only the best is good enough

voltage on Q_2 is dropped sufficiently to saturate it. Voltage on the collector of Q_2 rises toward supply potential.

The monitoring device (lamp or relay) in the collector circuit of Q_2 is energized to operate recording equipment. The collector of Q_2 is returned to the base of Q_1, which acts as a clamp to maintain the indication so that tests need not be continually monitored.

The circuit comprising Q_3 and Q_4 indicates opening of normally closed contacts. Bias on Q_3 is maintained through a resistor and the contacts under test. An open circuit removes the bias and the transistor saturates. The voltage drop in the base-bias network of Q_3 causes it to saturate also. The voltage rise on the collector of Q_4 energizes the indicating or recording device.

The two basic circuits can be built in module form and programed into the vibration test equipment for any number or arrangement of contacts under test. Indicator lamps are mounted on the test console rather than in the modules to simplify fabrication. These lamps may be operated from the monitor circuit relay with their own clamping transistors if the number of contact failures must be monitored repetitively.

Hall Probe Speeds Cyclotron Design

MAGNETIC field plotting system offers high speed and accuracy. The system makes possible detailed evaluation of performance of a cyclotron before it is built. It has been developed by Oak Ridge National Laboratory, which is operated for AEC by Union Carbide.

The plotting system is measuring strength of magnetic fields of complex configuration in less time and with greater accuracy than previously possible. An electromechanical system programs and positions a sensitive element that provides a voltage output directly proportional to magnetic field strength. Small size of the sensitive element, the Hall probe, contributes to measurement accuracy. Accuracy of the probe, a semiconducting wafer

square inch, is further enhanced by a newly developed compensating network that minimizes effects of temperature variations.

The system is being used to design the magnet for the Oak Ridge Isochronous Cyclotron. A quarter-scale model magnet using up to 400 kw of power is being tested. Detailed, precise measurements are required because of field complexity.

Cyclotrons to accelerate one type particle to a relatively low energy have used a uniform field tapering off slightly toward the edge for focusing. For higher energies average magnetic field must increase toward the edge of the magnet to compensate the relativistic increase in ion mass. The new cyclotron is also expected to accelerate a wide variety of ions. To provide strong focusing forces, a three-fold magnetic lens system is built into the magnet.

Field Measuring

An earlier way of evaluating and correcting a magnetic field was to choose the best known magnet design. In actual cyclotron operation, ion paths were traced outward from the center. Where ions became lost, the magnet was modified by grinding or patching until acceptable performance was obtained. The process was slow even for a uniform field. More recent methods of field measurement and orbit computing simplified the problem, but the many measurements required for fields necessitated greater speed.

Knowing a magnetic field pattern accurately, any type ion path can be calculated. Although relatively easy for a uniform field, this method for a complex field is possible only with accurate measurements and availability of fast computers. With the accurate field measuring equipment and with computer routines, a given magnetic field configuration can be evaluated in about 36 hours.

It is possible to test operate any cyclotron designs before the accelerator is constructed. Magnet designs can be tested with significant savings in time, effort and materials. It is now reasonable to seek versatility and standards of cyclotron performance previously unattainable.

Transistors Shrink To Pico Size

THE HEADLINE to this story might very well be: How Small Can You Get. At any rate, a remarkable degree of miniaturization has been achieved in transistors by Pacific Semiconductors, Inc., Culver City, California. (ELECTRONICS, 25 Mar., p 11) The new units are triple-diffused *npn* silicon mesa devices designed as low-power high-speed switches. One series is approximately 1/50th the size of the standard TO-5 package (Fig. 1). And an alternate type, called a pico transistor (Fig. 2) is 1/2000th the size of the TO-5 package. The latter is available for experimental use.

Electrically, the new units are in the same family group as the 2N696 and 2N697 types with power dissipation commensurate with their size. Specifications of these new units, not available at this writing, can be compared with characteristics given for the high-speed medium-power 2N696 *npn* silicon mesa transistor in Table I.

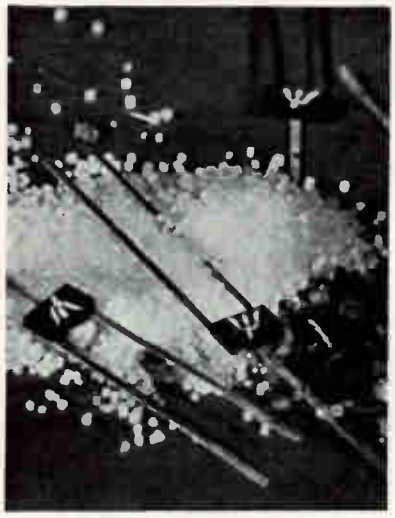
Table I—Characteristics of 2N696 Mesa (25° C)

Symbol	Characteristics	Min	Typical	Max	Test Conditions	
I_{CBO}	Collector Cut Off Current		0.01μA 5μA	1.0μA 100μA	V_C=30 V V_C=30 V	T=25°C T=150°C
V_{BESAT}	Base Saturation Voltage		1.0V	1.3V	I_C=150 mA	I_B=15 mA
V_{CESAT}	Collector Saturation Voltage		0.7V	1.5V	I_C=150 mA	I_B=15 mA
h_{FE}*	DC Pulse Current Gain	20	40	60	I_C=150 mA	V_C=10 V
h_{fe}	Small Signal Gain @ f=20 MC	2	4		I_C=50 mA	V_C=10 V
C_{ob}	Collector Capacitance		20PF	35PF	I_E=0 mA	V_C=10 V

* Pulse Conditions: Length ≤ 500 μsec; Duty Cycle < 2%.

ABSOLUTE MAXIMUM RATINGS (25°C)

V_{CER}	Collector to Emitter Voltage (R ≤ 10Ω)	40 V
V_{CBO}	Collector to Base Voltage	60 V
V_{EBO}	Emitter to Base Voltage	5 V
Total dissipation at Case Temperature 25°C		2 watts
at Case Temperature 100°C		1 watt
at Free Air Temperature 25°C		0.6 watt
Junction Temperature		175°C



Grains of salt and pepper, sprinkled on table top, give a good idea of the actual size of the uncased (top) and cased version of the tiny transistors. The latter was developed for convenience

To indicate the size reducation of typical circuits which can be made now using these miniature components, Clint E. Maiden, head of special products at PSI showed ELECTRONICS a tiny circuit he constructed. Maiden took a sure-starting multivibrator, originally described by Irwin Dorros of Bell Labs and replaced the standard capacitors with the microdiode capacitor Varicap™. Transistors were replaced with the pico-transistor PMT-010. The resistors loom like giant redwood trees in comparison. Maiden takes care to point out that this device is not being offered for sale.

Operating data for the free-running multivibrator: E = 3-v d-c to

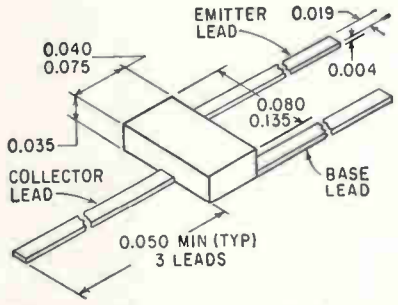


FIG. 1—Outline dimensions of the cased version of the pico transistor

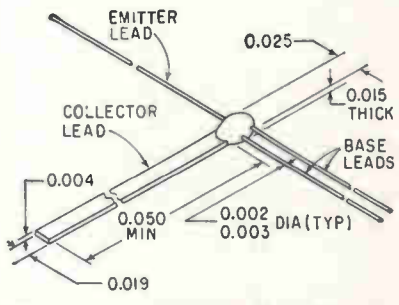


FIG. 2—Pico transistor without its case. This can be used as is

after routing, clip and save

a continuing series on technical topics of specific interest to engineers

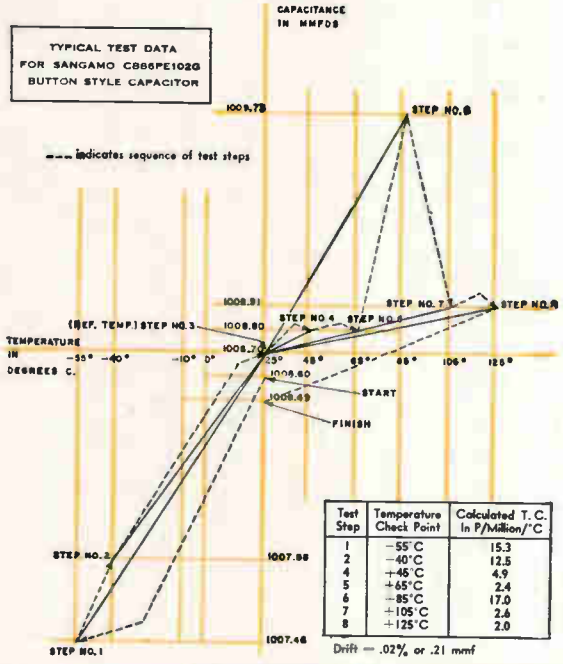
Folio 60-10 REFERENCE DATA FILE SANGAMO

A Typical Example of Capacitor Characteristic

Sangamo Reference Data File 60-9 was aimed at clarifying the meaning of the word "characteristic" as it applies to the capacitor industry. It cited the ways in which the term was defined and gave examples of how characteristic is designated in Paper, Electrolytic and Mica capacitor nomenclature. This article will explain the term as it is used for a specific type of capacitor . . . the mica dielectric capacitor.

Under discussion will be a Sangamo fixed, mica dielectric, button style capacitor . . . the CB86PE102G. It has been stated previously that the characteristic letter "E" defines the capacitance stability of the unit during one "round trip" excursion from room temperature (+25°C) to minimum and maximum temperatures specified for the capacitor. Capacitance stability is evidenced by two capabilities of the product: (1) Temperature Coefficient. This is the dynamic change in capacitance as a function of temperature. (2) Capacitance Drift. This is a static change in the room temperature capacitance after the temperature excursion. It represents the ability of the capacitor to retrace its "temperature coefficient" curve. Let's further investigate these two capabilities of mica capacitors.

FIGURE 1



Test Step	Temperature Check Point	Calculated T. C. In P/Million/°C
1	−55°C	15.3
2	−40°C	12.5
4	+45°C	4.9
5	+65°C	2.4
6	−85°C	17.0
7	+105°C	2.6
8	+125°C	2.0

FIGURE 2

CHARACTERISTIC Designator	Temperature Coefficient Parts/million/°C	Capacitance Drift
B	Not specified	Not specified
D	−100 to +100	0.3% or 0.3 mmf; whichever is greater
E	− 20 to +100	±.1% + 0.1 mmf

Temperature Coefficient (T. C.) is defined as the parts per million change in capacitance for every degree change in temperature. In equation form, it is defined as:

$$T.C. = \frac{(C_2 - C_1) \times 10^6}{(T_2 - T_1)\, C_1}$$

Where: T. C. = Temperature Coefficient in parts per million per degree C.
C_1 = Capacitance at reference temperature (+25°C) in mmf
C_2 = Capacitance at test temperature in mmf
T_1 = Reference temperature (+25°C).
T_2 = Test temperature in degrees C.

Figure 2 shows a table setting forth values for three characteristic designators. If the T. C. and Drift of a mica capacitor fall within the limits of those values shown in Figure 2, then the capacitor can be said to have a B, D or E characteristic. However, the temperature range of the capacitor must be specified.

Now let's look at Figure 1 again. The primary objective of the test is to find the maximum value of T. C. throughout the specified temperature range of the capacitor. In this case the temperature range of the CB86PE102G is —55°C to +125°C. The ideal test would determine all instantaneous values of capacitance from —55°C to +125°C but, until recently, time has been the prohibiting factor in this test procedure. The capacitance is therefore measured at selected temperature test points throughout the specified range. Today, through the utilization of the latest equipment and procedures, Sangamo can obtain these "in-between" values in a fraction of the previous time. This approach means significantly better-tested components for customer equipment. For the purpose of this article, only the selected test points will be used for checking maximum T. C. throughout the temperature range.

Notice that in Figure 1 there are 10 capacitance readings . . . Start, Steps 1, 2, 3, 4, 5, 6, 7, 8 and Finish. The T. C. is calculated for each temperature check point other than 25°C using the above equation. These points are Steps 1, 2, 4, 5, 6, 7 and 8. The test results have been computed and are tabulated in Figure 1. If, after having computed the value of T. C. for all seven points, the maximum plus and minus values lie in-between the limits of any one designator, then the capacitor is said to meet that "characteristic".

Capacitance Drift is simply the element that defines capacitance stability of the unit during *one* "round trip" temperature excursion as shown in Figure 1. It is expressed as a percentage and is computed by dividing the greatest single difference between any two of the three values recorded at +25°C by the second value recorded at +25°C (Reference Temperature) multiplied by 100. It can also be expressed in mmfds. by subtracting the smallest capacitance value recorded from the largest of the three values recorded at +25°C. If this value is then compared with those values of Drift shown in Figure 2, the characteristic of the capacitor can then be determined.

Temperature Coefficient of capacitance is usually the parameter of greatest interest to design engineers. Drift is often of secondary importance. Sangamo feels that these two parameters should be stated separately in specifications and encourages its customers to state their requirements quantitatively and separately for T. C. and Drift. Further, a precision capacitance tolerance does not insure or indicate capacitance stability.

SC-60-2

SANGAMO ELECTRIC COMPANY, Springfield, Illinois

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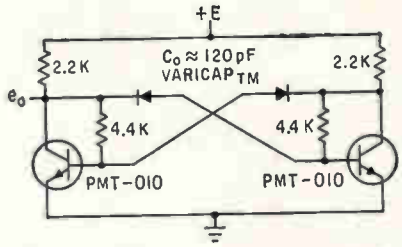


FIG. 3—Free-running multivibrator built with the pico sized components

12-v d-c; voltage swing (e_o/E) $\geqq$ 0.6; f = 1 to 1.5 megacycles.

