APRIL 24, 1959

electronics

A McGRAW-HILL PUBLICATION VOL. 32, No. 17 PRICE SEVENTY-FIVE CENTS

Special

The Challenge of Space

UTC NEW EXPANDED DO-T AND DI-T SERIES

Revolutionary transistor transformers hermetically sealed to MIL-T-27A Specifications.

UTC DO-T and DI-T transistor transformers provide unprecedented power handling capacity and reliability coupled with extremely small size. Comparative performance with other available products of similar size are shown in the curves (based on setting output power at 1 KC, then maintaining same input level over frequency range). The new expanded series of units cover virtually every transistor application.

DO-T

ACTUAL SIZE

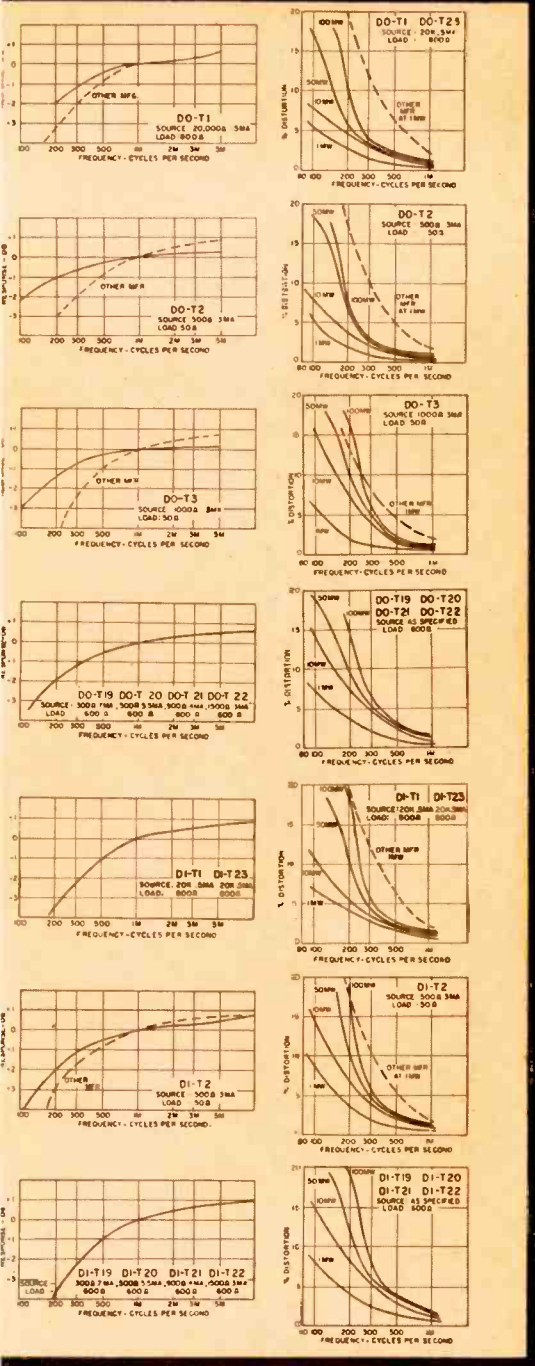
5/16 Dia. x 13/32, 1/10 Oz.

- High Power Rating . . . up to 100 times greater.
- Excellent Response . . . twice as good at low end.
- Low Distortion . . . reduced 80%.
- High Efficiency . . . up to 30% better.
- Moisture Proof . . . hermetically sealed to MIL-T-27A.
- Rugged . . . completely cased.
- Anchored Leads . . . withstand 10 pound pull test.
- Printed Circuit Use...plastic insulated leads.

DI-T

ACTUAL SIZE

5/16 Dia. x 1/4, 1/20 Oz.



DO-T No.	MIL Type	Application	Pri. Imp.	D.C. Ma.‡ in Pri.	Sec. Imp.	Pri. Res. DO-T	Pri. Res. DI-T	Level MW.	DI-T No.
DO-T1	TF4RX13YY	Interstage	20,000 30,000	.5 .5	800 1200	850	815	50	DI-T1
DO-T2	TF4RX17YY	Output	500 600	3 3	50 60	60	65	100	DI-T2
DO-T3	TF4RX13YY	Output	1000 1200	3 3	50 60	115	110	100	DI-T3
DO-T4	TF4RX17YY	Output	600	3	3.2	60		100	
DO-T5	TF4RX13YY	Output	1200	2	3.2	115	110	100	DI-T5
DO-T6	TF4RX13YY	Output	10,000	1	3.2	1000		100	
DO-T7	TF4RX16YY	Input	200,000	0	1000	8500		25	
DO-T8	TF4RX20YY	Reactor 3.5 Hys. @ 2 Ma. DC, 1 Hy. @ 5 Ma. DC				630			
	TF4RX20YY	Reactor 2.5 Hys. @ 2 Ma. DC, .9 Hy. @ 4 Ma. DC				630			DI-T8
DO-T9	TF4RX13YY	Output or driver	10,000 12,500	1 1	500 CT 600 CT	800	870	100	DI-T9
DO-T10	TF4RX13YY	Driver	10,000 12,500	1 1	1200 CT 1500 CT	800	870	100	DI-T10
DO-T11	TF4RX13YY	Driver	10,000 12,000	1 1	2000 CT 2500 CT	800	870	100	DI-T11
DO-T12	TF4RX17YY	Single or PP output	150 CT 200 CT	10 10	12 16	11		500	
DO-T13	TF4RX17YY	Single or PP output	300 CT 400 CT	7 7	12 16	20		500	
DO-T14	TF4RX17YY	Single or PP output	600 CT 800 CT	5 5	12 16	43		500	
DO-T15	TF4RX17YY	Single or PP output	800 CT 1070 CT	4 4	12 16	51		500	
DO-T16	TF4RX13YY	Single or PP output	1000 CT 1330 CT	3.5 3.5	12 16	71		500	
DO-T17	TF4RX13YY	Single or PP output	1500 CT 2000 CT	3 3	12 16	108		500	
DO-T18	TF4RX13YY	Single or PP output	7500 CT 10,000 CT	1 1	12 16	505		500	
DO-T19	TF4RX17YY	Output to line	300 CT	7	600	19	20	500	DI-T19
DO-T20	TF4RX17YY	Output or line to line	500 CT	5.5	600	31	32	500	DI-T20
DO-T21	TF4RX17YY	Output to line	900 CT	4	600	53	53	500	DI-T21
DO-T22	TF4RX13YY	Output to line	1500 CT	3	600	86	87	500	DI-T22
DO-T23	TF4RX13YY	Interstage	20,000 CT 30,000 CT	.5 .5	800 CT 1200 CT	850	815	100	DI-T23
DO-T24	TF4RX16YY	Input (usable for chopper service)	200,000 CT	0	1000 CT	8500		25	
DO-T25	TF4RX13YY	Interstage	10,000 CT 12,000 CT	1 1	1500 CT 1800 CT	800	870	100	DI-T25
DO-T26	TF4...0YY	Reactor 6 Hy. @ 2 Ma. DC, 1.5 Hy. @ 5 Ma. DC				2100			
	TF4...0YY	Reactor 4.5 Hy. @ 2 Ma. DC, 1.2 Hy. @ 4 Ma. DC				2300			DI-T26
DO-T27	TF4...20YY	Reactor 1.25 Hy. @ 2 Ma. DC, .5 Hy. @ 11 Ma. DC				100			
	TF4RX20YY	Reactor .9 Hy. @ 2 Ma. DC, .5 Hy. @ 6 Ma. DC				105			DI-T27
DO-T28	TF4RX2DYY	Reactor .3 Hy. @ 4 Ma. DC, .15 Hy. @ 20 Ma. DC				25			
	TF4RX20YY	Reactor .1 Hy. @ 4 Ma. DC, .08 Hy. @ 10 Ma. DC				25			DI-T28
DO-T29	TF4RX17YY	Single or PP output	120 CT 150 CT	10 10	3.2 4	10		500	
DO-T30	TF4RX17YY	Single or PP output	320 CT 400 CT	7 7	3.2 4	20		500	
DO-T31	TF4RX17YY	Single or PP output	640 CT 800 CT	5 5	3.2 4	43		500	
DO-T32	TF4RX17YY	Single or PP output	800 CT 1,000 CT	4 4	3.2 4	51		500	
DO-T33	TF4RX13YY	Single or PP output	1,060 CT 1,330 CT	3.5 3.5	3.2 4	71		500	
DO-T34	TF4RX13YY	Single or PP output	1,600 CT 2,000 CT	3 3	3.2 4	109		500	
DO-T35	TF4RX13YY	Single or PP output	8,000 CT 10,000 CT	1 1	3.2 4	505		500	
DO-T36	TF4RX13YY	Isol. or Interstage	10,000 CT	1	10000 CT	950	970	500	DI-T36

DO-TSH Drawn Hipermalloy shield and cover for DO-T's, provides 25 to 30 db shielding, for DI-T's DI-TSH

‡DCMA shown is for single ended useage (under 5% distortion—100MW—1KC) . . . for push pull, DCMA can be any balanced value taken by .5W transistors (under 5% distortion—500MW—1KC)

*DO-T units have been designed for transistor application only . . . not for vacuum tube service. Pats. Pend.

And Special Units to Your Specifications

UNITED TRANSFORMER CORPORATION

150 Varick Street, New York 13, N. Y.

PACIFIC MFG. DIVISION: 4008 W. JEFFERSON BLVD., LOS ANGELES 16, CALIF.

EXPORT DIVISION: 13 EAST 40th STREET, NEW YORK 16, N. Y. CABLES: "ARLAB"

electronics

APRIL 24, 1959

A McGRAW-HILL PUBLICATION
Vol. 32 No. 17

Issue at a Glance

Business

Engineering

Departments

Al Mitchell takes the stand for electronics

I. Allen Mitchell is President and a founder of United Transformer Corporation, a company which placed its first advertisement in electronics more than 25 years ago.

United Transformer manufactures 700 stock items for virtually every application in the electronics field. Mr. Mitchell is a graduate engineer who entered college at the age of 14. At 16 he was the chief engineer of a transformer company and at 18 the director of engineering.

Do you, Mr. Mitchell, directly or indirectly influence the purchase of electronic equipment for your organization?

Naturally, I do.

Do you use the electronics BUYERS' GUIDE as your source book for electronic purchases?

Yes. I keep it available in my office at all times.

How long have you been a subscriber to electronics?

Since the day of its inception.

Why have you continued to pay for electronics when you can receive ten other electronic publications free?

To me electronics has a peculiarity. It has excellent technical coverage. It has the most pages of advertising, and naturally I want to keep abreast of the industry in terms of the products shown in the ads.

For a number of years your company has reserved the inside front cover of electronics for its sales messages. What is behind this decision?

Basically, we are a key manufacturer in our field for engineering products. As such we prefer to maintain a prestige position in the prestige magazine of our industry.

If it's about electronics, read it in electronics

electronics

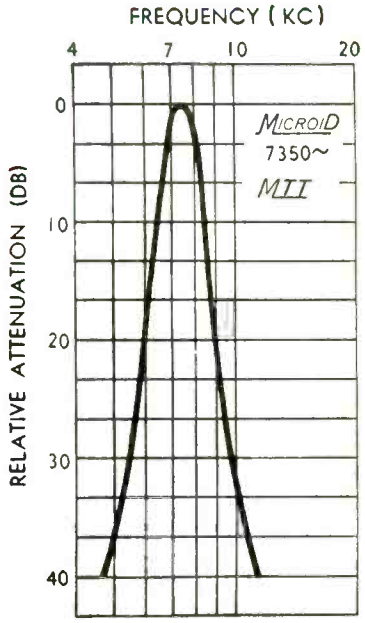
Published WEEKLY plus the mid-year electronics BUYERS' GUIDE
A McGraw-Hill Publication • 330 West 42nd Street, New York 36, N. Y.

SHRUNK BY EXPERTS

Burnell & Co. may not be experts in the art of head shrinking. But when it comes to toroids, filters and related networks, Burnell has the know-how to solve an infinite variety of small space problems. The new *MICROID* ® filters by Burnell & Co. are a notable achievement in the shrinking of filters which can be designed for low pass or band pass applications.

For example, as a low pass filter, Type *MLP* starts at 400 cps. Physical size is 11/16" x 1-11/16" x 1/2" max. For higher frequencies from 5 kc up to 100 kc, size is 3/4" x 1" x 1/2".

The band pass filter, Type *MTT* pictured here, ranges from 7,350 cycles up to 100 kc. Physical size is 1/2" x 19/32" x 15/16", weight .3 ounces, band width 15% at 3 db and + 60% — 40% at 40 db. Wherever space and performance are critical requirements, miniaturized *MICROID* ® low pass and band pass filters provide utmost reliability as well as more unit surface economy on printed circuit boards. Completely encapsulated, they are ideally suited to withstand high acceleration, shock and vibration environments. Write for special filter bulletin to help solve your circuit problems.



® REGISTERED TRADE MARK

Burnell & Co., Inc.

PIONEERS IN TOROIDS, FILTERS AND RELATED NETWORKS

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PELHAM 8-5000
TELETYPE PELHAM 3633

PACIFIC DIVISION
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RYAN 1-2841
TELETYPE PASACAL 7578

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SHOPTALK . . .

MICROCIRCUITS. More than a month ago the industry marveled at tiny electronic circuits developed under the Army Signal Corps' microminiaturization program and elsewhere. Two of our editors were already digging for stories in this area.

This week Associate Editor Mason tells you the business story of the Signal Corps program, and what the Navy's doing; the prime contractors' roles and who the subs are, what they are doing and what this program can mean to the industry.

Meanwhile, Associate Editor Sideris has been preparing tabular articles giving the first actual design information on microcircuit components so you can decide how the first fruits of this program may fit into your equipment. His first article on this subject will appear in our May 15 issue.

CHALLENGE OF SPACE. Historians centuries hence undoubtedly will categorize our times as the second great age of discovery. And the seven young men already in training for Project Mercury may well turn out to be the Magellans and the Cabots of outer space.

Electronics will play a major role in the conquest of space. Communications, guidance and navigation are obvious functions best handled electronically. Electronics may also generate the power needed aboard a space ship. It might even propel the vehicle itself.

In November, year 2 of the space age, Associate Editor Manoogian was assigned to do a special report on electronics in space. During the next six months he traveled, visiting industry and government scientists in other cities. He wrote dozens of letters, made countless telephone calls, attended pertinent meetings and seminars. Result was a 4½-ft stack of documents.

"The Challenge of Space" brings you the new and pertinent developments in space science that relate to our industry. The special report begins on p 65.

Coming In Our May 1 Issue . . .

IRE HIGHLIGHTS. Every year, the IRE show in New York is a busy time for ELECTRONICS staffers. Aside from their important function of buttonholing potential authors of future feature articles and digging up late, hot news about our fast-moving industry, the editors attend technical sessions, take prodigious amounts of notes, snap yards of photographs of slides, charts and graphs.

Next week, three members of our ubiquitous staff bring you the results of all this activity in a roundup. In this article by Managing Editor Carroll and Associate Editors Bushor and Weber, you'll read about new land-vehicle guidance by radar, new progress in medical electronics, microwave computers, space-ship tracking plans, minority carrier lifetime measurement in semiconductors using microwaves, and many other developments.

WEATHER SATELLITE. Vanguard II, launched late in February, was the first of the weather satellites. Despite some operating flaws, it is collecting hitherto inaccessible data, and weathermen are excited about the future use of satellites in meteorology.

Details of the instrumentation of the first weather-eye satellite are described in an article by R. Hanel, R. A. Stampfl, J. Licht, J. Cressey and E. Rich, Jr., of the U. S. Army Signal Research and Development Laboratory, Fort Monmouth, N. J. They describe the television-like instrument designed to record a picture of the earth cloud cover to locate and track major storms.

new transistors from Sprague*

SUPER HIGH-SPEED SWITCHING TRANSISTORS TYPE 2N501

	Typical	Maximum	Units
Rise Time (t_r)	9	18	mμsec
Storage Time (t_s)	9	12	mμsec
Fall Time (t_f)	7	10	mμsec

In circuit with current gain of 10 and voltage turnoff.

Also available as special type 2N501A for 100° C. maximum storage and junction temperatures.

This table tells the story. Sprague Type 2N501 germanium micro-alloy diffused-base transistors are the fastest mass-produced transistors available anywhere! They are unexcelled for high-speed computer applications. The ultra-low rise, storage, and fall time cannot be matched by any other transistor.

Ultra-precise process control in manufacture results in superb and consistent high quality. The basic electrochemical process of fabrication takes the guesswork out of transistor manufacturing. The result is outstanding uniformity of product.

Because of the electrochemical process, Sprague is able to fabricate a graded-base transistor with no intrinsic base region. The Type 2N501 can thus maintain its super high-speed switching characteristics right down to its saturation voltage, providing all the advantages of direct-coupled circuitry with no impairment of switching speeds.

Type 2N501 Transistors are available from Sprague now at extremely reasonable prices. They are transistors you can use today! You need not delay your development work for the future when you design high-speed switching circuits with Type 2N501 Micro-Alloy Diffused-Base Transistors.

Write for complete engineering data sheet to the Technical Literature Section, Sprague Electric Company, 35 Marshall Street, North Adams, Massachusetts.

* *Sprague micro-alloy, micro-alloy diffused-base, and surface barrier transistors are fully licensed under Philco patents. All Sprague and Philco transistors having the same type numbers are manufactured to the same specifications and are fully interchangeable-*

SPRAGUE COMPONENTS:

TRANSISTORS • CAPACITORS • RESISTORS
MAGNETIC COMPONENTS • INTERFERENCE FILTERS
PULSE NETWORKS • HIGH TEMPERATURE MAGNET WIRE • CERAMIC-BASE PRINTED NETWORKS
PACKAGED COMPONENT ASSEMBLIES

SPRAGUE®
the mark of reliability

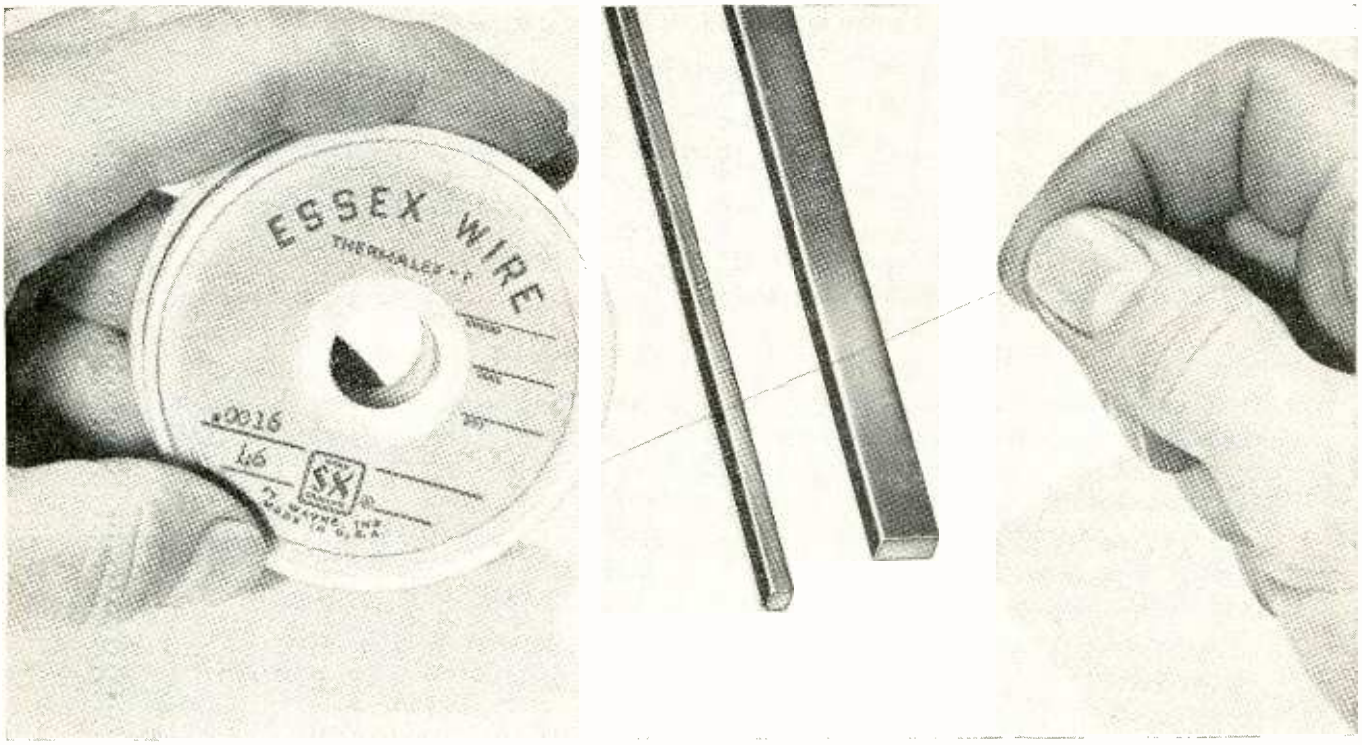
Now...all sizes and shapes of SX Magnet Wire for every "hot spot" application

ESSEX

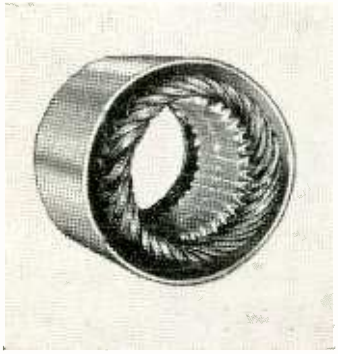
Thermalex-F®

MAGNET WIRE

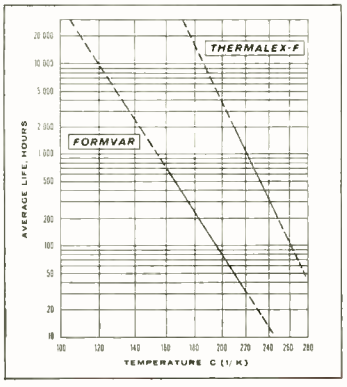
Class F (155°C)



Rounds, squares and rectangulars also available with single and double glass coverings



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



OUTSTANDING THERMAL STABILITY
A.I.E.E. #57 "Procedure for Evaluation of the Thermal Stability of Enameled Wire" which is an accepted test, indicates a 30,000 hours life at 170°C for unvarnished specimens.

Thermalex-F, a Class F (155°C) magnet wire insulation developed by Essex, is now available in round wire from 11 to 50 AWG size and all Formvar sizes of square and rectangular. This full size range gives every manufacturer the versatility he needs in one insulation type for his exact application!

SX® THE WIRE DESIGNED WITH THE FUTURE IN MIND

Magnet Wire Division
ESSEX WIRE CORPORATION
Fort Wayne, Indiana

Manufacturing Plants: Birmingham, Ala.; Anaheim, Cal.; Fort Wayne, Ind.; Hillsdale, Mich.

National network of Warehouses and Sales Offices ... Call your local "Essex Man."

HIGH efficiency at HIGH operating temperatures

SILICON POWER TRANSISTORS

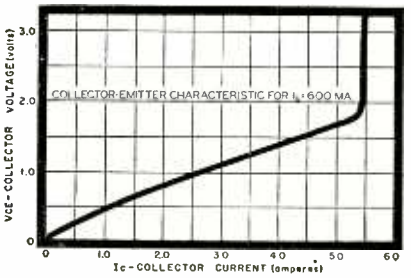
Available Now in production quantities!

The Westinghouse Silicon Power Transistor pictured above is a highly efficient device which greatly increases the range of applications for transistors which must operate without high losses in the "true power range." Thanks to a remarkably low saturation resistance—less than .750 ohms at 2 amperes and .5 ohms at 5 amperes—these transistors possess very low internal dissipation, and can be efficiently used in applications where they must handle as much as 1000 watts. For example, as a DC switch, handling 750 watts (150 volts at 5 amps) the internal dissipation is about 9 watts, with an efficiency of better than 99%.

Additionally, and unlike germanium units which are limited to approximately 85°C, these transistors can operate in ambient temperatures up to 150°C. Thus, even where the higher power rating is not required, these units may be used for their high temperature capabilities.

There are a great many applications for which this new type of silicon power transistor is ideally suited. It will find use in inverters or converters (AC to AC; AC to DC; DC to AC; DC to DC), regulated power supplies, servo output, and other aircraft circuits, as well as in certain amplifiers and switching applications.

Westinghouse Silicon Power Transistors are available in 2 and 5 ampere collector ratings. Both of these are available in 30, 60, 100, and 150 volt ratings in production quantities for your immediate applications. Sample quantities are available in higher voltage ratings. Call your Westinghouse representative or write directly to Westinghouse Electric Corporation, Semiconductor Department, Youngwood, Pennsylvania.



LOW SATURATION RESISTANCE

Important improvements in silicon purification and transistor fabrication have produced a new series of Westinghouse Power Transistors of exceptionally low saturation resistance.

YOU CAN BE SURE...IF IT'S

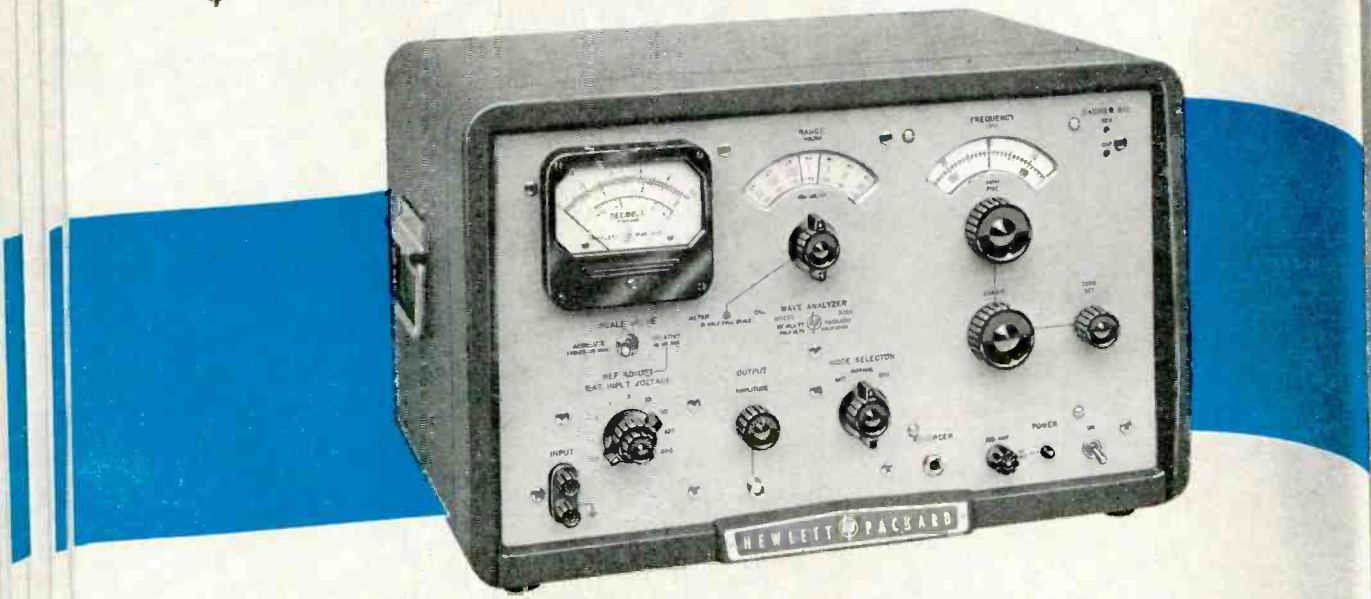
Westinghouse

CIRCLE 5 READERS SERVICE CARD

CIRCLE 6 READERS SERVICE CARD→

These pages from the new hp catalog in WAVE ANALYZERS in 10 years!

hp 302A WAVE ANALYZER



New, Transistorized — Directly Measures Wave Components

Advantages:

- No calibration or stabilization needed
- Direct readings; accurate
- Measures frequencies 20 cps to 50 KC
- Completely transistorized
- Battery or ac powered; hum free
- Low power consumption; no warm-up needed
- Very sharp acceptance circuits
- AFC; also frequency restorer circuit
- Compact, rugged, versatile

Uses:

Measures and analyzes fundamentals, harmonics, and intermodulation products in telemetering, carrier and vibration systems as well as audio circuits. Speeds analysis of noise and broadcast amplifier characteristics; modulation amplifier, film sound track and recording distortion; hum, network characteristics, etc.

NEW MODEL 302A Wave Analyzer represents a significant improvement in wave analyzer design.

Completely transistorized, sophisticated in design, highly selective, free of tedious calibration and stabilization before use—these are but a few of the important convenience and accuracy features in the new 302A.

Other exceptional features are low power consumption (in the order of 3 watts), provision for battery operation (18 to 28 volts) as well as ac line power, and elimination of warmup time.

Simple Operation

In operation the instrument functions as a highly selective tuned voltmeter. A front panel control selects the frequency to be measured and voltage is then read directly on the front panel meter.

Basically, Model 302A functions by separating an input signal into individual components so that each—the fundamental, harmonics and any intermodulation products—may be evaluated separately.

The instrument operates by mixing the input signal with an internal oscillator adjusted to provide a difference frequency of 100 KC. An automatic frequency control circuit maintains a constant difference frequency between the input and oscillator signals. This insures accurate measurements despite frequency drift in the input signal. After modulation by a voltage from the internal oscillator the

announce the first major improvement

signal is passed through a narrow-band crystal filter, amplified and metered.

Frequency Restorer

A frequency restorer circuit makes accurate frequency measurements possible at each component's frequency of the input wave. This circuit supplies a sinusoidal signal at the frequency of the specific component which can be measured on an electronic counter or observed on an oscilloscope. The amplitude of this signal is determined by the level of the selected component. When the mode selector switch is in the normal or AFC position, the signal appears at the output terminals if the meter is indicating.

Model 302A is also particularly useful for measuring small signals on noisy systems or transmission lines. When the mode selector is switched to "BFO" the instrument becomes an oscillator and tuned voltmeter automatically tuned by one control to the same or oscillator frequency. The selective tuned voltmeter then discriminates against the noise and measures the desired signal.

Speed and accuracy of measuring is enhanced by a linearly calibrated tuning control giving the same "tuning feel" throughout range.

Basic Laboratory Instrument

Covering the frequency range of 20 cps to 50 KC, the new hp 302A is equipped to perform a wide variety of daily measurements. It has broad usefulness not only in audio measurements but in vibration work, telemetry, and carrier applications. The instrument is compact, rugged and features conservative design and high quality throughout.

Specifications

Frequency Range: 20 cps to 50 KC.

Frequency Calibration: Linear graduation 1 division per 10 cycles. Accuracy ±(1 % + 5 ~).

Voltage Range: 3 μv to 300 v, full scale readings of:

300 v	300 mv	300 μv
100 v	100 mv	100 μv
30 v	30 mv	30 μv
10 v	10 mv	
3 v	3 mv	
1 v	1 mv	

Ranges provided by an input attenuator switch and a meter range switch in steps of 1:3 or 10 db. Meter range is indicated by a dial mechanically linked to input attenuator. An absolute-relative switch, in conjunction with a variable 10 db control is provided for adjustment of intermediate values.

Warm-Up-Time: None.

Voltage Accuracy: ±5% of full scale value.

Residual Modulation Products and Hum Voltage: Greater than 75 db down.

Intermediate Frequency Rejection: Intermediate frequency present in input signal rejected by at least 75 db.

Selectivity: ± 3½ cycle b.w.—at least 3 db down
± 25 cycle b. w.—at least 50 db down
± 70 cycle b.w.—at least 80 db down
beyond ± 70 cycle b.w.—at least 80 db down

Input Impedance: Determined by setting of input attenuator: 100,000 ohms on 4 most sensitive ranges, 1 megohm on remaining ranges.

Selected Frequency Output: 1 v open circuit at output terminals for full scale meter deflection. Output level control provided. Frequency response ±1 db, 20 cycles to 50 KC. Output impedance approximately 600 ohms.

B. F. O. Output: 1 v open circuit at output terminals. Output level control provided. Frequency response ±1 db, 20 cps to 50 KC. Output impedance approximately 600 ohms.

Automatic Frequency Control: Range of frequency holdin is ±100 cycles minimum.

Power: 115/230 v ±10%, 50/1600 cycles, 3 watts (approximately). Terminals provided for powering instrument from external battery source. Battery supply range 28 v to 18 v.

Weight: Net 43 lbs. Shipping 63 lbs. (cabinet mount). Net 35 lbs. Shipping 55 lbs. (rack mount).

Dimensions: Cabinet Mount: 20¾" wide; 12½" high; 14½" deep. Rack Mount: 19" wide; 10½" high; 13½" deep.

Price: $1,475.00 (cabinet); $1,460.00 (rack mount).

Data subject to change without notice.

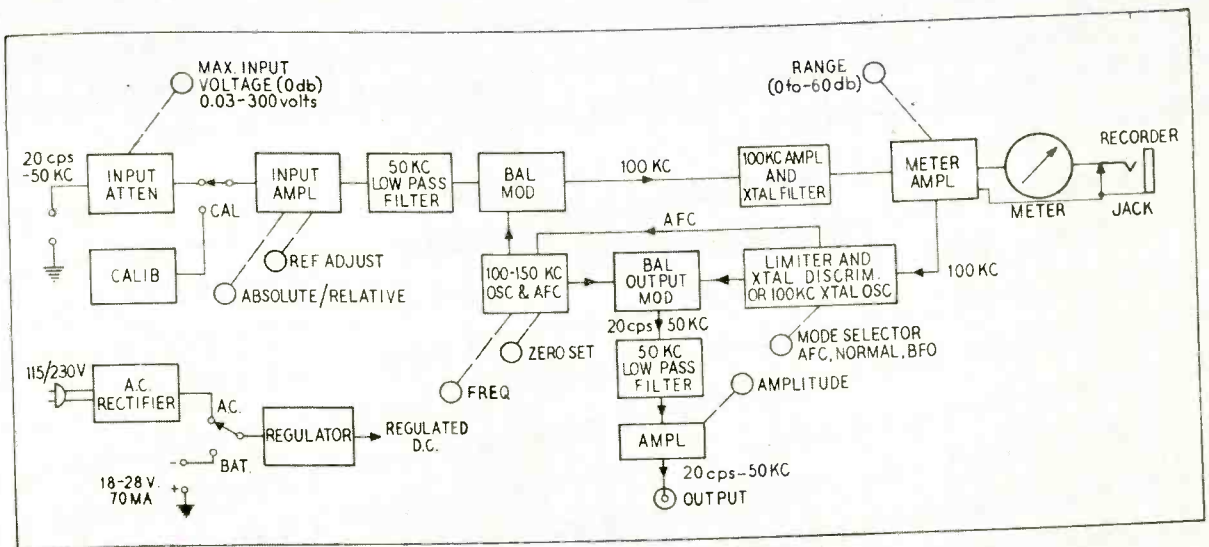
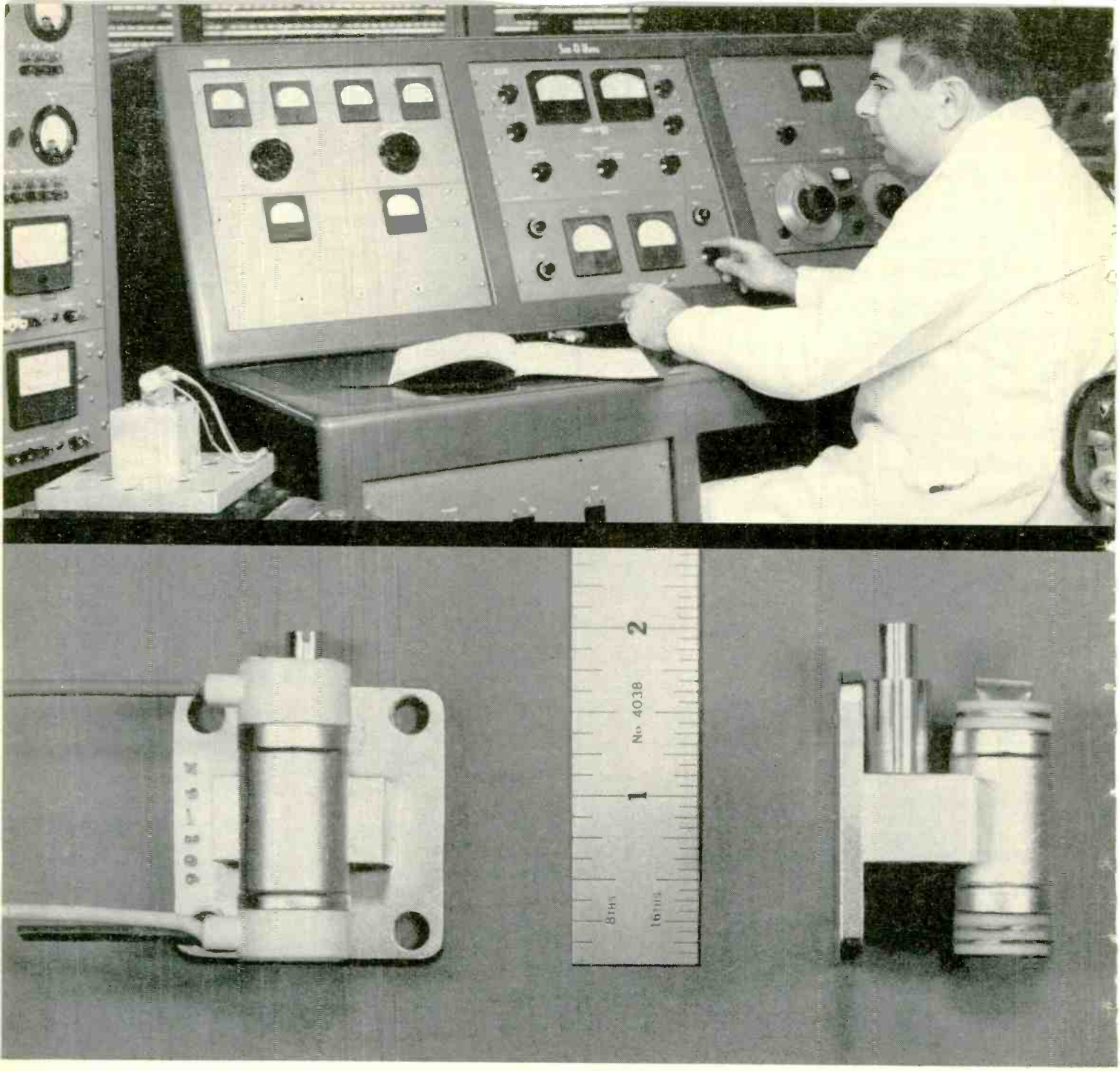


Figure 1. Block diagram, Model 302A Harmonic Wave Analyzer

HEWLETT-PACKARD COMPANY
Dept. 5487A, 275 Page Mill Road, Palo Alto, California, U.S.A.
Cable HEWPACK • DAvenport 5-4451
Field representatives in all principal areas



EIMAC CERAMIC-METAL REFLEX KLYSTRONS FOR SEVERE ENVIRONMENT APPLICATIONS

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

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

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

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

EITEL-McCULLOUGH, INC.