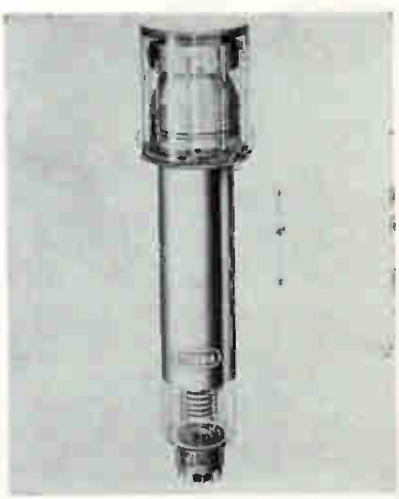
In a few months PSI expects to reduce the 0.075 in dimension of the cased unit to 0.040; and the 0.135 in dimension will shrink to 0.080 in.

New TV Camera Tube Improves Resolution

A NEW IMAGE ORTHICON (RCA-7389-A) designed primarily to provide extremely high quality performance in black and white tv cameras is now available.

Features of this tube include high capacitance target assembly, full response for fine-detail information and superior quality of the picture signal. The 4½ inch camera tube uses the same optics as found in the three-inch tubes, but has a signal-to-noise ratio that is considerably greater.

The high capacitance of the target assembly results from the increased area of the target and enables the new tube to have an extended linear portion of its light transfer characteristic and a larger output signal. This in turn



Improves quality of successive tv recordings

results in a higher signal-to-noise ratio and a longer dynamic range or gray scale.

Because of the longer dynamic range, the 7389-A is capable of handling a wide range of scene contrast without encountering undesirable redistribution effects. The increased target area also greatly improves the resolution capability and thereby provides black-and-white tv pictures, which, in addition to having greater contrast, are sharper, clearer, and more realistic.

The superior quality of the picture signal permits the making of a series of successive recordings while still retaining excellent picture quality.

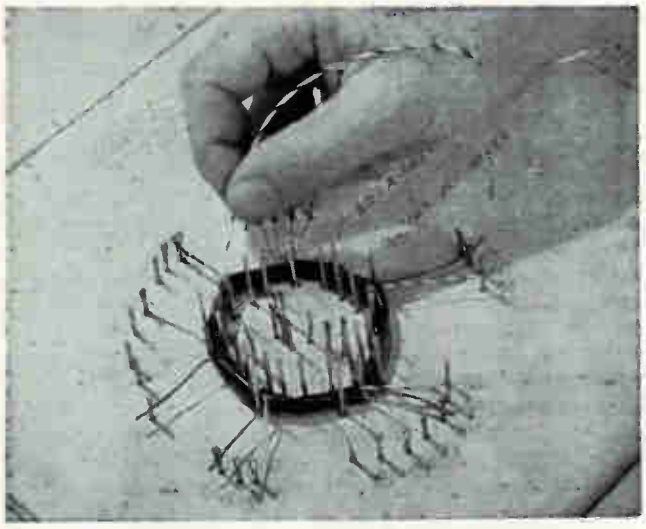
Tentative specification data on the 7389-A is available from the Electron Tube Division of RCA, Harrison, New Jersey.

Urge Materials Push

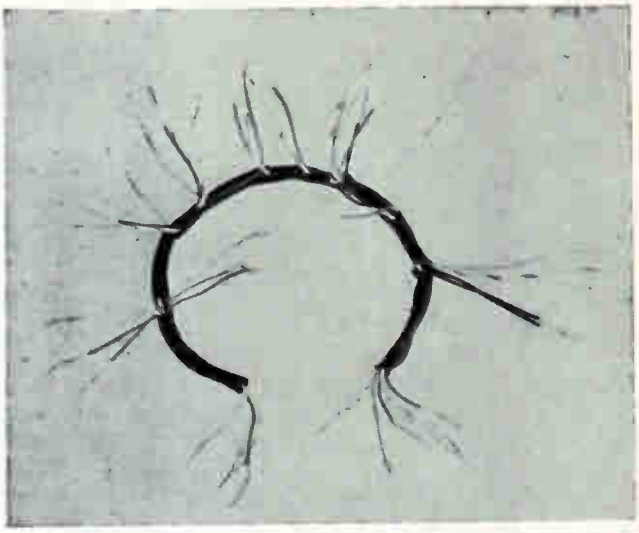
A COMMITTEE of the National Academy of Sciences, National Research Council recently stated that important national security programs, particularly those in defense, atomic energy, and space, are currently up against a materials barrier because the properties of most presently available materials are inadequate for the high-performance end items that must withstand severe temperature, pressure, radiation, corrosion, and stress environments.

The committee declared that the lag in the development of new metals, ceramics, and plastics is, at this moment, holding up the development of nuclear-propulsion systems and space vehicles, as well as missiles, rocket motors, naval vessels, and electronic devices for which theoretical designs now exist.

The committee recommended that the Government accord high priority in national security plans and programs to the science of materials, to the training of materials scientists and engineers, and to programs for the development of new and improved materials for national security uses. The group also observed that our conventional materials-supplying industries cannot be expected to invest their own money for these efforts.



Harness in preparation. After wire is slipped through the tubing, wire ends are held between the legs of cotter pins, which are used in place of the customary nails



Finished harness. Although the tube has shrunk enough to keep all wires in position during subsequent assembly, the tubing is still loose enough to allow individual wires to be replaced

Shrunken Tubing Wraps Harnesses

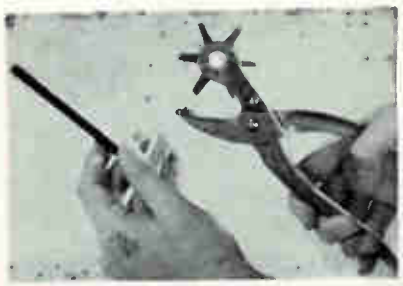
IRRADIATED POLYETHYLENE tubing shrinks about 50 percent in diameter when heated. This property has prompted its use as a harness wrapping by Eclipse-Pioneer Division, Bendix Corp., Teterboro, N. J.

The tubing is prepared by punching holes where wires are to emerge. It is pinched in the fingers and semicircles are punched along the fold. Harness preparation is conventional, except that the wires are fed through the ends or holes in the tubing. Up to 20 wires can be pushed into big tubing in a group.

After the harness or cable subassembly is prepared, the tubing is contracted with hot air from a hand blower. The tubing thermal-sets as it shrinks.

Small tubing is also used to terminate braid at the end of shielded wire. A brass eyelet is fitted over the conductor. The braid is soldered to the eyelet and the tubing tightly shrinked over the eyelet, removing a possible source of abrasion damage.

The tubing is fairly expensive,



Holes are made by pinching and punching

Tubing is formed around pins on the harness board

Tv Systems Check Transistors

Closed circuit television system is used to monitor quality during the production of mesa transistors at Motorola's Semiconductor Products Division, Phoenix, Ariz. The system enables operators to view the operating area (less in diameter than a human hair) of the devices at about 200 times actual size

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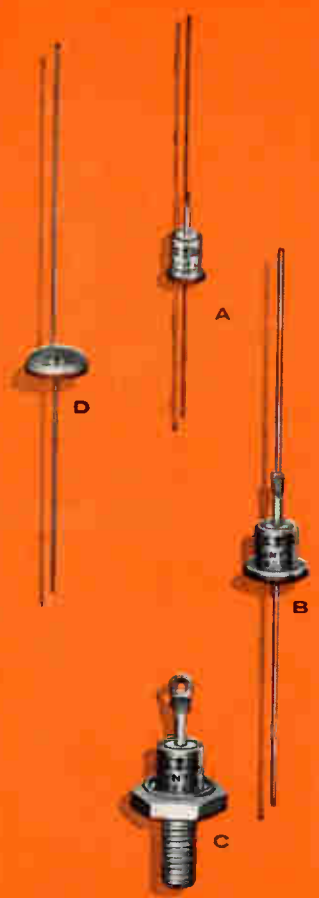

Type Number	Peak Inverse Voltage, Volts	DC Output Current, Ma	Max. DC Reverse Current Ma
A — 300 Ma Rated (at 50°C), 50 to 600 PIV Reverse Current Characteristics at 100°C			
1N1701	50	300	0.4
1N1702	100	300	0.4
1N1703	200	300	0.3
1N1704	300	300	0.3
1N1705	400	300	0.3
1N1706	500	300	0.3
A — 500 Ma Rated (at 50°C), 50 to 500 PIV Reverse Current Characteristics at 150°C			
1N1707	50	500	0.4
1N1708	100	500	0.4
1N1709	200	500	0.3
1N1710	300	500	0.3
1N1711	400	500	0.3
1N1712	500	500	0.3
B — 250 to 750 Ma Rated (at 50°C), 100 to 500 PIV Reverse Current Characteristics at 100°C			
SD-91	100	550	1.0
SD-92	200	550	1.0
SD-93	300	550	1.0
SD-94	400	550	0.80
SD-95	500	550	0.65
SD-91A	100	750	0.5
SD-92A	200	750	0.5
SD-93A	300	750	0.5
SD-94A	400	750	0.4
SD-95A	500	750	0.3
B — 250 Ma Rated (at 150°C), 50 to 600 PIV Reverse Current Characteristics at 150°C			
1N536	50	250	0.4
1N537	100	250	0.4
1N539	300	250	0.3
1N1095	500	250	0.3
1N1096	600	250	0.3

Type Number	Peak Inverse Voltage, Volts	DC Output Current Ma	Max. DC Reverse Current Ma
B — JAN Types — 250 Ma Rated (at 150°C) Reverse Current Characteristics at 150°C			
1N538	200	250	0.3
1N540	400	250	0.3
1N547	600	250	0.3
C — JAN Types — 400 to 1000 Ma Rated (at 135°C) Reverse Current Characteristics at 135°C			
1N253	95	1000	0.001
1N254	190	400	0.001
1N255	380	400	0.0015
C — Power Supply Types, 800 Ma Rated (at 100°C) Reverse Current Characteristics at 25°C			
1N 607	50	800	0.025
1N 608	100	800	0.025
1N 609	150	800	0.025
1N 610	200	800	0.025
1N 611	300	800	0.025
1N 612	400	800	0.025
1N 613	500	800	0.025
1N 614	600	800	0.025
C — Mag. Amp. Types, 800 Ma Rated (at 100°C) Reverse Current Characteristics at 25°C			
1N 607A	50	800	0.001
1N 608A	100	800	0.001
1N 609A	150	800	0.001
1N 610A	200	800	0.001
1N 611A	300	800	0.001
1N 612A	400	800	0.0015
1N 613A	500	800	0.002
1N 614A	600	800	0.0025
D — Commercial Types, 200 to 500 Ma (at 70°C) Reverse Current Characteristics at 100°C			
5E4 (Cap. Load)	400	350	0.5
(Res. Load)	400	500	0.5
2E4 (Cap. Load)	400	200	0.5
(Res. Load)	400	300	0.5

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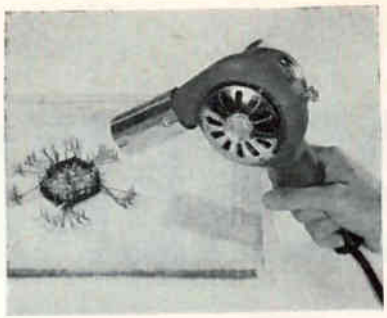
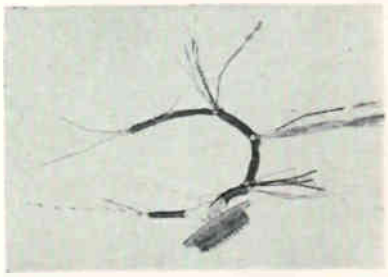


Hot air blower shrinks the tubing around wires



Several lengths of tubing may be used

but cost is offset by convenience and other features. Individual wires can be replaced without disturbing the remainder of the harness. It is colored and breakouts can be stamped, simplifying wire tracing. In airborne equipment, the tubing dampens vibration and protects fine wire from abrasion.

Bins Feed Small Parts In Order of Assembly

PARTS FEEDING machine which presents up to 38 components to an operator in assembly sequence is being used in England to manufacture printed circuit board assemblies for radio and tv. Called a Rotasembler, it was developed by Work Study Equipments, Woodford Green, Sussex.

The machine has 19 bins spaced around rings with a 28-inch diameter. Each bin is vertically divided into 2 hoppers. Each hopper ends in a feed lip fitted with an adjustable gate which controls the flow of parts onto the lip. The rings hang by spokes from a shaft mounted in the center of a Y-shaped plate. The plate is also used to bolt the machine to the work bench.

Hoppers are indexed into the delivery position by an air cylinder which is controlled by the operator

with a foot valve. The air cylinder's linear movement is changed into rotary movement of the bins by a pivoted lever, chain and ratcheted gear. The action of the air cylinder also releases, then tightens a braking cable and shaft.

In the application shown, at Regentone Radio and Television, Ltd., Romford, Essex, another foot pedal-air cylinder mechanism is used to crimp the component leads after they are inserted in the printed circuit board. The setup is reported to reduce operator learning time and fatigue while enabling the insertion of up to 2,000 parts an hour.

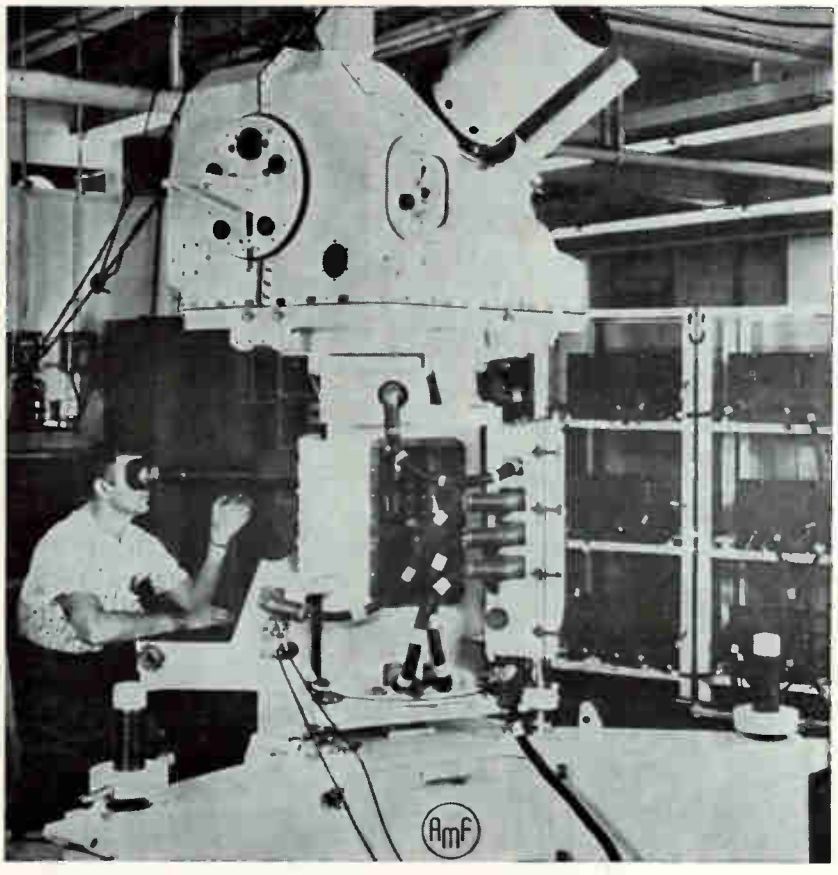
Assembly feeders in use at radio and tv plant

Gates seen over feed lips adjust flow of parts

Erasers Make Leads Of Components Shine

COMPONENT LEADS should be free of oxides before insertion in printed wiring boards for best dip soldering results. Boeing Airplane Company, Seattle, Wash., does the job quickly with ink erasers. A strip of metal is used to make the erasers into a tweezer-shaped tool. Accumulated oxides are removed from the erasers by rubbing them on clean sandpaper.

On The Market



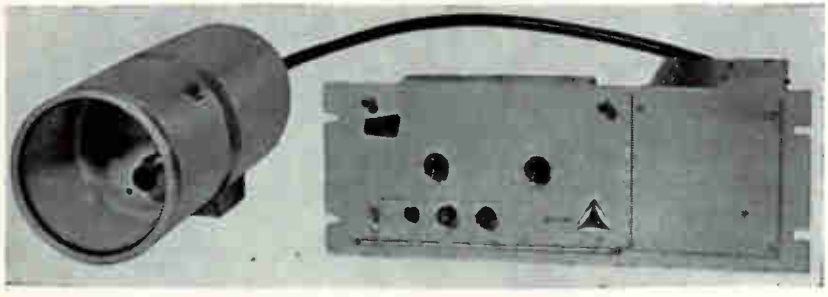
Missile Tracking Instrument Mount

INCORPORATING the latest electrical, servomechanical and optical principles, this Precision Instrument Mount (PIM) is said to make possible tracking of missiles, space satellites and aircraft.

The mount is a product of American Machine & Foundry Co., 261 Madison Ave., New York, New York. The tracking device can be used either for direct reading or for recording data on film.

The PIM is small enough to be easily dismanteled and relocated. It is anticipated that this product will pioneer a new family of down-range instrument mounts for the defense and space program.

CIRCLE 301 ON READER SERVICE CARD



Tv Camera Withstands Extreme Environments
uses plug-in transistorized circuit modules

DEVELOPMENT of a television camera rugged enough to withstand extremes of weather, shock and vibration, noise, salt spray and dust without auxiliary protection has been claimed by Dage Television Division of Thompson Ramo Wooldridge Inc., Michigan City, Ind.

Engineered to military requirements for aircraft and missiles, the unit is expected to find use in mines, oil refineries, powder plants and other critical industrial areas.

The unit, designated the Dage Model RGS-10 Ruggedized Television System, consists of a camera and control unit that can be operated 2,000 feet apart. The camera weighs 15 lb, is 16 in. long and 6⅞ in. in diameter. The camera control weighs 15 lb and is 7 by 19 in.

The camera is completely transistorized except for the vidicon tube. It features EIA synchronization, automatic light control over a 2,000 to 1 range, a built-in four-lens turret and horizontal resolution of more than 700 lines. The camera will operate from –20 F to 160 F, in noise levels of more than 185 db and vibration according to specification MIL-E-5272-B. The camera will operate with no limit on altitude.

Operational controls of the control unit include: on-off switch, automatic-manual target switch and beam. Also set-up controls such as pan and tilt and zoom lens. Vhf connectors provide peak-to-peak video composite or optimal modulated r-f. The complete system draws only 15 watts, 115 v, 50-60 cycle or 400 cycle (optional).

A complete line of accessories such as pan and tilt, lens turret, optical focus and zoom lens are available with the equipment. Any type or combination of lenses may be employed with the camera. Lenses used are an integral part of the camera and are protected from all environments.

CIRCLE 302 ON READER SERVICE CARD

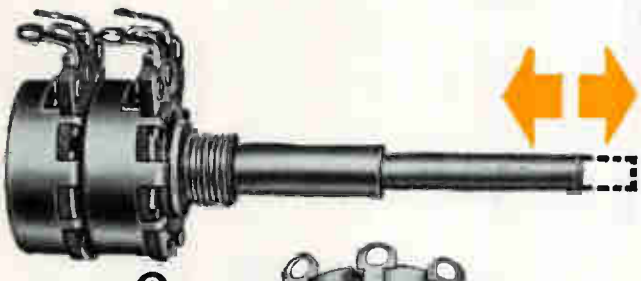
P-C Sandwich
six-layered unit

MINIATURIZED replacement for back-panel wiring in computers may be accomplished by printed circuit sandwiches produced in many layers and laminated together under heat and pressure. The components are being made by Photocircuits Corporation, 31 Sea Cliff Ave., Glen Cove, New York.

The manufacturer believes the new development will have uses in circuits having multiple crossovers

NEW CONTROLS FOR STEREO

Flexibility without Complexity



Even a wife can appreciate the major points of these special dual-element controls for 2-channel stereo equipment! No longer is it necessary to fiddle with 2 bass controls, 2 treble controls, and 2 volume controls to obtain proper stereo balance—then re-adjust everything when listening to monophonic material. No longer, that is, unless you're an ardent audiophile who would have it no other way.

For these new Stackpole controls "clean-up" the panels of stereo equipment, make them easier to operate and understand . . . yet retain all the flexibility of individual adjustments required on the most elaborate equipment.

1 FRICTION SHAFT DUAL—Type LS3: A friction fit between shafts causes both elements of this dual concentric shaft control to operate in tandem when either shaft is turned. Either element can also be adjusted independently by holding one shaft while rotating the other. Once set, either knob can be turned while maintaining stereo balance through a wide range of adjustment.

2 CLUTCH SHAFT DUAL—Type LS1: This wonderfully convenient control allows either simultaneous or individual adjustment of its two elements. A push on the inner shaft engages a clutch which connects both elements together for tandem operation by either shaft. Pulling the inner shaft permits each element to be individually adjusted without disturbing the other.

3 MATCHED ELEMENT TANDEM—Type L-Tandem: Through precise electrical matching and careful mechanical alignment, this stereo tandem control allows convenient, single-knob adjustment of both channels. It's ideal for adjustment of master volume or of bass or treble in systems where an absolute minimum of panel complexity is desired.

Mechanical and electrical specifications on these dependable 0.75-watt variable composition resistors are available on request. Electronic Components Division, Stackpole Carbon Company, St. Marys, Pa.

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Colditе 70+® fixed composition Resistors • Slide & Snap Switches • Ceramag® Ferrite Cores • Fixed composition Capacitors • Ceramagnet® Ceramic Magnets • Electrical Contacts • Brushes for all rotating electrical equipment • Hundreds of related carbon, graphite, and metal powder products.

and complicated interconnections among closely spaced component leads.

Connections between different levels in a multilayered circuit are made through use of Tuf-Plate plated-through-holes. A typical six-layered printed-circuit sandwich measures only 0.026 in. in thickness compared with a thickness of 0.062 in. for a conventional single circuit board.

CIRCLE 303 ON READER SERVICE CARD

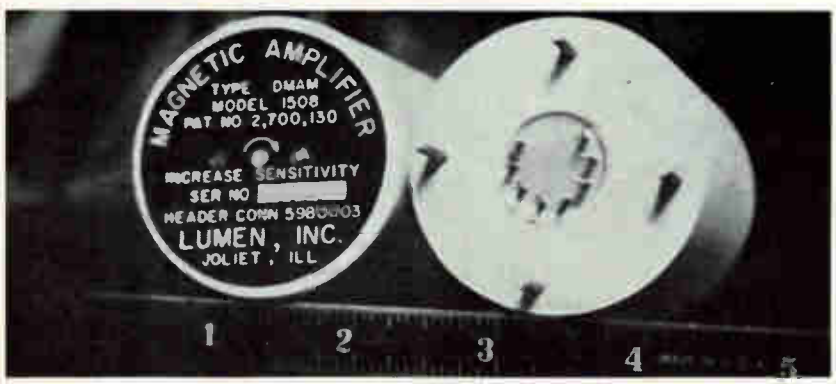
Tv Tube Cap Cuts Reflection
diffuses 75 percent of reflected light

A SPECIALLY treated laminated cap for television picture tubes has been developed by Corning Glass Works, Corning, New York. The cap diffuses 75 percent of reflected light without perceptible loss in picture resolution making it possible to view comfortably even with image-producing light sources in front of the tube face.

Used in combination with new bonded picture tubes, the laminated tube cap eliminates the long-standing problem of mirror-images on the face plate. The treated surface of the tube cap is as good as glass itself. It is not damaged by ordinary household abrasive cleaners. Picture resolution and glass chromaticity are unchanged.

The new tube caps are available in production quantities. The anti-reflection treatment is applied to contour face caps by the glass manufacturer.

CIRCLE 304 ON READER SERVICE CARD



Miniature Magnetic Amplifier for Instrumentation
provides 120 mv output with variable load

NEW LOW-LEVEL magnetic amplifier measures only 2⅛ in. in diameter and 2 in. high. The unit is produced by Lumen, Inc., P. O. Box 905, Joliet, Illinois.

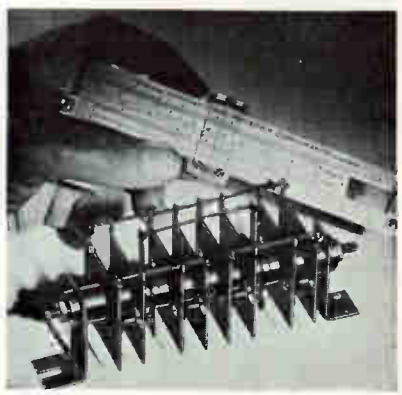
Designated the Model 1508, it has an input voltage variability of from 0 to 15 millivolts to 0 to 50 millivolts. With a minimum input signal it produces an output of 120 millivolts with a load impedance variable from 50 ohms to infinity.

The magnetic amplifier uses 26-v, 400-cps center tapped excitation with a regulation of plus or minus 10 percent. Power requirement is less than 1 watt. Signal source impedance is 16 ohms plus or minus 10 percent. The control circuit has effectively 7,500 ohms impedance.

Linearity of the amplifier is 1¼ percent and the unit's output will not vary more than plus or minus 1½ percent with any combination of line voltage and frequency changes.

The component will withstand O C to 75 C temperature and 25 g shock. Mounting is accomplished by four studs welded to the header of the case.

CIRCLE 305 ON READER SERVICE CARD

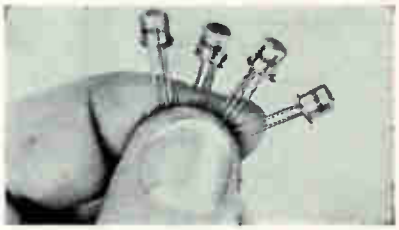


Silicon Stacks
medium power

INTERNATIONAL RECTIFIER CORP., 1521 E. Grand Ave., El Segundo, Calif. A broad series of over 125 JEDEC type silicon medium power rectifier stack assemblies offers ready-to-install packaged power rectifiers engineered to provide maximum power output through ideal heat transfer design. Units span a current range from 1.5 to 14.4 amperes d-c output, with d-c voltages from 31 to 1,500 v. Types 1N2638 through 1N2764 consist of glass-to-metal hermetically sealed silicon diodes mounted on 1.56 in. copper cooling fins. Mounting dimensions are from 3.48 in. to 7.53 in. Circuit configurations are single phase ½ wave, center tap,

bridge and mag-amp bridge, 3-phase ½ wave and bridge, and 6-phase star.