Eimac

San Carlos • California

ELECTRONICS NEWSLETTER

AMERICAN ELECTRONICS EXPERTS who visited eight Soviet electronics plants said in Moscow last week that on the management side the Soviets are moving towards U.S. ideas of independent, decentralized management and supply efficiency. Delegation chairman Ray C. Ellis, Raytheon vice president, said, however, that in none of the plants visited was productivity per worker greater than in the U.S. because the Russians lag in modernization. Ellis told the McGraw-Hill World News bureau in Moscow that the group saw no technological breakthroughs, described a color tv demonstration as "fair" and thinks future visiting groups of electronics men should be small and specialized for "more depth and less breadth."

SILICON CARBIDE power rectifier that operates at 500 C is being evaluated by the Air Force for missile and aircraft use. Device was reported this month by Cambridge Research Center which sponsored an international parley in Boston on SiC. Report on Westinghouse work indicates SiC holds promise for transistors at 500 C. But researchers say control of crystal growing for SiC transistors is not yet in sight. Limited quantities of semiconductor grade SiC are now becoming available for basic measurements. Four types of growth are being tried: from vapor phase, from solution, from melt under pressure and by chemical decomposition of silicon compounds in carbonaceous atmosphere.

British Government has appointed an electronics engineer, D. A. Senior, to its newly created post of scientific attache in Moscow.

PLASMA THERMOCOUPLE, first to convert nuclear reactor power directly into electricity, was announced this month by Los Alamos Scientific Laboratory. A single cell placed in a reactor far exceeded its expected lifetime by operating for almost 12 hours with an open circuit voltage of 3.8 volts and a short circuit current between 30 and 40 amps. The experimental thermocouple, resembling a frozen fruit juice can, uses a ¾-in.-long-rod containing enriched uranium. Rod is suspended in center surrounded by cesium gas. It was discovered last year that when cesium gas is substituted for one of a thermocouple's two contact metals, several hundred times as much direct current power is produced. In the reactor's core the neutron flux activates uranium fission heating in the can's center; flow of reactor coolant outside can drops temperature of cesium plasma.

NEW SOLID-STATE quantum mechanical amplifier that would make use of nuclear spin transitions is being studied at St. Louis University under a three-year $28,500 contract from Air Research and Development Command. Raser, for Radio Amplification by Stimulated Emission of Radiation, operates with improved gain and signal to noise ratio as temperature is reduced.

SATELLITE DETECTION by infrared techniques will be studied by Avion division of ACF Industries under a research contract from Air Research and Development Command. Firm says U.S. satellite experience shows that ir radiations are not only reflected and generated by the satellites themselves, but are also caused by interaction of the satellites with particles in space. Development problem, says Avion, is to make ir detection systems much more selective.

USAF'S GLOBAL COMMUNICATIONS will get a boost from an $18,715,141 contract to Philco for system modernization. Pact was announced last week by Rome Air Materiel Area. Hardware will be compatible with the long-range AIRCOM 480-L evolutionary improvement program now the subject of an ITT study contract.

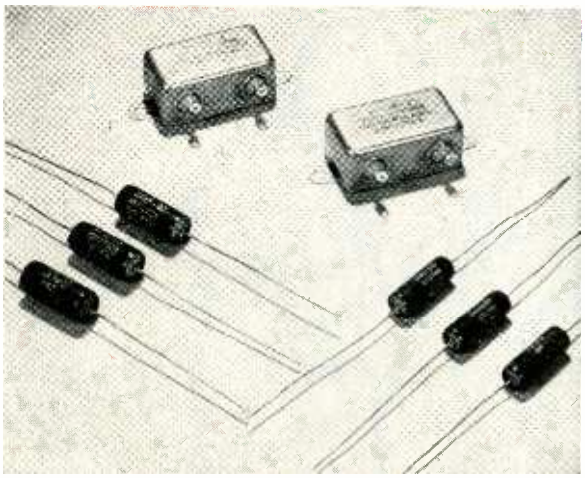
UNESCO's second international conference on medical electronics will be held in Paris from June 24 to 27, bringing together physicians and medical researchers with problems and electronics engineers and physicists with ideas and techniques.

TACTICAL EARLY-WARNING air search radar, MPS-21, designed for portable field use, has been demonstrated to Marine Corps. The 3,500-lb Sperry Gyroscope system is transportable by helicopter or truck, gives 3-D data—range, azimuth and elevation—at "long range and extreme heights." Search and height-finding reflectors are incorporated in a single V-beam antenna. System uses an inflatable radome.

AERIAL NEGATIVE FILM can be printed directly by a new Haloid Xerox electronic machine developed for the Air Force. Machine spews out a 9 × 9-in. print every 2½ sec. Firm has broadened its dry, electrostatic process into the making of continuous tone pictures, and says positive pictures can also be made from positive film with a slight adjustment.

AIR POLLUTION study involving an electronic cleaning process is being aided by a $78,000 grant from the National Institutes of Health to the Carnegie Institute of Technology. Study will be made of why some waste particles can be removed by an electrostatic precipitator and why other particles cannot be retained on the collecting electrode.

Dow Corning Silicone Dielectrics

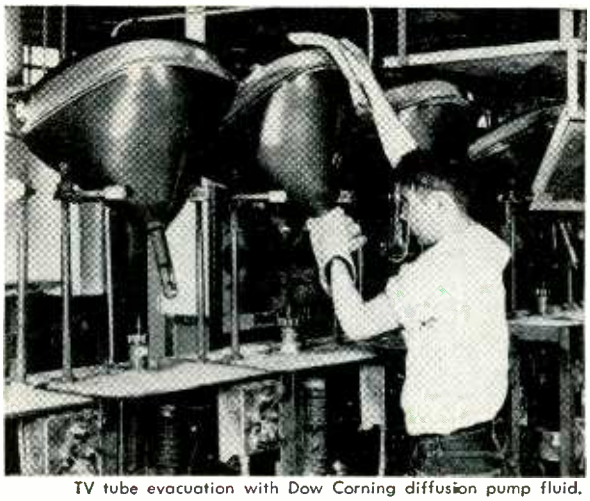


Aerovox capacitors impregnated with silicone dielectric fluid.

SILICONE DIELECTRIC FLUIDS IMPROVE COMPONENT CHARACTERISTICS

A liquid dielectric, Dow Corning 200 Fluid makes higher operating temperatures possible, increases stability, aids miniaturization and improves characteristics of electronic assemblies and components. Silicone fluid impregnated capacitors, for example, maintain near-constant capacitance at high and low temperatures, show little change in properties over a wide range of frequencies and environmental conditions.

CIRCLE 104 READERS SERVICE CARD



TV tube evacuation with Dow Corning diffusion pump fluid.

SILICONE DIFFUSION PUMP FLUIDS OFFER GREATER STABILITY, ECONOMY

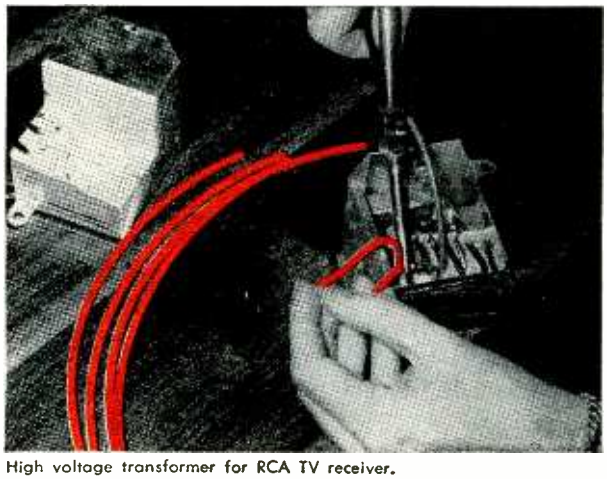
Because of their great stability, Dow Corning silicone fluids make diffusion pump operation more efficient and economical. They develop vacua in the range of 10^{-5} to 10^{-7} mm of Hg; resist oxidation even when exposed to air at operating temperatures. Dow Corning diffusion pump fluids do not decompose into gums or tars . . . save replacement costs and production time. In addition, they offer rapid recovery and quick pumpdown.

CIRCLE 105 READERS SERVICE CARD

SILASTIC COVERED WIRE RESISTS CORONA, OZONE

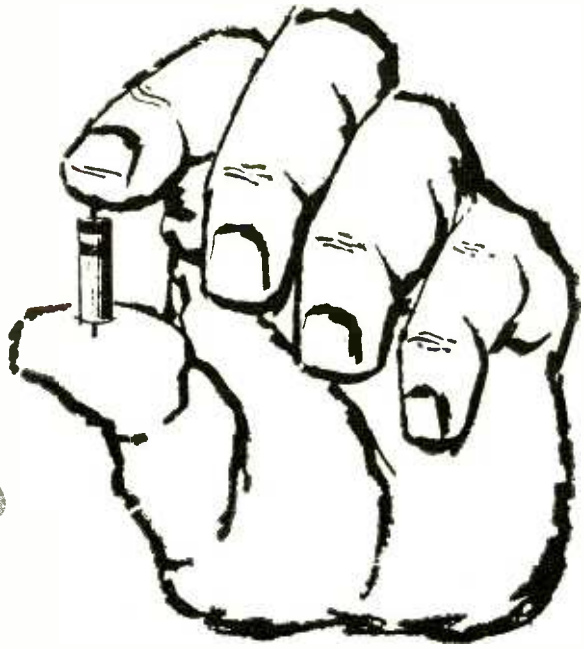
Wire and cable insulated with Silastic®, the Dow Corning silicone rubber, is easy to strip and solder — flexible for quick and convenient hookup of electronic components. Unaffected by moisture, weathering and temperature extremes from —90 to 250 C, Silastic insulation remains flexible and retains its dielectric properties despite long exposure to corona and ozone. Wire insulated with Silastic is readily available from leading cable manufacturers.

CIRCLE 106 READERS SERVICE CARD



High voltage transformer for RCA TV receiver.

A 1-WATT RESISTOR BECOMES A VOLTAGE STANDARD WHEN USED WITH A ®REGATRON PROGRAMMABLE POWER SUPPLY



Take a 1-watt resistor. Place it across the programming terminals of a Regatron Programmable Power Supply. Instantly you've fixed the output voltage to 1/1000 of the resistance value. For example, a 22.5K resistor will fix the output at 22.5V. For a perfect repeat every time, use the same resistor. For other voltages use a different resistor. The output will always equal 1/1000 of the resistance value.

In addition, you'll find that Regatron Programmable Power Supplies have all the other advanced features you would expect in a versatile laboratory instrument; super-regulation, vernier as well as main voltage control, and more. Compare a Regatron Programmable Power Supply with any other d-c power source, batteries included. You'll find you won't settle for less.

Regatron Programmable Power Supplies are available in voltage ranges covering 0-50 V dc, 0-100 V dc, 0-300 V dc, and 0-600 V dc. Current ratings are up to 3A, depending on model. Request Bulletins 350 and 765.

(Various models without the programming feature are also available in voltage ranges up to 1000 V and currents up to 1 ampere.)

POWER FACT No. 5 — **Regulation:**

Regulation would appear to be a simple operating characteristic of a power supply. Yet much confusion exists concerning the exact meaning of the word. Relative regulation, absolute regulation, etc. are different aspects which are often confused.

For definitions and a useful discussion of these matters, send for Technical Bulletin No. 2005. It is free of charge.

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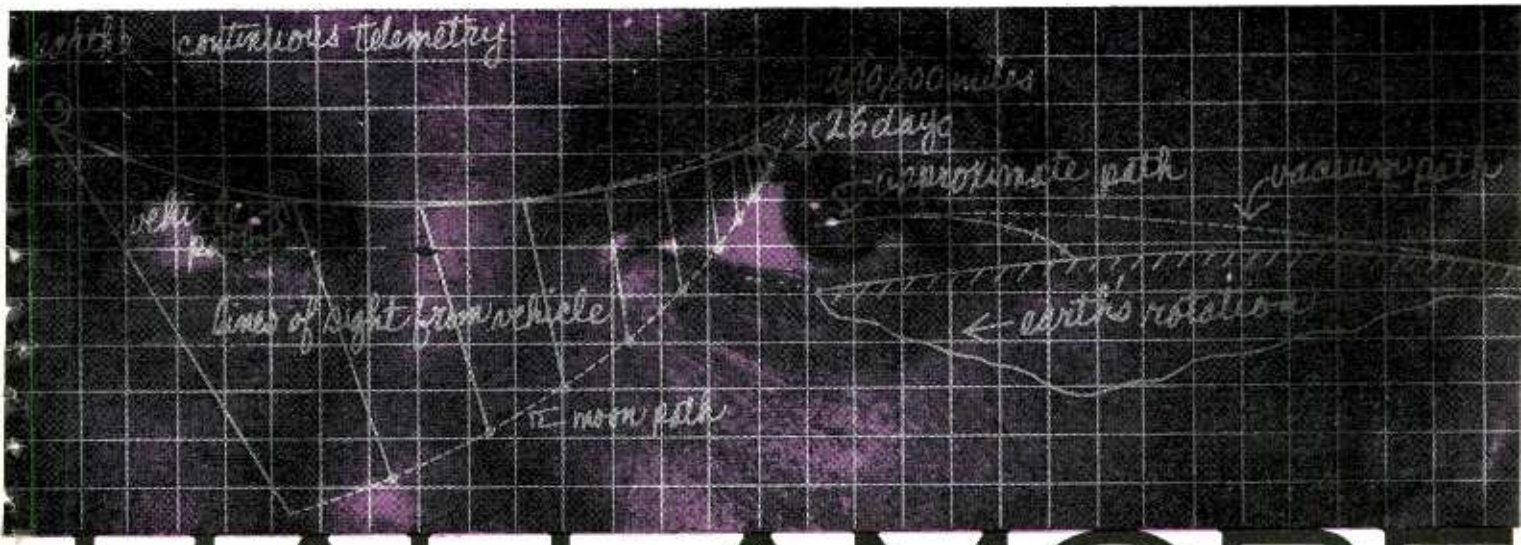
CREATIVE MINDS NEEDED to explore new fields in Space Age Electronics. Join one of the fastest growing engineering and scientific organizations in the new field of Space Electronics. Thus far, Hallamore has had a remarkable participation in nearly all of the space frontier programs...some of which are: 1. Development and manufacture of 4 tracking and telemetering stations for Explorer satellites. 2. Development and manufacture of 6 tracking and telemetering stations for United States Air Force lunar probe. 3. Development and manufacture of 4 tracking and telemetering stations for United States Army lunar probe. 4. Ultra-sensitive receivers for atomic cloud propagation studies. 5. Airborne reconnaissance TV system. 6. Underwater electromagnetic wave communications studies. 7. Automatic checkout equipment for space missiles. Such programs are on contract, and equipment is in field operation at the present time. If you have a highly creative mind, with an educational background of BS to PHD and an active interest in theory, circuit development, or project engineering, we invite you to join our outstanding team, to search into the future and to share in the rewards of Hallamore's dynamic growth. For further information, please write or call: Frank W. Lynch, V.P. Engineering, Hallamore Electronics Company, 8352 Brookhurst Avenue, Anaheim, California / Prospect 4-1010 : a division of The Siegler Corporation.



HALLAMORE

WASHINGTON OUTLOOK

OBSERVERS expect Congress to tack extra funds on to Navy's fiscal 1960 appropriation for the electronics-dominated antisubmarine warfare program.

Navy experts have given the House Appropriations Committee a harrowing picture of Russia's growing submarine strength. Also, details of a secret report by the Pentagon's weapon-system evaluation group have been leaked. They point up the inadequacy of Navy ASW capabilities—in detection, tracking and destruction of enemy subs.

The Administration's ASW budget for next year totals $1.1 billion, about $270 million under this year's program. ASW planners say their original budget proposal called for an additional $1.2 billion for procurement, research and development, and shipbuilding. This sum, ASW officials have told Congress, was chopped out by the Defense Dept. and Budget Bureau.

Included in a $71.6 million R&D fund are sums for improved underwater communications; development of detection, classification and countermeasures equipment; and development of a 3-dimensional underwater test range.

Then there are: $26.1 million for procurement of improved sonar, training gear and identification apparatus; and $260,000 for communications equipment.

- **The National** Aeronautics & Space Administration has scheduled launching six space probes and 14 earth satellites for next year.

  Of special interest to the electronics industry is a project to develop space maps for charting radiation belts discovered above the earth's atmosphere. NASA scientists now want a clearer picture of where the radiation is concentrated and how it moves.

  A series of satellites will be sent up to collect this data. It is needed before a man is plummeted into space flight, and the scientists hope it will shed light on use of space for world-wide communications.

- **Other major space projects** will lean heavily on electronics.

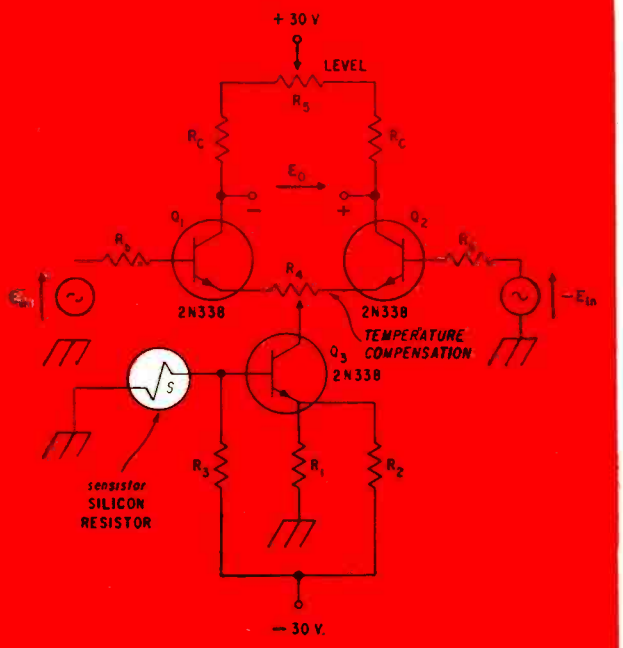
  NASA has earmarked $15.5 million for development of communications and meteorological satellite systems. This excludes costs for launching vehicles. Plans include putting a 740-lb relay communications satellite in a 22,400-mile orbit. The Defense Dept. will probably chip in additional funds. Timetable for the project runs for some five years.

  NASA officials say radio-radar equipped navigation satellite systems will eventually replace existing long-range navigation systems. The satellite systems also seem feasible for use in automatic correction of accumulated errors in inertial guidance systems employed by military aircraft, surface vessels and submarines.

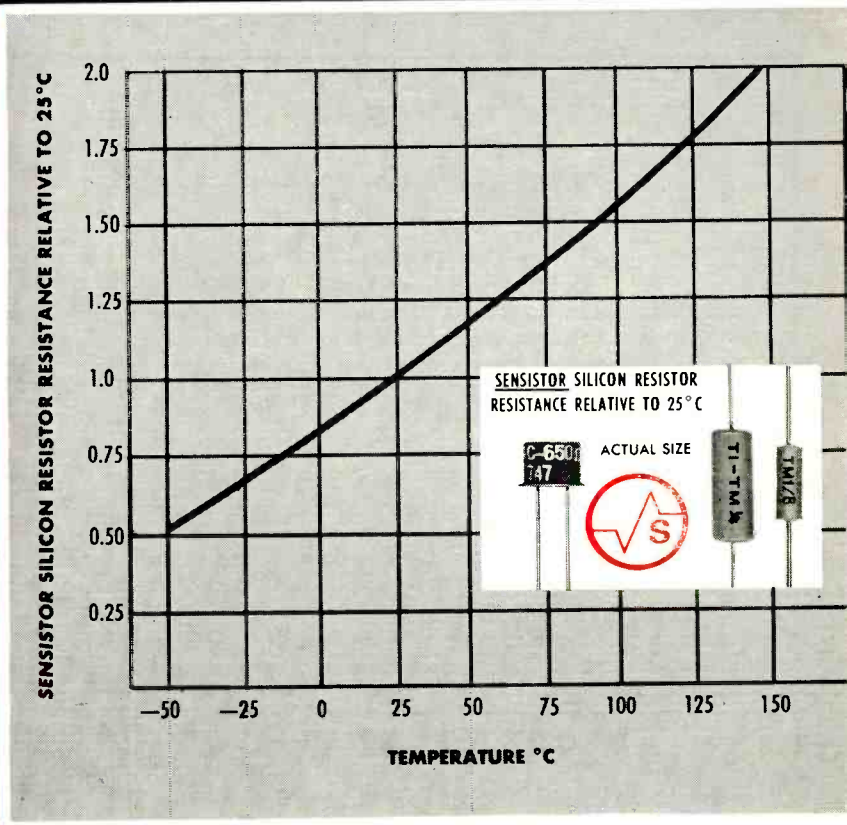
  Also planned are tracking and data reduction facilities to cost $11.5 million; analog computing equipment and a terminal guidance facility to cost $2.8 million to be installed at the high-speed flight station; $3.3 million for a central flight control and range operations facility; a new data reduction center at the Ames Research Center; and $10 million for a global tracking and communications system.

  And plans include: general research on atmospheres, ionospheres, magnetic field, energetic particles, and gravitional field, and the development of geodetic and astronomical satellites.

TI APPLICATION NOTE



DIFFERENTIAL DC AMPLIFIER USING *SENSISTOR* SILICON RESISTOR.
Write on your company letterhead for additional applications and data sheet.



HOW TO INCREASE DIFFERENTIAL DC AMPLIFIER STABILITY WITH *sensistor** SILICON RESISTORS

Low drift transistor amplifier circuit using *sensistor* silicon resistor gives drift performance superior to vacuum tube amplifiers for low source impedance applications.

The sensistor silicon resistor has a unique positive temperature coefficient of +0.7%/°C plus a constant rate of change as shown in the graph to the right. Over a 15°C temperature range, the *sensistor* silicon resistor's temperature-resistance curve approaches linearity to an extent that allows its use as a compensating component in a differential D-C amplifier.

This low drift amplifier finds a wide range of low source impedance applications in airborne telemetry where the performance of other types of D-C amplifiers is limited by weight requirements, acceleration, shock, and vibration. It is particularly useful with low level transducers such as thermocouples, strain gages and accelerometers.

DESIGN CONSIDERATIONS

TI 2N338 silicon transistor provides excellent performance as a low drift DC amplifier when used in circuits such as the one shown above.

For optimum performance keep $(2R_b + R_4)$ as small as possible, preferably less than 2000Ω, and the collector currents of Q_1 and Q_2 should remain below 100 μA.

Drift cancellation featured in an uncompensated differential configuration provides an amplifier with an equivalent input drift of 400 μV/°C or less with standard production transistors.

Drifts as low as 6μV/°C will result if the compensating circuit composed of Q_3, sensistor resistor S and their biasing resistors is used with a matched pair of transistors.

CIRCUIT OPERATION

Sensistor resistor S and its biasing resistor R_3 serve as a voltage source which has an output linearly related to temperature . . . level potentiometer R_5 adjusts output voltage E_o to zero when E_{in} is zero . . . potentiometer R_4 adjusts for minimum output drift due to ambient temperature changes.

As temperature increases, the resistance value of S also increases causing the base of Q_3 to go more negative, thereby reducing the collector current of Q_3. This temperature-dependent current is fed into the differential amplifier through R_4.

Depending on the wiper position of R_4, the correcting signal may be positive, negative or zero. When the wiper is centered, zero correction results. As temperature increases, output voltage E_o tends to go more positive if the R_4 wiper is placed nearer the Q_2 emitter and negative if the wiper is placed nearer Q_1. The optimum setting for R_4 can be determined by cycling over the desired temperature range to give a minimum drift for changes in ambient temperature.

*TRADEMARK OF TEXAS INSTRUMENTS

from THE WORLD'S LARGEST SEMICONDUCTOR PLANT

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SEMICONDUCTOR-COMPONENTS DIVISION
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DALLAS, TEXAS

FREQUENCY STANDARDS

PRECISION FORK UNIT
TYPE 50

Size 1" dia. x 3¾" H. Wght., 4 oz.*

Frequencies: 240 to 1000 cycles
Accuracies:—
Type 50 (±.02% at —65° to 85°C)
Type R50 (±.002% at 15° to 35°C)
Double triode and 5 pigtail parts required
Input, Tube heater voltage and B voltage
Output, approx. 5V into 200,000 ohms

*3⅛" high
400 - 1000 cy.

FREQUENCY STANDARD
TYPE 50L

Size 3¾" x 4½" x 5½" High
Weight, 2 lbs.

Frequencies: 50, 60, 75 or 100 cycles
Accuracies:—
Type 50L (±.02% at —65° to 85°C)
Type R50L (±.002% at 15° to 35°C)
Output, 3V into 200,000 ohms
Input, 150 to 300V, B (6V at .6 amps.)

PRECISION FORK UNIT
TYPE 2003

Size 1½" dia. x 4½" H. Wght. 8 oz.*

Frequencies: 200 to 4000 cycles
Accuracies:—
Type 2003 (±.02% at —65° to 85°C)
Type R2003 (±.002% at 15° to 35°C)
Type W2003 (±.005% at —65° to 85°C)
Double triode and 5 pigtail parts required
Input and output same as Type 50, above

*3½" high
400 to 500 cy.
optional

FREQUENCY STANDARD
TYPE 2005

Size, 8" x 8" x 7¼" High
Weight, 14 lbs.

Frequencies: 50 to 400 cycles
(Specify)
Accuracy: ±.001% from 20° to 30°C
Output, 10 Watts at 115 Volts
Input, 115V. (50 to 400 cycles)

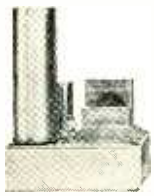
FREQUENCY STANDARD
TYPE 2007-6 *NEW*

TRANSISTORIZED, Silicon Type
Size 1½" dia. x 3½" H. Wght. 7 ozs.
Frequencies: 400 — 500 or 1000 cycles
Accuracies:
2007-6 (± .02% at —50° to +85°C)
R2007-6 (±.002% at +15° to +35°C)
W2007-6 (±.005% at —65° to +125°C)
Input: 10 to 30 Volts, D. C., at 6 ma.
Output: Multitap, 75 to 100,000 ohms

FREQUENCY STANDARD
TYPE 2121A

Size
8¾" x 19" panel
Weight, 25 lbs.
Output: 115V
60 cycles, 10 Watt
Accuracy:
±.001% from 20° to 30°C
Input, 115V (50 to 400 cycles)

FREQUENCY STANDARD
TYPE 2001-2



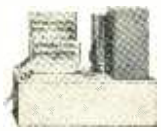
Size 3¾" x 4½" x 6" H., Wght. 26 oz.

Frequencies: 200 to 3000 cycles
Accuracy: ±.001% at 20° to 30°C
Output: 5V. at 250,000 ohms
Input: Heater voltage, 6.3 - 12 - 28
B voltage, 100 to 300 V., at 5 to 10 ma.

FREQUENCY STANDARD
TYPE 2111C

Size, with cover
10" x 17" x 9" H.
Panel model
10" x 19" x 8¾" H.
Weight, 25 lbs.
Frequencies: 50 to 1000 cycles
Accuracy: (±.002% at 15° to 35°C)
Output: 115V, 75W. Input: 115V, 50 to 75 cycles.

ACCESSORY UNITS
for TYPE 2001-2



L—For low frequencies
multi-vibrator type, 40-200 cy.
D—For low frequencies
counter type, 40-200 cy.
H—For high freqs, up to 20 KC.
M—Power Amplifier, 2W output.
P—Power supply.

This organization makes frequency standards within a range of 30 to 30,000 cycles. They are used extensively by aviation, industry, government departments, armed forces—where maximum accuracy and durability are required.

WHEN REQUESTING INFORMATION
PLEASE SPECIFY TYPE NUMBER

American Time Products, Inc.

Watch Master
Timing Systems

Telephone: PLaza 7-1430

580 Fifth Ave., New York 36, N. Y.

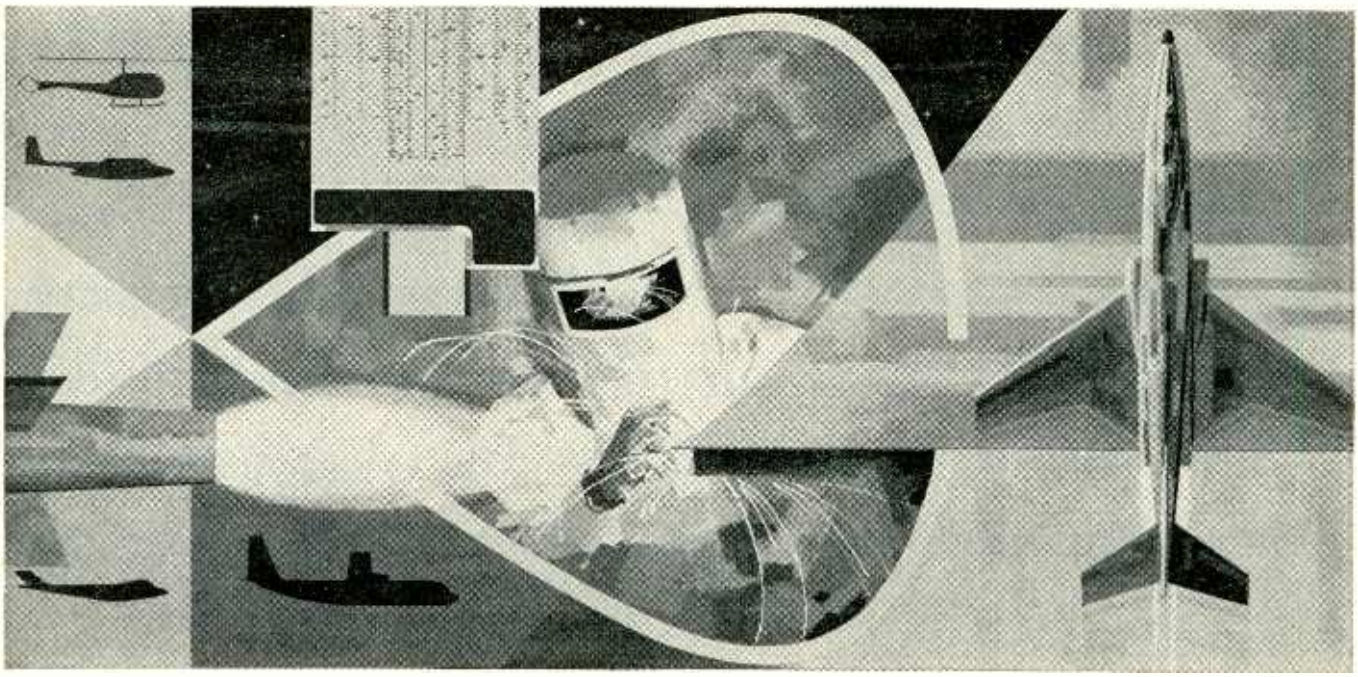
TEMCO
AIRCRAFT-DALLAS

FROM DESIGN
TO PRODUCTION
TEMCO
FOLLOWS THROUGH

Temco is regarded by its customers as a follow-through company . . with solid performance in every aspect of the contract from design to production. We consider it our business to be a partner on the job . . to cooperate willingly, to communicate freely.

Temco follows through by keeping top management and the customer informed on overall progress and program status. It follows through on quality control . . on materials during testing without waiting for a go-ahead on the next move. It naturally follows that Temco delivers a quality product, on schedule, and at the lowest possible cost.

For many years Temco has grown in the fields of subcontracting and aircraft modification. In addition it is rapidly developing its own proprietary products and participating in prime weapons systems development. It has the management, the capabilities, integrated skills and facilities to design, develop and produce for the electronics, aircraft and missile industries. Whether you need a component, subsystem or complete system, team up with Temco . . Temco follows through.



SYSTEMS MANAGEMENT	TEMCO ®
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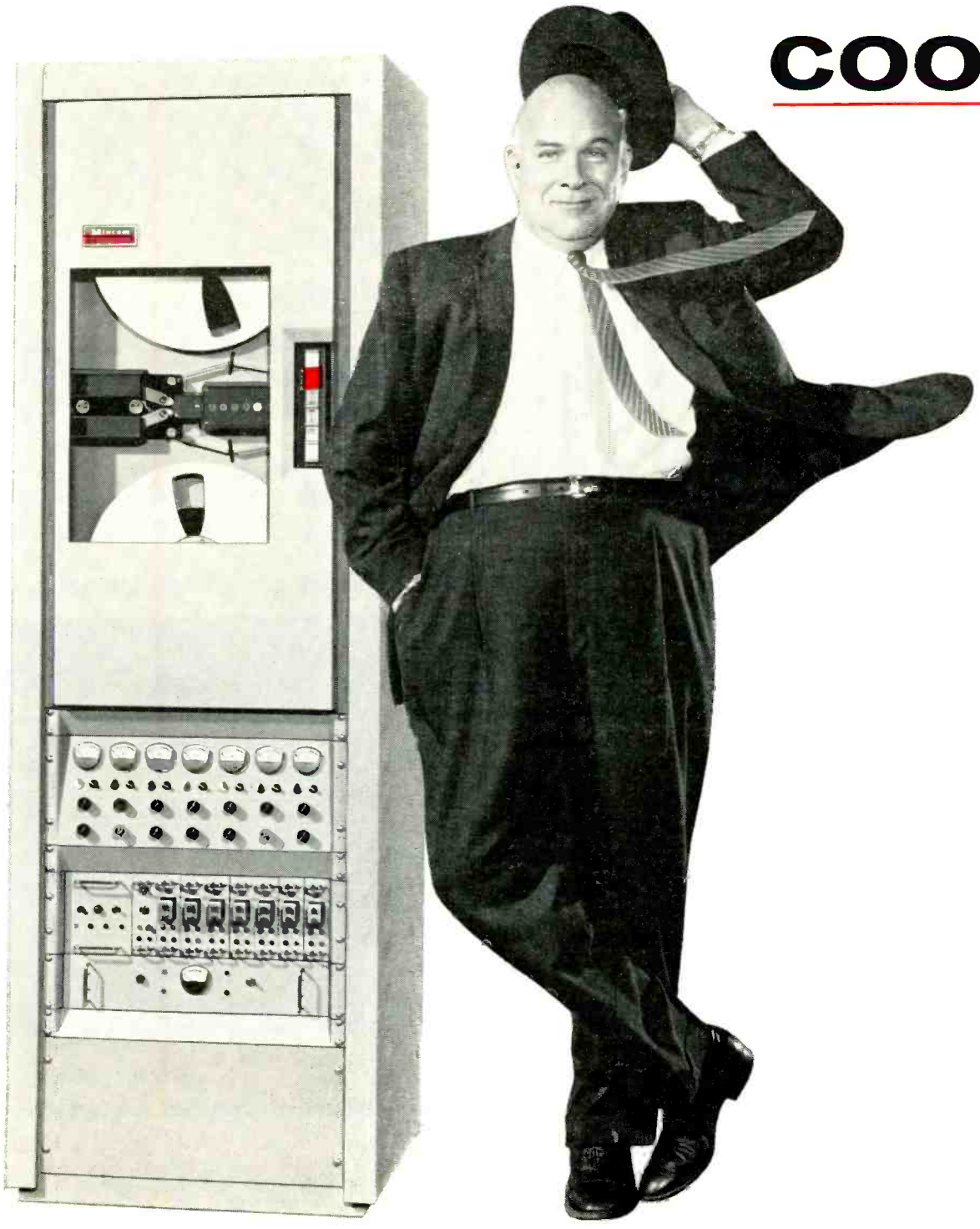
COOL



Standby time is no problem with the new, cool (all-transistorized) Mincom C-100. No blowers necessary — and the new Mincom Model C-100 Instrumentation Recorder/Reproducer is particularly new in its simplicity and reliability. Six speeds record frequencies from 50 cps to 100 kc. Only 500 watts input for 14-track system. No mechanical brakes. Only 0.1% flutter and wow. Instant push-button speed control, no belt changes. Interested? Write Mincom for specifications today.

3M COMPANY ... WHERE RESEARCH IS THE KEY TO TOMORROW

MINCOM DIVISION MINNESOTA MINING AND MANUFACTURING COMPANY

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New, Electro Instruments all-electronic, totally transistorized digital voltmeter

50 conversions per second • 1000 megohms input impedance • Fully automatic ranging

Model 8409 Voltmeter and Ratiometer

all the features you want in a medium-speed digital voltmeter

- 3 ranges, 9.999/99.99/999.9 volts
- Automatic, manual and remote ranging
- Automatic polarity
- One digit accuracy
- 4 digit in-line visual readout
- BCD and decimal electrical output
- Direct printer operation—local/remote control
- New 5¼" x 19" front panel
- Modular construction throughout
- Provision for external reference voltage

Plus accessory modules for every application

AC: All transistorized Model 110; considerably faster AC/DC conversion than presently available models. Fully automatic ranging and direct AC voltage readout on the Model 8409.

Ohmmeter: All transistorized Model KIM-000. Provides constant current through test resistor with negligible power dissipation. Voltage measurements made across resistor and read out directly in ohms with fully automatic ranging.

Also scanners, code converter modules, print control modules and many others to solve all digital problems — from simple voltmeter applications to complex data logging systems.

Ask your EI *representative for complete information.*

Electro Instruments, Inc.

3540 Aero Court San Diego 11, California

Firms Report Steady Upturn

AS THE YEAR moves along in its second quarter, electronics firms are continuing to reflect the steady upward trend that characterizes the general business picture today. Continued expansions and good earnings typify this week's announcements.