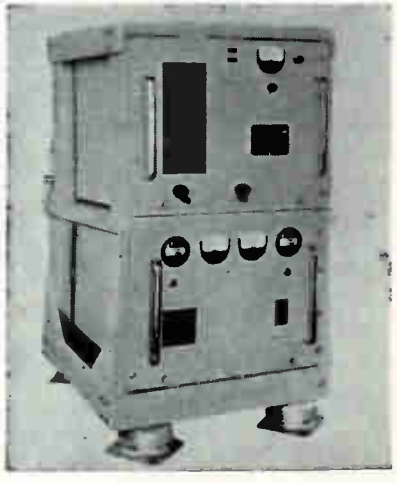
CIRCLE 306 ON READER SERVICE CARD



Tunnel Diodes
gallium arsenide

TEXAS INSTRUMENTS INC., Semiconductor-Components Division, P. O. Box 312, Dallas, Texas. The 1N650 series gallium arsenide tunnel diodes were designed for specific applications in high speed computer circuitry such as logic circuits, amplifiers, oscillators and general computer purposes. The series, packaged in the lightweight standard JEDEC TO-18 case, provides guaranteed peak currents up to 10 ma ± 2 percent, large voltage swings, high peak to valley ratios (greater than 15 to 1), guaranteed forward voltages up to 1.1 v ± 5 percent, and high temperature operation up to 150 C.

CIRCLE 307 ON READER SERVICE CARD



R-F Amplifier
225 to 400 Mc

MANSON LABORATORIES, INC., 375 Fairfield Ave., Stanford, Conn. Model RD-210 is a 1 Kw r-f amplifier operated class B linear. Designed as a final stage amplifier for a uhf transmitter, it is continuously

tunable from 225 to 400 Mc with a carrier operating in either F-1 or A-3 mode. Tuning is accomplished by a simple two knob adjustment working in conjunction with a positive gear train that adjusts both the grid and plate tuning circuits simultaneously. This method insures ease of alignment with a minimum of error. Amplification is obtained with two air-cooled tetrodes thus permitting a reduction in physical size and weight. The built-in power supplies also contribute to compactness by utilizing silicon diodes in place of conventional tubes.

CIRCLE 308 ON READER SERVICE CARD

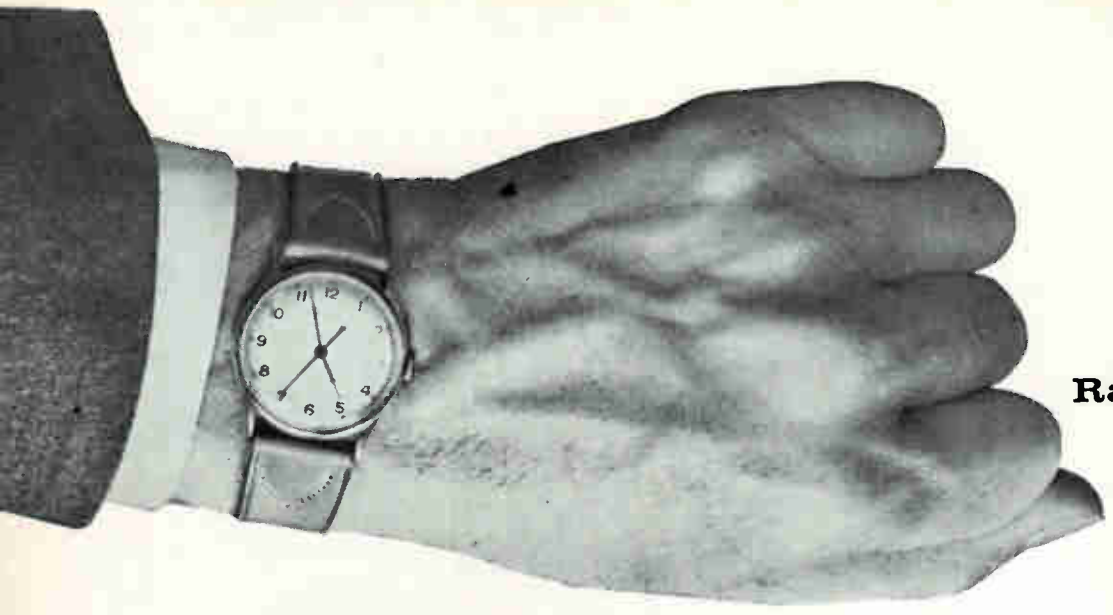
Frequency Counter versatile unit

ERIE-PACIFIC, 12932 South Weber Way, Hawthorne, Calif., announces a low-cost frequency flow rpm counter featuring in-line Nixie readout and modular construction for maximum flexibility. Unit with appropriate sensors reads directly in cps, gallons per minute, rpm, or any physical variable that can be converted to a proportional frequency. Model 720 was designed to meet OEM electronic counter requirements including measurement or calibration of: flow rate, engine or electric motor rpm; oscillator, wave filter, and vibration frequencies. Instrument was designed particularly for day-in day-out production line usage with an absolute minimum of operator fatigue.

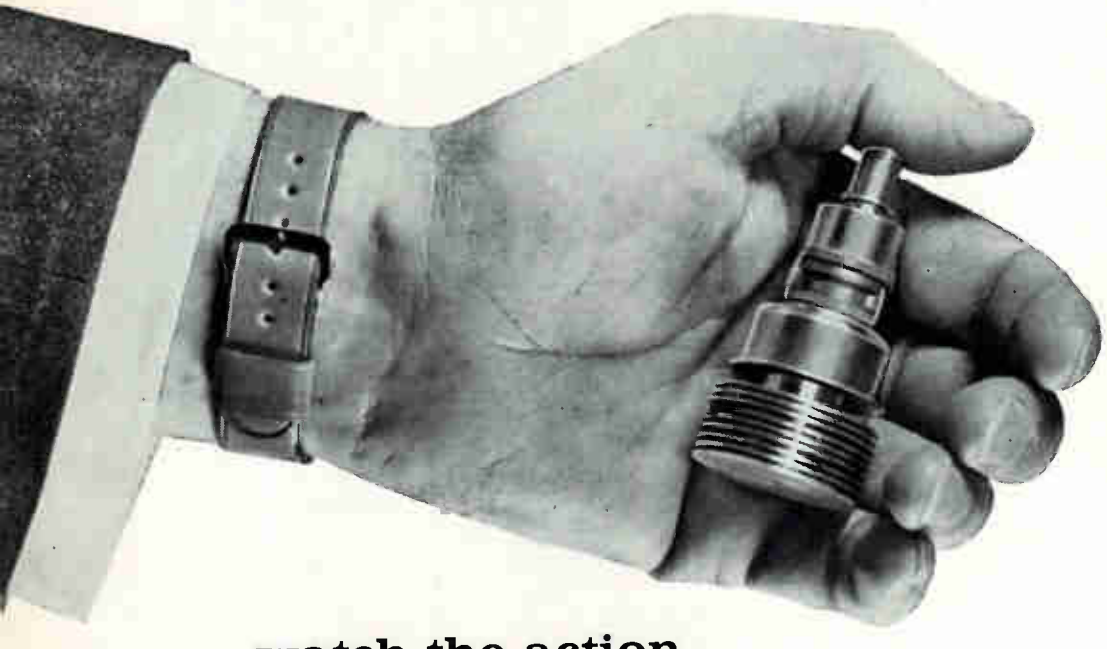
CIRCLE 309 ON READER SERVICE CARD

Test Equipment for 15,000-22,000 Mc

WAVELINE, INC., Caldwell, N. J. A line of precision microwave test equipment in the WR-51 waveguide size is designed to operate over a frequency range of 15,000 to 22,000 Mc. Included are items such as pre-



When you need any electronic part in a hurry...



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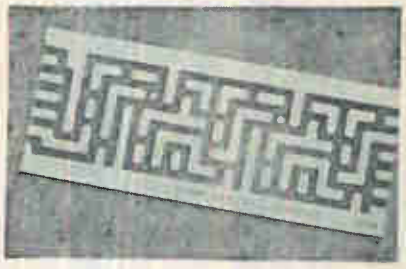
cision crossguide directional couplers, calibrated variable attenuators, variable screw tuners, multihole broadwall couplers, low and high power terminations, sliding terminations, adjustable shorts, and transitions from RG 91/U to WR-51 waveguide and RG-53/U to WR-51 waveguide.

CIRCLE 310 ON READER SERVICE CARD



Circuit Pattern pre-etched

DYNAMEANS INC., 1511 W. Clark, Burbank, Calif., has developed Dynamaze a pre-etched circuit pattern which is designed and optimized to accommodate practically any circuit configuration encountered in transistor circuit design. It eliminates the waste of time encountered in building breadboard chassis, mounting of tiepoints, crimping of component leads etc. Size is 2 in. by 5 in. by $\frac{1}{16}$ in. Base material is epoxy glass. Dynamaze is acid resistant, nonbreakable, heat resistant, and washable. Price is $2.00.

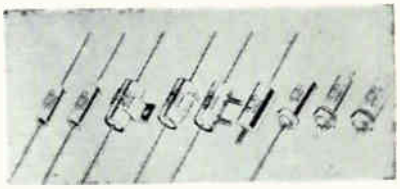
CIRCLE 311 ON READER SERVICE CARD

Power Source ultraminiature

BURMAC ELECTRONICS CO., INC., 142 S. Long Beach Road, Rockville Center, N. Y. Model 859 is a source of keep-alive power for microwave TR switch tubes. Unit's input impedance is sufficiently low to permit use of any required series resistor called for under TR tube specifications. Capacitors per MIL-6-25A,

transformer per MIL-T-27A and silicon diodes are used. The 859 is resin cast, thermal shock resistant, and measures 1⅛ in. by 1⅛ in. by 1¾ in., weighs less than 3 oz. Output voltage and current are −700 v d-c minimum and 200 μa, respectively. Ripple is 5 percent peak to peak maximum and line power 115 v at 400 cps. Price: $49.50.

CIRCLE 312 ON READER SERVICE CARD



Miniature Capacitors hermetically sealed

CORNELL-DUBILIER ELECTRIC CORP., South Plainfield, N. J. Type MTWK metalized paper-plastic film capacitors for military, industrial and other high-grade electronic equipment for operation from −55 C to +125 C without voltage derating. They are designed for use in power supply filter circuits, bypass functions and where high insulation-resistance values are not essential, as well as applications in which occasional momentary voltage breakdowns can be tolerated. Temperature characteristics, such as dissipation factor and capacitance change are comparable to those of standard paper-dielectric capacitors, but afford higher capacitance values than are generally obtainable with the same size paper-dielectric or metallized-paper types. Type MTWK is supplied in 200 v, 400 v and 600 v d-c sizes.

CIRCLE 313 ON READER SERVICE CARD

Rotary Switch highly versatile

THE GAMEWELL CO., Chestnut St., Newton Upper Falls 64, Mass. Ideal for circuit sampling, sequencing, programming, digital generators, etc., the custom-designed SG-270 precision rotary switch fills the need for a highly versatile switching component. A precious metal ring forms the heart of the switch. It

can be cut into many angular segments with connections to the segments made through adjacent terminals on the periphery of switch housing. Precious metal rings and brushes provide smooth, low torque, trouble-free action with either make-before-break or break-before-make contacts. Multiple gangs can be assembled to provide multipole switches. Cased in special plastic, switch is inherently fungus resistant and stable at high temperatures. Sizes: $\frac{5}{8}$ in., $1\frac{1}{4}$ in., $1\frac{5}{8}$ in., 2 in., 3 in., 5 in. diameter in various mounting styles.

CIRCLE 314 ON READER SERVICE CARD

Fixed Delay Line
fine adjustment

FERRANTI ELECTRIC INC., 95 Madison Ave., Hempstead, L. I., N. Y. Type 5802 is a torsional mode delay line designed for military environments per MIL-T-5422D and Air Force Standard Module packaging requirements (WCLN 58-18). Delays are available from 50 to 500 μsec and digit rates up to 1 Mc. A limited number of taps can be provided. Input and output impedances to suit circuit requirements.

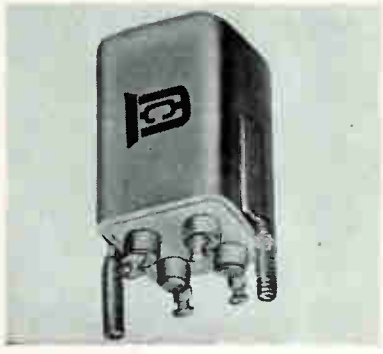
CIRCLE 315 ON READER SERVICE CARD

T-W Tube
weighs 1.0 lb

HUGGINS LABORATORIES, 999 E. Arques Ave., Sunnyvale, Calif. The HA27 electrostatically focused, L-band amplifier traveling wave tube operates on a frequency range of 1,000 to 2,000 Mc with a small

signal gain of 30 db min., and a saturation power output of 7 db min. It measures 1 in. in diameter and 16 in. in length; meets the requirements of military specifications in operating temperatures, vibration and shock performance. No magnetic structure either solenoid or permanent magnet is needed by the HA27.

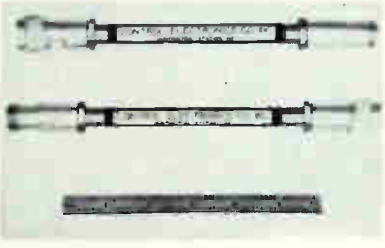
CIRCLE 316 ON READER SERVICE CARD



Transformers mu shielded

MICROTRAN CO., INC., 145 E. Mineola Ave., Valley Stream, N. Y., announces a line of subminiature size transistor transformers in mu metal construction. Use of mu metal, in place of steel cans, provides hum pick-up reduction of approximately 20-30 db. Available in MIL-AF construction ¾ in. square by 1⅛ in. high or in cylindrical construction ⅞ in. diameter by 1⅛ in. high. Manufactured to meet MIL-T-27A, Grade 4, Class R, with 10,000 hr reliable life. Units are supplied with either high compression glass or ceramic terminals.