• **Electronic Specialty Co.,** Los Angeles, has purchased **Electrical Engineering & Manufacturing Corp.,** Los Angeles, for an undisclosed amount. ESC is a supplier of specialized electronic controls for aircraft, missiles and space vehicles. Combined sales of the two companies are reported running to about $7 million. The purchased firm will continue to manufacture a-c and d-c motors for planes and missiles.

• **Lockheed Aircraft,** Burbank, Calif., has purchased a controlling interest in the Puget Sound Bridge and Dredging Co., Seattle, Wash. Lockheed will use the Puget Sound facility for construction of nuclear powered submarines capable of firing Polaris missiles. It will also make use of the Seattle firm's construction experience in building ground support facilities for missiles and space craft. The construction firm has estimated assets exceeding $10 million.

• **Erie Resistor** reports satisfactory earnings for last year despite continuation of its plant modernization program and the expansion of manufacturing and marketing facilities. Net sales amounted to $21,202,186 as compared to $24,737,643 for 1957. Earnings totaled $510,441 in 1958, $542,811 in 1957. Company president G. R. Fryling points to the success of his firm's cost-reduction program as a decisive factor in improving earnings during the latter half of 1958. Shareholders' equity climbed for the ninth consecutive year.

• **Lear Incorporated,** Los Angeles, announces earnings up 87 percent for 1958 over the previous year, despite slightly reduced shipments. Net earnings were $1,607,751, equal to 68 cents a share on 2,377,081 shares of common stock outstanding at December 1958. This compares with $858,921 representing 36 cents a share on 2,368,156 shares in 1957.

• **Collins Radio** stockholders have approved reclassification of Class A and Class B stock into a single class of common. All common stock in Collins now has voting privileges.

OVER THE COUNTER

1958 BIDS LOW	1958 BIDS HIGH	COMMON STOCKS	WEEK ENDING April 3 BID	WEEK ENDING April 10 BID	WEEK ENDING April 10 ASKED
3¾	20½	Acoustica Assocs	31	31	38¾
1⅝	3	Advance Industries	3⅛	3⅜	3⅞
3⅛	6⅝	Aerovox	7⅞	7⅜	8⅝
5½	15	Appl'd Sci Princet	11¼	9	12
1⅛	8⅞	Avien, A	9¼	8½	10½
6¾	24	Baird-Atomic	28½	29	32
9¾	13⅜	Burndy	14¾	15	16¾
6¾	9	Cohu Electronics	7⅜	7⅜	8
11	22½	Collins Radio	33	32¼	35⅝
32½	49	Cook Electric	43½	48	54½
4	7	Craig Systems	9¾	9⅞	11
17⅝	25⅜	Eastern Industries	19½	19	21½
1¾	8⅜	Elco Corp	7¼	7¾	8¾
10½	21	Electro Instr	28	27	31⅛
34	49	Electronic Assocs	40½	39	44⅝
5	11	Electronic Res'rch	16½	18	19⅞
8½	12¾	Electronic Spec Co	14⅛	14⅞	16½
15¼	49½	Epsco, Inc	36	38	46⅛
5½	9⅜	Erie Resistor	9½	9½	10½
10	17½	Fischer & Porter	15¾	15	16¾
5½	10½	G-L Electronics	13½	13	15¾
12	27	Giannini	30½	29¼	32¾
...	...	Haydu Elec Prod	5¼	5¼	6½
30	39½	Hewlett-Packard	46	44¾	48¼
23¼	48	High Voltage Eng	53	52½	60½
1¾	3	Hycon Mfg	3¾	3⅝	4½
1⅛	5⅛	Industro Trans'tor	5¼	3¾	5¾
...	...	Internat'l Rec'f'r	25¾	24½	27¾
...	...	Interstate Engin'g	30½	31½	36¾
1½	4¾	Jerrold	6⅜	6⅜	7¼
21	30	D. S. Kennedy	31¾	31½	36⅛
3¾	29	Lab For El'tronics	32	30½	35⅝
19¼	28	Leeds & Northrup	28½	28	31⅛
2	3⅛	Leetronics	3¼	3½	4¼
5	18¾	Ling Electronics	26½	26½	31⅛
3¼	8¼	Magnetic Amplifiers	10⅛	9	11¼
2⅞	4½	Magnetics, Inc	5¼	5⅛	5⅝
4⅝	12	W. L. Maxson	14⅛	14½	16
10⅝	29	Microwave Assocs	34	35	43
5¼	11¾	Midwestern Instr	11⅛	12¼	14⅝
1⅛	7	Monogram Precis'n	11¼	10⅞	12⅞
3½	7¼	Narda Microwave	9¾	10⅛	11¼
...	...	Narda Ultrasonics	10⅛	9¾	11
9¼	16	National Company	19¾	20¼	22½
14¼	56	Nuclear Chicago	38	36	41⅜
4½	7⅜	Pacific Mercury, A	11¼	11¾	14⅜
10⅛	27½	Packard-Bell	39	35½	41⅜
4¼	9⅜	Panellit, Inc	7⅞	7¾	8⅝
21	53¾	Perkin-Elmer	43	42	46⅝
11⅜	19½	Radiation, A	21¾	19¾	23⅞
2⅛	7⅜	Reeves Soundcraft	7⅝	6¾	8¼
13	32½	Sanders Associates	26	27½	30⅞
...	...	Silicon Transistor	9	9⅜	11¼
7	12	SoundScriber	18	17¾	19⅛
22¼	40	Sprague Electric	46	47	53
26	35	Taylor Instruments	34¾	34½	37¼
5½	15	Technical Operat'ns	18	20	27¼
5½	15¾	Telechrome Mfg	24½	26	30⅜
3¼	7¾	Telecomputing	10¾	10⅞	12
1⅛	2¾	Tel-Instrument	2½	2½	3
8¾	16¼	Topp Industries	14⅜	13½	15⅞
3¾	10¾	Tracerlab	11½	11¾	14⅛
1⅛	3⅜	Universal Trans'tor	⅞	1⅜	1⅞
14¼	40	Varian Associates	49½	51	63½

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

Here's How to Cut Contact Costs... Maintain High Performance Quality...

Use General Plate Clad Contact Materials

Among the many advantages in using General Plate Clad Contact Materials are better electrical performance, longer operating life and lower fabricating costs.

Single and double inlay, overlay and toplay make it possible to manufacture complete contact assemblies to close tolerances by single blanking and forming operations. Compare this to multiple operations whereby the contacts and supporting members are fabricated separately and then assembled by brazing, welding or staking methods and you readily see the savings in production costs alone.

But that's not all . . . here at General Plate we specialize in supplying you with complete fabricated clad contact assemblies ready for installation. They will save you money, time and trouble . . . problems of precious metal inventory and scrap disposal are eliminated.

Why not find out how you can cut costs, increase performance with General Plate Clad Contact Materials and fabricated assemblies. Write:

You Can Profit By Using General Plate Clad Contact Materials

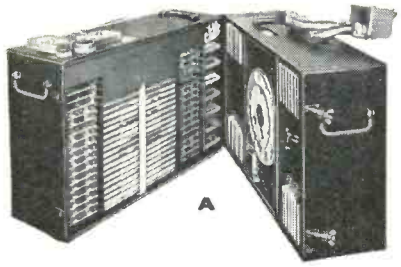
Typical example of how General Plate Clad single and double inlay reduces fabrication and assembly costs by simple one-step stamping.

METALS & CONTROLS CORPORATION

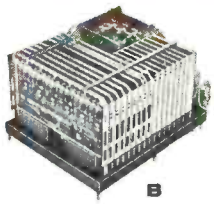
General Plate Division

1304 Forest St., Attleboro, Mass.

FIELD OFFICES: NEW YORK • CHICAGO • DETROIT • INDIANAPOLIS • MILWAUKEE • PASADENA



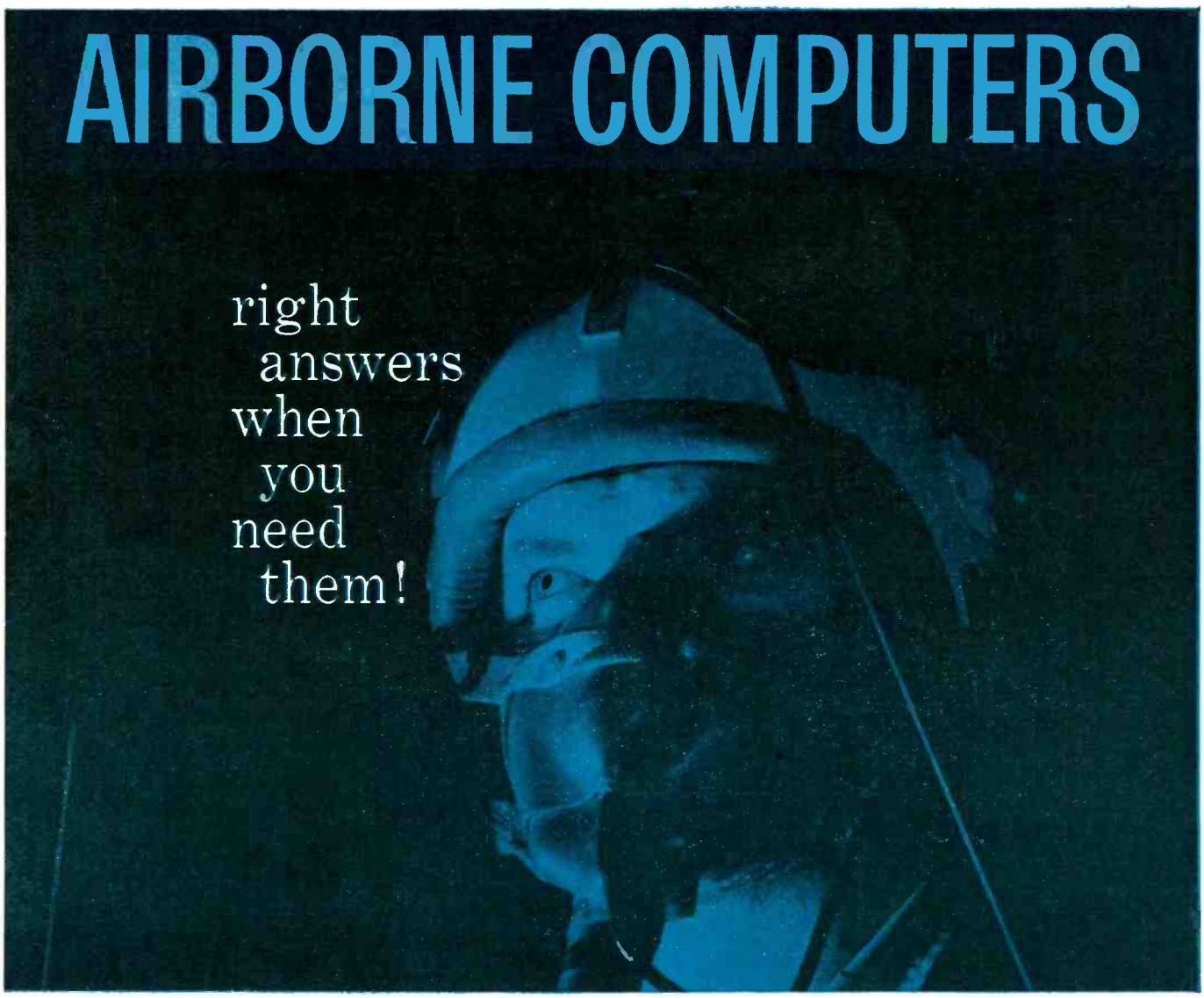
LIBRASCOPE AIRBORNE COMPUTERS*



IN A CLOUDED MOMENT OF DECISION, Librascope Airborne Digital Computers read-out accurate data... providing fire control, auto-navigation and bombing information ■ *The reason:* experienced Librascope engineers conceive and design computers and systems compatible with input data. Optimum system accuracy and reliability at minimum size and weight is achieved. ■ In the field, Librascope Airborne Computers are proving the dependability predicted in laboratory tests. Many military systems rely heavily on Librascope equipment and controls for right answers when they need them. *Adaptable to your needs are our two decades of experience creating* COMPUTERS, CONTROLS, *and* SYSTEMS *for both military and industrial use.*

AIRBORNE COMPUTERS

right answers when you need them!



*

Typical of Librascope's leadership in airborne digital computers are: **A** Incremental digital computer for Navy aircraft calculating bombing and navigation information. (Developed in 1954.) **B** Small transistorized general purpose digital computer for such problems as auto-navigation for aircraft and missiles. (Developed in 1958.) For detailed information on how Librascope solutions can apply to your computer systems problems, write...

For information on career opportunities at Librascope, write Glen Seltzer, Employment Manager.

LIBRASCOPE

A GENERAL PRECISION COMPANY

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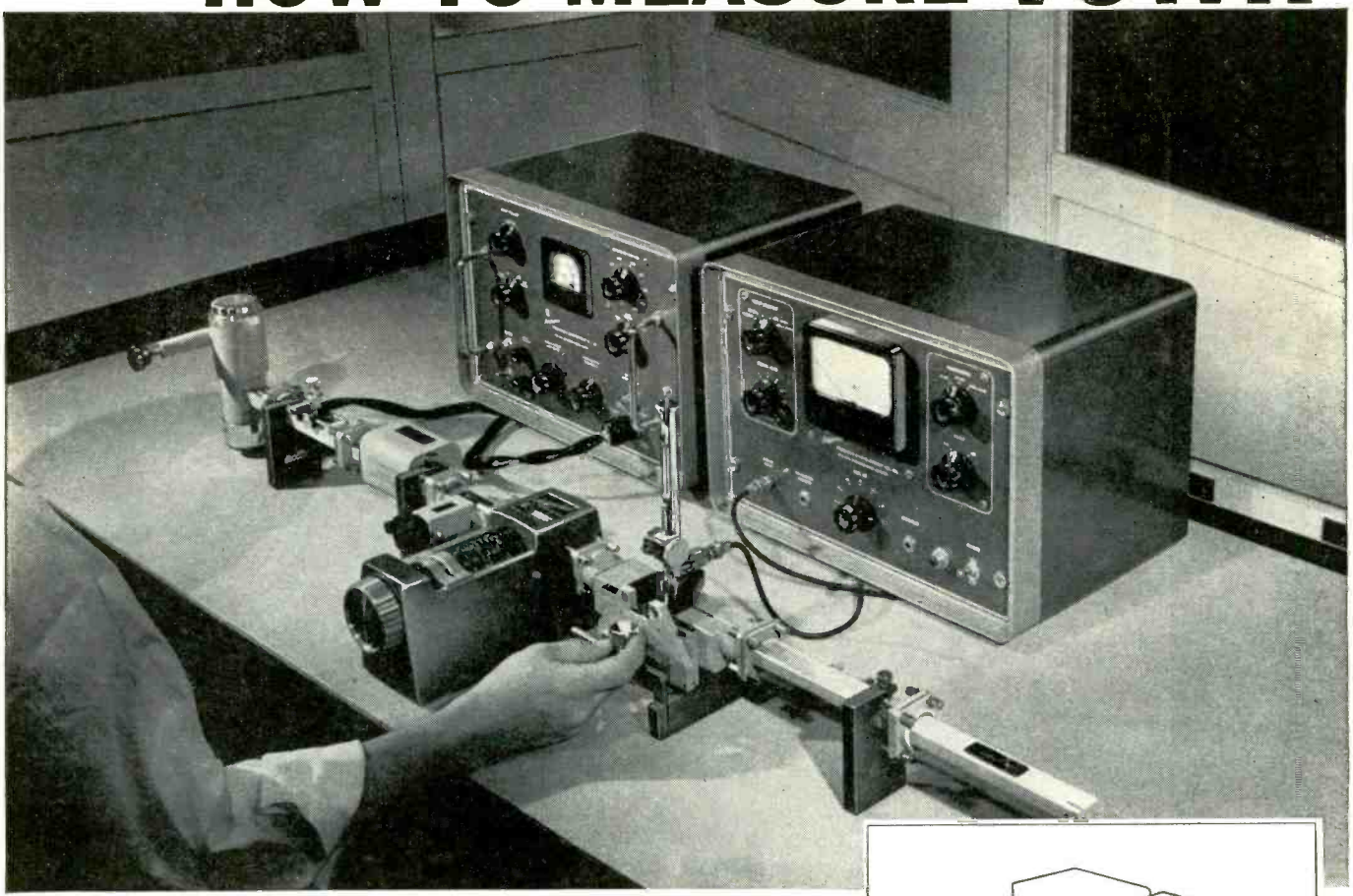
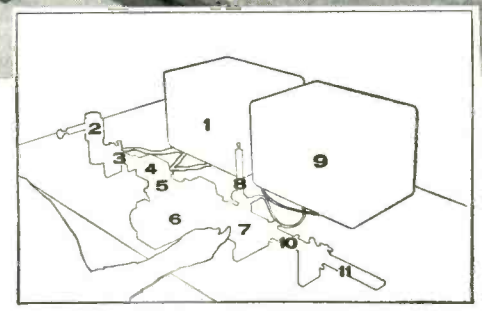
HOW TO MEASURE VSWR



This microwave measurement bench is for the determination of Voltage Standing Wave Ratio using the slotted-line technique. Other systems utilizing directional couplers or magic tees for measurement of VSWR are known, but the use of the Slotted Section assures maximum accuracy.

Regardless of the technique used, accurate readings depend on the precision of the test instruments involved. When it comes to microwave test instruments PRD produces the widest range of the most precise equipment available anywhere in the world.



You will notice in the measurement bench shown that there are four test components separating the klystron tube mount from the Slotted Section. These are: A Slide Screw Tuner, ferrite Isolator, Level Set Attenuator, and a broadband direct reading Frequency Meter. THE USE OF THESE FOUR COMPONENTS IN THE TEST LINE IS MANDATORY FOR PRECISE VSWR MEASUREMENTS!

The reason for this is clear when you consider the interrelationship between VSWR, power, and frequency.

The Slide Screw Tuner is used to match the klystron output to that of the tandem test line, thereby maximizing its output and increasing its stability.

The use of the ferrite Isolator assures klystron frequency and power stability by shielding the source generator from changes in impedance further down the line. It accomplishes this with negligible attenuation of the incident power. The Level Set Attenuator is used to adjust the amount of power feeding the remainder of the test line.

The reaction Frequency Meter accurately monitors the output of the klystron by a resonant dip on the Standing Wave Amplifier.

A Slotted Section, tuned Broadband Probe, Standing Wave Amplifier, and matched Termination complete the precision waveguide, X-band, VSWR bench. A Klystron Power Supply to provide the signal source with power and modulation and a Fixed Waveguide Attenuator to simulate the unknown are also shown.

Special problems in VSWR and other related measurements? — Contact our Applications Engineering Department.

We at PRD have pioneered the development of precision microwave test instruments . . . PRD is the only pioneer company today producing microwave test instruments exclusively. In fact, we're just about the largest microwave company in the world . . . our cable address is MICROWAVE, New York, USA.

For technical details and specifications covering products shown write:

TEST INSTRUMENTS USED IN THIS X-BAND VSWR BENCH

1—809 Klystron Power Supply, catalog page F-10
2—703 Shielded Tube Mount, catalog page F-8
3—303-A Slide Screw Tuner, catalog page B-14
4—1203 Isolator, catalog page A-21
5—159-A Level Set Attenuator, catalog page A-17
6—535 Frequency Meter, catalog page D-12
7—203-D Slotted Section, catalog page B-11
8—250-A Broadband Probe, catalog page B-12
9—277-A Standing Wave Amplifier, catalog page E-7
10—UNKNOWN—represented by a 140 Fixed Waveguide Attenuator, catalog page A-11
11—116-A Waveguide Termination, catalog page A-19

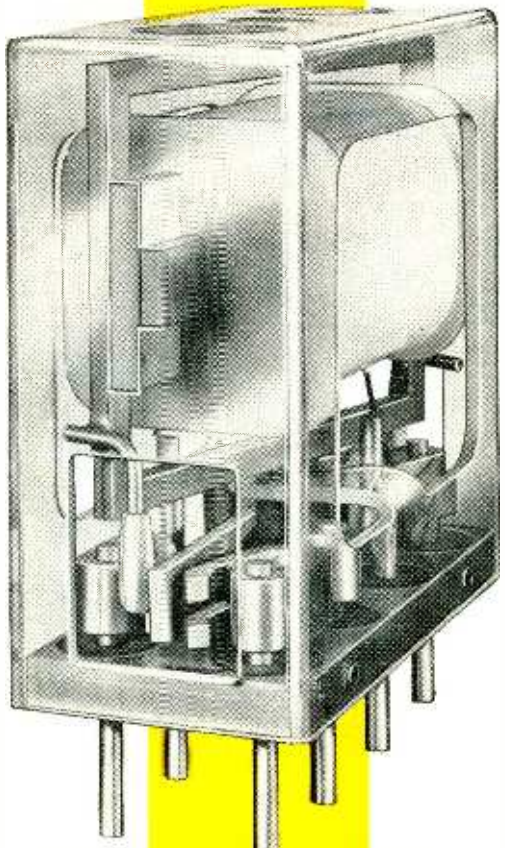
MICROWAVE ENGINEERS-SCIENTISTS
Positions offering stimulating challenges with unlimited potential are now open at PRD. Please address all inquiries to Mr. A. E. Spruck, PRD, 202 Tillary Street, Brooklyn 1, New York.

Polytechnic Research and Development Co., Inc.

202 Tillary Street, Brooklyn 1, New York. Telephone: ULster 2-6800
West Coast Office: 2639 So. La Cienega Blvd., Los Angeles 34, California. Telephone: TExas 0-1940

4 times actual size

Mock-up of CLARE Type F Relay enlarged to show operating mechanism. Note bifurcated contacts which enable this relay to handle a wide variety of contact loads.



With this ONE RELAY

You can handle contact loads from 3 amperes down to 1 microampere, 1 millivolt

SPECIFICATIONS

Ambient Temperature	−65° C to +125° C.
Shock	65 Gs for 11 milliseconds.
Vibration	5-75 cps at maximum excursion of 1/8 inch, 75-2000 cps at 20 Gs acceleration.
Dielectric Strength	Sea level—1000 volts rms between terminals and frame, and between adjacent circuits; 750 volts rms between contacts of a set. At 80,000 ft., 350 volts rms.
Insulation Resistance	1000 megohms minimum at 125° C.
Coils	Coils up to 10,000 ohms available for a wide range of voltage or current operation.
Nominal Operating Power	250 milliwatts.
Pickup Time	3.5 milliseconds nominal.
Dropout Time	1.5 milliseconds nominal.
Contact Arrangement	2 pdt (2 form C).
Contact Rating	3 amps resistive at 28 volts d-c or 115 volts a-c; also will handle loads of 1 microampere @ 1 millivolt reliably.
Contact Resistance	0.03 ohm maximum.
Contact Life	500,000 operations minimum at 2 amps; 100,000 operations minimum at 3 amps; 1,000,000 operations minimum at 1 amp.
Enclosure	Hermetically sealed, filled with dry nitrogen at 1 atmosphere pressure.
Mounting	All popular mounting arrangements available.
Terminals	Printed circuit; solder; plug-in (matching socket available). Variations of printed-circuit terminal length on 1/10-inch grid spacing available.
Weight	17 grams.
Military Specifications	MIL-R-25018, except as to contact bounce.

ACTUAL SIZE
All popular mounting arrangements are available. Terminal arrangements nicely suited to 1/10 inch grid spacing.

• In one relay—the Type F—CLARE provides a precise component of unusual flexibility for long life operation under a wide variety of contact loads.

Tests have shown a performance of over 22,500,000 operations at 0.1 ampere, 115 volts a-c. Minimum contact life at 3 amperes is 100,000 operations. Contacts have carried 1 microampere, 1 millivolt for 700,000 operations with a failure resistance of 500 ohms, with no misses recorded.

This amazing low-level life is primarily a result of the use of gold plated contacts. These same contacts, however, will carry up to 3 amperes.

A special plug-in mounting arrangement that will stand extreme shock and vibration is now available.

The CLARE Type F Relay is hermetically sealed, operates perfectly in a wide range of temperatures, withstands heavy shock and vibration—is fast and more than moderately sensitive.

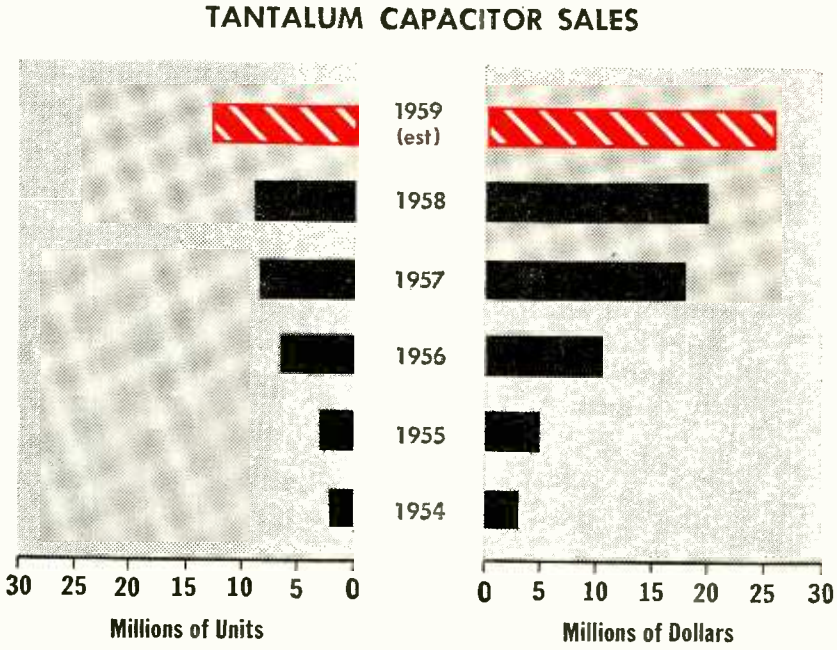
Send for Engineering Bulletin No. 124

Write or call C. P. Clare & Co., 3101 Pratt Blvd., Chicago 45, Illinois. In Canada: C. P. Clare Canada Ltd., 2700 Jane Street, Toronto 15. Cable Address: CLARELAY.

CLARE RELAYS

FIRST in the industrial field

CIRCLE 24 READERS SERVICE CARD



Tantalum Capacitor Sales Rise

SALES of tantalum capacitors in 1959 are expected to reach $26 million, or some 13 million units. Forecast anticipates an increase over 1958 of 30 percent in dollar sales and 44 percent in units.

Last year, some 9 million units were sold, worth $20 million. Between 1954 and 1958, unit sales rose 350 percent while dollar volume increased 567 percent.

Armed Forces accounted for lion's share of 1958 dollar sales, 70 percent. However, military's portion of unit sales last year was only 48 percent due to concentration of Armed Forces spending on higher price types.

Solid-electrolyte sales are growing faster than sales of other tantalum capacitor types—wire, foil or liquid-electrolyte. Of total 1958 unit sales, approximately 10 percent (900,000 units) were solid types. Used in missiles and other airborne equipment, they are expected to command an even higher share of sales this year.

Approximate average price of four tantalum capacitor types at time of this writing were: wire, $0.50; foil, $2.50-$4.00 range; solid-electrolyte, $1.10-$2.00 range; liquid-electrolyte, $2.00. Large liquid-electrolyte types, however, cost between $10 and $20 each.

Characteristics offered by tantalum capacitors include: small size, low leakage, long life, low power factor, resistance to corrosion, high reliability, high stability of capacitance value and light weight of finished product.

Tantalum capacitors are used in missiles, high-altitude aircraft, telephone apparatus, hearing aids, airborne electronic equipment, atomic energy, computers, instruments and oil exploration equipment.

• **EIA** announces a new market service for manufacturers selling through electronic parts and sound gear distributors. Called Buying Index of Distributors, it aids parts manufacturers to determine if they are getting proper share of the market in each U.S. county.

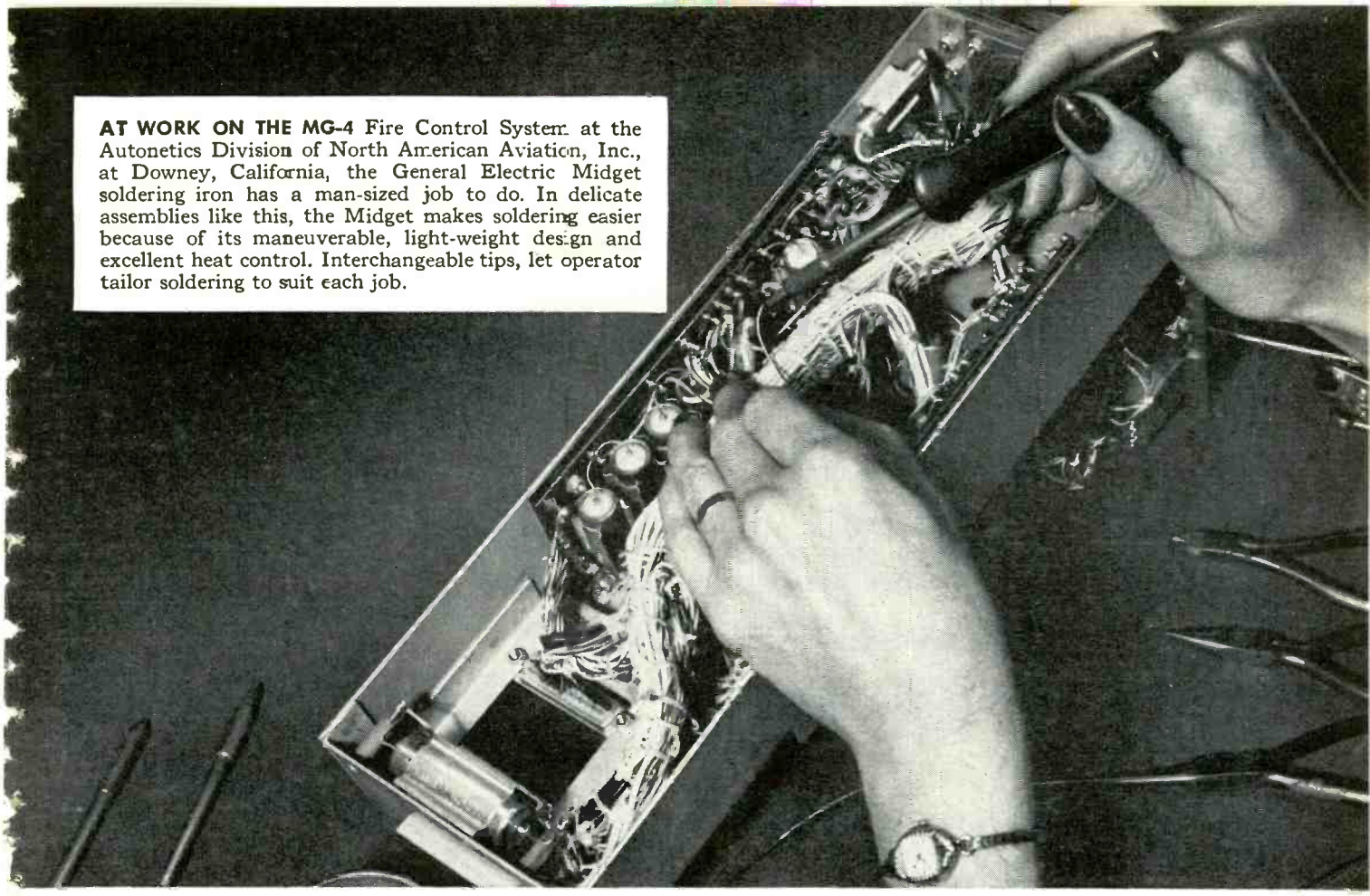
FIGURES OF THE WEEK

LATEST WEEKLY PRODUCTION FIGURES

(Source: EIA)	Apr. 3, 1959	Mar. 6, 1959	Change From One Year Ago
Television sets	111,563	95,794	+58.7%
Radio sets (ex. auto)	263,316	277,682	+77.9%
Auto sets	104,090	41,698	+149.6%

STOCK PRICE AVERAGES

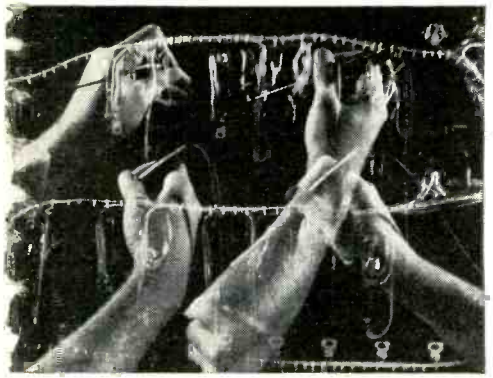
(Standard & Poor's)	Apr. 8, 1959	Mar. 11, 1959	Change From One Year Ago
Electronics mfrs.	82.28	80.20	+63.7%
Radio & tv mfrs.	97.24	93.97	+116.6%
Broadcasters	92.10	87.20	+61.3%



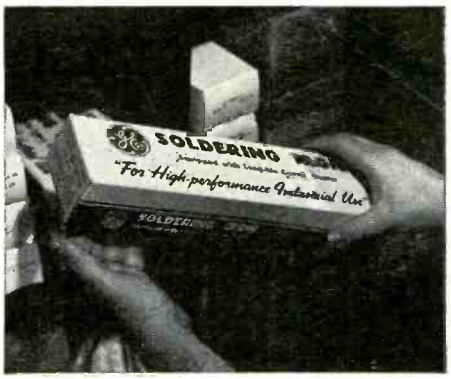
AT WORK ON THE MG-4 Fire Control System at the Autonetics Division of North American Aviation, Inc., at Downey, California, the General Electric Midget soldering iron has a man-sized job to do. In delicate assemblies like this, the Midget makes soldering easier because of its maneuverable, light-weight design and excellent heat control. Interchangeable tips, let operator tailor soldering to suit each job.

DEPENDABLE G-E MIDGET IRON cuts costs of producing MG-4 Fire Control Systems by reaching through maze of resistors, small wires, and tiny tubes quickly, easily, efficiently. . .reducing risk of damage to adjacent parts. Finished assembly, above, is one of the MG-4 System components used on North American F-86K Sabre Jets. It helps the pilot find aggressor aircraft.

Autonetics Cuts Sabre Jet Costs With General Electric Midget Soldering Irons



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



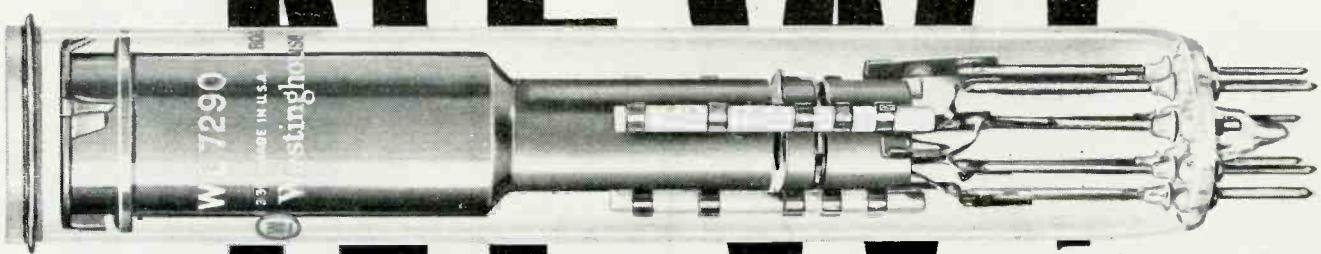
DELIVERY TODAY is now possible on popular soldering irons and other General Electric heaters and devices from a local distributor near your plant. Your replacement inventory may be reduced. For the name of your nearest stocking distributor for G-E heaters and devices, call your General Electric Apparatus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

SAVINGS ACHIEVED by several users and information about the construction features of General Electric soldering irons are included in a new bulletin, "Save While You Solder," GED-3553. For a copy, call your G-E distributor or write Section 724-7, General Electric Company, Schenectady 5, New York.

GENERAL ELECTRIC

Westinghouse tube engineering... serving the nation through imagination

NEW!



WESTINGHOUSE-DEVELOPED

special vidicon for slow scan

This new Westinghouse vidicon WL-7290 has been designed with extremely high dark resistance, permitting picture retention for both slow- and delayed-scan transmission.

The WL-7290 is in production. Sample quantities immediately available. Requests for technical data are invited.

THE WL-7290 FEATURES:

- Standard vidicon quality with normal scan
- Dark current 1/100 of standard vidicon
- Retention of 450 TV line resolution for minimum of 45 seconds with scan off
- Will operate in a standard vidicon camera

The WL-7290 is ideally suited to Narrow Band Transmission such as telemetering or telephone line transmission.

YOU CAN BE SURE... IF IT'S

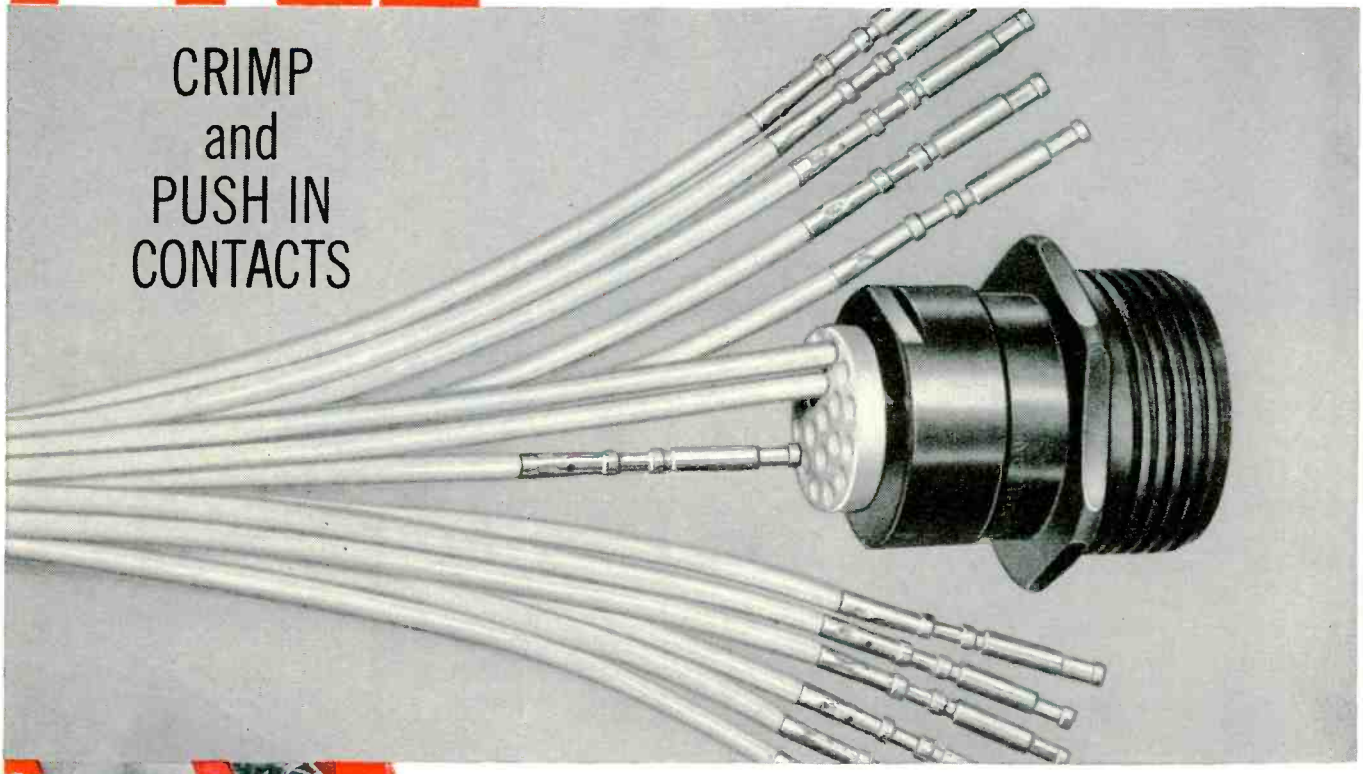
Westinghouse

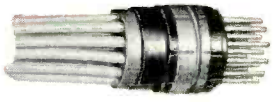
Electronic Tube Division Elmira, N.Y.

PYLE-STAR-LINE® CONNECTORS

WITH NEW MOD. 2 INSERTS FOR HIGH-SPEED, RELIABLE TERMINATION

CRIMP
and
PUSH IN
CONTACTS





Mod. 2 Insert, 19-Pole
with metal housing removed

1. Individual contacts are crimped to wires outside connector by a semi-automatic tool, then, for assembly, inserted one by one into insulation with crimped joint intact. Solder well contacts are also available.

2. Contact retention ability of resilient insulation exceeds the requirements of MIL C-5015-D even after many reassemblies.

3. Simplicity of wire termination increases reliability and greatly reduces errors in circuitry. Changes in circuitry are simple and speedy.

4. Up to 100 poles for wires sizes 18, 16, 12 or 10, with no sacrifice in environmental resistance, or ability to meet and exceed MIL C-5015-D in Class A, B, C, E and R.

5. Two-piece **Mod. 2 Insert** is interchangeable within Standard Pyle-Star-Line barrel shells with three-piece **Mod. 1 Insert.***

**Mod. 1 Inserts for wire sizes up to 4/0 are available for disconnect and for current rupturing service.*

Environmental Limits of Pyle-Star-Line connectors	
Temperature	—80 F. to 225 F.
Pressure	300 PSI External, 90 PSI Internal
Chemical Resistance	Most acids, most alkalis, oil
Corrosion Resistance	Salt Spray: 300 days without failure
Dust Resistance	Exceed requirements of MIL C-5015D
Shock Resistance	50G Minimum
Vibration	Exceed 20G to Method II of Mil C-5015D
Humidity & Moisture Resistance	Exceed Class E. Spec. of Mil C-5015D
Air Leakage	Meet Class E Spec. of Mil C-5015D

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SINCE 1897

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Write for complete specifications:

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Connectors • Conduit Fittings • Circuit Controls • Lighting Fixtures • Floodlights

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NEW FROM JFD Electronics

LC TUNERS

Why use *two*—a capacitor and inductor—when *one* will do? The new JFD LC Tuner combines a variable inductor *and* capacitor in one compact unit. For space-conscious design engineers this means more circuit in less space, better reliability, greater economy, faster assembly, reduced size and weight.

A few of the many advantages of JFD LC Tuners are:

1. Rugged electro-mechanical construction affords unusually high stability under conditions of severe shock and vibration.

2. Use of glass or quartz dielectric assures a low temperature coefficient and operation without derating over a wide range of extreme environmental conditions.

3. Sensitive adjustment with anti-backlash design for smooth and positive tuning.

4. Flexibility in design to suit circuit requirements. The number of turns, types of windings, size and type of capacitor plates, Q and other parameters can be designed to suit individual circuit requirements. Performance characteristics can also be varied by using other core materials, such as, brass or ferrites, by having the piston grounded or ungrounded and by other types of loading.

This is another example of JFD creative engineering to solve today's problems and tomorrow's applications. For information or engineering assistance on your specific tuning needs, call or write today.

Panel and Printed Circuit Mounting Types Standard LC Tuners Now Available

Model	Self Resonating Frequency Range	Length Above Panel	Diameter
LC303	450–700 MC	.635	5/16"
LC304	300–500 MC	.845	5/16"
LC306	200–450 MC	1.104	5/16"
LC309	125–200 MC	1.691	5/16"

PHONE DEWEY 1-1000

JFD

Pioneers in electronics since 1929

ELECTRONICS CORPORATION

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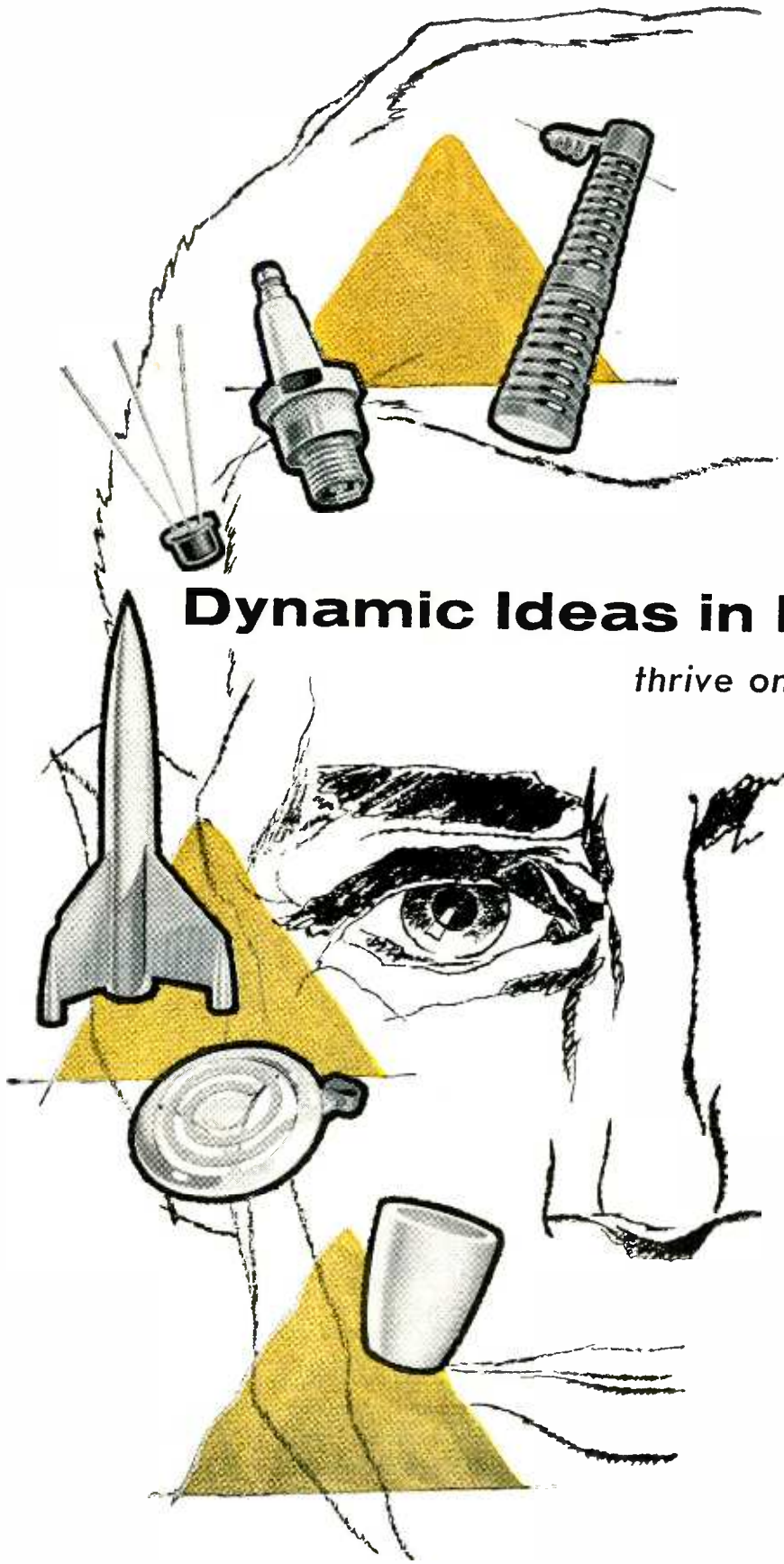
JFD Canada Ltd.
51 McCormack St.
Toronto, Ontario, Canada

JFD International
15 Moore Street
New York, New York



Here are the "basic ingredients" in some of today's most advanced design concepts . . . Norton Ceramic Materials. Exceptionally versatile, these exciting materials are meeting operating requirements of products and processes across industry.

Norton Ceramic Materials offer design engineers a wide range of outstanding physical, chemical, thermal, and electrical properties. What's more, they provide interesting *combinations* of these properties. For example: CRYSTOLON* silicon carbide provides high thermal conductivity as well as exceptional thermal strength; ALUNDUM* aluminum oxide has excellent chemical stability in addition to good abrasion resistance; MAGNORITE* magnesium oxide offers high purity, thermal and electrical resistance; fused

Dynamic Ideas in Engineering . . .

thrive on Norton ceramic materials

zirconium oxide is today's highest melting point material available in tonnage quantities and it's immune to both reducing and oxidizing atmospheres. And each product has *many* other invaluable properties.

Think of Norton Ceramic Compositions as essential components in equipment for metal and chemical processing, electrical, electronic, ceramic and nuclear applications . . . as "the answer" to literally hundreds of design problems. They're manufactured to meet highly exacting standards of purity, density, shape, size and wear resistance . . . available in granular and in fabricated form to meet *your* requirements efficiently and economically. For complete details, write for "Norton REFRACTORY GRAIN". NORTON COMPANY, Refractories Division, 933 New Bond Street, Worcester 6, Mass.

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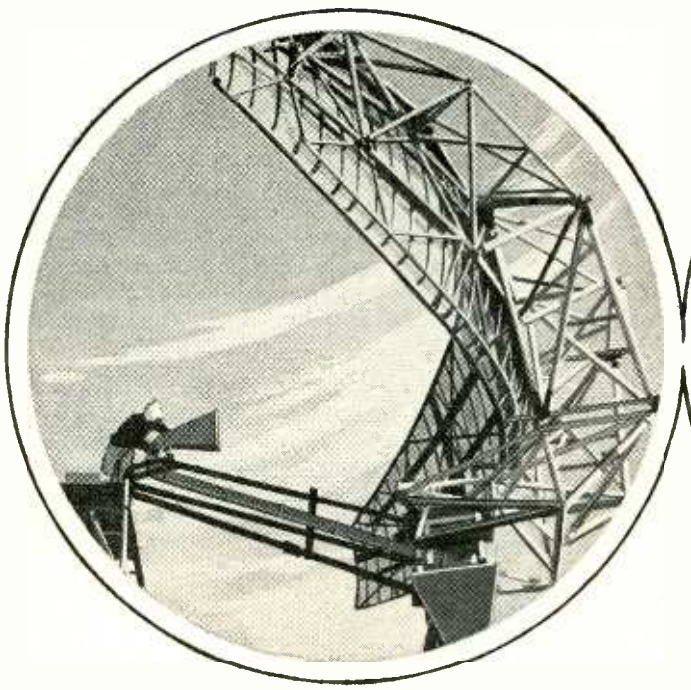

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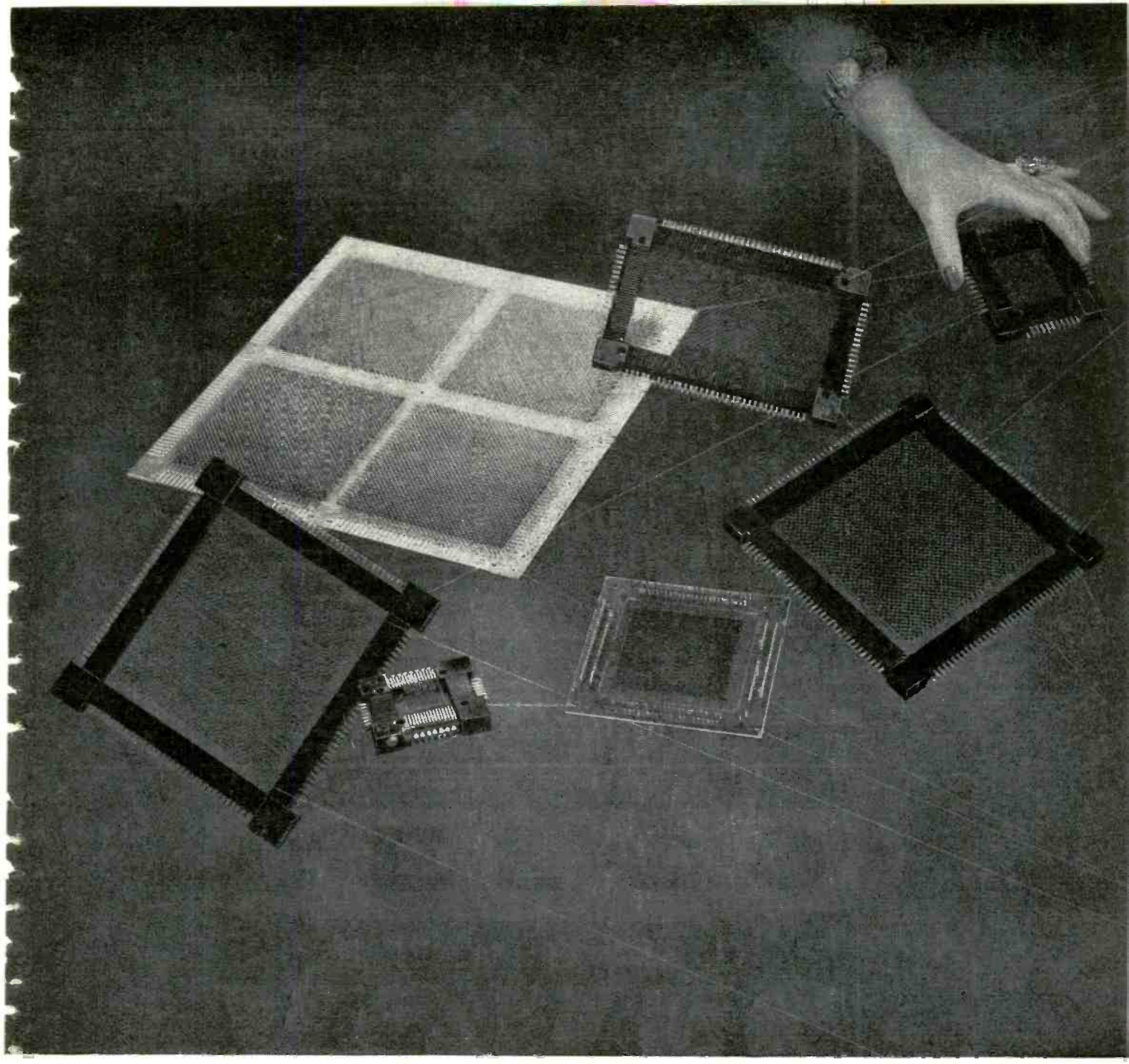

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Circuits Shrinking Fast

All three military services are pushing microminiaturization of electronic circuits with big industry contracts

INDUSTRY RESPONSE to the Army Signal Corps $5 million micromodule development program (ELECTRONICS, p 18, June 27, 1958) continues to gain momentum this week. The project to shrink electronic equipment to one tenth normal size by building components on ceramic wafers has stimulated 332 inquiries from electronics firms.

Thirty-three companies have expressed interest in applying the micromodule concept to their equipment designs. Of these, seven are aircraft or missile manufacturers and 15 are electronics corporations.

During first year of the program, interviews were held with 107 companies. Eight subcontracts have been awarded to seven firms (Table I). Additional contracts are planned, according to prime contractor RCA, with Weston Instrument, Sprague and Philco Lansdale for resistors, capacitors and transistors, respectively. Exact number of contracts and volume have not been determined for the other components listed in the table.

The program has already passed the half way mark. Complete prototype models for subassemblies will be ready by the end of this month. Final model design will be completed by August.

Schedule for the remainder of the program calls for construction of the final model by February 1960 and test, evaluation and final delivery to the Army by April 1, 1960.

Navy Microcircuit Plans

All three services are currently working on microminiaturization of circuits. The Office of Naval Research is directing work in molecular electronics. Molecular electronics avoids individual components by building circuit functions directly into the material.

Much of Navy's microminiaturization program is being carried out in the Army-Navy Instrumentation Program. Objective of ANIP is the simplification of cockpit instrumentation systems in aircraft. Computers and other microminiaturized electronic units and new presentation techniques will display only the essential information to the pilot.

Directed by the Office of Naval Research, Douglas is prime coordinator for fixed-wing aircraft and Bell Helicopter for rotary-wing planes. Subcontracts from Douglas and Bell have gone to Varo Manufacturing, Servomechanisms, Litton, Laboratory for Electronics and Kaiser Electronics.

Litton establishes the fundamental requirements for the computer as to capacity, speed and logic. Varo then determines how these basic requirements for performance can be met. One technique being employed by Varo is production of electronic components by vacuum deposition of metals (ELECTRONICS, p 22, July 11, 1958).

Varo's requirements, in turn, are given to Servomechanisms where a search is made for adequate materials. Materials are handed over to Varo where circuit elements are produced. These elements are then delivered to Litton to use in the computer.

Servomechanisms is also making digital computer logic and memory devices through the interaction of magnetic domains in thin films of evaporated nickel-magnetic alloys. This technique may also result in purely electronic data-handling systems.

Kaiser Electronics is developing a flat plate tube which will use solid-state circuits. Laboratory for Electronics is engaged in establishing circuit requirements along with Varo.

Other Programs

Apart from Navy's activity in ANIP, money has been appropriated for the Office of Naval Research to sign a contract with the Stanford Research Institute for work on an electron-activated technique for microminiaturization that will eventually be capable of making one million circuits per square inch.

USAF will sign a $2-million contract with Westinghouse, Baltimore, the end of this month for the investigation of microminiaturization by molecular engineering. The specific technique involves controlled dendritic growth of crystals resulting in specific properties.

A number of companies are working independently on molecular engineering. One such firm is Texas Instruments (ELECTRONICS, p 82, April 10).

Table 1—Signal Corps Micromodule Subcontracting and Plans

Components	Subcontracts Let	Subcontracts Planned
Resistors	Weston Instrument	Weston Instrument
Capacitors	Sprague (2) P. R. Mallory	Sprague
Transistors	Philco Lansdale	Philco Lansdale
Semiconductor Diodes	Pacific Semiconductor General Instrument	—
Quartz Crystals	Midland Mfg. Co.	—
Relays/Switches	none	—
Cables/Connectors	none	—
Batteries	none	—
Thermistors	none	—

Exploding Wires Simulate Reentry

TEMPERATURE in million-degree range can be produced by the exploding wire phenomenon, it was reported this month by Naval Research Lab.

V. A. Scherrer described NRL project at a Boston conference sponsored by AF Cambridge Research Center. Gathering of 200 scientists heightened importance of EWP as basic research tool in studying shock waves, missile reentry materials, oxidation of met-

als, coating-bonding, and microsecond photography.

Principal sources of energy are: discharge from bank of low-inductance storage capacitors and a coaxial cable discharge system. Tremendous concentration of heat, magnetic energy in fine wire vaporizes and disperses material of wire in few millionths of a second with loud report and a flash whose brillance is 20 times that of the sun's surface.

Primary component of energy storage system used in NRL project is parallel plate capacitor using water as dielectric. Capacitor stores 15,000 joules of energy at 500 kv and rings at a frequency of about 2 mc through the exploded wire load. When electrical power of 10^{11} watts is deposited in fine wires of 0.04 — 3 mils diameter, million-degree temperatures are possible, Scherrer reported.

Through use of special x-ray spectrographic techniques, NRL researchers also observed large yield of 75 electron volt, 250 ev and 1 kev x-rays.

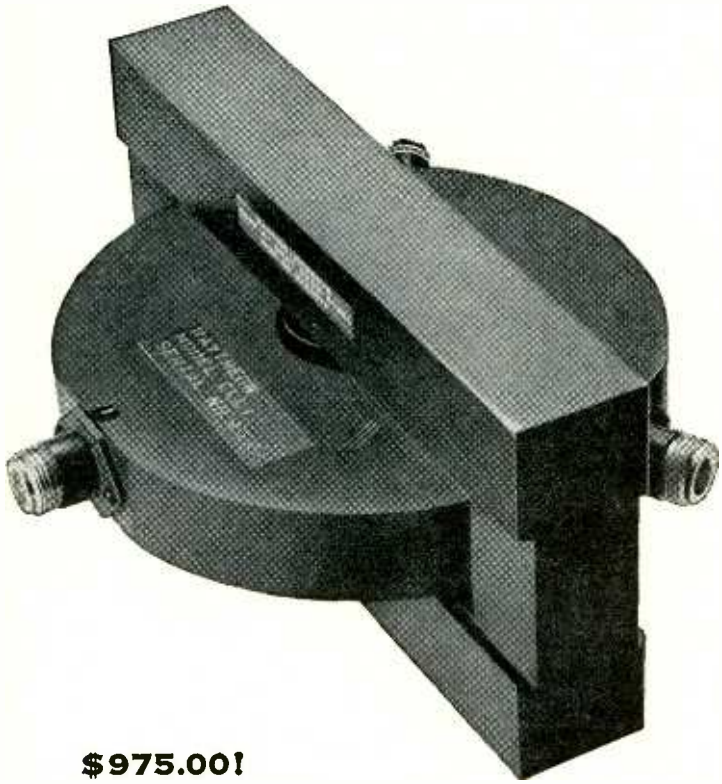
It was disclosed at conference that a 49.5 kilojoule capacitor discharge system was established at Sandia Corp., Albuquerque, to investigate application of exploding wires as fuses for proposed Los Alamos Scientific Laboratory 12-megajoule Project Sherwood capacitor bank.

Geophysics Research Directorate of AFCRC, conference host, will soon get a 300,000-joule capacitor bank to further EWP studies.

Help From Space

Employing technique used in computer analysis of missile flight magnetic data, Lockheed scientists have helped develop new weapon for early detection of hardening arteries. Heartbeat pulsations of patient are recorded by vasocomputer (right) on to missile-type magnetic tape

NEW MASER CIRCULATOR FOR L-BAND



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The new circulator, designated CLL1, combines an extremely low insertion loss of 0.3 db with 25 db isolation and VSWR of less than 1.1 centered at any frequency from 900 to 1,600 mc. With a permanent magnet, as illustrated, performance is typically 0.4 db and 20 db with a maximum VSWR of 1.25 over any 50 mc band. However, with a tuned magnetic field, the same performance is obtainable over a 100 mc band.

To learn more about this significant development or other important Raytheon advances in microwave ferrite devices, please write stating your particular area of interest to the address below.

TYPICAL SPECIFICATIONS

	CLL1	CLL2
Frequency range	*1260 ± 25 mc*	*1400 ± 25 mc*
Isolation		
Minimum	*20 db*	*20 db*
Maximum	*25 db*	*25 db*
Insertion loss		
Minimum	*0.3 db*	*0.3 db*
Maximum	*0.4 db*	*0.4 db*
Power Average	*5 watts*	*5 watts*
VSWR		
Minimum	*1.08*	*1.08*
Maximum	*1.25*	*1.25*
Weight (max.)	*9.0 lbs.*	*9.0 lbs.*
Max. dimension	*7½ in.*	*7½ in.*

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The major problem confronting electronics space researchers is to design spaceborne equipment which will operate reliably without human attention over extended periods of time. This equipment must also be small enough and light enough to be carried by the space vehicle, yet it must be sturdy enough to withstand enormous shocks, and sensitive enough to react instantaneously to any emergency. These specifications are without precedent.

Designing electronic systems for space vehicles still on the drawing board is the goal of the Space Technology Program at AIL. This is only one of the many programs concerning advanced design and systems management, currently under way at Airborne, that have created immediate openings in the following fields:

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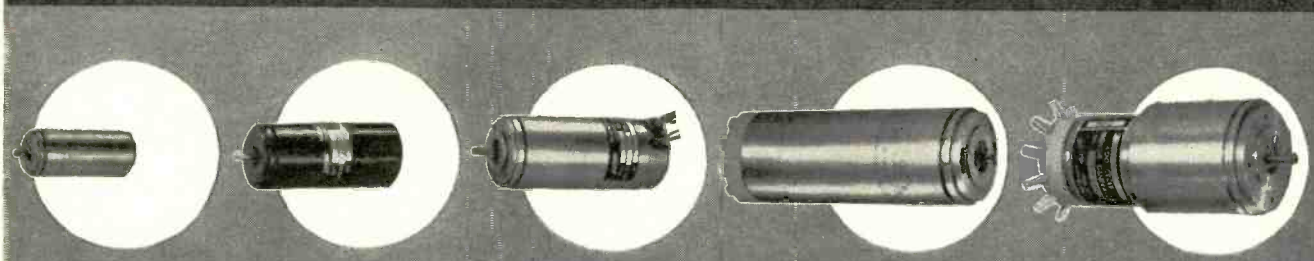

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Oster Type	Size	Length Inches	Wt. Oz.	Rotor Inertia gm cm²	MOTOR					GENERATOR				
					Rated Voltage Ø 1	Rated Voltage Ø 2	No load speed RPM	Watts per phase @ Stall	Stall Torque OZ. IN.	Excit. Volt.	Output Volts per 1000 RPM	Lin.% to 3600 RPM	Null MV	Phase Shift @25°C
8MTG-6201-01	8	1.850	2.3	0.77	26	40/20	6,500	2.2	0.16	26	0.25	0.5	15	± 5°
*10MTG-6228-02	10	2.157	4.2	0.72	115	115/57 5	9,500	2.8	0.26	115	0.45	1.5	19	±10°
10MTG-6229-12	10	2.100	2.9	1.09	33/16.5	52/26	9,500	3.0	0.28	26	0.45	1.5	13	±10°
*10MTG-6229-03	10	2.100	2.9	1.09	26	26	10,500	3.0	0.26	18	0.3	1.5	12	±10°
10MTG-6229-15	10	2.100	2.9	1.09	26	26	10,500	3.0	0.26	26	0.3	1.5	12	±10°
*10MTG-6232-05	10	2.104	4.2	1.1	115	36/18	6,500	3.5	0.26	115	0.30	1.5	15	±10°
11MTG-6251-13	11	2.531	7.0	1.3	115	115/57.5	6,500	3.5	0.63	115	0.55	0.5	19	±10°
11MTG-6251-00	11	2.531	7.0	1.1	115	40/20	6,500	3.5	0.63	115	0.55	1 5	19	±10°
11MTG-6254-01	11	2.200	6.0	1.1	115	115/57.5	6,500	3.5	0.63	115	0.55	1.5	19	±10°
15MTG-6280-01	15	3.281	14.0	5.3	115	115/57.5	5,000	6.2	1.5	115	3.0	0.2	13	± 5°
†*15MTG-6276-03	15	3.875	15.0	4.4	115	57.5	8,500	5.8	0.70	115	2.75	0.2	13	± 0.5°
18MTG-6302-02	18	3.680	20.0	5.7	115	115/57.5	9,000	16.0	2.7	115	3.0	0.2	13	± 5°
18MTG-6302-04	18	3.680	20.0	5.7	115	115/57.5	4,800	9.2	2.4	115	3.0	0.2	13	± 5°

*These units designed for 85°C ambient but same characteristics can be designed for 125°C. †Additional 21.4 watts for heater, the values given are independent of ambient temperature.

Other products include servos, synchros, resolvers, motor-gear-trains, AC drive motors, DC motors, servo mechanism assemblies, reference and tachometer generators, servo torque units, actuators and motor driven blower and fan assemblies.

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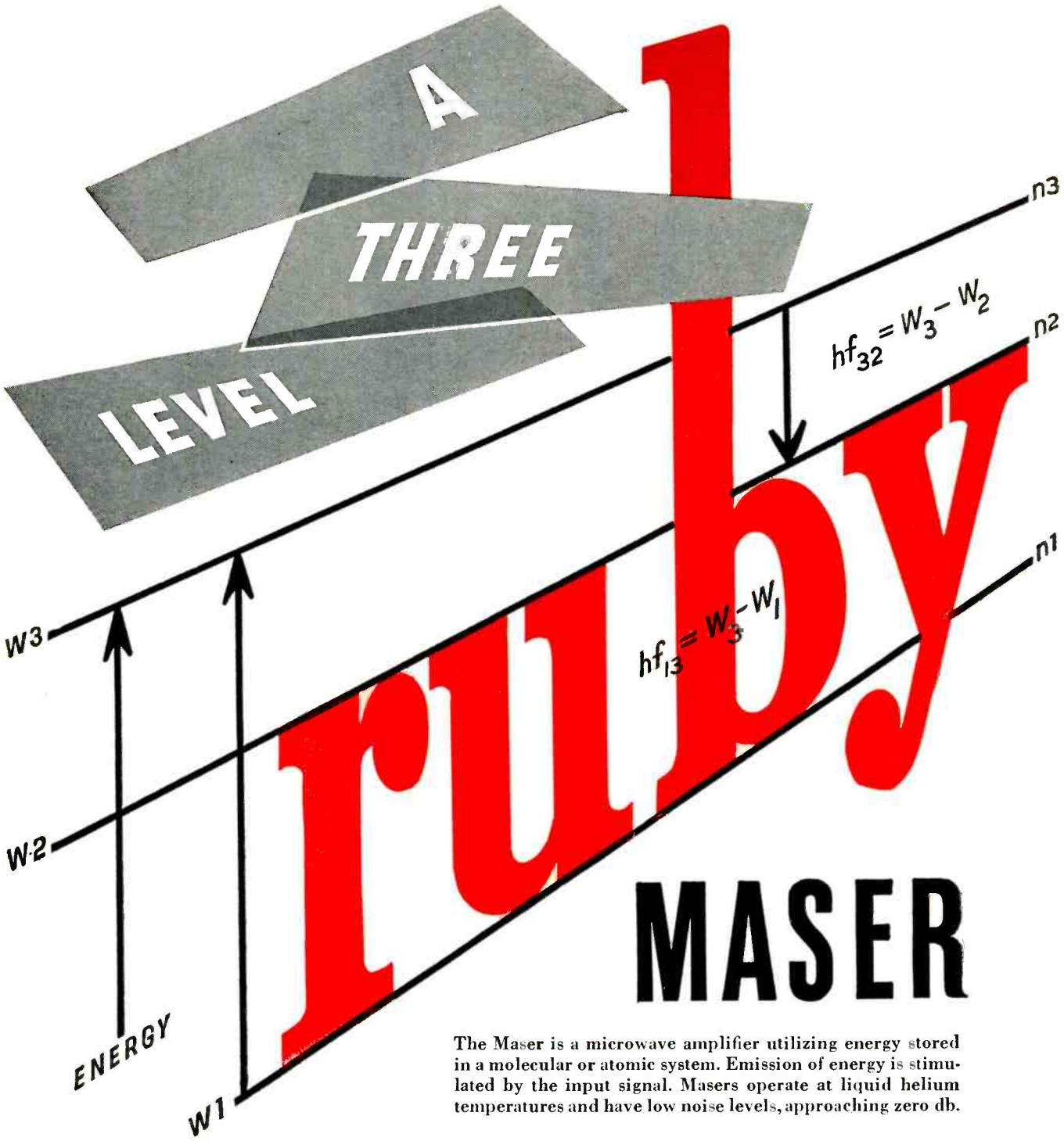

The Maser is a microwave amplifier utilizing energy stored in a molecular or atomic system. Emission of energy is stimulated by the input signal. Masers operate at liquid helium temperatures and have low noise levels, approaching zero db.

Recently, a university research laboratory† used LINDE single crystal synthetic ruby (Al_2O_3 with Cr_2O_3 additive) in a three-level solid state Maser. The ruby crystal was placed in the Maser's tuned cavity and a magnetic field of 4200 gauss was applied. To bring electrons from a ground state into a permissible higher energy level, a pumping frequency of 24 kMc was used and the Maser amplified signals at 9.3 kMc.

LINDE supplies other crystals, including rutile, spinel, and sapphire. (Al_2O_3). Sapphire is used in infrared optical systems, windows for higher power microwave tubes, spacers and supports in vacuum tubes, radiation pipes. It has strength at elevated temperatures, melts at 2040°C., is hard, inert, nonporous, and can be sealed to metals and glasses. Sapphire is available in the shape of domes, windows to 4½ inches in diameter, rods and special configurations.

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†*Maser Action in Ruby*, by G. Makhov, C. Kikuchi, J. Lambe, and R. W. Terhune. "Physical Review," Vol. 109, No. 4, p. 1399, Feb. 15, 1958.

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Tubes and Transistors Push

Fast-moving developments in both arts underscore the need for better flow of information to engineers who must apply them

IMPROVED design and manufacturing techniques for both tubes and transistors are pushing electronic engineering into an unparalleled state of flux this year with regard to future equipment applications.

Tubes, particularly those designed for high-frequency broadband applications, are challeging transistors with rugged and compact construction which often employs ceramics.

Transistors, with their small size, mechanical ruggedness and low power requirements, are moving towards higher frequency applications, more standardization, greater reliability and lower cost.

Some Confusion

Today, some engineers tend to become confused when they interpret manufacturers' specifications. They often use a transistor or tube to the limit of one of its characteristics without realizing they are overstepping the ability of the unit in other respects. Then they start talking about "bad transistors" or "bad tubes."

Some writers of military specifications invariably tend to dictate the use of transistors largely because they feel top military or management brass want the "newest" devices used. Thus transistors are often misapplied, because less reliability data is presently available.

More data will soon be forthcoming. Several transistor manufacturers have indicated they are intensifying efforts to get feedback from customers and to keep tabs on uses.

Individual engineers hold varied opinions about the future of tubes and transistors. Conservative engineering opinion holds that despite future design and manufacturing strides, tubes and transistors will each retain intrinsic advantages in different areas of application. Many engineers closely associated with either tubes or transistors admit they are not overly familiar with the latest developments in the other field.

The accelerating sophistication of both tubes and transistors has increased the burden of evaluation by engineers in various segments of the industry. It also complicates the task of communicating such data to other engineers.

Tube Makers Organize

Recently eight electronics firms that manufacture both tubes and transistors—in some cases within the same division of the corporation—did something to bolster the position of tubes.

An Electron Tube Information Council was formed to emphasize the engineering factors involved in selection of a tube (ELECTRONICS, p 11, Apr 3). Participating so far are CBS-Hytron, GE, Philco, RCA, Raytheon, Sylvania, Tung-Sol and Westinghouse.

Tubemen are distinguishing between tubes of today and tubes of tomorrow. Data is already being made available about new ceramic tubes, such as that used in the final amplifier of Pioneer IV to transmit up to 407,000 mi. at 890 mc. New reliability data will soon be sent out, including data on tubes used in the Sage system and in missile guidance through outer space.

"The forthcoming years will see a tremendous growth in the production and use of electronic devices and equipment," says the Council. "In this expansion both vacuum tubes and semiconductor devices will have their place. . . . It is the considered opinion of this Council that only by engineering test can the best device for the applications be determined."

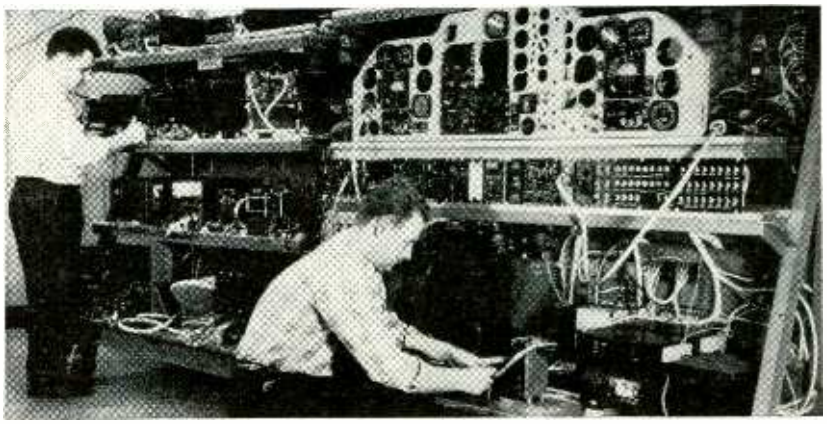
For many users the choice will get down to electrical characteristics per unit cost.