CIRCLE 317 ON READER SERVICE CARD



Bandpass Filters aluminum cased

CONTROL ELECTRONICS CO., INC., 10 Stepar Place, Huntington Station, L. I., N. Y. Part of a new line are two microwave bandpass filters that feature wide pass bands and very sharp skirts in the stop bands. Top unit is the MWF-103 which has a 8,650 Mc to 11,000 Mc bandwidth as opposed to the bottom unit, the MWF-102, which has a bandwidth of 7,000 Mc to 11,000 Mc. Both filters have input/output impedances of 50 ohms and maximum insert loss of 2 db in the pass band. At 5 percent and 15 percent of either end of the passband, the attenuation is 30 db down and 60 db down, respectively.

CIRCLE 318 ON READER SERVICE CARD

Tape Recorder facsimile type

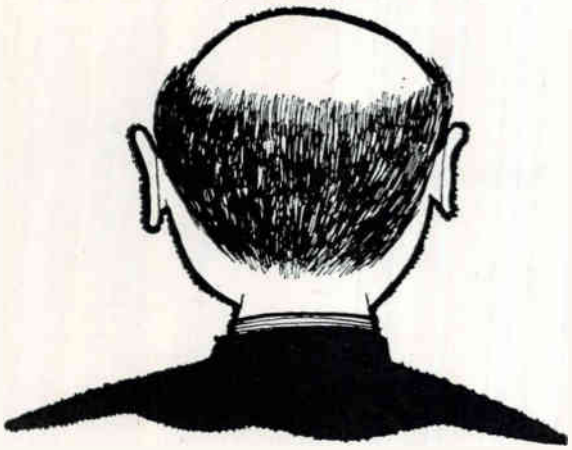
MUIRHEAD & CO. LTD., Beckenham, Kent, England. The D-944-D facsimile tape recorder is a precision unit designed to store picture transmissions which can then be retransmitted later without going through the process of receiving, developing, fixing and re-scanning. A synchronizing circuit employing a Muirhead tuning fork insures that synchronism between the transmitter and receiver is maintained.

CIRCLE 319 ON READER SERVICE CARD

Flexible Waveguide balanced-phase

E.M.T. CORP., Newton, N. J., announces the balanced-phase Flex-Guide for uhf waveguide transmission lines. The new construction is essentially a convoluted flexible tube with two axially lapped seams, one on each broad waveguide wall located diametrically opposite each other, close to the side walls. Employing two seams, properly located, minimizes the cross-section distortion associated with bendings since the annealed seam is supported by

IT'S WHAT'S IN HERE THAT COUNTS



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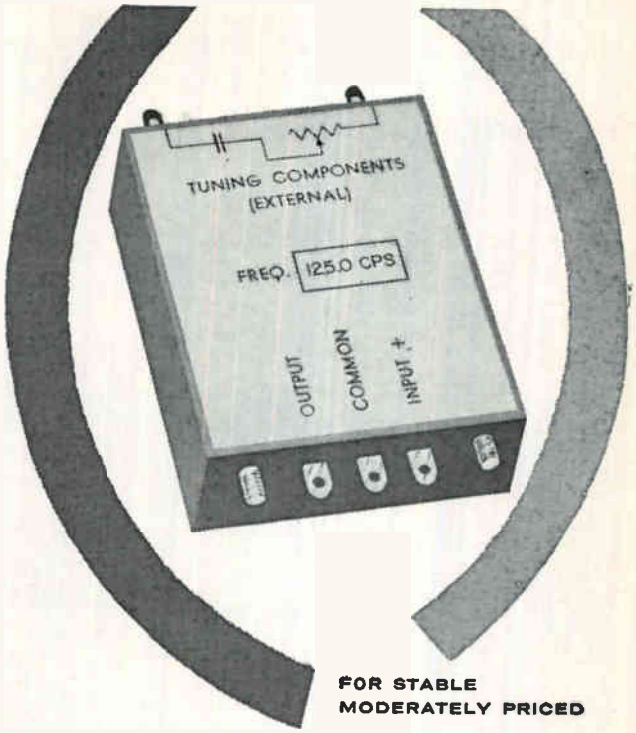

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AUDIO RANGE OSCILLATORS

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Range of frequency adjustment.....plus or minus 2%
Frequency drift.....less than 0.27% drift from 22° to 50 C.
Operating voltage.....12 volts D. C.
Operating current.....3 MA max. at 12 V. D. C.
Output wave shape.....Sinusoidal or peaked
Output voltage.....Up to 4 volts RMS into resistance of 200k ohms (depends upon desired wave shape)
Max. Dimensions*.....50 cps—4" x 3" x 1-½"
125 cps—3-½" x 2-¼" x 1"
1,000 to 10,000 cps—2-¼" x 2-¼" x 1"
Construction... Stabilized Hartley type transistorized oscillator, molybdenum permalloy core toroid inductor, stabilized plastic film tuning capacitance, encapsulated.
Applications... Research, electronic musical instruments, audio signal generators, control devices, industrial instrumentation, etc.

PRICE RANGE: $8 to $15

For further information concerning the type "C" or special higher stability adaptations contact Components Division—Allen Organ Company, Macungie, Pa.

*Not including fine frequency adjustor

Allen ORGAN COMPANY
the most respected name in electronic organs

COMPONENTS DIVISION
MACUNGIE, PENNSYLVANIA

CIRCLE 103 ON READER SERVICE CARD 103

the strong side walls. In addition, the flexible tubing which is soldered or welded to flange fittings at the extremities is supported at the corners (strongest parts of the cross-section) by specially designed brackets, which preclude from flexing the areas near the fitting that have been annealed during fabrication, thus improving the flex life of the assembly.

CIRCLE 320 ON READER SERVICE CARD

Power Supplies transistorized

CORNELL-DUBILIER ELECTRIC CORP., South Plainfield, N. J., has announced two power supplies for mobile service. Model 12TP12 is a transmitter power supply which converts 10.5 to 14.5 v d-c (12.6 v d-c nominal input, such as from battery sources) to 500 v d-c at 240 ma (120 w) output, or 500 v d-c at 150 ma and 250 v d-c at 100 ma. Ratings based on 50 percent transmit duty cycle. It measures 5¼ in. by 4¼ in. by 3 in., weighs 1¾ lb. Model 12TP3 is a receiver power supply which converts 10.5 to 14.5 v d-c (12.6 v d-c nominal input) to 300 v d-c at 100 ma (30 w) output, or 300 v d-c at 70 ma and 150 v d-c at 60 ma. Ratings based on continuous duty. It measures 5⅞ in. by 3¾ in. by 1½ in., weighs ¾ lb. Both units are circuit-protected against transients and overloads.

CIRCLE 321 ON READER SERVICE CARD

Video Amplifier wide band

INSTRUMENTS FOR INDUSTRY, INC., Hicksville, L. I., N. Y. Model XT-320 transistorized video amplifier captures faint picture signals over a wide frequency band for the oscilloscope screens of radar, telemetry

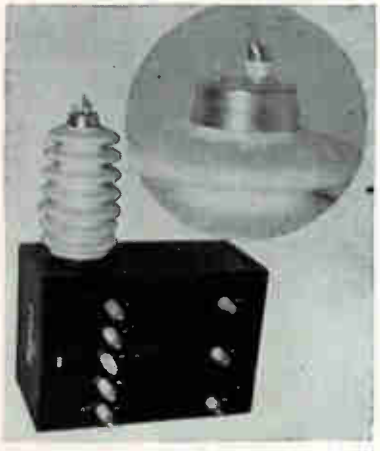
and other military and space surveillance systems. It can cover the broad band from 100 Kc to 200 Mc. It features 20 db gain across the band width. Unit is about the size of two king-size packs of cigarettes.

CIRCLE 322 ON READER SERVICE CARD

D-C/D-C Amplifier
highly accurate

KEARFOTT DIVISION of General Precision Inc., 1150 McBride Ave., Little Falls, N. J. The A3700-01 d-c to d-c amplifier assembly consists of an input mechanical modulator, a high gain a-c amplifier, and an electrical demodulator output. With associated network assemblies D4818 or D4819, this assembly functions as a d-c operational amplifier with a gain in the range of 1 to 10 with an accuracy of ± 0.02 percent. The amplifier is also capable of delivering ± 10 v d-c to any load in excess of 5,000 ohms.

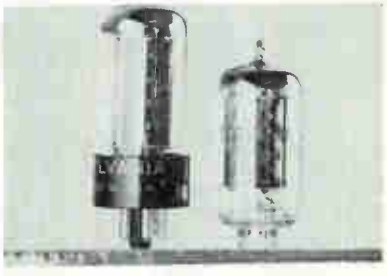
CIRCLE 323 ON READER SERVICE CARD



Pulse Transformer
high voltage

BURMAC ELECTRONICS CO. INC., 142 South Long Beach Road, Rockville Centre, N. Y. The PT120 h-v pulse transformer features a dual output terminal. The oil filled transformer has an input of 9.6 Kv peak pulse at 426 amperes and is designed to operate at a pulse width of 6 μsec at 833 pps. Output characteristics are 54.5 Kv peak pulse at 75 amperes, bifilar wound, capable of 3 amperes filament current at 230 v a-c. The primary is tapped to yield a varying output from 52 Kv to 58 Kv peak pulse. Unit is 7⅜ in. long by 5¼ in. wide by 10 in. high. Forced air cooling of 600 fpm is suggested under continuous operation.

CIRCLE 324 ON READER SERVICE CARD



Receiving Tube
for p-c boards

SYLVANIA ELECTRONIC TUBES, Emporium, Pa. The 9-T9 design consists of a straight-sided T-9 (Bantam) bulb wherein a 9-pin miniature circle of leads replaces the conventional octal base (tube at left). New design facilitates the assembly of equipment using printed circuitry by reducing component congestion and complicated wiring. Company says it also results in higher power than is possible with T-6½ types, an important factor in vertical deflection and audio circuits. Tube assemblies capable of high plate dissipation can now be utilized in p-c boards where 9-pin sockets are widely used.

CIRCLE 325 ON READER SERVICE CARD

Portable Checkout
for aircraft

INTERNATIONAL DYNAMICS CORP., 170 Coolidge Ave., Englewood, N. J. The VPT-10B air data, pitot static, calibrator-tester is a small, lightweight portable unit. It contains a motor-driven vacuum and pressure pump, electromechanical servo regulators, Kollsman precision readout instruments, and proper

connections for external attachment to an aircraft's pitot static system or other system to be checked. The Kollsman pressure controlling sensors can be set to maintain pressure to very close tolerances.

CIRCLE 326 ON READER SERVICE CARD

Silicon Transistors
mesa type

TEXAS INSTRUMENTS INC., Semiconductor-Components Division, P. O. Box 312, Dallas, Texas. The TI 2N1564-, 5- and 6 general purpose-silicon mesa transistors feature an alpha cutoff frequency of 50 Mc and are capable of operation throughout a 1 to 50 ma collector current range. They provide a-c beta spreads of 20-50, 40-100 and 80-200. Beta at −55 C is guaranteed at a minimum of 12, 20 and 40. The devices are packaged in a standard JEDEC TO-5 case with the collector attached directly to the header, providing maximum resistance to shock and vibration. Units will dissipate 600 mw at 25 C T_A. Collector-base voltage is rated at 80 v and collector emitter voltage is 60 v.

CIRCLE 327 ON READER SERVICE CARD

Compact Transmission
15-speed

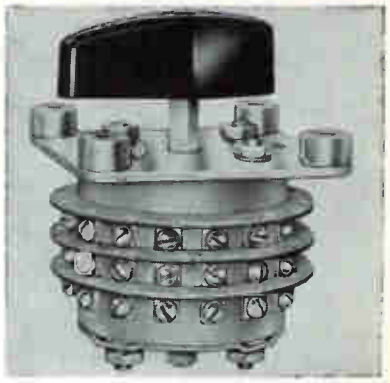
DYNAMIC GEAR CO., Dixon Ave., Amityville, N. Y. This rugged transmission, utilizing gears made of DuPont Delrin, features 15 precisely controlled speeds ranging from 3.3 to 7,812 rpm. RPM is electronically controlled by the use of magnetic clutches with desired speeds obtained by mere dialing. Case dimensions, excluding power source and control panel, measures 4¼ in. wide, 7¼ in. long and 3⅝ in. high. Torque developed at the various speeds ranges from 50 oz in. to well over 100 oz in. Typical applications of the transmission are for recording instruments such as oscillographs and other devices requiring constant and precise speeds. It can also be used as a laboratory device for testing servo packages.

CIRCLE 328 ON READER SERVICE CARD

Relays
resonant reed

BRAMCO, INC., 4501 Belvidere, Detroit 14, Mich. Resonant reed relay has four channels with frequencies from 315 cps to 405 cps. Sensitivity is 3 mw with a bandwidth of 6 cps. Contact rating is 60 ma at 67½ v. Field coil impedance is 27,000 ohms. Unit has a closure time of 75 millisec. It measures less than 1½ in. all dimensions. Price is under $5.00 in production quantities.