Transistors Do Talking

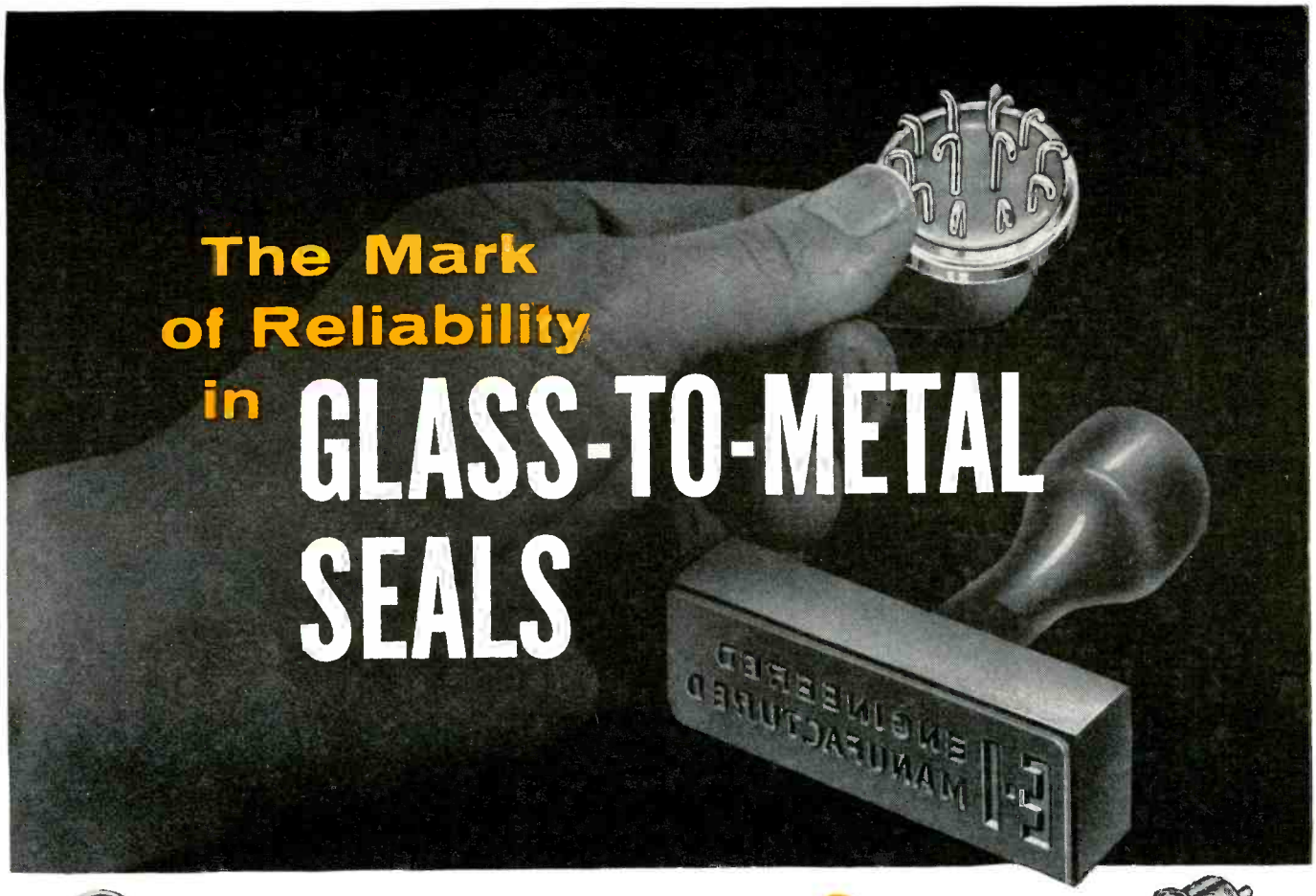
Receiving tube sales dropped from $384 million in 1957 to $342 million last year. Transistor sales climbed from $70 million to $113 million. However, most tube people feel that last year's recession largely caused the decline in tube sales. They think new designs will bring new growth.

Spokesmen for firms making transistors, some for only three years, emphasize that they are also optimistic. They are, for the most part, letting their product do the talking. They are also becoming particularly interested in expanding their market by having transistors properly used.

Checking Helicopter Gear



Helicopter's electronic system being "debugged" in mockup before installation in six Sikorsky S-58's soon to be delivered to Coast Guard. Gear includes instruments for all-weather flying, communications and automatic stabilization




Compression End Seals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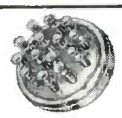
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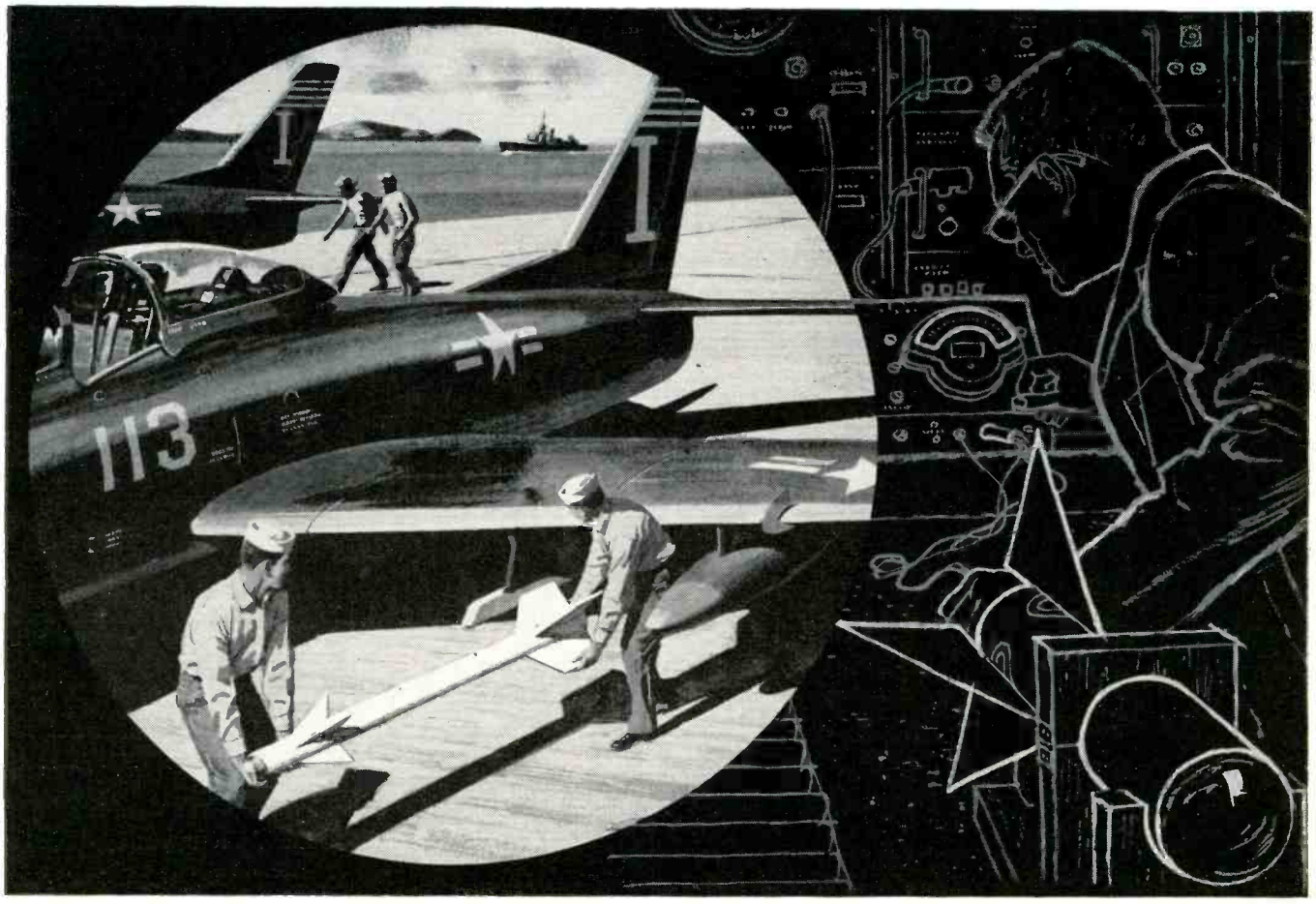

At Philco the world of tomorrow is *NOW!* Here are human resources, plus ultra-modern facilities, plus tremendous accumulated experience in research and development. Here too, are unlimited career opportunities in the fields of missiles and guidance, weapons systems, All-Transistor computers, infra-red, advanced radar techniques and communications systems. At Philco, versatility is the key to tremendous capacity in advanced technology. Make Philco your prime source for prime contracts from development to delivery.

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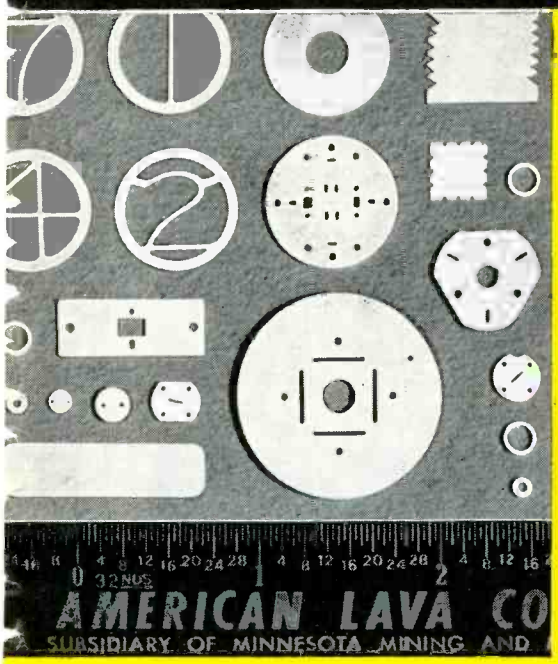
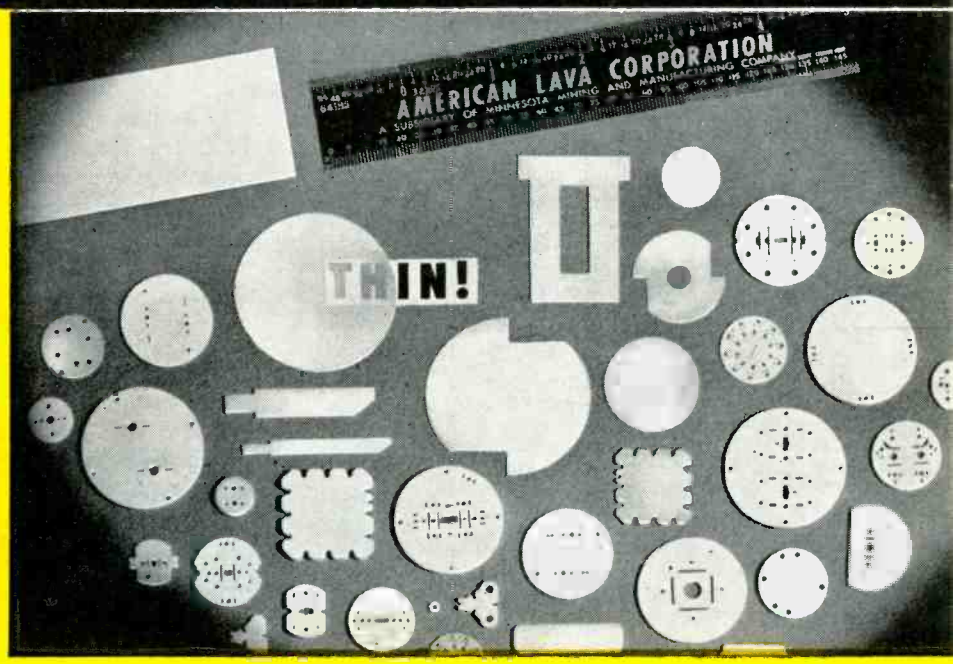
NEW ALSIMAG® THIN CERAMICS!

will these alumina ceramics give you

SMALLER, LIGHTER, MORE RUGGED UNITS?





Miniature AlSiMag Alumina Ceramics—some as thin as 0.005"—are being used in electron tubes, microwave windows, transistor platforms . . . as insulators in hearings aids . . . in digital counter tubes, radio crystal cages . . . in high temperature transformers, relays, fuses, micro-modules . . . high temperature amplifiers . . . and other high temperature devices including high temperature printed circuitry . . . as well as various mechanical applications.

The relatively high strength of these thin ceramics and their superior performance in high temperature, high frequency applications may help you answer the demands for smaller, lighter, more rugged units. This strength also sharply reduces damage from fatigue failure, heat deterioration, shock and vibration, and makes new automatic assembly operations practical.

Since these thin ceramics were pioneered by American Lava several years ago, demand has increased rapidly and steadily. Spurred by constantly increasing requirements, our production facilities are now capable of shipping in volume and at practical prices, small intricate shapes that were considered impossible as recently as 1955.

Free bulletin and typical samples of thin AlSiMag Ceramics sent on request

A Subsidiary of Minnesota Mining and Manufacturing Company

AMERICAN LAVA CORPORATION

CHATTANOOGA 5, TENN.
57TH YEAR OF CERAMIC LEADERSHIP

For service, contact American Lava representatives in Offices of Minnesota Mining & Manufacturing Co. in these cities (see your local telephone directory): Atlanta, Ga. • Boston: Newton Center, Mass. • Buffalo, N. Y. • Chicago: Bedford Park, Ill. • Cincinnati, O. • Cleveland, O. • Dallas, Texas • Detroit, Mich. • High Point, N. C. • Los Angeles, Cal. • New York: Ridgefield, N. J. • Philadelphia, Pa. • St. Louis, Mo. • St. Paul, Minn. • So. San Francisco, Cal. • Seattle, Wash. **Canada:** Minnesota Mining & Manufacturing of Canada, Ltd., P. O. Box 757, London, Ontario. **All other export:** Minnesota Mining & Manufacturing Co., International Division, 99 Park Ave., New York, N. Y.

New Markets In Basic

It's now predicted that, within six years, electronics will be "the only way" to control manufacturing processes

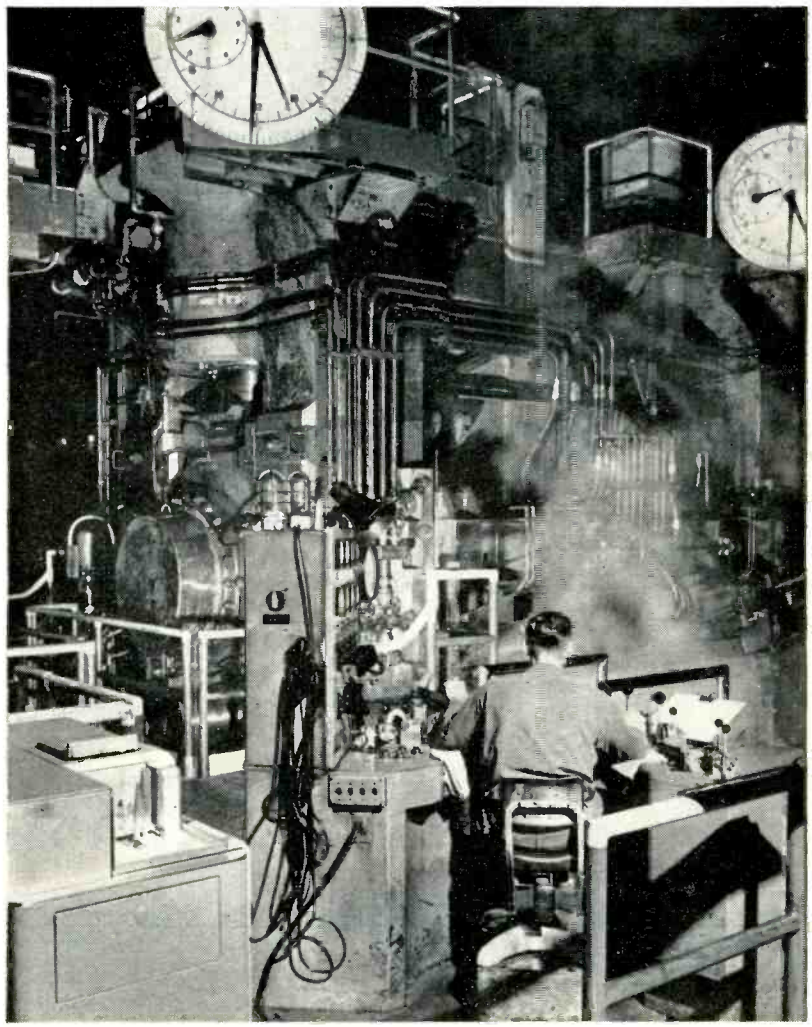
GROWING INTEREST in electronic control of today's mass production methods is opening new fields for computer manufacturers and instrument makers.

Last month at the ninth annual Iron and Steel Conference of the Instrument Society of America in Pittsburgh, officials of major steel companies heard talks on electronic control.

An on-line computer system was described for open-hearth furnace operation. F. C. Schneider of General Precision Controls said the computer will scan, compute and log approximately 200 variables from twelve open-hearth furnaces.

In addition to computers, electronic process control instruments are gaining in importance to steel makers. A Virginia operator who processes coal for steel mills has placed in operation an electronic radiation gage to govern the separation of ash from coal.

Electronic instruments have been recently installed to measure the exact footage of sheet steel coming out of a rolling mill. This is done



Electronic controls such as these in a rolling mill of the Aluminum Co. of America are finding new markets in industry

Metals

by putting a magnetic pulse into the steel at twelve-inch intervals and detecting the passage of each pulse on a scanner located at fixed distance along the processing line.

Operators say the magnetic pulse system gives a much more accurate footage count than they had been able to obtain with tachometers attached to the rollers.

Chemicals, Too

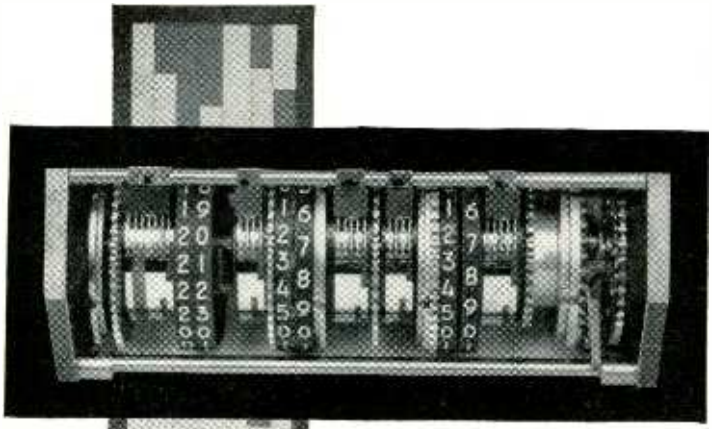
The chemical industry is also showing great interest in electronic controls. At a symposium in St. Louis a few weeks ago, chemical producers discussed the new demands being placed on them by current technological and political changes. Says H. K. Nason, a vice president of Monsanto Chemical, "This is especially true within the structure which includes instrumentation, automatic process control and systems engineering."

A spokesman from du Pont said his industry's investment in automation grows larger every year, and is primarily in small separate units whose good performance is essential to plant operation.

He discussed the use of general purpose computers to keep track of instruments, study maintenance performance and schedule preventative maintenance.

In a report on control systems for the chemical industry, J. L. Kelly of American Cyanamid told his audience: "The electronic control system is found in the role of newcomer despite the fact that earliest control loops were electrically operated. Nevertheless," he added, "due to the growing complexity of industrial processes, it (electronics) will be the only method that will control the 1965 plant."

One instrument maker, discussing increased electronics use, told ELECTRONICS of four firms with a long record of service to the steel and chemical control industries who have, during the past year, switched from production of pneumatic and hydraulic equipment to an almost exclusively electronic line.



. . . Kearfott analog-to-digital converters

accuracy, reliability, varied capacities and codings

Kearfott's direct drive converters translate shaft rotation into electrical and visual digital form. These mechanically positioned units consist of coded drums, the number depending on the code and total count. The first, or units drum, connects directly to the input shaft and rotates as the shaft turns. On models where more than one drum is used, high speed odometer type gearing provides interconnection. All models can be read "on the run" or "on demand" and all tracks may produce simultaneous or serial readings, depending on the interrogating pulse.

The high performance and quality of Kearfott's analog-to-digital converters are assured by stringent testing for:

Mechanical Accuracy: The location of any code transition point must fall within one-third bit of its true angular position.

Low and High Temperature: All units operate efficiently at temperatures ranging from − 65° F to + 260° F.

Brush Skip: Conducted in conjunction with tests for temperature, vibration, shock and acceleration. A typical brush skip test employs 200 μsec., 23V DC amplitude interrogating pulses at 4000 cycles per second. With the shaft rotating, each output drum track is monitored for a total of 500,000 pulses, in which "lost" counts or "skips" will not exceed 1 in 15,000.

Shock: Kearfott converters are subjected to 18 shocks in three different planes with shock loading of ± 15 g's.

Vibration: Units must withstand vibrations between 5 and 500 cps with applied load of ± 10 g's.

Acceleration: All units are subjected to radial accelerations of varying magnitudes up to a maximum of ± 7.5 g's.

Life: Over 1 million linear feet (1000 hours at 82 RPM) of continuous brush travel on drum coded patterns can be achieved without excessive wear to drums, brushes or other sub-components.

Write for new ADAC brochure.

ANALOG-TO-DIGITAL CONVERTER CHARACTERISTICS

Kearfott Unit No.	423830-1	423607-1	Y1241-11A	P1240-11A	Y1240-11A	U1240-11	P1241-11A
Code (1)	B.D.	B.D.	B.D.	B.D.	B.D.	B.D.	C.B. (Gray)
No. of Drums	1	1	2	3	3	4	5
Range	0 to 84 in 348.5° of arc. 11.5° dead spot coded O	−19 to 0 to + 19	0 to 359	(+) 0 to (+) 999 (−) 999 to (−) 0	0 to 359.9	0 to 359.9	0-32,768 (2^{15})
Bits per Revolution	85	39	40	20	40	40	16
Revolutions for Total Range	1	1	9	100	90	90	2,048
Volts D.C.	23	12	23	23	23	23	10.5
Current (ma.)	20	20	20	20	20	20	20
Inertia (gm. cm.²) (2)	158	48	104	28	158	100	20
Unit Diameter (in.)	2⅛	1¾	1 15/16	1 7/16	1 15/16	1.875	1 7/16
Unit Length (in.)	31/32	1 1/16	1-43/64	1 15/16	2 3/16	2.8125	3
Life (3)	10^6 revolutions or 10^3 hours						
Static Torque (in.-oz.) (4)	0.5	0.1	1.0	.5	1.0	1.0	2 (break) 1 (running)
Weight (oz.)	5	3.5	5.75	4	7.75	6.5	5
Maximum Speed (RPM)	1100	250	300	400	300	700	600
Dielectric (Volts DC)	500	500	500	500	500	500	500

(1) B.D. (Binary Decimal), C.B. (Cyclic Binary).
(2) Inertia measured at maximum trip.
(3) Under recommended conditions.
(4) At room temperature.

Engineers: *Kearfott offers challenging opportunities in advanced component and system development.*

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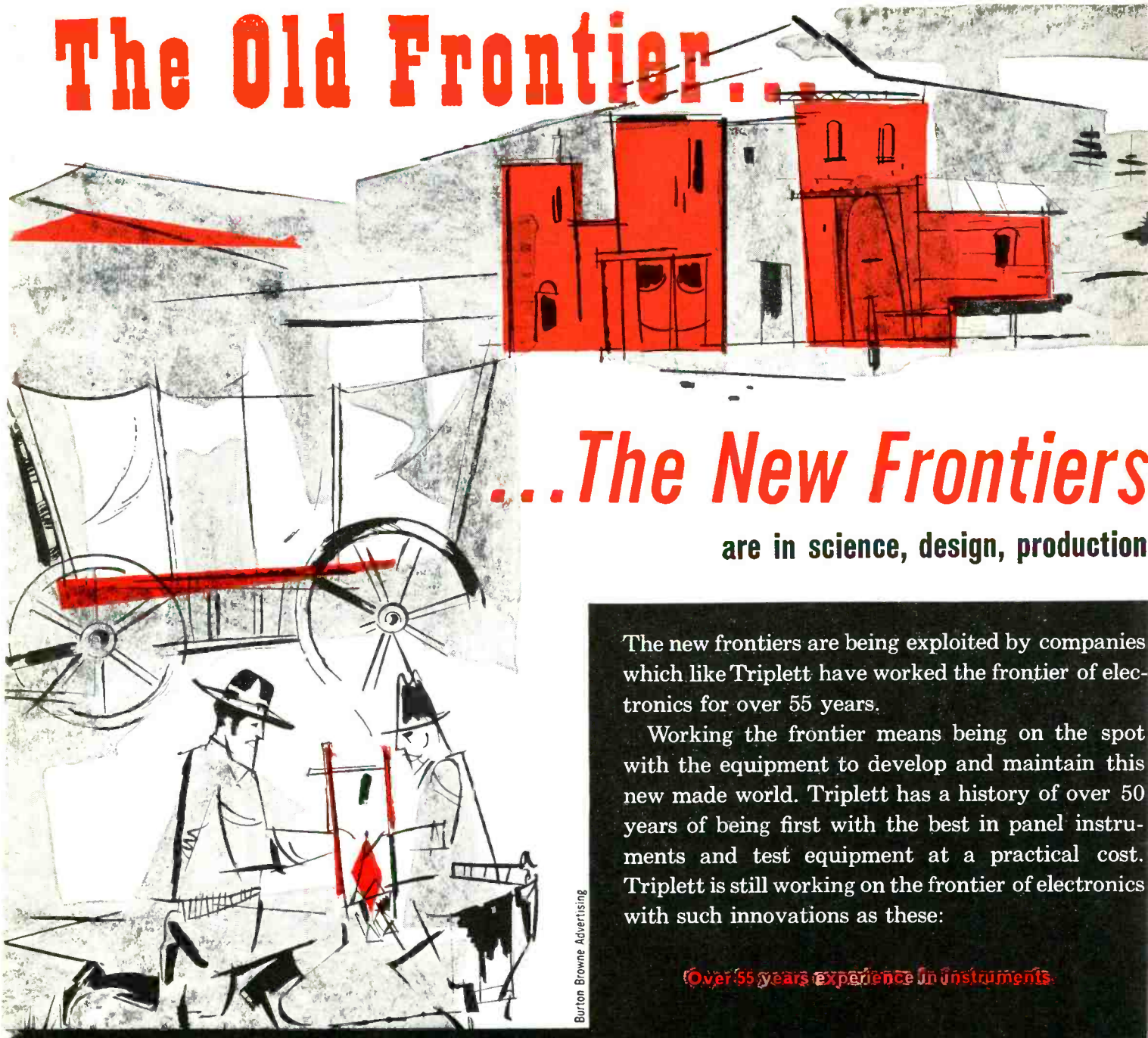
The Old Frontier...



...The New Frontiers

are in science, design, production

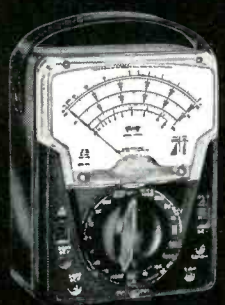
The new frontiers are being exploited by companies which like Triplett have worked the frontier of electronics for over 55 years.

Working the frontier means being on the spot with the equipment to develop and maintain this new made world. Triplett has a history of over 50 years of being first with the best in panel instruments and test equipment at a practical cost. Triplett is still working on the frontier of electronics with such innovations as these:

Over 55 years experience in instruments

Burton Browne Advertising

Model 310 a complete miniature V-O-M with single switch selection and the ranges and accuracy of units several times its size. Used with Model 10 clamp-on ammeter plugged in it becomes one of the world's most versatile pieces of test equipment—even measuring current flow without stripping wires.



Model 630-PL V-O-M with such advanced features as an unbreakable clear plastic front for wide range, shadowless, instant vision, polarity reversing switch, single king size knob for selecting both range and circuit, continuous resistance readings from 0.1 ohm to 100 megohms.

Model 690-A, a new Transistor Tester with more Triplett "plus" in accuracy and simplicity, for testing leakage and gain of all low and medium power PNP and NPN transistors. Small, rugged, battery-operated, it measures DC Beta from 5 to infinity. Affords exact tests for shorts, checks forward & reverse leakage of diodes. Features single switch selection of transistor types, positive "off" to prevent accidental battery drain, separate "calibrate" and "gain" buttons eliminate errors, transistor socket and external leads for any basing arrangement.

New Unimeters—a great step forward in increasing meter inventory flexibility while cutting inventory cost. These Select-Your-Range unimeters consist of only two basic meter movements which can be combined with any one of a number of separate dial-component units for a wide variety of meter ranges. Movements quickly and simply slide onto dial-components and lock together—no soldering, no wiring. Exclusive Triplett Bar-Ring construction for self-shielding, greater accuracy and sensitivity.

TRIPLETT

Triplett Electrical Instrument Company
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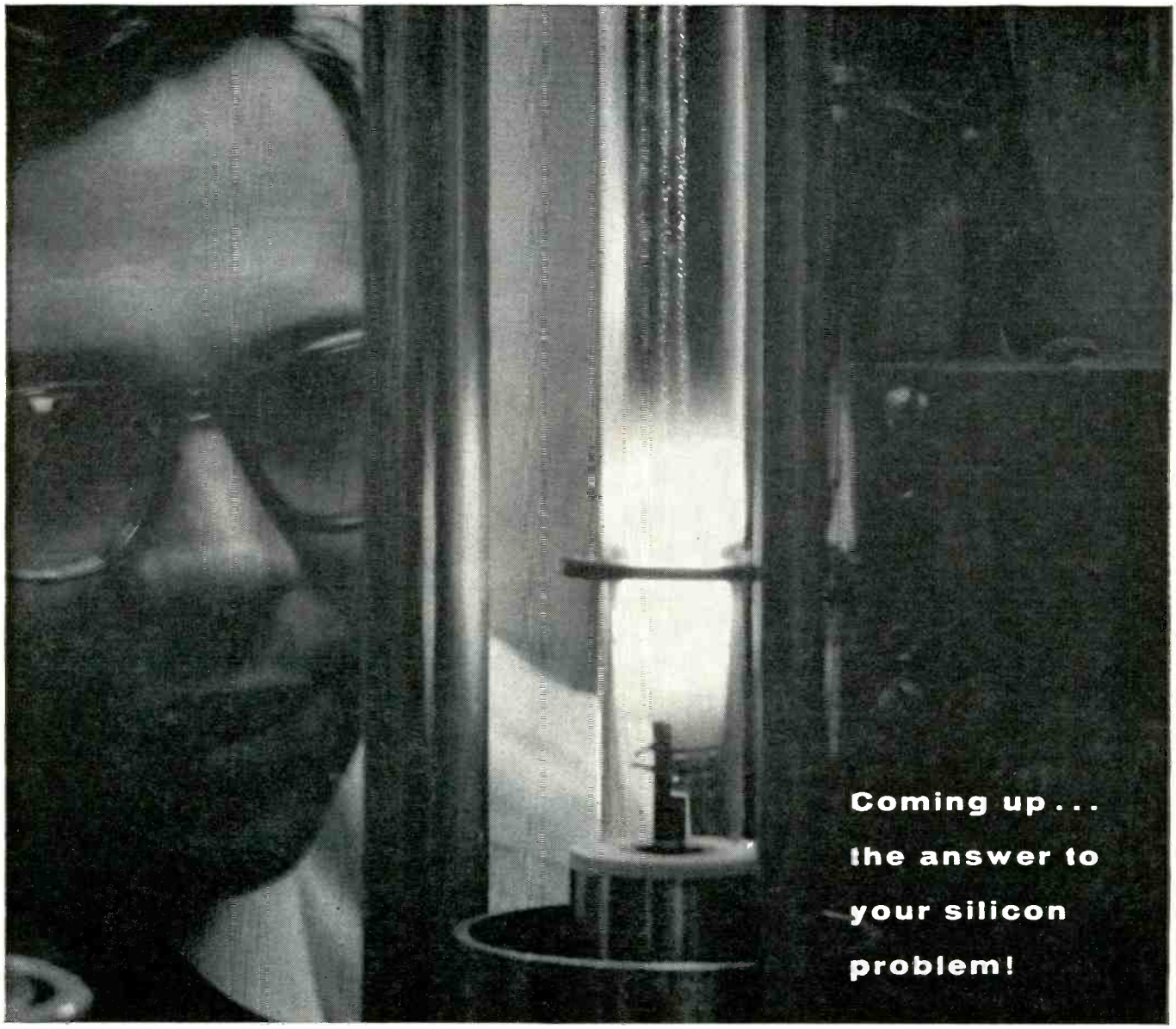

Du Pont . . . manufacturer of Hyperpure Silicon offers the services of technical specialists

When you specify Du Pont HYPERPURE Silicon, you get a product of highest dependability as well as expert technical assistance, when needed. Experienced Du Pont Technical Specialists will gladly discuss techniques of crystal growing and materials processing with you. What's more, you can take advantage of Du Pont's new $3,000,000 Technical-Service Laboratory designed for researching customer problems.

Floating zone single crystals of Du Pont HYPERPURE Silicon are available in a wide range of resistivities. Du Pont HYPERPURE Silicon is also supplied in densified cut rods . . . and rods suitable for float zone refining. They're offered in several grades with carefully controlled purity levels.

Here's more news: Du Pont's new Brevard, N. C., plant has a capacity of 70,000 lbs. of HYPERPURE Silicon per year. That means you're assured of a prompt supply of high-purity silicon in the form you need. For more information, write Du Pont . . . pioneer producer of semiconductor-grade silicon.

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

HYPERPURE SILICON

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BETTER THINGS FOR BETTER LIVING
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NOW... UNIFORM

SILICON DIODES

FROM

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THROUGH

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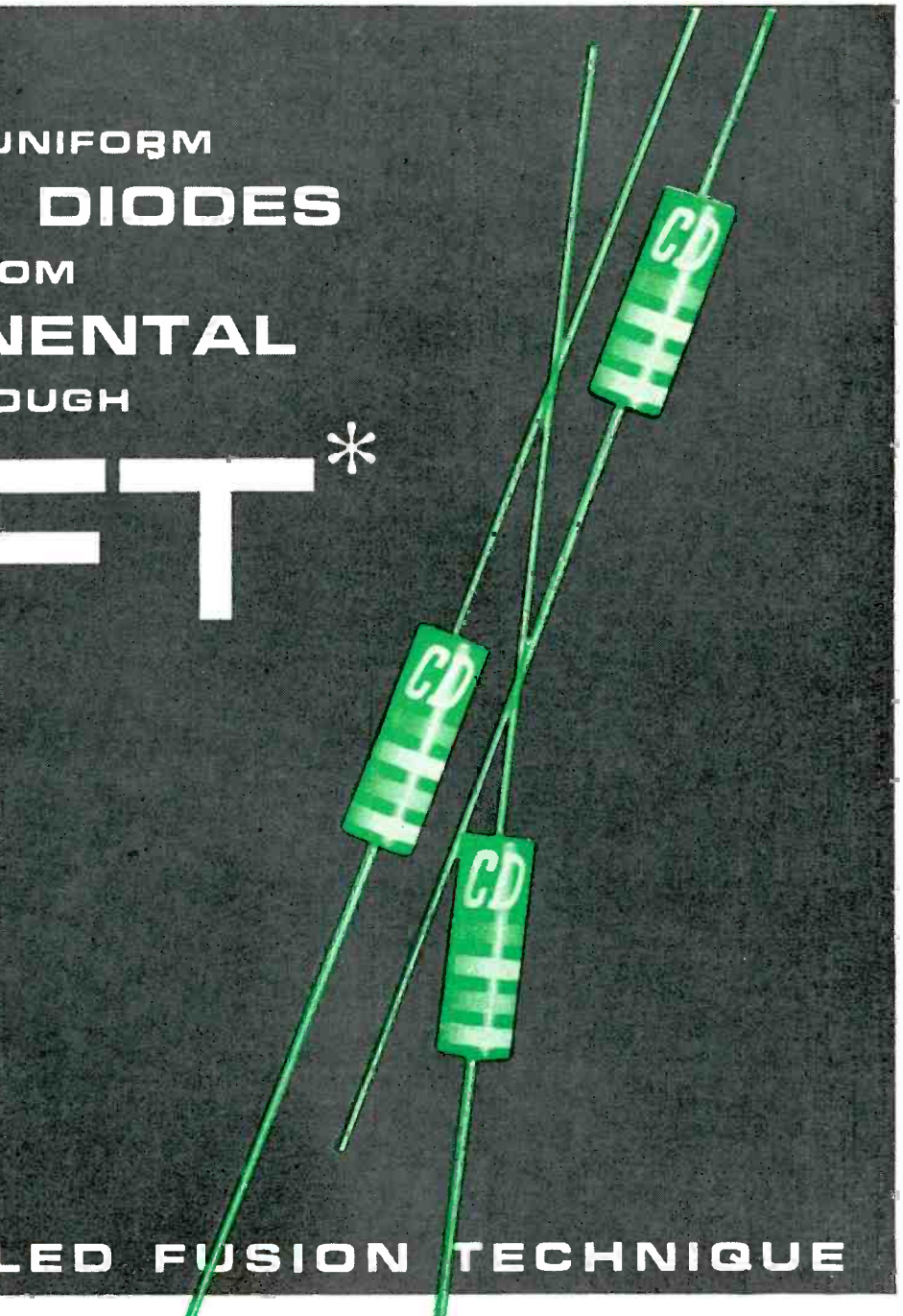
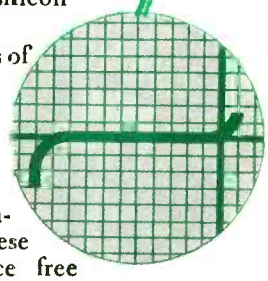


*CONTROLLED FUSION TECHNIQUE

The Controlled Fusion Technique effects precise control of the junction formation and its geometry, resulting in improved parameter values and exceptional product uniformity. This process is one factor contributing to the high reliability and advanced characteristics of the initial Continental product line of signal silicon diodes.



Rigid limits covering the sharpness of the knee or "hardness" of the reverse characteristic, although not usually specified, are included in the exacting monitoring of Continental diode production. This checks all processes following junction formation, and diodes which meet these limits must have a crystal surface free of harmful contaminants which can change the diode performance with age—sometimes catastrophically.

The improved parameter values are in good balance to allow the diodes to be used in most circuit positions without resorting to types which penalize one value to gain in another. The table lists several types representative of production.

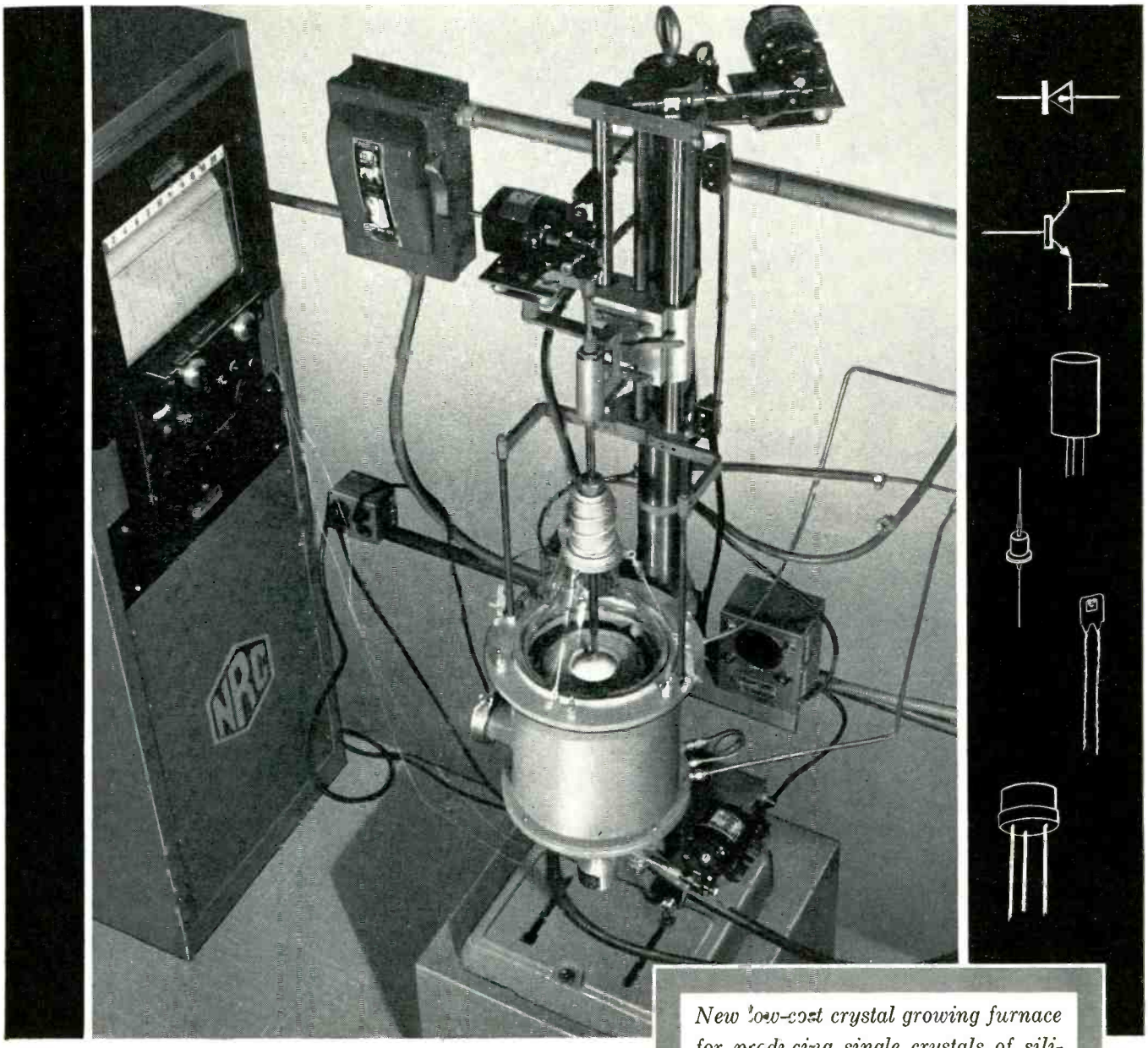
Diode Type	Working Voltage V_{RM}	Forward Current @ IV	Reverse Current @ V_{RM} 25°C	150°C
CD1113	130 V	250 mA	.005 μA	5 μA
CD1114	180	250	.005	5
CD1115	225	250	.005	5
CD1116	300	250	.010	10

Other, less severe, specifications can also be met and the uniformity of production allows the acceptance of double ended specifications when necessary for circuit performance.

A brochure describing the diodes more fully and listing available types is awaiting your request for a copy.

CONTINENTAL DEVICE CORPORATION

12911 CERISE AVENUE • HAWTHORNE • CALIFORNIA



New low-cost crystal growing furnace for producing single crystals of silicon, germanium, and intermetallic compounds with reliability and consistently high quality.

NOW GROW CRYSTALS EASILY

Here's an inexpensive, packaged, production unit for making crystals for diodes, transistors, photocells, solar cells or infrared detectors. The new unit combines the three essential features needed for successful operations:

Precise temperature control of the melt — can be maintained within one-half degree.

Vibrationless operation is achieved through special shock mounts, flexible drive shafts, and precision ground screws.

Freedom from contamination is assured by leak-free fabrication and careful selection of materials used in the hot zone.

This furnace is a real money-maker. You can grow a 150 gram crystal in about three hours. It is practically foolproof to operate, easy to maintain. Because it is a resistance furnace, it has a lower initial and operating cost.

It has exceptional flexibility. Rates of seed rotation, pulling rate, crucible rotation, and crucible withdrawal in either direction are all variable and independently controlled. Diameters variable to 1¼ inch, length to 10 inches.

Investigate how much money this unit can make for you. Call or write us today for a quotation or for more detailed information describing the Model 2801-B Crystal Growing Furnace.

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Transponder Traces Boxcars

New device may soon solve a big railroad industry problem—following rolling stock

TRANSPONDER developed by Link Aviation may soon be at work solving one of railroading's most difficult problems . . . tracing rolling stock.

Operation of the transponder (see photo) calls for attaching the small plastic encapsulated response circuit to each boxcar and installing interrogator loops along the roadbed. As the car passes the interrogator loop, an induction field is set up which triggers the response circuit. The resulting reply pulse is relayed to a central tracer location.

This transponder relays an electronic identity signal while moving past a stationary interrogator

Each response circuit is designed to emit a unique signal to identify the car it is attached to.

The response circuit includes a transistor, two coils and filters, a diode and two ferrite rods. One rod receives the interrogator signal, the other emits the reply pulse.

The interrogator is a coil of wire buried in the roadbed or placed within 1,000 ft of the track.

Other possible applications for the system besides railroads exist in motor freight and public transportation.

Solid-State Work Moving Into Infrared

SOLID-STATE research is headed toward infrared-optical work in submillimeter wavelengths, according to Harvard professor Nicholas Bloembergen.

A solid-state infrared quantum counter under development at Harvard promises spectroscopy much higher resolution in millimeter range.

Maser-like device uses paramagnetic salts, is basically an energy converter, with a multiplier phototube as quantum counter and an arc or gaseous discharge for optical pumping.

The infrared quantum counter was proposed by Bloembergen before an American Physical Society meeting this month at MIT. The device is not yet in operation.

Bloembergen said a maser used as coherent infrared generator with an infrared quantum counter as a detector would comprise a "very powerful combination." Masers in the infrared-optical range are under development by Columbia's C. H. Townes.

Also at APS meeting, Bernard Mathias of Bell Labs reported evidence that superconductivity and ferromagnetism are positively related—not mutually exclusive.

Combining magnetic metals like chromium, manganese, iron with other metals can make alloys that become superconducting at relatively high cryogenic temperatures.

Mathias said discovery of ferromagnetic superconductors makes possible synthesis of new magnets, also metals which are superconducting and behave like strong magnets at same time.

Probably three years will be needed to evaluate impact of the discovery, the Bell Labs scientist said, but he said it may result in simplification of design and other improvements in superconductive memory devices such as the cryotron.

Calibrate RF Output and Percent AM directly

—with these new BRC Signal Generator Calibrators—from 500 KC to 1000 MC

Available in Two Calibrated, Low Level Output Ranges—

Type 245-D: 0.5, 1 and 2 Microvolts
Type 245-C: 5, 10 and 20 Microvolts

- Provides direct calibrated measurement of RF voltage at 0.025, 0.05 and 0.1 volts
- Affords direct calibrated measurement of percent AM
- Provides calibrated source of RF voltage at 0.5, 1 and 2, or 5, 10 and 20 μv
- Completely transistorized—no external power source required
- Portable—simple to operate

RF Range: 500 kc to 1000 mc

RF Voltage Measurement Levels:

INPUT:	0.025, 0.05, 0.1 volts
OUTPUT:	5, 10, 20 μv (245-C)
	0.5, 1, 2 μv (245-D)

RF Voltage Accuracy:

INPUT:	±10% 500 kc to 500 mc*
	±15% 500 mc to 1000 mc*
	*when supplied from a 50 ohm nominal source, with a VSWR <2
OUTPUT:	±10% 500 kc to 500 mc
	±20% 500 mc to 1000 mc

RF Impedance:

INPUT:	50 ohms
OUTPUT:	50 ohms*
	*at output jack on instrument and at output connector of Type 517-B Output Cable

RF VSWR:

INPUT:	<1.3 500 kc to 500 mc
	<1.6 500 mc to 1000 mc
OUTPUT:	<1.05 500 kc to 100 mc*
	<1.07 100 mc to 500 mc*
	<1.1 500 mc to 1000 mc*
	*at output connector of Type 517-B Output Cable

AM Range: 10 to 100%

AM Accuracy: ±10% 30 cps to 15 kc*
±15% 20 cps to 20 kc*
*modulating frequency

AM Frequency Range: 20 cps to 20 kc

RF Input Requirements: 0.05 volts

Unique design features make Type 245 Signal-Generator Calibrators ideally suited for laboratory, production and field applications in the calibration of signal generators and the testing of receivers. No corrections of any kind are required over the entire frequency range; the instrument is direct reading in both input and output voltage level as well as percent AM from 500 kc to 1000 mc. Completely transistorized, the circuit is designed for maximum stability and reliability. Only two simple balance adjustments are required, permitting rapid measurement. Prices: TYPE 245-C $390.—TYPE 245-D $385. F.O.B. Boonton, N. J.

THE NEW BRC CATALOG—ask for your copy today! Contains complete data and specifications on Boonton Precision Test Equipment including new instruments with exclusive design features.

25th ANNIVERSARY *Precision Electronic Instruments since 1934*

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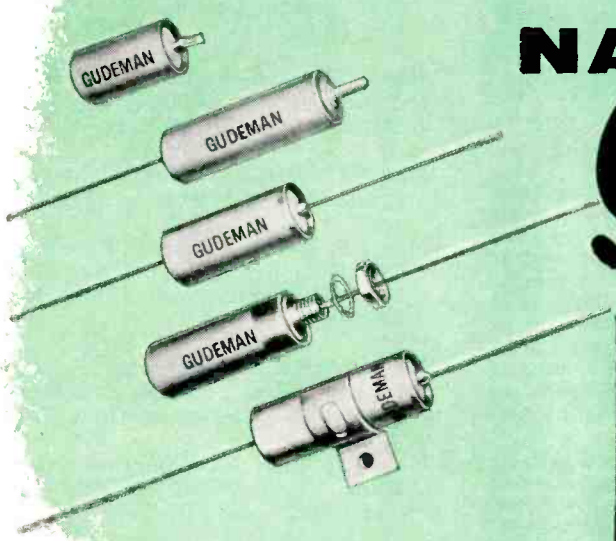
For close capacity tolerance and capacitance stability

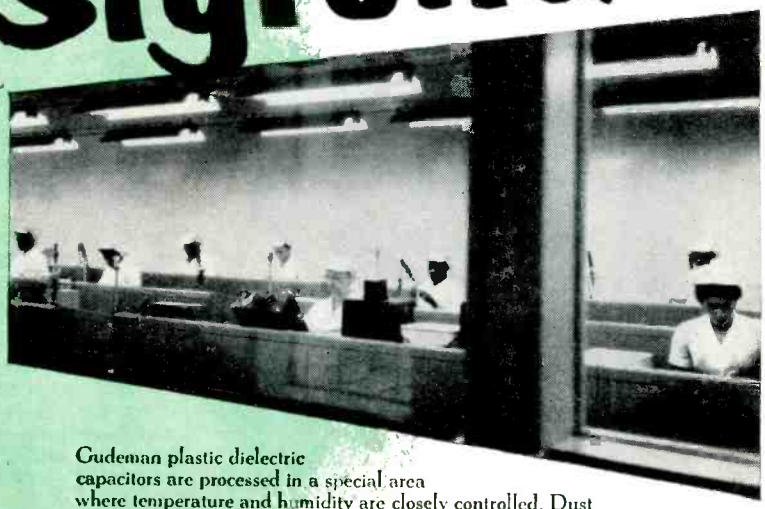
Gudeman Polystyrene Capacitors

are wound with

NATVAR Styroflex®



Gudeman capacitors are made in a wide range of capacitance values, voltages, and cases. Natvar Styroflex film is used in all Gudeman polystyrene capacitors.



Gudeman plastic dielectric capacitors are processed in a special area where temperature and humidity are closely controlled. Dust and other contaminants are filtered out, and as an extra precaution, operators wear nylon caps, smocks, and gloves. Operators like Styroflex because it winds easily. Quality control inspectors like it because the capacitors test out "on the nose" with a minimum of rejects.

The Gudeman Company, Chicago, one of the principal capacitor manufacturers, uses Natvar Styroflex film in their new series X-727 and X-728 capacitors. These polystyrene capacitors are used in such exacting applications as: critical timing circuits requiring capacitance stability, and low dielectric absorption; tuned circuits; laboratory standards; analog and digital computing circuits; circuits requiring storage capacitors with long time constant; and radiation counters.

Natvar Styroflex film is used as the dielectric because it has all of the outstanding properties of polystyrene plus toughness, uniformity, and complete flexibility due to bi-axial orientation during the manufacturing process.

Natvar Styroflex is available in standard thicknesses from .00035" to .006" in rolls from ½" to approximately 10" in width, or in special put ups to meet manufacturing requirements.

Natvar

Natvar Products

- Varnished cambric—sheet and tape
- Varnished canvas and duck—sheet and tape
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- Varnished papers—rope and kraft—sheet and tape
- Varnished, silicone varnished and silicone rubber coated Fiberglas*—sheet and tape
- Slot cell combinations, Aboglas®
- Isoglas® sheet and tape
- Isolastane® sheet, tape, tubing and sleeving
- Vinyl coated and silicone rubber coated Fiberglas tubing and sleeving
- Extruded vinyl tubing and tape
- Styroflex® flexible polystyrene tape
- Extruded identification markers

*T.M. (Reg. U.S. Pat. Off.) OCF Corp.

We will be very happy to supply information on any of our products on request.

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MEETINGS AHEAD

Apr. 28-30: Power Sources Conference, USA Signal Research & Devel. Lab., Fort Monmouth, Shelburne Hotel, Atlantic City, N. J.

Apr. 30-May 1: Controllable Satellites Conf., ARS, MIT, Cambridge, Mass.

May 3-7: Electrochemical Society, 115th Annual Meeting, Hotel Sheraton, Philadelphia.

May 4-6: Aeronautical Electronics, National Conf., PGANE of IRE, Biltmore Hotel, Dayton, O.

May 4-7: Instrumentation Flight Test Symposium, ISA, Seattle, Wash.

May 4-8: Society of Motion Picture & Television Engineers, Annual Convention, Fontainebleau Hotel, Miami Beach, Fla.

May 5-7: Electromagnetic Relays, National Conf., NARM, Oklahoma State Univ., Stillwater, Okla.

May 5-7: USA National Committee, URSI, PGAP, PGCT of IRE, Willard Hotel, Wash., D. C.

May 6-8: Electronic Components Conference, AIEE, EIA, IRE, WCEMA, Benjamin Franklin Hotel, Philadelphia.

May 6-8: Seventh Region of IRE, Technical Conf. & Trade Show, Univ. of Mexico, Albuquerque, N. M.

May 11-13: Power Instrumentation, National Symposium, ISA, Kansas City, Mo.

May 11-13: Automatic Techniques, Joint Conf., PGIE of IRE, AIEE, ASME, Pick-Congress Hotel, Chicago.

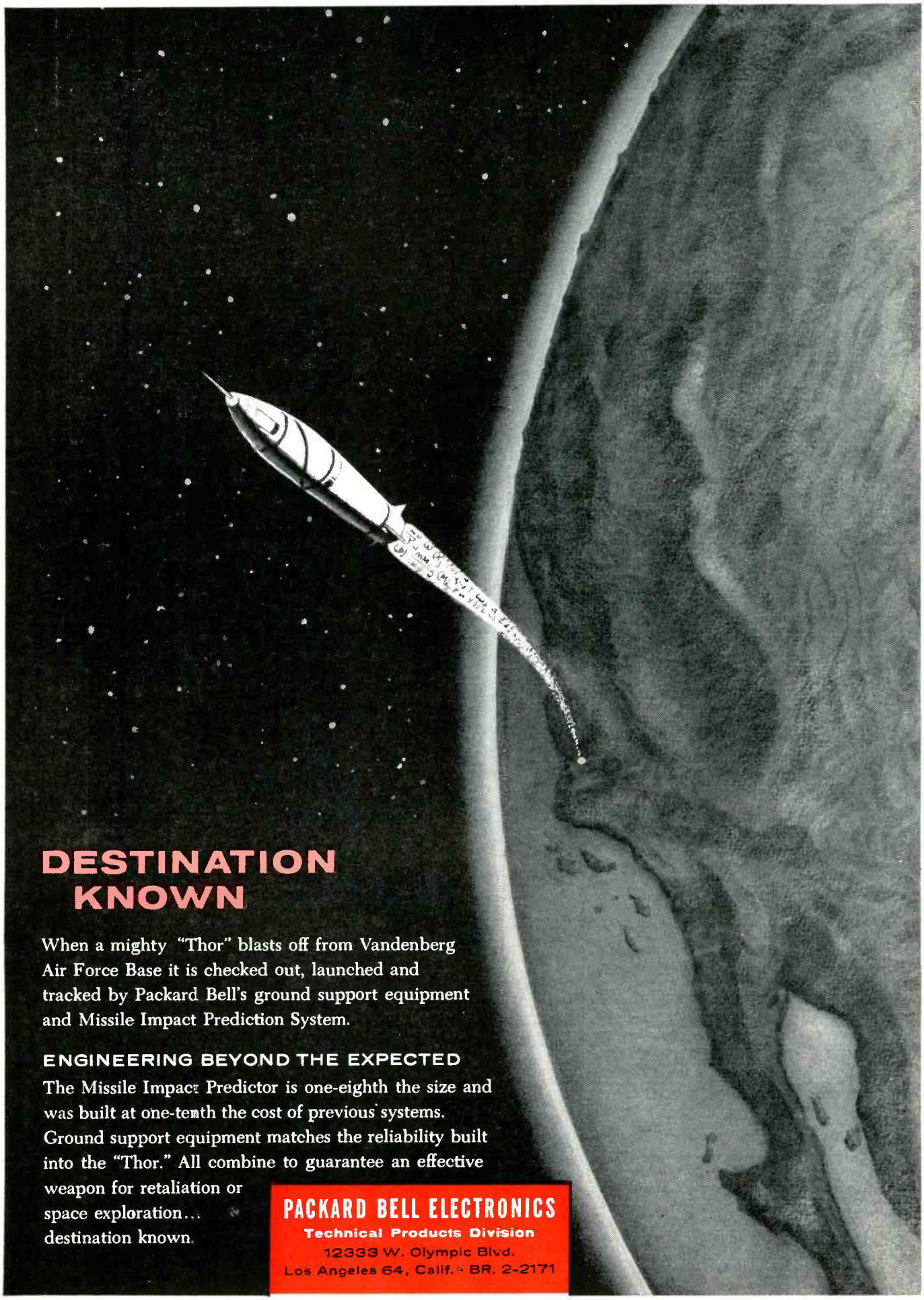
May 12-14: Assoc. of American Railroads, Communications Meeting, Netherland-Hilton Hotel, Cincinnati, O.

May 18-20: Instrumental Methods of Analysis, ISA, Shamrock-Hilton Hotel, Houston, Tex.

May 18-20: Electronic Parts Distributors Show, EISC, Conrad-Hilton Hotel, Chicago.

May 21-27: Transistors and Assoc. Semiconductor Devices, International Conv., Institution of Electrical Engineers, Earls Court, London.

There's more news in ON the MARKET, PLANTS and PEOPLE and other departments beginning on p 118.



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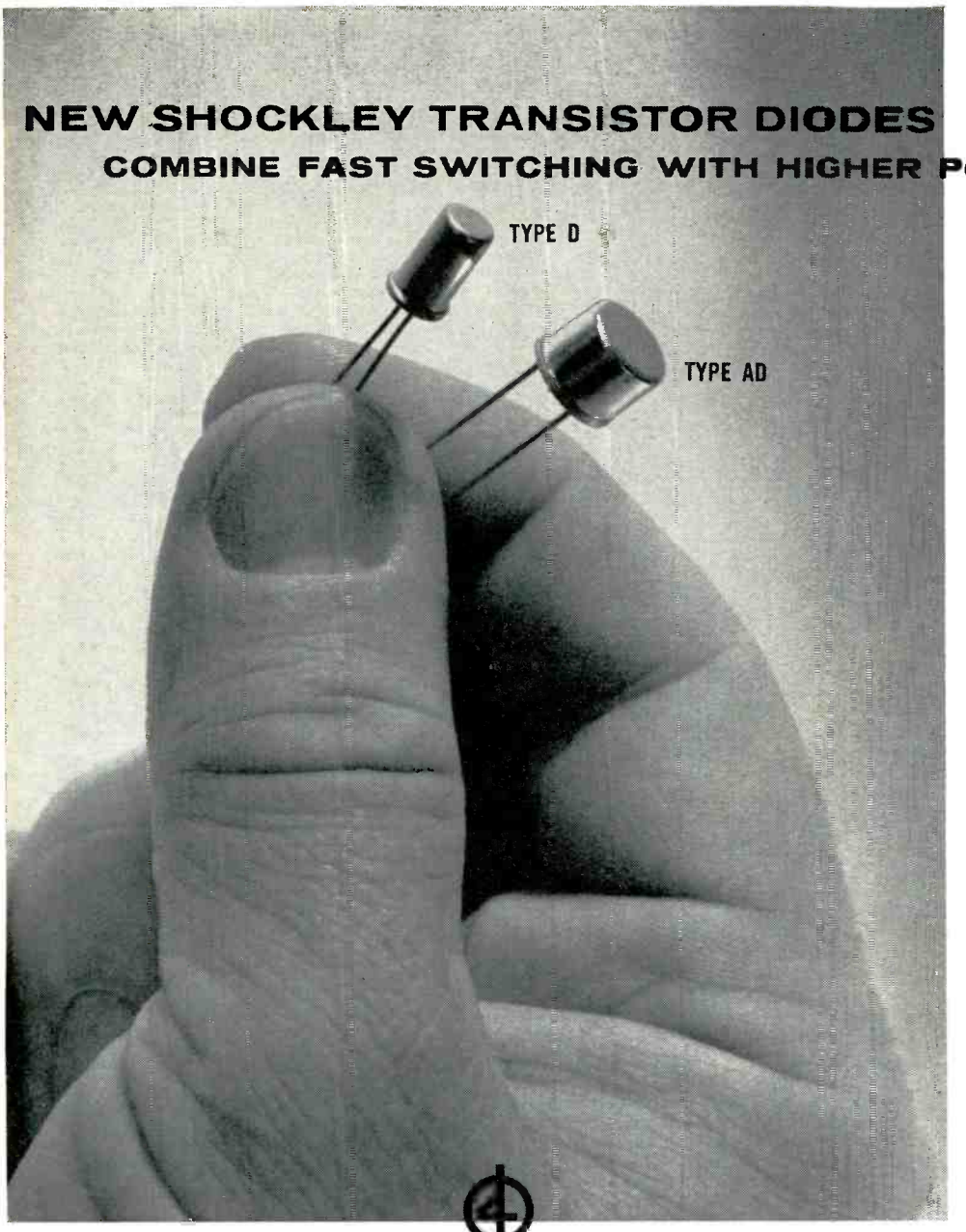
NEW SHOCKLEY TRANSISTOR DIODES

COMBINE FAST SWITCHING WITH HIGHER POWER HANDLING



Faster switching . . . determined by an "on" time constant of approximately 0.1 μs and an "off" time constant of approximately 0.2 μs . . . coupled with increased power handling ability, are now available with the Shockley 4-layer transistor diode – a two-terminal, self-actuated silicon switch with operating characteristics based on the principles of transistor action.

This new device is solving critical solid-state circuitry problems in many fields, requiring close tolerances . . . and unfailing reliability.

TYPICAL APPLICATIONS

PULSE GENERATORS
PULSE AMPLIFIERS
OSCILLATORS
RELAY ALARM CIRCUITS
RING COUNTERS
DETONATOR FIRING CIRCUITS
MAGNETRON PULSING
SONAR PULSING
TELEPHONE SWITCHING
COMPUTER CIRCUITS

CHARACTERISTICS OF SHOCKLEY 4-LAYER TRANSISTOR DIODES

Available in production quantities

TYPE NO.	Switching Voltage (V_s)
TYPE D	
4N20D	20 ± 4
4N25D	25 ± 4
4N30D	30 ± 4
4N35D	35 ± 4
4N40D	40 ± 4
4N45D	45 ± 4
4N50D	50 ± 4
4N55D	55 ± 4
4N60D	60 ± 4
4N80D	80 ± 8
4N120D	120 ± 12
4N200D	200 ± 20
TYPE AD	
4N30AD	30 ± 4
4N40AD	40 ± 4
4N50AD	50 ± 4
4N200AD	200 ± 20

OTHER CHARACTERISTICS OF ALL UNITS		
	TYPE D	**TYPE AD**
Holding Current (I_h)	3 ± 2; 10 ± 5; 20 ± 5 and 35 ± 10 ma. < 1 or > 50 on special order.	15 ± 10 and 35 ± 10 ma.
Holding Voltage (V_h)	0.5 to 1 volt	0.5 to 1 volt
Switching Current (I_s)	< 200 μ amps.	< 200 μ amps.
"On" Time Constant	0.1 μs (Circuit will determine specific switching time)	0.1 μs (Circuit will determine specific switching time)
Capacitance	Generally < 100 $\mu\mu$f. Exact value dependent on V_s and applied voltage.	Generally < 100 $\mu\mu$f. Exact value dependent on V_s and applied voltage.
Ambient Temperature	–60°C. to 100°C.	–60°C. to 100°C.
Current Carrying Capacity	50 ma. steady d.c. or 2 amp. pulse current--50 μs (or less) pulse duration.	300 ma. steady d.c. or 20 amp. pulse current--50 μs (or less) pulse duration.
Resistance (R)	R_{off} - > 1 megohm R_{on} - < 7 ohms at I_h + 25 ma. - < 2 ohms at 2 amps. (typical value 0.2 ohms)	R_{off} - > 1 megohm R_{on} - < 7 ohms at I_h + 25 ma. - < 1 ohm at 3 amps. (typical value 0.06 ohms)

ENGINEERING DATA AND ASSISTANCE

Our engineering staff, under the direction of Dr. William Shockley, will assist in solving circuitry problems using standard transistor diodes; also, will develop custom units to meet individual specifications. Write to Dept. 2-9.

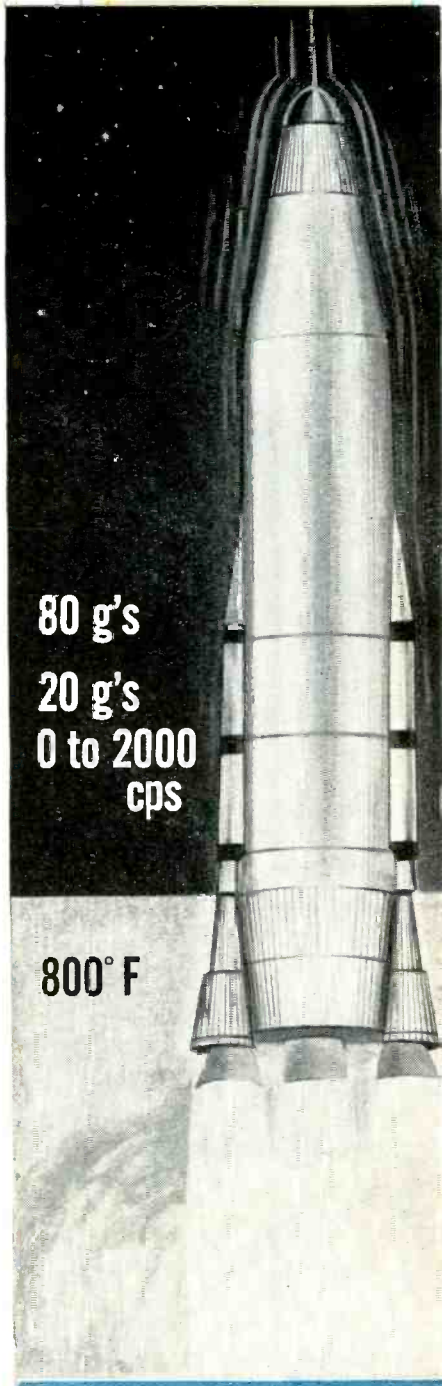
Shockley Transistor Corporation

Stanford Industrial Park, Palo Alto, Calif.

A SUBSIDIARY OF BECKMAN INSTRUMENTS, INC.

cppc Progress Report:

ENVIRONMENT



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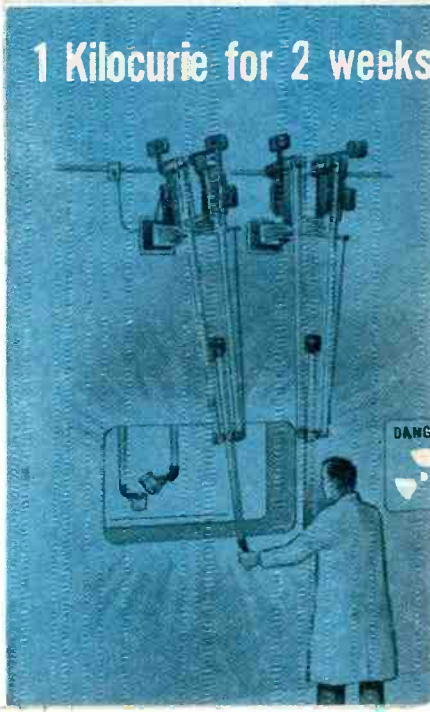
A year and a half ago we announced our synchros for direct turbo jet engine mounting which successfully resist 450° F. Since then we have progressed to where we are developing synchros that withstand 800° F for short periods and retain their precision characteristics.

Our high temperature resistant line of synchros can now be obtained in sizes 8, 10 and 11. High temperature units also available in our servo motors, motor generators and precision computing resolvers.

SIZE 8 SYNCHRO
ACTUAL SIZE

Radioactivity

We recently delivered radioactivity resistant synchros to a manufacturer of radioactive material handling equipment. When tested, these synchros successfully resisted unremitted radiation from 1 Kilocurie of Cobalt 60 for 2 weeks. The synchros remained functional in all respects i.e. accuracy, nulls, lubrication, insulation unimpaired.



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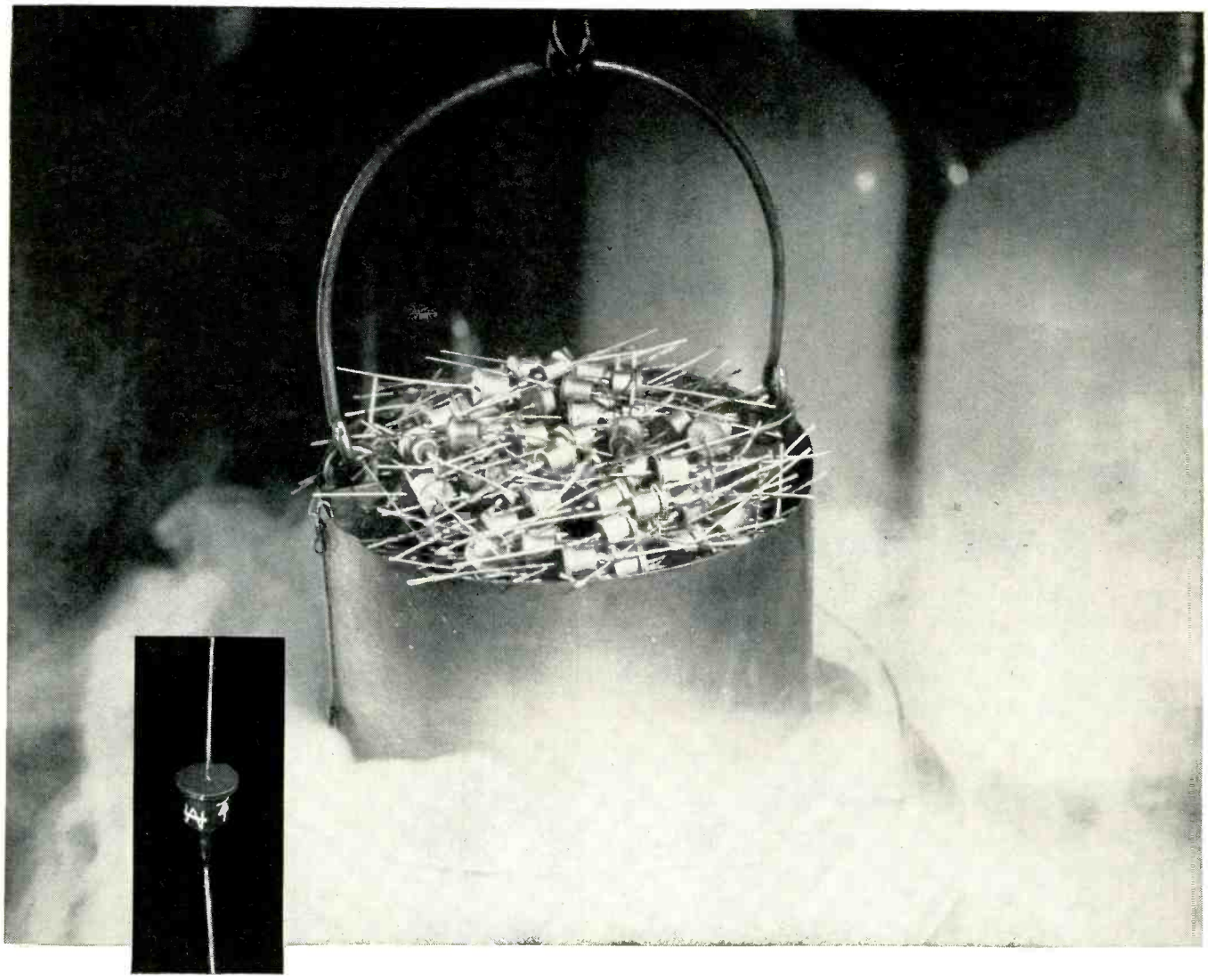

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Mallory Type E "Top Hat" silicon rectifiers are designed for the most severe environmental conditions. And we make sure that *each one* is capable of taking extreme duty, by giving its hermetic seal a rigorous test before the rectifier is shipped to you. First, it's immersed for 15 minutes in a bath of ethylene glycol at 150° C. After five minutes at room temperature, it is plunged into a —65° C acetone/dry ice bath. This process is repeated 3 times. Then the rectifier is subjected to 20 psi pressure in alcohol before being tested.

It's a more thorough way of testing . . . and it's your assurance of top quality and long, dependable life of Mallory Type E silicon rectifiers.

All Mallory silicon rectifiers feature the diffused junction in a design that increases rectifier area for higher efficiency and long service life. Metallic contacts are gold plated for cleaner junctions and greater reliability. And 100% production testing by automatic equipment eliminates any chance of human error.

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encapsulated silicon rectifiers for high quality and reliability at commercial prices.

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for fuse type clip mounting where simplified replacement is required.

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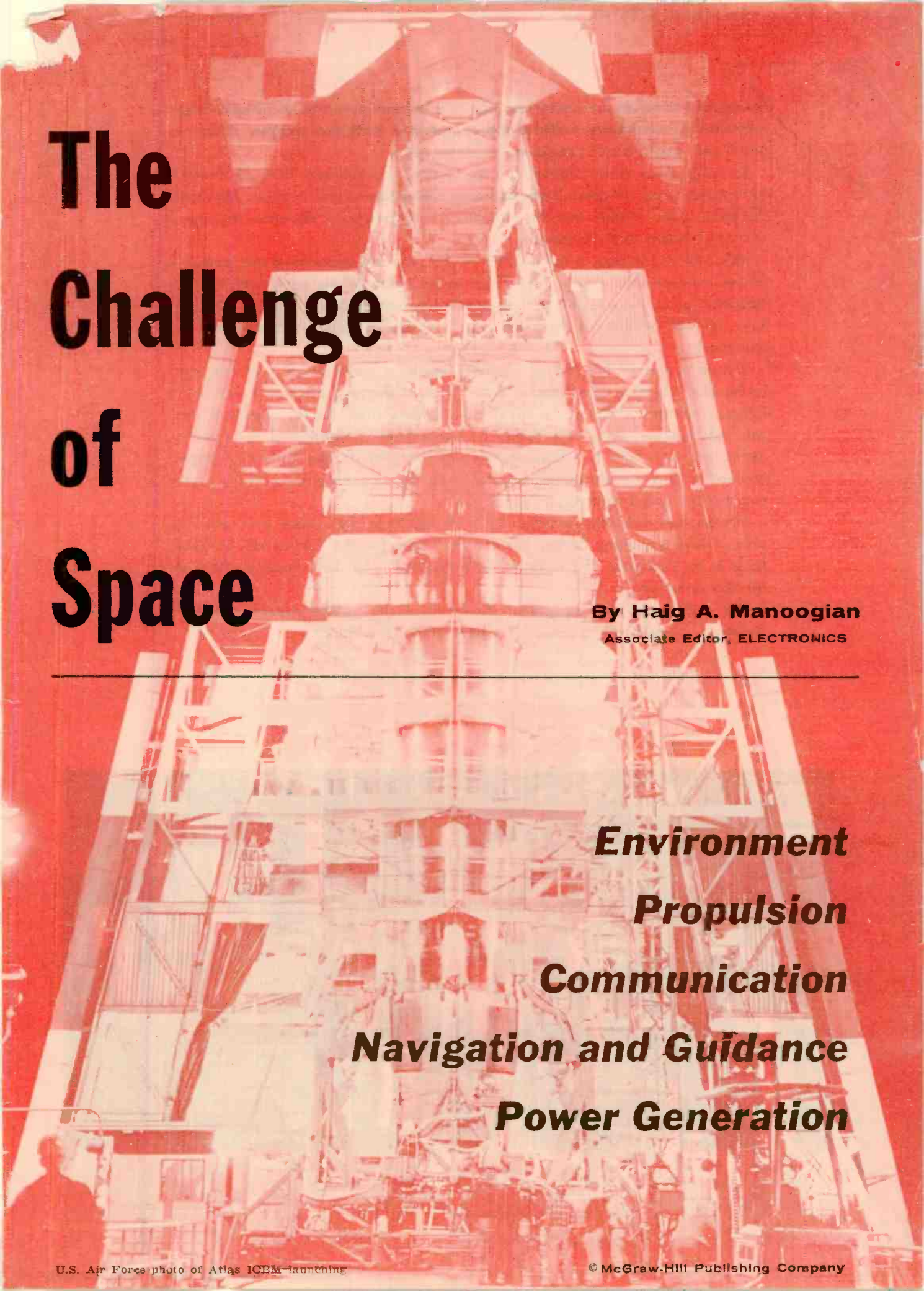
The Challenge of Space

By Haig A. Manoogian
Associate Editor, ELECTRONICS



Environment

Propulsion

Communication

Navigation and Guidance

Power Generation

U.S. Air Force photo of Atlas ICBM launching

Throughout the ages men have had the urge to cross the frontiers of knowledge and explore the unknown. Bold and imaginative men have always strived to attain new goals, never accepting the status quo.