CIRCLE 329 ON READER SERVICE CARD

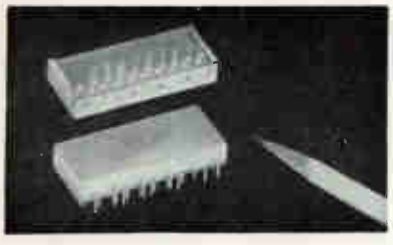


Rotary Switch
16-position

ELECTRO SWITCH CORP., King Ave., Weymouth 88, Mass. Manufactured in accordance with BuShips Drawing 815-1853013 and MIL-S-21604, the type JK rotary switch provides 16 positions, fifteen ON and one OFF, for 3, 5 and 10 ganged sections from one to ten. With an interrupting rating of 5 amperes at 125 v a-c, unity power factor, this switch has

an electrical-life rating of 40,000 operations (make and break). Contacts are non-shorting (break-before-make). Screw terminals are provided. Switch is designed for mounting behind a ¼-in. maximum panel. Switch body diameter is 2 1/8 in. Depth behind panel is 2 3/4 in. for a single-section switch, 6 in. for a 10-section switch. Weights range from 19 to 44 oz.

CIRCLE 330 ON READER SERVICE CARD



Logic Module
for digital systems

TELE-DYNAMICS, Division of American Bosch Arma Corp., 5000 Parkside Ave., Philadelphia 31, Pa. Type 6000A logic module, containing two solid-state switching circuits, can be interconnected to form all of the major building blocks required for digital systems. Each switching circuit contains a 4-input diode gate, an inverting amplifier, and a transition-triggered pulse generator. The logic module operates at a maximum pulse repetition rate of 5 Mc. The inverting amplifier output has a 40 nanosec rise time and an 80 nanosec fall time. The pulse output occurs on a positive-going transition. The pulse has a half-amplitude duration of 100 nanosec. Power consumption is less than 1 w per module.

CIRCLE 331 ON READER SERVICE CARD

Test Instruments
versatile unit

BARKER & WILLIAMSON, INC., Bristol, Pa. Matchmaster model 52-500 protects radio transmitters dur-

ing tuning and facilitates adjustment of antenna systems. It is designed for permanent connection into 50 ohm coaxial lines such as RG-8/U. Self-contained, the unit includes: (1) built-in dummy antenna of 52 ohms, which prevents the development of excessive voltages in pi-network output circuits during tuning or mistuning; (2) swr indicators—direct measurement of the swr on the antenna transmission line being provided by the flick of a switch; and (3) radio frequency power meter—scale calibrated to read transmitter output power directly up to 600 w.

CIRCLE 332 ON READER SERVICE CARD

Portable TV Battery
silver-cadmium

YARDNEY ELECTRIC CORP., 40-50 Leonard St., New York, N. Y., has developed a lighter, smaller silver-cadmium portable tv battery capable of more than 2,000 hr of operation (500 charge-discharge cycles). The 8-cell power pack (8XYS5) weighs only 2.6 lb; is 3.16 in. wide, 3.24 in. long and 3.92 in. high; offers 22.4 watt-hr per lb and 1.5 watt-hr per cu in. It is rated at 5 ampere hours; has a nominal operating voltage of 8.7 v; and can be operated at temperatures ranging from −20 F to 140 F and stored at temperatures ranging from −40 F to 165 F. In typical application, it produces 8.7 w for 6.7 hr.

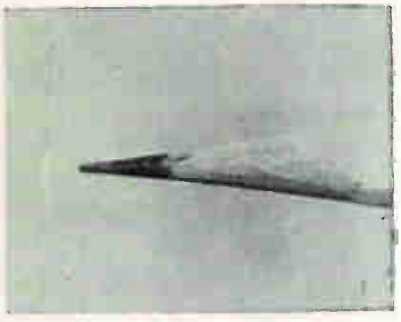
CIRCLE 333 ON READER SERVICE CARD

Signal Generator
1,300 to 2,500 Mc

SIERRA ELECTRONIC CORP., 3885 Bohannon Drive, Menlo Park, Calif. Model 201B f-m signal generator covers the frequency range of 1,300 to 2,500 Mc in one band. It provides excellent f-m characteristics and is specifically designed for

telemetry and data transmission applications in this range. Featuring a 1 percent deviation linearity, unit can be frequency modulated by applications of external signals having modulation bandwidths up to 500 Kc.

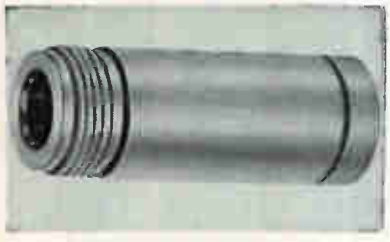
CIRCLE 334 ON READER SERVICE CARD



Incandescent Lamp
microminiature

KAY ELECTRIC Co., 14 Maple Ave., Pine Brook, N. J. The microminiature Pinlite is an incandescent lamp that measures 0.015 in. in diameter and 0.062 in. in length. Furnished with axial platinum leads 0.003 in. in diameter, it produces a bright pinpoint of light. It operates on 1.5 v d-c, 15 ma. Typical applications include: missile applications, computer read-out, meter pointer visual aid, high frequency indicator to 3,000 Mc, "low-voltage, low current circuit performance indicators for transistorized circuits." It also has many uses in medicine and medical electronics.

CIRCLE 335 ON READER SERVICE CARD



Coax Terminations
fixed-mismatch

RADAR DESIGN CORP., Syracuse, N. Y. These deliberately mismatched terminations present a constant known value of vswr to 50-ohm line over an extended frequency range, to facilitate rapid calibration of vswr-measuring equipments. Applications include: rapid calibration of microwave reflectometers (including scope-trace types), quick overall accuracy check of slotted line equipments and as realistic dummy loads during microwave network development. N, BNC and TNC connector types cover 0-3,000 Mc and LT connector types cover 0-1,500 Mc. Standard vswr values are 1.5, 2.0, 2.5, 3.0. Price is $35 to $75 per unit depending on connector type.

CIRCLE 336 ON READER SERVICE CARD

Servo Amplifiers
small units

MUIRHEAD & Co. LTD., Beckenham, Kent, England. The D-846 transistorized servo amplifiers are designed to supply the center-tapped, low voltage control windings of 400 cps size 10, 11, 15 or 18 servomotors. The units are of compact design, have a low power dissipation and are eminently suitable for use in larger servo equipments.

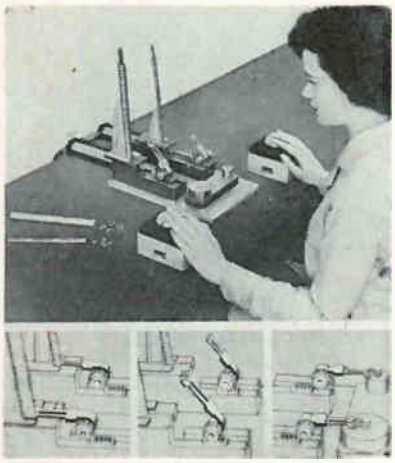
CIRCLE 337 ON READER SERVICE CARD

High Vacuum Diode
forced-air-cooled

CENTRAL ELECTRONIC MANUFACTURERS, 2 Richwood Place, Denville, N. J., announces the XD-18 diode for use in giant size radar power supplies and modulators. This forced-air-cooled high vacuum type diode will withstand 40 Kv piv and delivers 15 amperes average current. As a clipper or shunt diode it is rated at 300 amperes maximum current. The hard tube diode is ruggedly constructed, and measures

10½ in. long with a diameter of 4⅝ in. The tube conveniently mounts in a standard CEM socket.

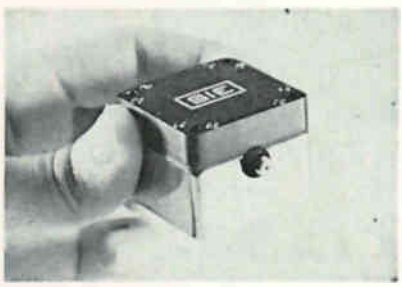
CIRCLE 338 ON READER SERVICE CARD



Assembly Machine for retaining rings

WALDES KOHINOOR, INC., 47-16 Austel Place, Long Island City 1, N. Y. The Ring-O-Mat is designed for high-speed, mass-production assembly of radially-installed Truarc series 5103 Crescent rings, series 5133 E-rings and series 5144 Reinforced E-rings. Rapid loading with stacked rings supplied in the tape-wrapped Rol-Pak cartridges assures a constant supply of the fasteners. The unit illustrated was designed to install two rings simultaneously in the roller assembly in front of the operator. A series 5144 ring is used to secure the large roller to the base plate; a smaller series 5133 ring fastens the roller at the right.

CIRCLE 339 ON READER SERVICE CARD



Vibration Pickup small size

SOUTHWESTERN INDUSTRIAL ELECTRONICS CO., 10201 Westheimer Road, Houston 27, Texas. Model TD-6 vibration pickup incorporates a newly developed, unique magnetic circuit which combines the temperature stability of magnetic damping with the sensitivity previously available only in fluid damped units. Featured are small size (1½ by 1½ by 1⅝ in.), light weight (6.5 oz), wide frequency range (20-2,000 cps) and low price ($175 and quantity discounts are available). Its threshold velocity is essentially zero.

CIRCLE 340 ON READER SERVICE CARD

Relay constant voltage

HI-G, INC., Bradley Field, Windsor Locks, Conn. Over a temperature range of — 65 C to + 85 C, the SV series constant voltage relay will maintain its pull-in voltage to within ± 5 percent of nominal. Pull-in voltage may be chosen in the 25 v d-c to 200 v d-c range. Contact rating 4 amperes at 115 v a-c or 32 v d-c, life 100,000 cycles, vibration 20 g to 2,000 cps, shock 50 g for 11 millisec.

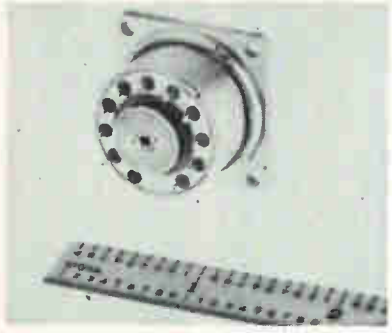
CIRCLE 341 ON READER SERVICE CARD

Dual Controls back-to-back

CLAROSTAT MFG. CO., INC., Dover, N. H., has available an assembly of two potentiometers welded back-to-back. Assembly permits a variety of mountings including a single bushing through chassis, U-bracket-mounting, and other variations. Designed to meet the growing requirements for channel balancing such as in stereo systems, limited space applications, unitized chassis construction, etc. The controls are available in various sizes, wattages, and winding arrangements. Half-watt composition element controls to 2 w; available in resistance ranges from 500 ohms to 10 megohms. Wirewound element controls are available in 2 w to 4 w rating from 1 ohm to 100,000 ohms. The back-to-back arrangement makes possible positioning of the ter-

minals of each control to each other in any desired position.

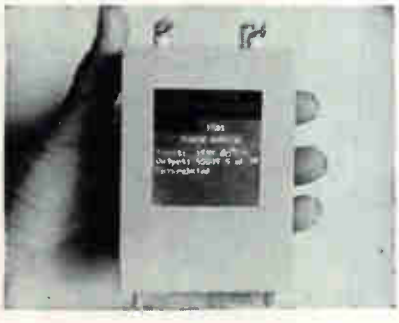
CIRCLE 342 ON READER SERVICE CARD



Linear Accelerometer hermetically sealed

FAIRCHILD CONTROLS CORP., Components Division, 225 Park Ave., Hicksville, N. Y. Model TA-400 is designed for missile and aircraft application. It has an extremely sensitive differential transformer pick-off. It will measure acceleration from $\pm\frac{1}{4}$ g to ± 50 g. Unit has partially controlled damping over a temperature range from 55 to +100 C. The pick-off is wired with additional taps to allow a d-c or a-c excitation (filterable from pick-off excitation) to be superimposed. This torques the restrained pendulum in either direction from null.

CIRCLE 343 ON READER SERVICE CARD



D-C Power Supply very small package

ATLAS TRANSFORMER CO., 1839 Moore St., San Diego 1, Calif. Model 1501 is a 5,000 v d-c power supply in a package measuring $2\frac{7}{8}$ in. by 3 in. by $4\frac{1}{4}$ in. Unit is capable of delivering up to 5 ma. It has less than 1 percent ripple and is designed for a 115v a-c at 60 cps input.

CIRCLE 344 ON READER SERVICE CARD

Literature of

REFRACTION SEISMOGRAPH SYSTEM. Southwestern Industrial Electronics Co., 10201 Westheimer Road, Houston 27, Texas. The P-19 portable refraction seismograph system is described in an illustrated bulletin. Specifications are included.

CIRCLE 380 ON READER SERVICE CARD

FANS AND BLOWERS. Globe Industries, Inc., 1784 Stanley Ave., Dayton 4, Ohio. Bulletin FB is a new simplified guide to determining cooling requirements for electronic applications and for selecting the proper type and capacity of most miniature fans and blowers.

CIRCLE 381 ON READER SERVICE CARD

INSULATING MATERIAL. Natvar Corp., Randolph Ave., Woodbridge, N.J., has available a data sheet and samples of Teraglas, a flexible insulating material comprising a base fabric, woven from polyester warp yarns and continuous filament glass filler yarns, coated with an improved varnish, possessing exceptional dielectric strength properties under elongation.

CIRCLE 382 ON READER SERVICE CARD

LEAK DETECTORS. Consolidated Electrodynamics Corp., 360 Sierra Madre Villa, Pasadena. Calif. Bulletin 1857 contains tables of conversion factors, formulas, performance charts, hints and other useful information for users of mass spectrometer-type leak detectors.

CIRCLE 383 ON READER SERVICE CARD

TRANSFORMERS. Arnold Magnetics Corp., 6050 W. Jefferson Blvd., Los Angeles 16, Calif. A two-color bulletin offers detailed technical data on a range of small-size, high-temperature transformers.