In early times, this compelling urge caused adventurous men to venture far out into great unknown lands and oceans to discover and explore. Men with this spirit today venture into the contrasting small world of the atom, equipped with the modern tools of science.

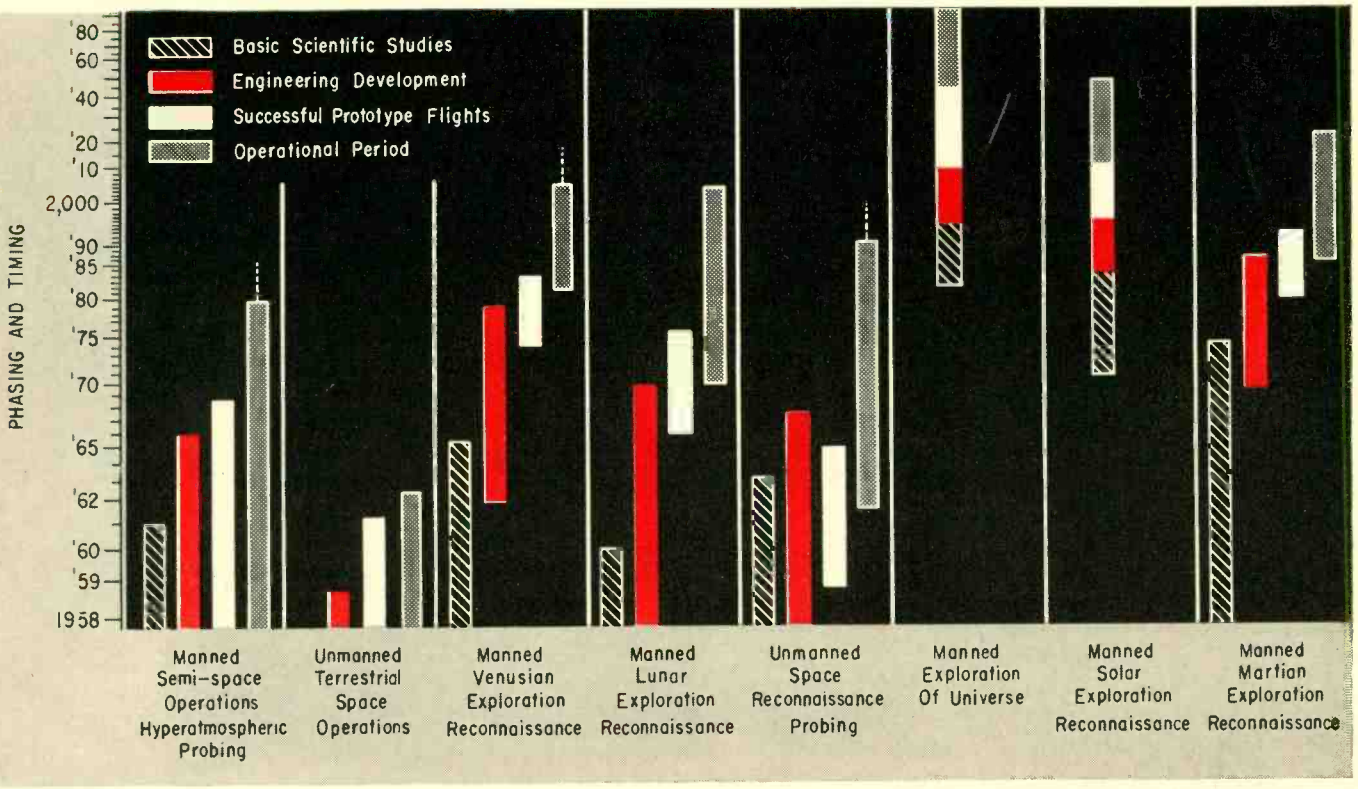
Man has also looked to the heavens to discover and understand the mysteries of the universe. His efforts have been limited, first by his eyes, later by the telescope and most recently by instrumented rockets and satellites. Soon, however, he will be free of these limitations when he himself ventures into the unknown.

This achievement will require a sharp break, in many ways, with the past. In the past one man often made discoveries that changed the world and man's future. Tomorrow's discoveries in space will more often be the results of men working together, each contributing his specialized knowledge of the complex technology that will be required. As will be seen in the following pages, electronics and the electronics engineer will play an essential part in almost every phase of the venture into space.

Human and scientific resources that will get man into space are available now. However, many of our present-day ideas for the future will probably have to be modified. The ways in which things will be done tomorrow are not all known today.

The techniques and equipment discussed in this article represent today's thinking. Tomorrow's concepts may bear little resemblance.

Timetable for Future Interplanetary Space Operations[16]



ENVIRONMENT

Electronic equipment and components must be designed to operate in a relatively unknown environment. Known space temperature data and recent radiation measurements indicate that serious limitations may be imposed on some materials

EARTH is one of the smaller planets that revolve around the star we know as the Sun. This Sun is a minor star in a local galaxy of hundreds of billions of stars that constitute the Milky Way, a disk-like system about 100,000 light years in diameter and 20,000 light years thick at the center. Our planetary system is 30,000 light years from the galactic center and rotates about this center once every 250-million years at 600,000 mph.

Pluto, the farthest planet from the Sun, is about 5½ light-hours away. In comparison, the nearest of the other star systems to our Sun is Alpha Centauri, at a distance of 4 light-years. Outside the Milky Way the nearest galaxy, Andromeda Nebula, is 2.2-million light-years away. The Milky Way and Andromeda Nebula are only two of hundreds of millions of galaxies in the Universe. This then is the great unknown that man will enter with his first successful space flight as the initial step.

Table I—Distances of Solar System Bodies

	Mean Dist. from Sun (× 10^6 mi)	Distance to Earth (× 10^6 miles)		Average Time for One-Way Communication
		max	min	
Mercury	36	138	48	8 min
Venus	67	162	24	8 min
Earth	93			
Mars	142	249	34	13 min
Jupiter	484	602	366	45 min
Saturn	887	1,030	734	1 hr, 12 min
Uranus	1,790	1,960	1,610	2 hr, 40 min
Neptune	2,800	2,920	2,680	4 hr, 10 min
Pluto	3,680	4,680	2,650	5 hr, 30 min
Moon		0.253	0.222	1.27 sec

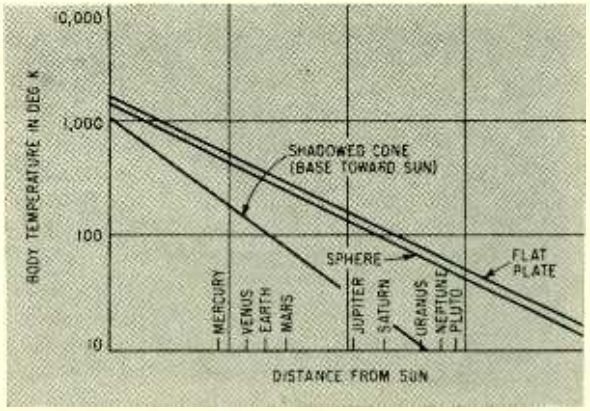


FIG. 1—Temperatures attained in space by black or gray bodies of various shapes

SOLAR SYSTEM——Table I lists the distances of the planets in our solar system from the Sun and Earth and Table II lists some of their orbital and physical characteristics.

Typical of the environmental factors that must be considered when designing electronic hardware are temperature and radiation.

Table II lists temperatures that may be encountered on other planets. Outside the protective shields of planetary atmospheres, bodies in space can reach much higher temperatures. At the Earth's distance from the Sun but outside its atmospheric shield a black body can reach temperatures of 300 to 400 K; Fig. 1[1] illustrates the temperatures of various shapes of black or grey bodies at various distances from the Sun. Table III[1] lists maximum operating temperatures for typical electronic components.

Cosmic radiation space may present a serious hazard, not only to humans, but also to improperly shielded components and materials. This radiation

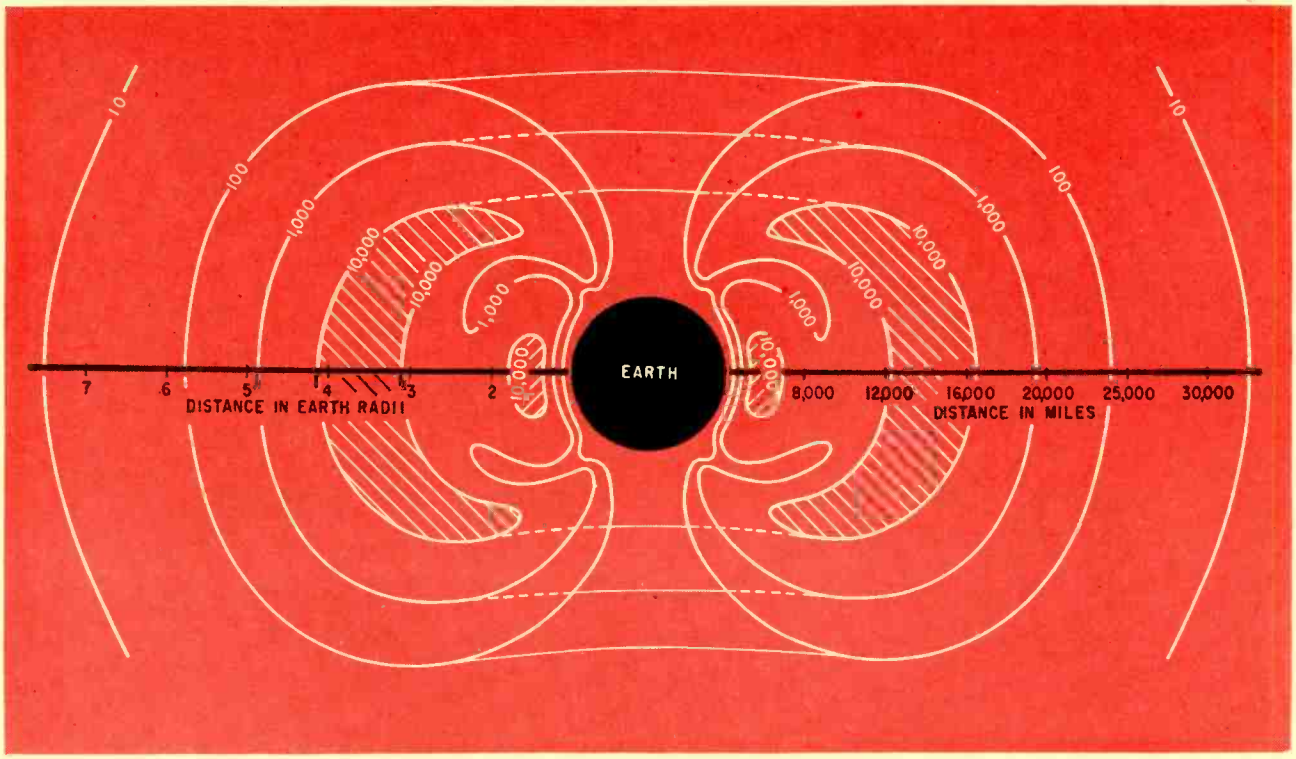


FIG. 2—Radiation in Earth's vicinity is in form of two concentric doughnut-shaped belts; contour lines of this cross-sectional representation indicate particle counts per second. Outer belt is believed to be caused by spurts of gas from Sun

is in the form of high-speed particles from space—about 80 percent being protons and the remainder comprising other subatomic particles.[2] Recent observations in the Earth's vicinity have established that it is surrounded by doughnut shaped belts of radiation. As illustrated in Fig. 2, the inner belt reaches its peak at about 2,000 miles and the outer peak at about 10,000 miles from the Earth. Farther out the radiation steadily diminishes to extremely low values beyond 40,000 miles. The maximum radiation intensity in each of the two belts reaches about 25,000 counts/sec, or about 40,000 particles/sq cm/sec.[3]

Table III—Approximate Temperature Limits of Conventional Electronic Components

Batteries	225 C	A-C Generators	250 C
Bearings	540 C	A-C Servo Motors	500 C
Capacitors	500 C	Insulated Wire	500 C
Circuits	550 C	Potentiometers	200 C
Relays	125 C	Radiation Detection Tubes	100 C
Selsyns	450 C	Semiconductor Silicon	200 C
Transformers	500 C	Semiconductor Germanium	75 C
Tubes	600 C	Semiconductor Selenium	125 C

Table II—Motions and Physical Characteristics of Solar System Bodies

	Number of Satellites	Mean Diameter (miles)	Escape Velocity (mph)	Rotation Period (days)	Revolution about Sun			Probable Atmosphere	Maximum Surface Temperature (deg C)
					Period	Mean Velocity (mph)	Inclination to Ecliptic		
Mercury	0	3,100	9,400	88	88 days	107,000	7°	——	+400
Venus	0	7,700	22,500	——	225 days	78,200	3° 24′	CO_2	+ 94
Earth	1	7,900	25,200	1	365 days	66,600	0	——	+ 60
Mars	2	4,200	11,200	1.03	687 days	54,000	1° 51′	H_2O, CO_2, N_2	+ 30
Jupiter	12	87,000	133,500	0.41	11.9 yr	29,150	1° 18′	CH_4, NH_3, H_2, He	−129
Saturn	9	72,000	79,300	0.43	29.5 yr	21,600	2° 29′	CH_4, NH_3, H_2, He	−152
Uranus	5	32,000	46,800	0.45	84 yr	15,100	46′	CH_4, NH_3, H_2, He	−168
Neptune	2	27,600	50,400	0.66	165 yr	12,200	1° 46′	CH_4, NH_3, H_2, He	−200
Pluto	0	3,600	24,000	6.03	248 yr	10,450	17° 9′	——	−223
Moon		2,160	5,400		27.3 days (about Earth)	2,300	5° 8′	——	−152

PROPULSION

Continuously powered interplanetary flights cannot be attained with conventional chemical rockets. Once vehicles attain escape or orbital velocity, supplementary electronic propulsion may be used to provide continuous thrust

DEVELOPMENT of adequate propulsion systems will be the engineering key to successful space flight. Two distinctly different phases must be considered.

A high-thrust propulsion system is necessary to get a vehicle off the earth's surface and to attain escape or orbital velocity. Once escape velocity is attained, the vehicle will rise through the earth's gravity field without additional propulsion; theoretically it will continue on into space, traveling a parabolic trajectory, and ultimately reach infinity with zero velocity. Table II lists the velocities necessary to escape some of the bodies in the solar system.

At orbital velocity, which is less than escape velocity, centrifugal force balances the gravitational force on the vehicle, causing it to travel a circular orbit as a satellite. The farther the vehicle is from the earth, the less the velocity necessary to keep it in orbit.

Escape velocity, at any level of a satellite orbit, is approximately 1.4 times the orbital velocity at that level.[4] Therefore, a low-thrust propulsion system is sufficient to provide the additional velocity increment necessary to escape the orbit and travel to any other planet's orbit.

Numerous electronic propulsion systems have considerable promise as low-thrust rocket engines. Their characteristic properties of long operating time at small propellant consumption rates make them particularly attractive for long interplanetary flights since they can, if desired, provide continuous acceleration during entire flights.

ION ROCKET—One electronic system under development utilizes an ionic propellant.

As illustrated in Fig. 3, propellant material is vaporized and introduced into an ionizing chamber at a controlled rate. The ions are extracted from the chamber by a negative electrostatic field of approximately 10^6 v/ft and accelerated to exhaust velocities of 300 to 400 $\times$ 10^3 mph to provide the main component of thrust. Experimental results have tentatively established the minimum accelerating voltage for efficient operation at 10 to 12 kv.[5]

Electrons produced in the ionization process are returned to the power source that supplies the ionizing chamber and the accelerating field; they are then recreated by thermionic emission and accelerated by a positive electrostatic field to a velocity approximating that of the ions and are recombined with the ions in the exhaust trail in back of the vehicle to neutralize space-charge effects on the vehicle. The accelerated electron stream also makes a small contribution to the engine's total thrust.

Propellants of the highest possible atomic or molecular weight, which form singly charged ions, are most efficient; ions of equivalent atomic or molecular weight much less than 100 produce thrusts too low to be especially useful. Possible propellant materials include liquids such as mercury and solids like uranium tetrachloride, cesium, thorium and rubidium.

The mechanics of the ionization chamber depend to a degree on the ionization potential of the propellant. Some low-potential materials can be ionized by the simple boiling of hot tungsten or platinum surfaces. Other materials must be vaporized by electron bombardment of a target anode, or require high-energy arcs for efficient ionization.

PLASMA ROCKETS—Much work is also being done

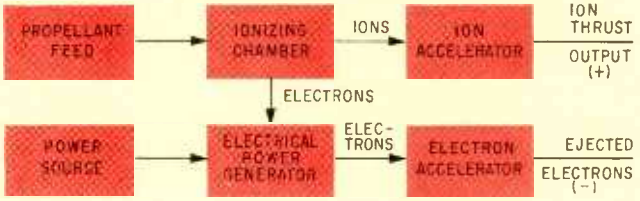
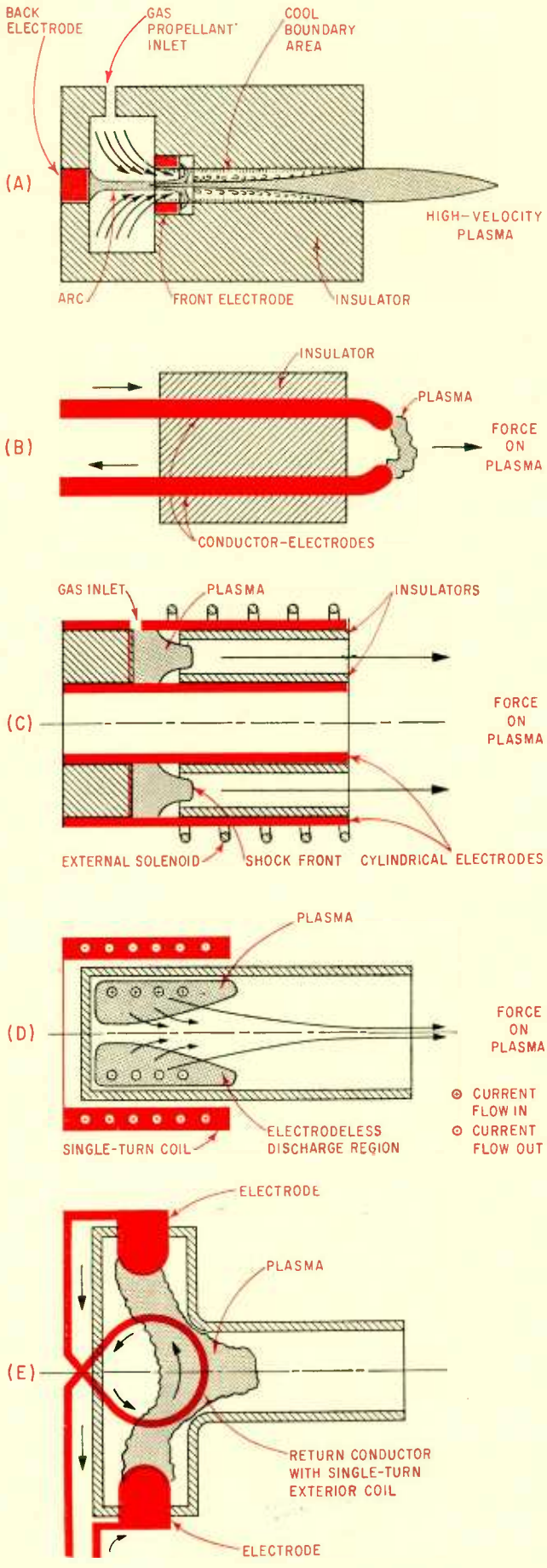
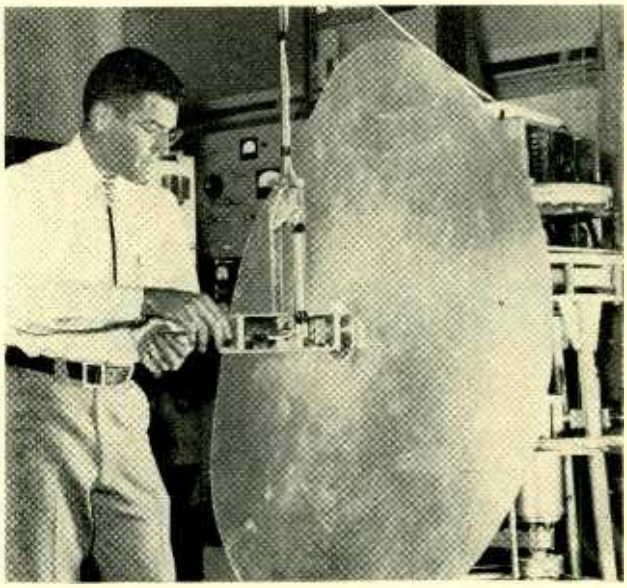


FIG. 3—Basic components of ion-drive propulsion system





Scientist in charge of Los Alamos Laboratory's solar sail development adjusts counterweights on miniature dynamic mockup. Electric motor spins plastic sheet flat by centrifugal force

on various types of plasma propulsion systems.

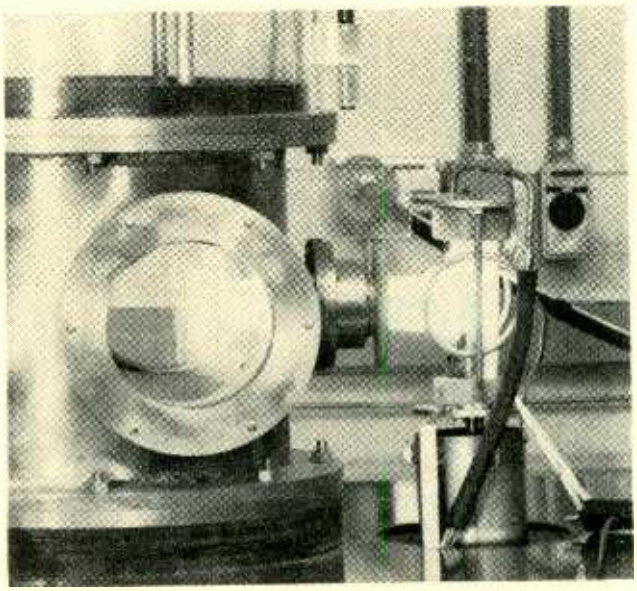
Thermal plasma accelerators are essentially arc devices, as illustrated in Fig. 4A. Nitrogen, hydrogen or argon gas is fed into a cylindrical arc chamber where it is heated to 10,000 to 100,000 F and ionized as it passes through the arc. A combination of thermal and magnetic pinch effects on the arc concentrates most of its energy at the center of the cylinder of flowing gas plasma, causing the plasma to exit from an orifice in one of the electrodes at velocities up to 10,000 mph. As ions and electrons remain mixed in a plasma, neutralization is not necessary in any of the plasma accelerators.

Heat transfer from the gas to the chamber walls causes 25 to 40 percent of the total electrical input power to be absorbed in cooling the electrodes. About 50 percent of the input power is used to ionize the gas, leaving 5 to 15 percent for kinetic motion of the plasma propellant.[6]

Magnetic-plasma or magnetohydrodynamic devices impart an accelerating force to a plasma producing current by the interaction of a varying magnetic field. The magnetic field is produced by the return current in fixed external conductors.

One of the simplest magnetic plasma accelerators is shown in Fig. 4B.[7] Initiation of a spark between the conductors, which are in an atmosphere of 1 micron Hg, vaporizes sufficient material from the conductors to produce a plasma of metallic ions and electrons. Buildup of the spark-producing current in the conductors creates an increasing magnetic field that accelerates the plasma away from the electrodes at velocities as high as 20 cm/μsec. Plasma motion can be restricted to the

FIG. 4—Plasma engines use high-temperature heating (A) or interaction of a varying magnetic field (B, C, D and E) to impart accelerating force on plasma



Exhaust plasma from experimental General Electric T-tube accelerator deflects scale vane, visible in porthole at left, to give approximate indication of thrust produced

Full-scale mockup of Rocketdyne experimental ion-drive engine that will weigh about 1½ lb and produce about ¼-lb thrust. Electrical power will be supplied by nuclear reactor power generator

axial direction by adding a magnetic field parallel to the axis.

In the accelerator illustrated in Fig. 4C, a uniform radial current sheet is drawn between two coaxial conducting cylinders and accelerated by the increasing magnetic field.[9] The current sheet forms a shock wave, in the gas mass preceding it, that heats and ionizes the gas. An axial magnetic field keeps the plasma away from the walls of the coaxial cylinders.

Exhaust velocities as high as 500,000 mph have been obtained using hydrogen or deuterium as propellants.

An electrodeless accelerator is illustrated in Fig. 4D.[9] A current pulse through the single-turn conductor causes a rapid buildup of an axial magnetic field. The electric field induced breaks down the gas in the tube and produces circular current loops in the plasma that are in opposite phase to the current loops in the external conductor. The magnetic field confined between the external conductor and the plasma current sheets implodes the plasma inwards toward the axis. The plasma then expands symmetrically outward along the axis from the coil region and reaches velocities of 10 cm/μsec.

Table IV—Characteristics of Rocket Engines

	Specific Impulse (sec)	Ratio of Thrust to Engine Weight	Vehicle Accceleration (g)
Chemical	200 to 400	50 to 80	1.2 to 1.5
Nuclear	400 to 1,000	10 to 50	1.2 to 1.5
Ionic	5,000 to 20,000	0.0005 to 0.00005	0.00001
Plasma	300 to 20,000		0.1 to 0.001

T-TUBE ACCELERATOR——Figure 4E illustrates an experimental accelerator whose electrodes and discharge region are arranged in a T geometry.[10] After a discharge is initiated, return current from the gun passes through a single-loop coil so located as to produce a magnetic field normal to the current passed within the tube. The Lorentz force thus created is perpendicular to the field and the plasma current accelerates the plasma out the side arm of the tube.

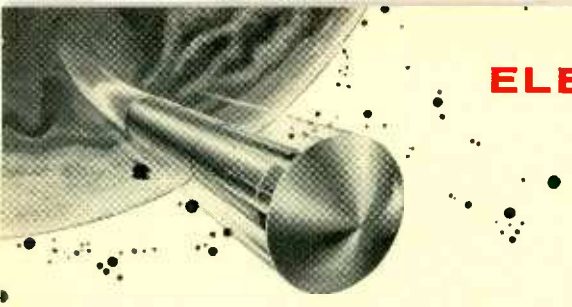
Operating at a 20-cps firing rate, in an ambient air pressure of 0.2 mm Hg, this device produces about 0.25 lb of thrust at 57,000 ft/sec for 500 joules power input.[11] Higher velocities can be obtained by using lower molecular weight gases instead of air as propellants.

The high currents that are necessary for these magnetic accelerators are usually supplied from high-voltage storage capacitors that are discharged by spark-gap switches. The switches are triggered by high-voltage pulses.

All of the electronic propulsion systems covered require high power inputs; 200 to 300 kw input is necessary to produce about a pound of thrust. Suitable power-generation equipment must therefore accompany ionic or plasma rockets into space.

PHOTON SAILING——Numerous proposals have been made to solve the power-generating problem by harnessing solar energy in a photon sail. Photon radiation on a huge sail of aluminized-plastic film could provide estimated thrusts of 1.7×10^{-7} to 2×10^{-7} lb per sq ft of reflecting surface for infinite periods of time.[12, 13]

Table IV lists some of the performance characteristics of present and future propulsion systems.[14] Specific impulse in generally used as a figure of merit and is equal to the pounds of thrust per pound of fuel consumed per second.



COMMUNICATION

Cosmic noise sources and Earth's outer atmosphere, which is opaque to much of electromagnetic spectrum, will probably present greatest limitations in Earth-to-Space communications. Transmissions in free space should be relatively easy

SPACE COMMUNICATION systems will play a vital role in interplanetary flight. Besides providing contact with the occupants of space vehicles, communication links will be necessary for data transmission, navigation and guidance, and other important functions. Evaluation of present-day knowledge of the problems that may be encountered indicates that, with refinement and evolution, current communication techniques can be adapted for space.

Communications in space may be grouped into two categories: between points in space or points in space and the Earth. For line-of-sight transmissions in free space, the signal power at the receiver is given by the one-way range equation

$$P_R = \frac{P_T G_T A_R}{4\pi D^2} = \frac{P_T G_T G_R c^2}{(4\pi Df)^2}$$

where P_T is radiated power, G_T and G_R are transmiting and receiving antenna gains, c is velocity of propagation, A_R is effective receiving antenna area and f is frequency. For isotropic antennas (gain = 1), the range equation reduces to $P_R/P_T = (c/\pi\ Df)^2$, which is equal to free-space loss; expressed in decibels, free-space loss = 36.6 + 20 (log D + log f) and is given in nomogram form in Fig. 5[15] for various transmission distances from the Earth at different frequencies. Actual losses for Earth-to-space communications will be higher than this basic loss because of propagation losses incurred in the Earth's atmosphere.

PROPAGATION CHARACTERISTICS — To much of the electromagnetic-wave spectrum, the Earth's atmosphere acts as an opaque barrier. There, however, are two regions of partial transparency; an optical window in the visible wavelength region of 5×10^{-5} to 10^{-4} cm and a radio window in the vhf, uhf region from 1 cm to 10 m. In addition, there are some other partial transparencies in the i-r and x-ray regions.

Even in the radio-window region, numerous factors cause varying degrees of signal attenuation in the troposphere and ionosphere. Referring to Table V[16] (see p 74), which lists some of the propagation characteristics of frequencies of 3 mc to 1.5×10^9 mc, it would seem that frequencies between 100 and 10,000 mc are suitable for line-of-sight communication between space vehicles and Earth stations.[15]

Effects of auroral reflection, absorption and scattering, predictable radio-star interference and signal fading due to Faraday rotation of the plane of polarization can often be neglected above 1,000 mc. However, water-vapor absorption becomes more serious at frequencies approaching 10,000 mc, particularly at small angles above the horizontal.[15]

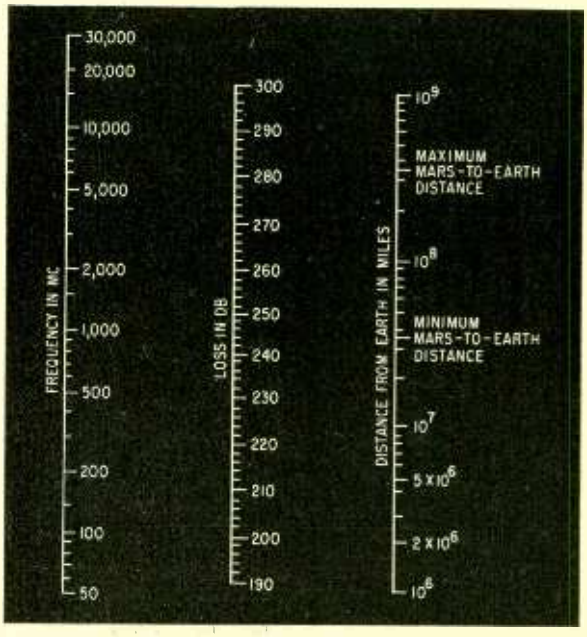


FIG. 5—Nomogram for determination of free-space transmission loss at various distances from Earth

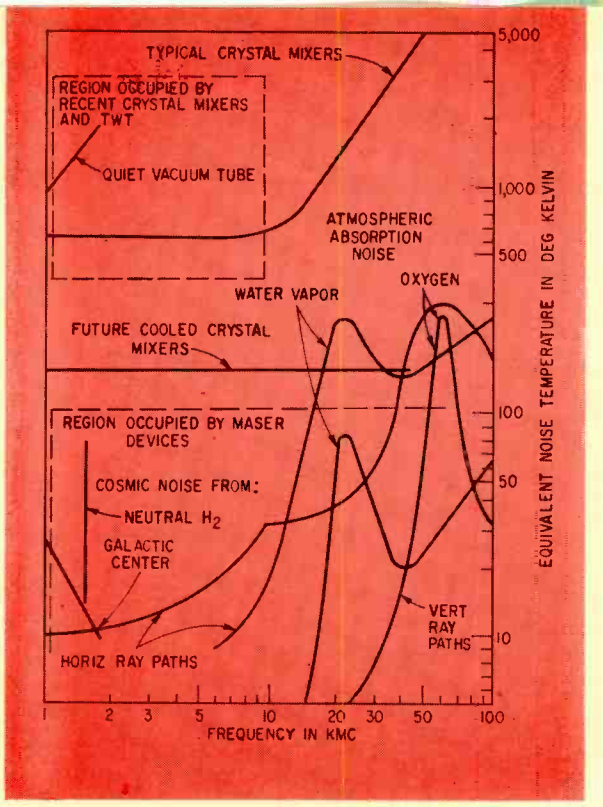


FIG. 6—Equivalent temperatures of various sources of noise

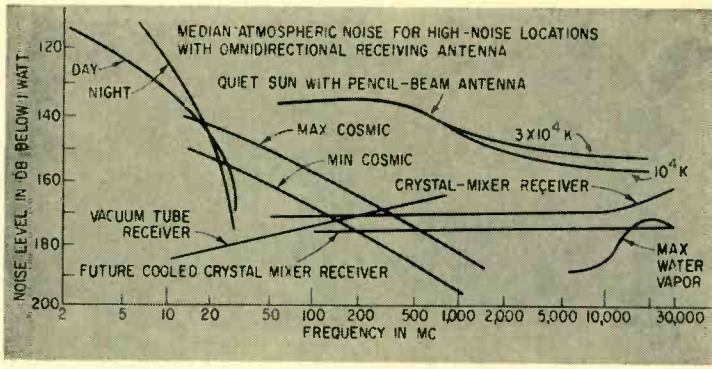


FIG. 7—Overall limitations on receiver sensitivity due to various cosmic, atmospheric and receiver noise sources

As listed in Table II, many of the planets in the solar system have atmospheres of various kinds and degrees. The effects of these gases on propagation may have to be considered for space-to-planet communications.

Vehicles in line-of-sight communication with each other in space would probably be limited in operating frequency only by the refractive effect that occurs at very low frequencies within regions of space in which charged particles and a magnetic field are simultaneously present. Operating frequencies of 22,000 or 60,000 mc would minimize interference with Earth communications services because of the absorption by water vapor and oxygen in the Earth's atmosphere.[15]

ANTENNAS—Transmission range can be increased by judicious choice of antennas for ground stations and space vehicles.

For the space vehicle it is desirable to employ a large directive antenna to obtain maximum gain, yet the antenna's size must be compatible with that of the vehicle and its beam width must not be so small as to greatly increase tracking difficulties.

For ground stations, large high-gain tracking antennas, similar to those used for radio astronomy, are available. To track a moving vehicle in space, the ground antenna's scan rate and beam width must be such that the ground-to-space signal will be originated by the leading edge of the main lobe and the return signal from space will be received by the lobe's trailing edge.

The circular parabolic-reflector antenna is one of the most advanced of the mechanical scanning types. This anntenna can provide power gains of $7Af^2/c^2$ (A = aperture area), with main-to-minor lobe ratios of at least 40 db and illumination efficiencies of 55 to 65 percent over a wide range of frequencies.[15]

At certain times, such as orbiting during takeoff

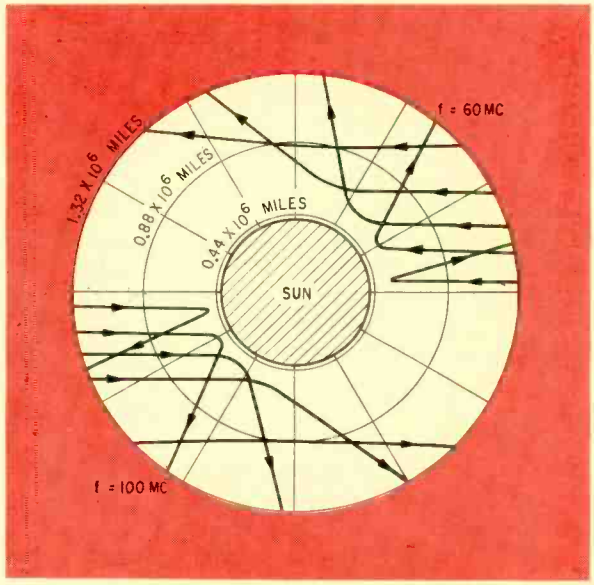


FIG. 8—Ionized field in Sun's vicinity refracts communication paths in its near vicinity

or reentry, scan rates of at least 3 deg/sec may be necessary. If the inertia of mechanical scanning antennas becomes too great to achieve this rate, electrical scanning techniques may be necessary.[15]

Fading from Faraday rotation losses in the atmosphere may be avoided by circular polarization of the antennas; this, however, would result in a 3-db loss over the power that could be received with linear polarization.[15]

NOISE—Receiver noise level usually determines the weakest signal that can be received. Development of maser and nonlinear-reactance amplifiers, such as the parametric amplifier, have lowered the noise level due to amplification to such a low level that external

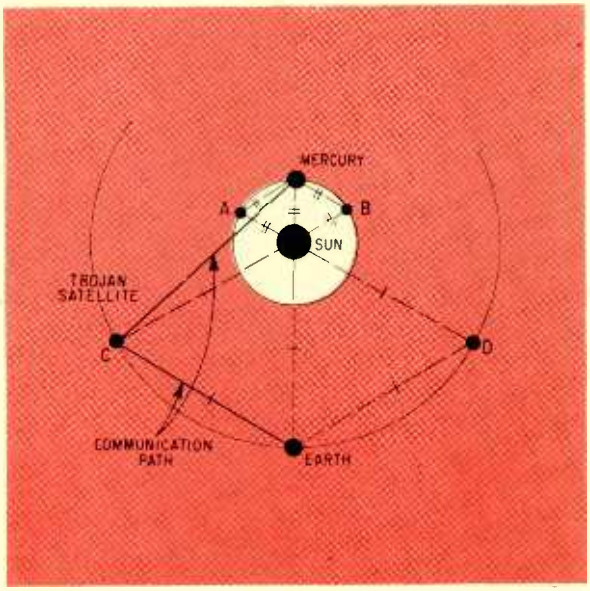


FIG. 9—Relay satellite placed at a Trojan point of two bodies in space will remain stabilized in that position

noise sources picked up by the receiving antenna have become the limiting factors in sensitivity. The noise power received by an antenna can be expressed in terms of antenna noise temperature by the relationship $T_a = P_a/KB$, where P_a is the antenna noise power, K is Boltzman's constant and B is receiver bandwidth.