CIRCLE 384 ON READER SERVICE CARD

SILICON RECTIFIERS. Sarkes Tarzian, Inc., Semiconductor Division, Bloomington, Ind., has released its new silicon rectifier handbook, which normally sells for one dollar, free of charge. Seven chapters cover semiconductor theory, manufacturing methods, rec-

the Week

tifier characteristics, rectifier circuits, test circuits, rectifier and filter circuit design, and application techniques.

CIRCLE 385 ON READER SERVICE CARD

CAPABILITIES BROCHURE. LEL, Inc., 380 Oak St., Copiague, L.I., N.Y. A new brochure describes the capabilities and facilities of the company, the range of products developed, and includes a partial listing of the customers who utilize them. Company background is outlined.

CIRCLE 386 ON READER SERVICE CARD

SOLDERING BOOKLET. Anchor Metal Co., Inc., 966 Meeker Ave., Brooklyn 22, N. Y., announces the publication of a handy booklet written especially for production personnel involved in soft and hard soldering.

CIRCLE 387 ON READER SERVICE CARD

INSTRUMENT JOURNAL. Allen B. DuMont Laboratories, Inc., 750 Bloomfield Ave., Clifton, N. J. Issue 8 of the *Instrument Journal* contains articles on printed wiring and techniques of repairs, simulation testing for reliability and four new crt developments.

CIRCLE 388 ON READER SERVICE CARD

RELAY MANUAL. Diaphlex Division, Cook Electric Co., 2700 Southport Ave., Chicago 14, Ill., has released a relay manual featuring 30 types of relays (with 1,000 variations), for communications, computers, industry and the military.

CIRCLE 389 ON READER SERVICE CARD

PARTIALLY COATED METALS. Alpha Metals, Inc., 56 Water St., Jersey City 4, N.J., has available a technical data sheet describing the physical properties of partially coated metals used as base tabs in the manufacture of transistors, or as a solder-coated part acting as its own preform.

CIRCLE 390 ON READER SERVICE CARD

PROGRAMMABLE POWER SUPPLIES. Electronic Measurements Co., Inc., Eatontown, N.J. Bulletin 375 explains the optional chopper stabilization feature of Regatron programmable power supplies.

CIRCLE 391 ON READER SERVICE CARD

Republic Foil Goes South

LAST YEAR Republic Foil Inc. of Danbury, Conn., looking around for a location suitable for its aluminum foil etching operation, spotted fifty-five acres of industrial property in Salisbury, North Carolina. The milieu seemed so suited to company needs that Jack Douglas, president, and his associates lost no time in putting up a division that is presently devoted exclusively to etch 99.99 percent pure aluminum foil for electrolytic capacitors.

The foil is rolled at Republic's Rolling Mill division in Danbury and shipped to Salisbury for processing. The Salisbury site was chosen because of several key factors. Large quantities of foil dictated a low-cost power area with enough land to permit future expansion. Transportation facilities were also a consideration. The 15,000-sq-ft plant houses foil etching lines and supplementary equipment. Plant equipment was planned by Bill Hooper, Republic's vice president in charge of research and development, specifically to produce high purity foil.

Financing of the Electrochemical division was accomplished in May, 1959, through the sale of 70,196 shares of the company's capital stock at $12.50 per share in accordance with a subscription offering to stockholders and sale to underwriters. Subsequently, in July, 1959, the company's stock was listed on the American Stock Exchange.

The company's rolling mill in Danbury is a major producer of standard purity aluminum foil for electrical capacitors. This division also manufactures converter foil for packaging and decorative purposes.

Each production roll of etched foil turned out at the Salisbury plant is tested in a modern control laboratory built right into the production line. Other physical and chemical tests are completed before the roll is approved for slitting and shipping to the customer.

Republic's two divisions employ approximately 175 persons.

DCA Adds Plant, Expands Another

DYNAMICS CORP. OF AMERICA recently announced that it has added a new expandable facility (its sixth) at Farmingdale, N. J., and has greatly enlarged the operation of its main communications plant in Long Island City, N. Y.

The new 31,000 sq ft Farmingdale plant will be the main production center for the company's television and f-m broadcast equipment (formerly manufactured at Long Island City), and will also manufacture specialty transformers and air purifiers.

At the company's Long Island City plant (operated by its Radio Engineering Laboratories subsidiary) the steadily increasing influx of orders for tropospheric scatter communications equipment has necessitated greatly expanded operations. Administrative and engineering departments have been enlarged by 30 percent. The number of employees has been tripled (from approximately 200 a year ago to almost 600 today).

Together with a new plant addition now being completed at the company's Reeves-Hoffman Division (producers of quartz crystals and fractional h-p motors) in Carlisle, Pa., these latest expansions bring the total manufacturing space in all six DCA plants to roughly 800,000 sq ft.

TMI Division Hires Englert

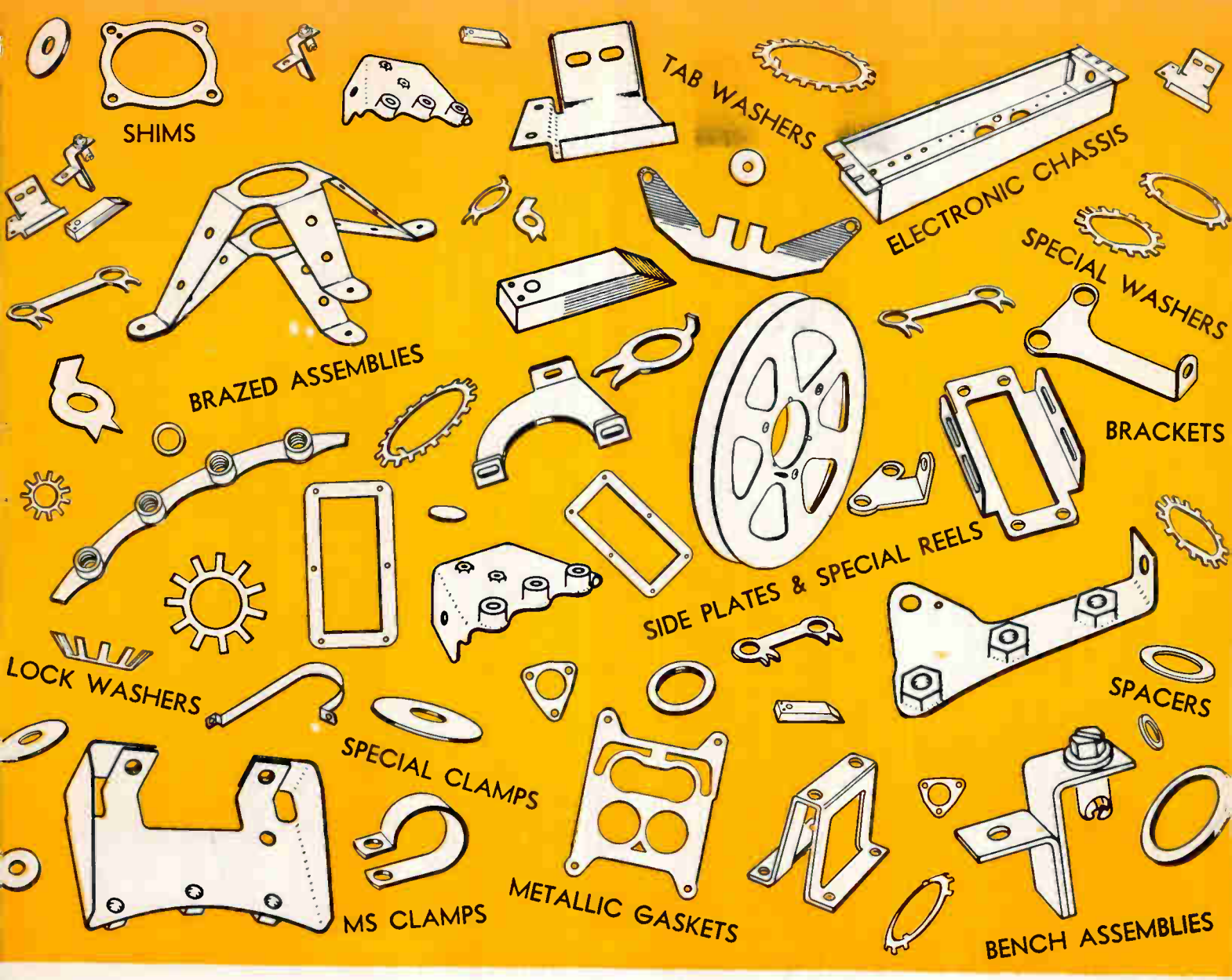
ROBERT ENGLERT has joined Telemeter Magnetics, Inc., Components Division, as applications engineer. He will provide engineering assistance for customers' problems involving magnetic data storage components.

Englert was formerly with Telecomputing Corp. where he served as western manager of field engineering, a position he held for 4 years.

The TMI Components Division is engaged in the development and manufacture of ferrite magnetic cores for memory and logic functions, wired core arrays, and complete memory modules.

General Radio Elects Officers

DONALD B. SINCLAIR, formerly vice president and chief engineer of the General Radio Co., West Concord,



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You'll get better service on Stampings from THE LAMINATED SHIM COMPANY. This is literally true because (a) we've been doing it since 1913, and (b) we've perfected our own special equipment, toolings and techniques—all unknown to the ordinary stampings shop. Therefore you get *exactly* what you want, including the degree of precision you need—any contour, often without dies—any size—any quantity—fast, and at a surprisingly low cost—according to our

1 **"ONE PLUS" METHOD**

Applies when you need just a few pieces for prototypes or experiment. We hold all critical dimensions, yet avoid tooling charges.

2 **SHORT RUN METHOD**

More than "a few," but less than production quantities. Temporary tooling, simple dies and special presses keep costs down.

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Applies when quantity, tolerance, size and contour factors justify our standard production tooling and/or nominal die charges.

4 **"WATCH DOG" SERVICE**

A routine procedure. We re-evaluate repeat orders as to quantity and specs—then use the Method best for you.

Result: lowest possible cost per unit, regardless of quantity. Want more details? And suggestions for ordering Stampings economically? Send for STAMPINGS Folder No. 3—a most helpful reference booklet.

Stampings DIVISION • THE LAMINATED SHIM COMPANY, INC.

4601 UNION STREET, GLENBROOK, CONNECTICUT

Mass., was recently appointed executive vice president and technical director at a meeting of the board of directors.

At the meeting, Arthur E. Thiessen, formerly vice president, was named chairman of the board. Ivan G. Easton, formerly engineering manager, was appointed vice president for engineering, and Harold M. Wilson, formerly manufacturing manager, was named vice president for manufacturing.

Sinclair, Thiessen and Charles C. Carey were reelected directors at the annual stockholders' meeting. Lawrence H. Pexton and John D. Quackenbos were elected treasurer and clerk of the company, respectively.

Carey continues as president and chairman of the management committee.

Johnson Takes New Position

ROBERT V. JOHNSON, has been appointed manager of applications engineering in the Equipment Division of Levinthal Electronic Products, Palo Alto, Calif., a subsidiary of Radiation, Inc. He moves to Levinthal from Lenkurt Electric Co., where he was concerned with sales of research and development programs and systems engineering in connection with carrier telephone and telegraph and other communications-engineering activities for the government.

In his new post Johnson will be in charge of applications-engineering activities affecting the

company's line of transmitters, modulators, power supplies, pulse transformers, and accessories as used in the fields of radar, communications and tube development.

MARS Schedules Program for May

THE First U.S. Army MARS (Military Affiliate Radio System) SSB Technical Net, whose mission is to disseminate technical knowledge by radio communication, announces its May schedule. Upon completion of the May lectures, the net will recess until September.

The net meets on 4030 kilocycles each Wednesday at 9:00 P.M. EDT.

The schedule for May includes:

May 4—"Antenna Panel" by W. Offutt, engineering manager; L. DeSize, group leader, and B. Woodward, engineer, Airborne Instruments Lab, Inc., Melville, L. I., N. Y.

May 11—"Frequency Control" by G. Winkler, scientist, USARDL, Ft. Monmouth, N. J.

May 18—"Communication Electronic Needs of the Future" by J. V. Harrington, division head, and B. Lax, MIT Lincoln Laboratory, Lexington, Mass.

May 25—"Fundamentals of Oscillator Operation" by R. W. Gunderson, editor, Braille Technical Press, New York, N. Y.

Avnet Hires A.W. Keough

ARTHUR W. KEOUGH has been appointed quality control manager of the Los Angeles division of the Avnet Electronics Corp., it was recently announced by Robert H. Avnet, chairman of the board.

The company, which has plants in Westbury, N. Y., Los Angeles and Sunnyvale, Calif., and Chicago, Ill., assembles and distributes electronic connectors and other components to the electronics, missile and aircraft electronics industries.

Keough comes to Avnet from Westinghouse, where he was quality control foreman at the Bath, N. Y., plant.

BACKTALK

Low-Frequency Antennas

Please note the following corrections to the article "Design Charts for Low-Frequency Antennas," p 86, March 18.

In the first paragraph, the reference superscript (1) should appear after "antenna size."

The last line of the first column on page 88 should read ". . . where $C_2 = 0.35\ d_o$ is the capacitance of the disk in pf (remote from earth), d_o is the . . ."

In the caption for Fig. 4, change "$60 < (h/2) < 90$" to read "$60 < (h/a) < 90$."

I would appreciate your publishing these corrections at an early date. Thank you for your consideration and for the fine presentation given this article.

PHOENIX, ARIZONA G. J. MONSER

Materials

Why doesn't the government do something about the serious lag in the development of materials? In many cases the state of the art in the field of electronics is held up due to inadequate materials. This blind spot is a greater threat to our national security than many people seem to realize.

ST. JOHN S. C. MORRISETTE
VIRGIN ISLANDS

The National Academy of Sciences has recently published a report voicing the same sentiments. See p 85, this issue.

Quartz Clock

In the Feb. 12 issue of ELECTRONICS we read an article by Mr. J. Bauer on research in Switzerland. On page 91, at the end of the report, are mentioned the works made in electronic horology and in particular the development of a small quartz clock.

We would like to specify that our firm is at the origin of this work and that one of the prototypes realized has obtained in the United States the "excellency certificate" of the "Miniaturization Award", in 1959.

Moreover, we inform you that these high precision frequency and

time standards are on the point of coming out commercially, and that the applications foreseen are, namely: marine chronometer, portable instrument for geophysics and geodetics, clocks for office and home use. The precision indicated by the author above mentioned is improved by a factor of 10 approximately, and passes from 0.1 sec per 24 hr (approx 1 x 10^{-7}).

A. G. KRASSOIEVITCH
HEAD OF RESEARCH AND DEVELOPMENT
ADVANCED RESEARCH DIVISION
PATEK PHILLIPPE & CO.
GENEVA, SWITZERLAND

'Fine Reporting'

I feel that you did a very fine job of reporting the state of the art as it exists at the moment in your article, "How Built-In Damping Stills Vibration," p 186, Mar. 11. I am sure your report will be of real service to your many readers.

E. A. JOHNSON
WATERTOWN, MASS.

Diodes

In your article, "Diodes: New Market Appeal" (p 36, Feb. 26), you state that my colleagues and I have achieved Esaki diode oscillation frequencies of 5,300 Mc/sec. at one microvolt. It should, of course, be one microwatt.

R. F. RUTZ
POUGHKEEPSIE, N. Y.

Surface Gap Plug

I note that both B and C in the photo in "Electronics Advances In Ignition Systems," p 82, March 25, point to the ground electrode. Did you intend this, or should C point to the thin dark ring, the gap material (insulator) which lies between A, the center electrode, and B, the ground electrode ring?

TOLEDO, OHIO A. J. VADINO

Our thanks to Mr. Vadino, who provided the plug used in the photo, for raising this point. Actually, we intended that arrow B should point to the dark inner ring (semiconductor gap) and C to the light ring (ground electrode) between the two dark rings.

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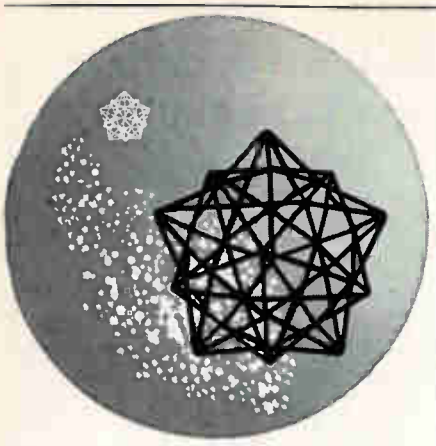

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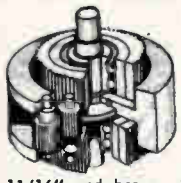

The 1:1 reverse ratio spur gears are 48-tooth, 32 pitch brass with 3/16" available face. On one side, the shaft is 23.64" dia. for 11/16" and has a pin hole, then increases in dia. to .377" for the remaining 3/16" of length. On the other side, the shaft is .377 dia. 1/4" lg. 2-13/16" dia. is required to clear the body.
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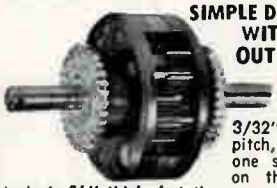

1:1 reverse ratio spur gears are aluminum, 3/32" face, 32 pitch, 32 tooth on one side, 48 tooth on the other. The body is 3/4" thick, but the sun gears are spaced out so that they are 1 1/2" apart. 1/4" dia. shaft on each side is 23/32" long. OA length 3 1/8". Requires 1-23/32" dia. to clear the body.
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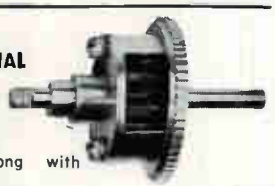

1:1 reverse ratio, 60 teeth on large gear; 1/4" shaft. Size: 3" long with 1-15/16" dia.
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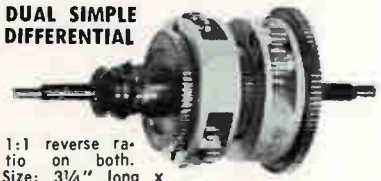

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IN1467	75 amp.	200 volts	11.00
IN1468	75 amp.	300 volts	12.50
IN1469	75 amp.	400 volts	14.00
05T7	100 amp.	50 volts	12.50
10T7	100 amp.	100 volts	13.00
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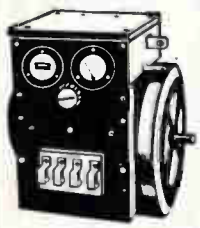

7.5 kw, 3428 rpm, pf .95 Star connected 120/208 3 phase, 22 amps. Delta connected 120 volt single phase 66 amps. Self excited. Complete with control box, voltage regulator, AC voltmeter and frequency meter. Shaft 1" dia., 2" long; overall dim. of unit: 21"x18"x 20".
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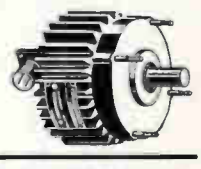

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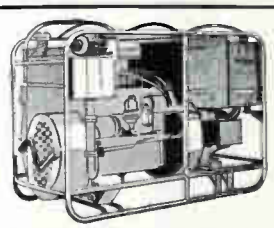
Model #5ATB324E5
Output 120/208 volts AC, 400 cycle, 11.75 kva, 32.6 amp., pf .85. Input 220/440 volts AC, 60 cycle, 3 phase, 15 h.p. Unit complete with motor starter and controls. **Price $750.00**



POWER UNIT PU-104/U

5 KW 120/208 volt AC single or 3-phase permanent magnet type 400 cycle alternator. Alternator is driven by Hercules model ZXB 4-cylinder 4-cycle "L" head liquid cooled gasoline engine. This unit is complete with a control panel.
Price $495.00

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P. O. Box 12, N. Y. 36, N. Y.

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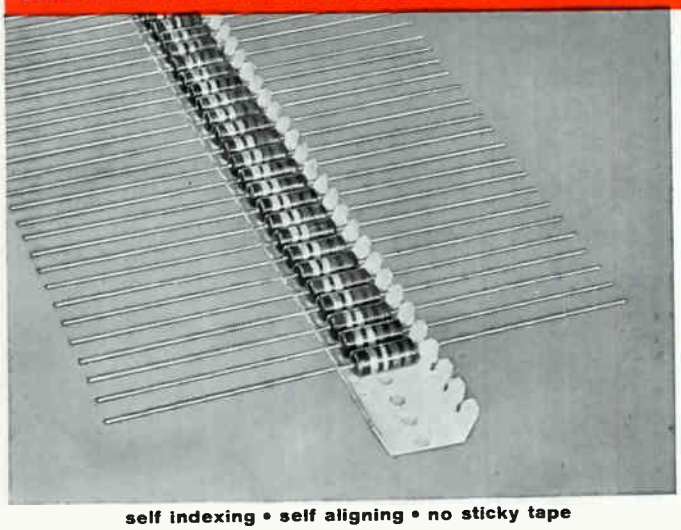
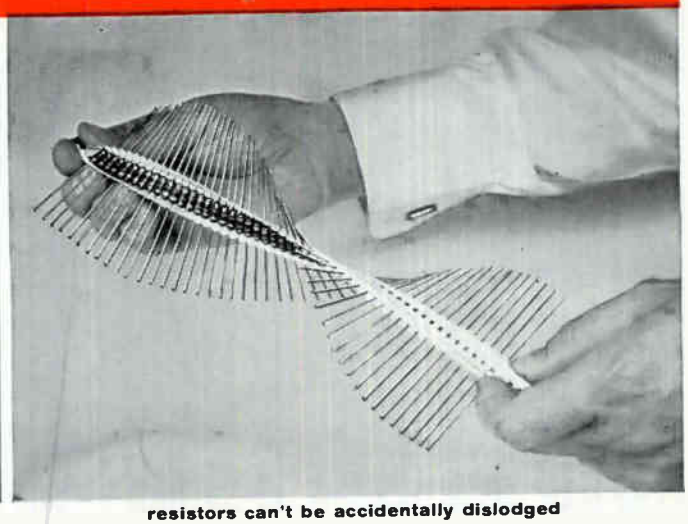
In AUTOMATION PACKAGING if it's news, expect it first from IRC

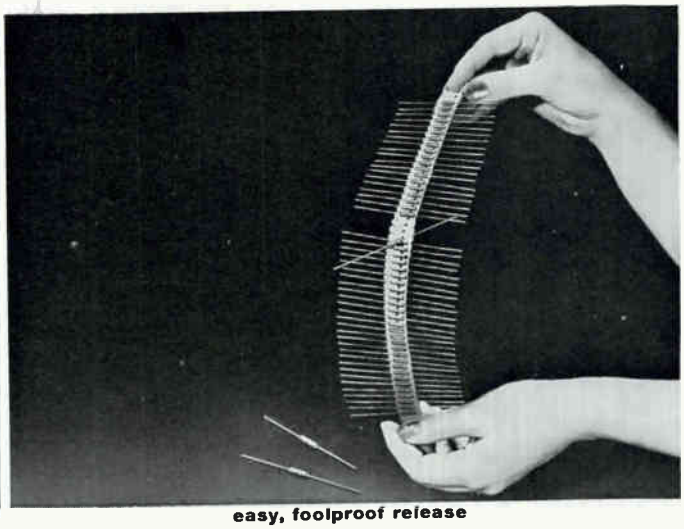


self indexing • self aligning • no sticky tape



resistors can't be accidentally dislodged

uniform quantity in each strip and box



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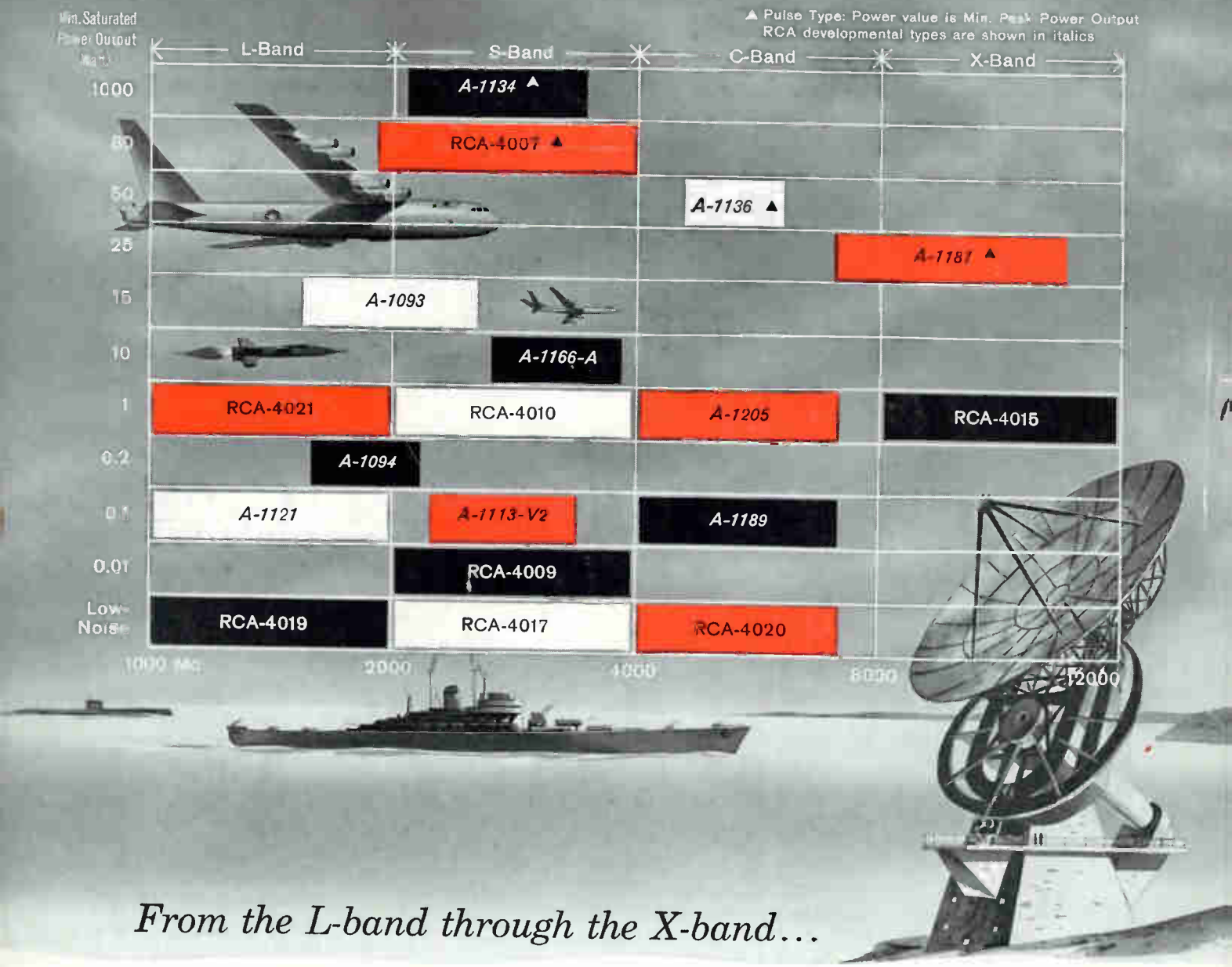

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