The limiting factor in the high-frequency band may be atmospheric noise. This noise varies with season and time of day, the highest level prevailing over land in tropical regions. Cosmic and solar noise present limitations as the communication antennas will act as radio telescopes; the least noise of this type is from the galactic polar regions and the most from along the galactic equator and near the galactic center.[15]

Another possible source of interference that a space vehicle may encounter is the multipath that will be received when the vehicle is in the near field, or Fraunhoffer region, of a planet. A signal to the vehicle will be reflected by the planet as a constant-intensity echo throughout this near-field region because the planet's large effective area will cause it to be, in effect, a non-point source. In addition, the incident-signal wavefront progressing around the planet's curvature will result in a train of delayed reflections that will cause the multipath signal to have a ringing effect.[15]

Figure 6 illustrates recent estimates of the equivalent noise temperatures presented by various sources of receiver and background noise. An overall picture of the limitation of noise is presented in Fig. 7.[15]

Since narrow bandwidths increase receiver sensitivity and reduce interference, they will undoubtedly be resorted to as a method of conserving power in the initial space flights that may have only limited power available for communication purposes.

Table V—Propagation Characteristics

Frequency	Type	Characteristics
3 mc	ground wave	reflected by ionosphere, follow Earth's curvature
	whistlers	follow magnetic field lines
3 to 30 mc	ionospheric	reflected by ionosphere
3 to 100 mc	ionospheric	scattered in ionosphere, reflected by aurora, reflected by meteors, line of sight
100 to 10,000 mc	tropospheric	scattered in troposphere, diffracted by obstacles, line of sight
10^4 to 7.5×10^8 mc	millimeter and infrared	absorbed by atmosphere, line of sight
7.5×10^8 to 1.5×10^9 mc	light	visible to eye, scattered by atmosphere, absorbed by clouds

RELAY SATELLITES—Communications to and from space or in space will be restricted for some time to line of sight by the propagation characteristics of the frequencies used. At times, however, the terminal stations will be so located that they will be out of line of sight. For example, a space vehicle in back of the Moon or a vehicle or planet eclipsed by the Sun would be out of communication with the Earth. Also, if the communication path passes near the Sun, it might be appreciably refracted by the ionized field from the Sun's corona; Fig. 8 illustrates how rays of 60 or 100 mc will be bent at various distances and angles to the Sun.[17, 18]

These difficulties may be circumvented in the future with satellite relay stations stratigically located in space. Three satellites, spaced equidistantly in a central body's equatorial plane and orbiting in synchronism with its rotation, would constitute one form of relay. The satellites could be either active or passive relays; active relays could function as storage and readout devices as well as repeaters. Passive relays could be reflectors in the form of spheres, segmented spherical surfaces, Van Atta arrays, corner reflectors or plane surfaces.[16]

One way of transmitting near or around the Sun would be to place a relay satellite at a Trojan point of one of the planets. In a two-body system, the two points on either side of a connecting line through the bodies that would form two adjacent equilateral triangles are termed Trojan points. Satellites placed at either of these two points would be stabilized there by the gravitational forces of the bodies involved. If Mercury and Earth were in the positions shown in Fig. 9, the Trojan points of Mercury and the Sun would be A and B, and those of Earth and the Sun would be C and D. A satellite placed, arbitrarily, at C could be used to communicate between Earth and Mercury.[19, 20]

NAVIGATION AND GUIDANCE

Initial stages of interplanetary flights can be navigated by refined versions of conventional radio or interial guidance techniques. Once in space environmental limitations may necessitate use of some form of celestial navigation

ANOTHER PROBLEM facing man as he ventures into space is that of interplanetary navigation. A mistake may take him to infinity.

Space flights in the near future will undoubtedly be propelled by ballistic rockets, using chemical propellants. As the technology progresses, spacecraft will probably also be powered by electronic or similar forms of propulsion that will be capable of producing a low-thrust over a long period of time, but will be incapable of providing the necessary high thrust for putting the vehicle into space or an orbit around the Earth.

BALLISTIC ROCKET GUIDANCE——With ballistic rockets, a power impulse is applied for a short initial period and the rest of the flight is unpowered, with the vehicle coasting in the complex gravitational field of interplanetary space. Guidance accuracy is thus established by the vehicle's position and velocity at the instant of transition from powered to free flight.

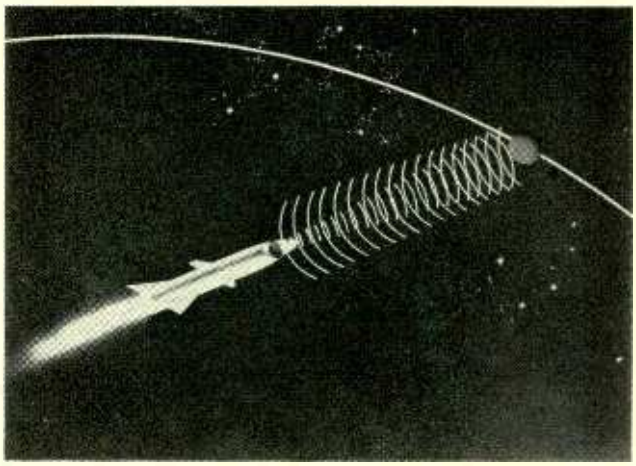
There are maximum tolerable errors for the angular alignment and the magnitude of the velocity vector of the vehicle at the time of power cutoff. As illustrated in Fig. 10[16, 21] for a particular trip the least speed error is permissible for the greatest alignment error and the least error in the velocity angle is permissible for the greatest speed error. Values for comparable curves for interplanetary trips would be several orders of magnitude greater than those for the trips shown.

This initial guidance could be established by inertial or radio techniques, similar to those in current missiles.

LOW-THRUST PROPULSION GUIDANCE——Interplanetary expeditions with electronic or similar forms of continuous propulsion will require much more complex guidance.

First, as illustrated in Fig. 11 the vehicle must be guided into a satellite orbit around the Earth in the ecliptic or reference plane in which the Earth orbits about the Sun. This may be done directly, if the terrestial latitude of the launching site is not more than 23.5 deg North or South (the angle of the inclination of the ecliptic plane to the equator), by present-day satellite launching techniques.

Once in orbit, the electronic propulsion system would spiral the vehicle outward into or beyond the region where the Sun's gravitational field predominates over that of the Earth. In that region, the



Space vehicles may utilize beam-riding systems for terminal navigation and guidance, as in this Arma illustration

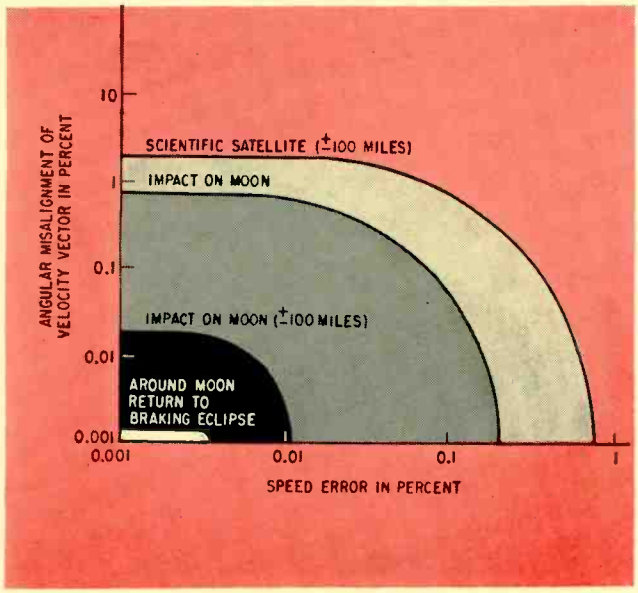


FIG. 10—Maximum permissible errors for angular alignment and magnitude of space vehicle velocity vector at power cutoff

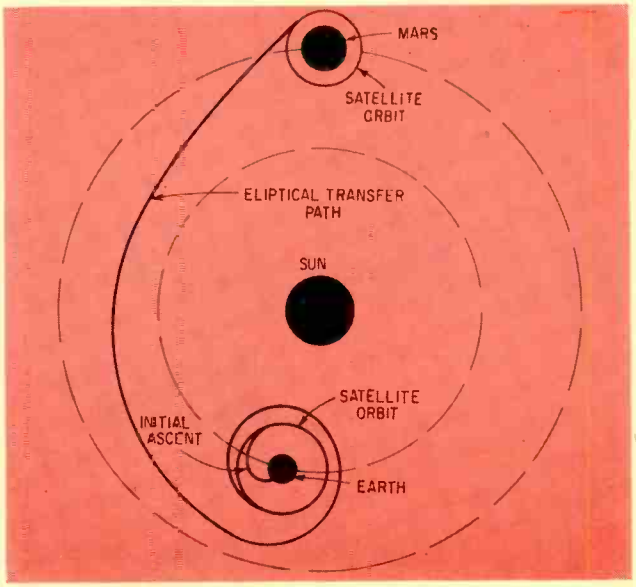


FIG. 11—Possible flight path for Mars trip by space vehicle with chemical and electronic propulsion

vehicle would be directed into an elliptical transfer orbit around the Sun, calculated to intercept the orbit of the destination planet. Where the orbit planes intersect, the vehicle is directed into an orbit around the planet; this new orbit will be at an angle to the ecliptic, as can be seen from Table II.

Guidance considerations for the Earth-to-satellite orbit phases of the flight are similar to those involved in the initial guidance of ballistic missiles.

INERTIAL GUIDANCE——Basically, inertial guidance systems consist of three accelerometers, mounted on a stabilized platform, and a computer as illustrated in Fig. 12. The accelerometers integrate the vehicle's accelerations to yield velocity components along three orthogonal axes. The accelerometer axes are maintained at a fixed spatial orientation and isolated from rotational motions of the vehicle by a set of gyroscopes placed in a frame with three degrees of freedom relative to the vehicle.

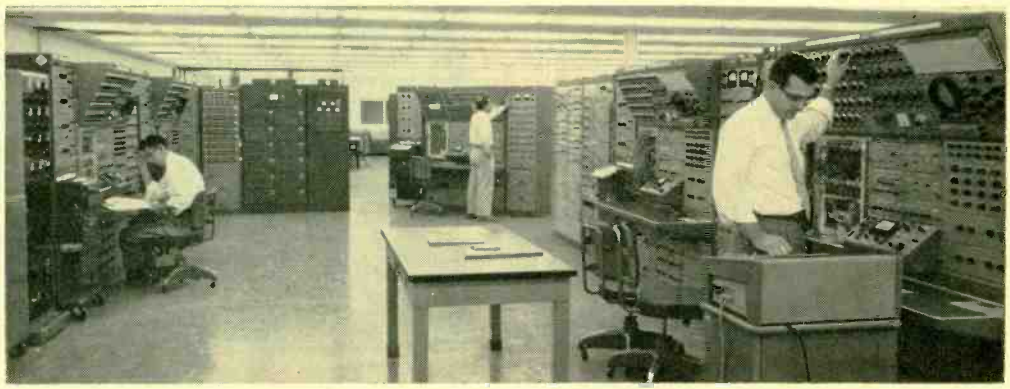
The computer operates on the accelerometer indications and provides output signals to control the vehicle's roll, pitch and fuel cutoff point. In addition, a continuous measurement of velocity and position in an internal frame of reference is also provided.

Speed accuracy is determined primarily by the accelerometers and orientation accuracy by gyroscopic performance. Acceleration errors are oscillatory in nature rather than increasing with time. Gyroscope drift, however, leads to platform misalignment that increases with time.

Once the vehicle is in midcourse, the inertial guidance would provide a continuous measurement of position as long as the vehicle is in acceleration. However, long interplanetary missions, a year or longer in time, would impose serious limitations on this form of guidance.

As the inertial guidance system would be operating in free space, the oscillatory error characteristics would be modified so that a constant acceleration error, for example, would increase at $\frac{1}{2}at^2$ instead of as a bounded oscillatory function. An acceleration error that would produce an error of 1,000 feet in a normal missile flight application would instead produce an error of approximately 100,000 miles after 1 year of operation in space.[21]

During extended conventional aircraft or missile flight, buildup of gyroscope drift errors is minimized



Data processing installation at Convair determines satellite orbits from tracking information

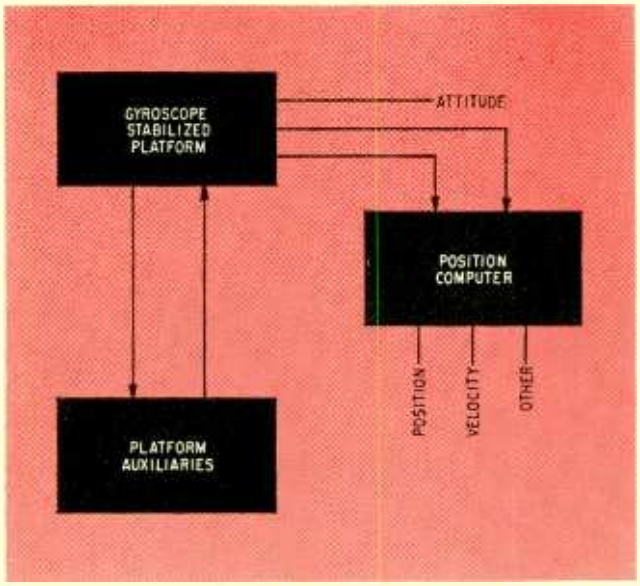


FIG. 12—Basic inertial guidance system necessary to obtain proper velocity vector during initial flight phase

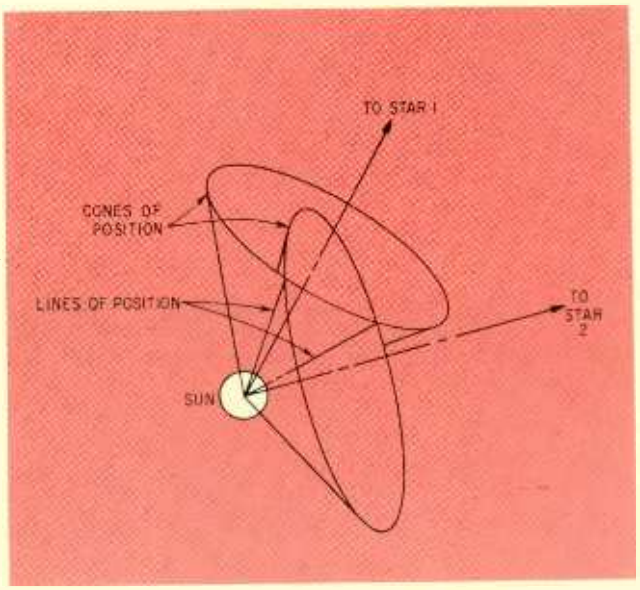


FIG. 13—Position in space along radial component can be fixed from two stars and Sun

by Schuler tuning, which relies on the Earth's gravitational field for its operation. The gravitational field becomes too weak for this technique when the vehicle is far out in space or if the vehicle is made almost or partially weightless in a satellite or elliptical orbit by centrifugal force. This particular problem may be solved in the future by development of all-electronic gyroscopes that use no moving parts; one proposed system would utilize the electron spin in paramagnetic materials to achieve extremely high accuracies.

Since a vertical reference vector normal to the Earth's surface beneath a vehicle in a satellite orbit closely coincides with the gravity vector, the vertical vector could possibly be used to replace the ineffective gravity vector to minimize gyroscope drift error accumulations. The Earth's horizon could be scanned or sensed by an infrared system to establish the vertical reference vector in day or night, during all kinds of surface weather.[23]

Present-day radio techniques may possibly also be used for midcourse guidance, but these systems involve almost all the atmospheric propagation problems of space communications.

CELESTIAL NAVIGATION —— Celestial navigation may be the most suitable recourse for interplanetary flight. The techniques would probably be variations or three-dimensional forms of methods now used in two-dimensional form.

The coordinate system in which the navigation problem will be worked out will probably have as its base circle the ecliptic, the plane of the Earth's orbit. Position is specified by celestial latitude β and celestial longitude λ; β is measured from the ecliptic plane and λ from the vernal equinoctial point. Counterparts of terrestial latitude and longitude are declination and right ascension. Center of the coordinate system will be at the center of the body about which the vehicle is orbiting—initially the Earth, then the Sun and finally the destination planet.

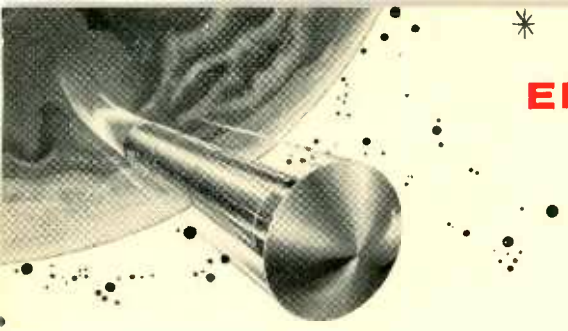
To establish position uniquely on a spherical surface by measurement of directions generally requires knowledge of direction of three points, at least one of which is at a finite distance.

Figure 13 illustrates a method of determining position in space by using stars as two reference points and the Sun as a third.[23] The locus of position of a measurement between the Sun and another star is a cone whose apex is the Sun. Another cone of position is provided by a second Sun-star measurement. The intersections of the two cones yield two straight lines of position. Ambiguity may be eliminated by knowing beforehand the approximate position so that the measured result will be in the form of a correction to an assumed latitude and longitude. A third cone of position would also remove the ambiguity of the two lines of position and may also improve the accuracy of the measurement slightly.

Celestial latitude and longitude may be determined in this manner without reference to time; a time reference is necessary only when comparing with the vehicle's predicted position in its transfer orbit about the Sun.

Because the stars are considered for all practical purposes to be at infinity, they can only be used to determine the direction of the radius vector from the center of the coordinate system, in this case the Sun, to the vehicle and the vehicle's direction of travel.[23, 24] For absolute position, the magnitude of the radius vector must also be known. This radial coordinate may be determined without a time reference by measuring the vehicle's distance from the Sun at any instant with a thermal radiation sensing system[25] or by measuring the apparent diameter of the Sun.

Planetary observations can be used to obtain absolute position, both angular and radial coordinates, with greater geometric accuracy than star fixing. This technique, however, requires a precision clock to fix the planets' locations at any instant.



ELECTRONICS IN SPACE

POWER GENERATION

Manned space vehicles with electronic propulsion will require hundreds of kilowatts and even megawatts of continuous electrical power. Complete nuclear reactor installations may have to be designed into vehicles to supply this power

RECENTLY-LAUNCHED SATELLITES and space probes have had relatively low electrical power requirements —of the order of watts. As the scope and sophistication of their instrumentation are steadily advanced, their power requirements will concurrently increase into the kilowatt range. Finally, the advent of manned interplanetary flight and electronic propulsion systems will boost power needs into the range of megawatts.

While considering the power necessary for getting man into space and to distant bodies in the solar system, thought must also be given to making him self-sustaining once he reaches his destination; here again, need arises for relatively large amounts of continuous electrical power.

Power for present-day and near-future short-term space applications will undoubtedly be continued to be supplied by solar cells, fuel cells and other forms of batteries discussed in "Power Sources for Space Age Electronics," ELECTRONICS, March 20, 1959. However, these power sources must be reappraised for long-term high-power applications of the future.

CHEMICAL BATTERIES——Highest theoretical performance for a straight chemical reaction is at this time that obtained from a hydrogen-oxygen fuel cell. Though their theoretical upper limit is 1,400 w-hr/lb., present cells deliver only about 300 w-hr/lb.; improvements may raise this figure to 1,000 w-hr/lb.[2, 26]

Since batteries are essentially low-voltage devices, reliability considerations may limit battery packs to about 10 kv. Their sensitivity to ambient temperature and need to be kept warm may further limit performance in a space environment; in addition, zero-gravity and various forms of radiation may also have deleterious effects.

Chemical batteries will probably be most useful in long space flights as energy-storage devices to supplement other prime sources of power during peak-load or nonproductive periods; zinc-silver batteries, for example, can deliver 700 w/lb for periods of about a minute.

SOLAR POWER——Approximately 1.35 kw of solar power is incident per square meter at the Earth's distance from the Sun.[2, 27]

The simplest way to harness this energy at the present time is through use of batteries of silicon solar cells. Assuming that 30 to 50 percent of the power incident on these cells is reflected, and including other losses, the conversion efficiency above the atmosphere should be about 9 to 12 percent.[26] This efficiency is currently attained with selected cells that produce approximately 135 w per square meter of cell surface.

On a weight basis, a bare cell will deliver about 300 w/lb in full sunlight; including the weight of the supporting structure and protective cover for a battery of cells, the output drops to about 3 w/lb. Improvements in packaging of the cells and production techniques, to produce lighter and thinner cells, may result in outputs of 5 w/lb.

Present cells have small areas due to the necessity for single-crystal construction and internal resistance considerations. They require surface temperatures of about 70 F to reradiate wasted energy and therefore may require surface cooling for efficient operation. Radiation in space will probably not present any deleterious effects on the cells' life span.

Since many hundreds of thousands of solar cells would be necessary to generate power in the kilowatt region, their use for the present seems to be limited to low-power applications. For continuous power, during periods that the cells may not be in sunlight, energy storage must be provided in the form of batteries.

THERMIONIC CONVERTER——One of the solar devices that offers great promise for future development is the thermionic converter.[27] Figure 14 shows

a basic system arrangement. A reflector collects the incident solar energy into a container whose opening is just large enough to include the area of intense heat flux concentrated by the reflector. The container is lined with thermionic converter cells, their cathodes facing the inside so as to be at approximately 2,000 F. Anodes face the Sun and are at about 1,000 F; this temperature is sufficiently high to reradiate wasted energy.

It is estimated that 25 w/lb will be produced for the converters alone and 12.5 w/lb including the weights of the reflector and radiator. Future work seems to be in the area of finding materials having the proper electron work functions for the operating temperatures desired.

LUNAR POWER STATION—Solar energy incident on the Moon may be utilized to generate electrical power for future Moon dwellers; a recent proposal suggests taking advantage of the vacuum on the Moon to convert large amounts of solar energy to electrical power by the photoelectric effect.[28]

To construct the Moon power station, a thin plastic sheet, coated with a 1-micron thickness of photosensitive material, would be stretched and supported over several acres of the lunar surface. A thin wire mesh would then be placed over, but insulated from, the plastic-film photocathode as a photoanode. Insulated sections of this assembly would be series connected for higher voltages, as desired. Internal impedance would be lowered to 0.1 ohm or less.

The solar conversion efficiency would depend, along with other factors, on the work functions of the material used; the lower the work function, the longer the cutoff wavelength and the larger the portion of the solar spectrum that can be usefully converted. Early experiments have yielded efficiencies of 0.1 percent, but efficiencies up to 25 percent are expected with further development.

The complete power station operating at 25-percent efficiency would produce 300 w/lb or 118 w/sq m. These power values are for the Sun at zenith and would change throughout the lunar day.

An important consideration when using solar power in any form is that the intensity of the incident solar energy rapidly decreases as the distance from the Sun is increased. For example, the power from the Sun in the vicinity of Mars is only half that obtainable near the Earth.

NUCLEAR POWER—Generation of large quantities of electrical power for long periods of time will probably be accomplished by some form of nuclear power.

Radioisotopes may be used in numerous ways. A direct way is to collect the beta particles emitted by an isotope like strontium 90; such a battery would produce about 10 kv at 50 $\mu\mu$a, or 0.2 w-hr/lb over the isotope's half-life of 28 years.[2]

Another recently developed battery utilizes thermocouples to convert the radiation from $\frac{1}{3}$ gm of polonium 210 into 5 w of electrical power; this device will produce about 2,600 w-hr/lb for a 140-day half-life period, increasing in efficiency as temperature de-

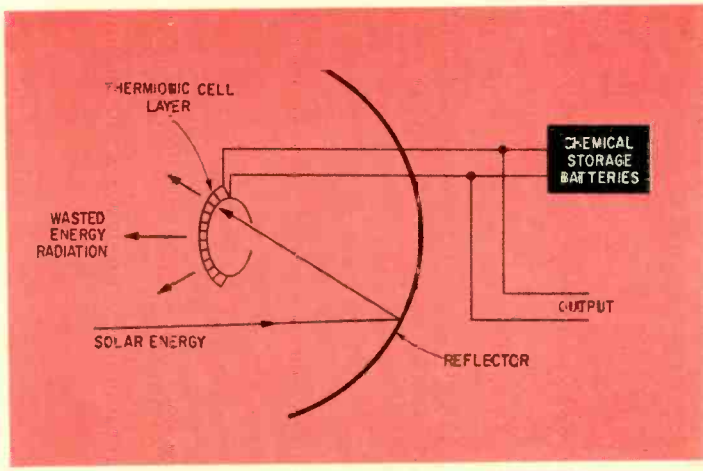
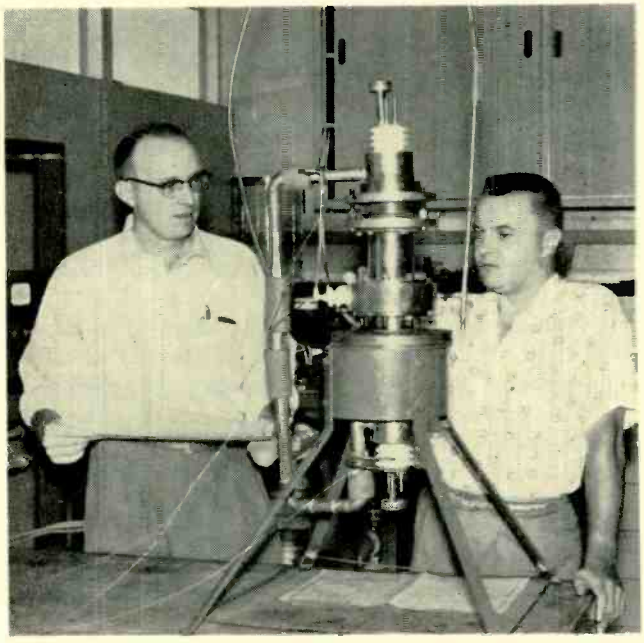


FIG. 14—Basic arrangement for thermionic-converter system



Test chamber for plasma thermocouple is inspected by two of scientists that developed new power generator at University of California's Los Alamos Scientific Laboratory

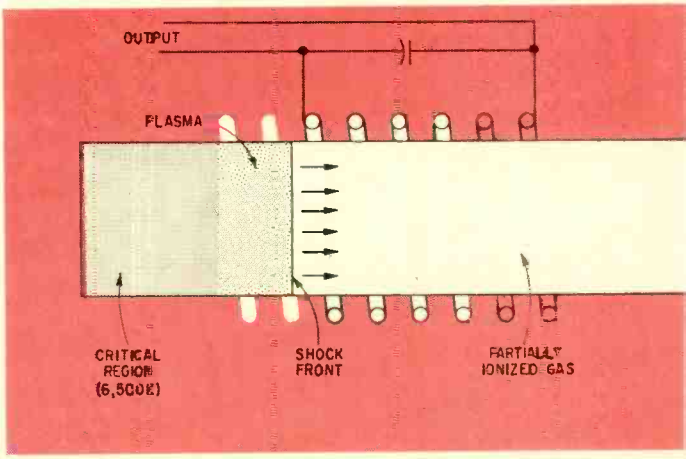


FIG. 15—Plasma-fission reactor would produce electricity directly

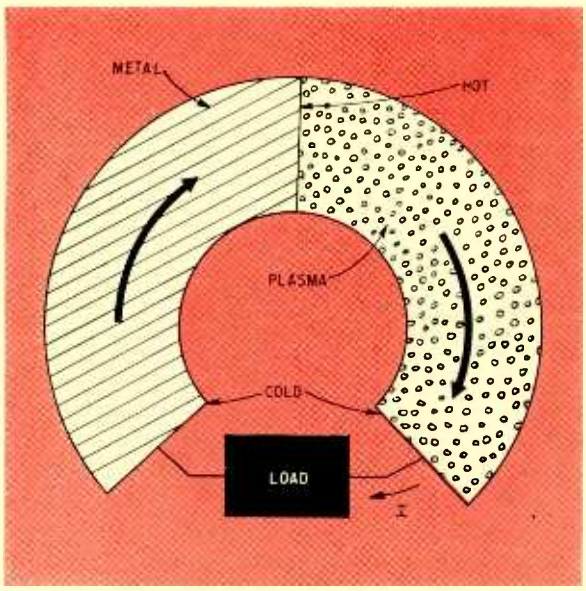


FIG. 16—Basic plasma-metallic thermocouple

creases. Further development may produce 10 to 1,000 kw-hr/lb.

Though isotope power sources may ultimately outperform chemical batteries, their future use may be influenced by the fact that there may never be sufficient material available to permit their large-scale operation.[2, 26]

Nuclear reactors seem, at this time, to be the way to supply the hundreds of kilowatts or megawatts of power that will be needed for electronic propulsion.

The great weight of fission reactor sources is due to the conventional methods used to convert the thermal energy into electrical power. Application of superconductivity concepts to the electrical conversion equipment may help to reduce their weight substantially.[29] There is hope, however, that fission energy may be converted into electrical power directly in the reactor.

FISSION-PLASMA REACTOR —— A proposed plasma reactor would operate in a fashion opposite that of a magnetic plasma accelerator for propulsion use.[30]

As illustrated in Fig. 15, the reactor would be a cylindrical shape containing uranium 235 gas, at just below criticality. An initial disturbance at one end of the cylinder will cause the gas at that end to become critical and the resulting fission energy will drive a shock wave to the other end of the tube. As the ionized gas or plasma behind the shock wave passes through the magnetic field, part of its kinetic energy will be transferred to the external circuit as an induced current in the magnetic circuit. Reaching the other end, the plasma will be sufficiently compressed and heated to become critical and institute a shock wave in the reverse direction. The magnetic field would be maintained by a resonant circuit formed by the coil and capacitor.

It is estimated that a 26 by 150 ft reactor will produce 20 cps power of 480 kw, at an overall efficiency of 20 percent.

PLASMA THERMOELECTRIC CELL——Another direct conversion system, which is now under development, is based on a plasma thermocouple. As illustrated in Fig. 16, one of two metallic elements of a conventional thermocouple is replaced by a plasma of ionized gas. Since the thermoelectric power of the plasma is about 1 mw/C compared to 1 μv/C for metals, the current flow through the cell is about 1,000 times greater.[31]

An experimental thermoelectric cell utilizing a cesium plasma at 300 C and hot and cold junction temperatures of 2,630 C and 350 C has produced about 10 w per sq cm of emitter surface at 5-percent efficiency.[31]

The author thanks the individuals, societies and companies that so freely offered their cooperation in this undertaking.

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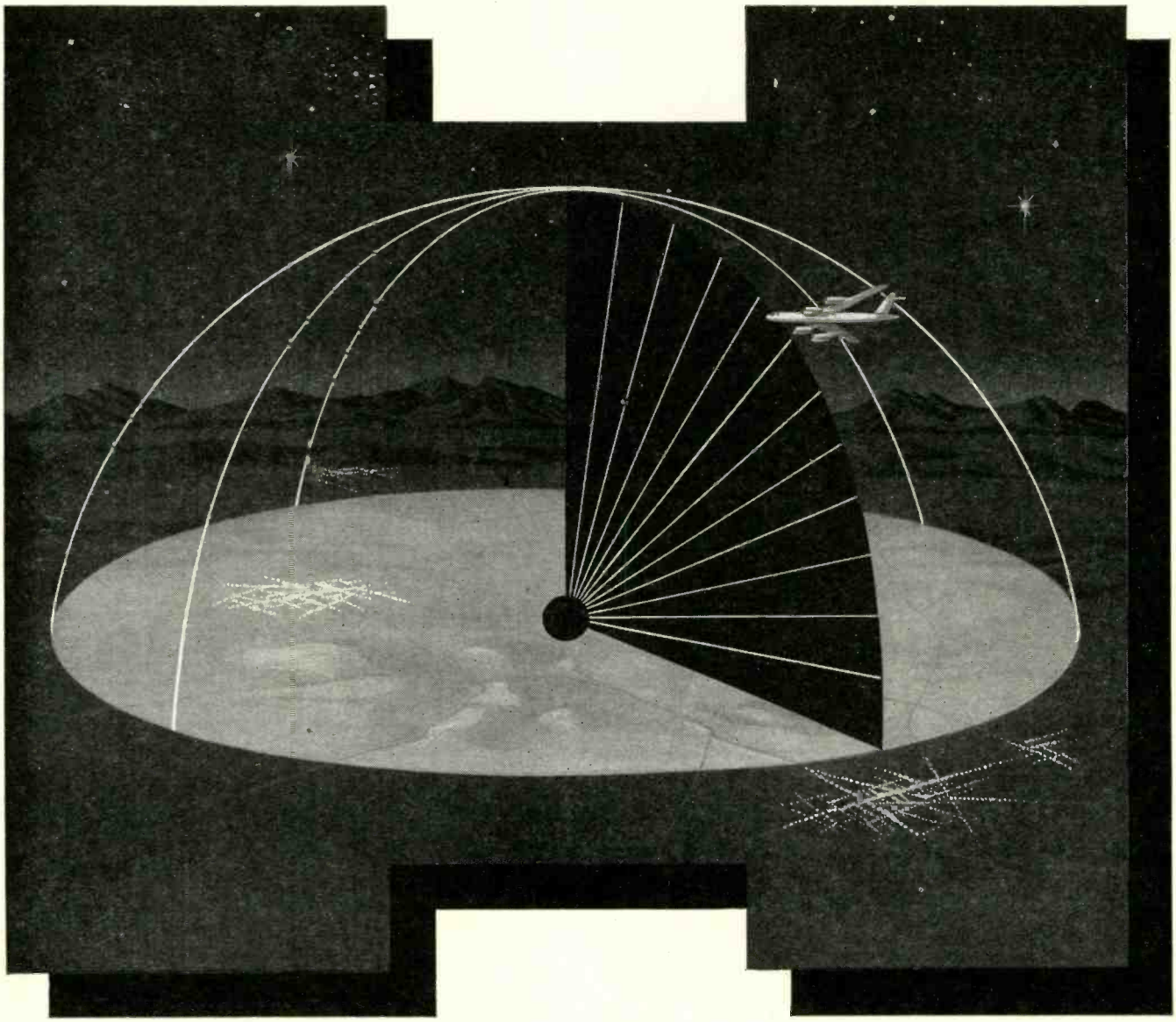

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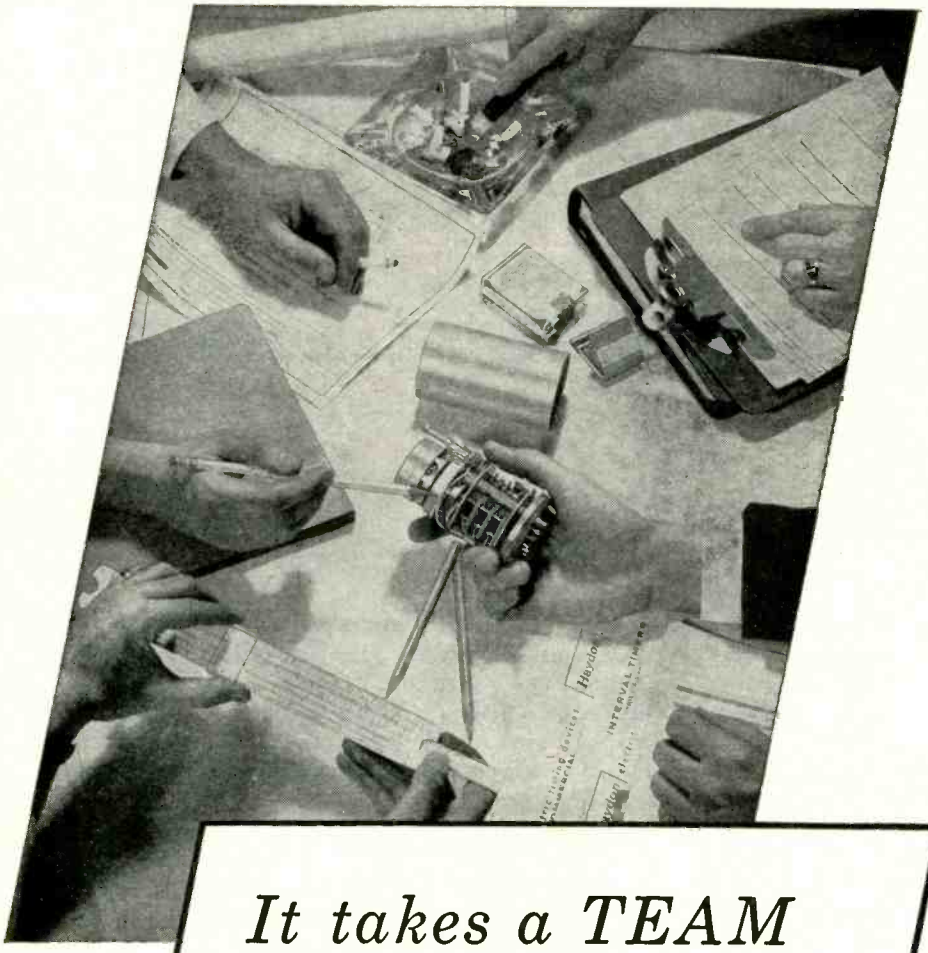

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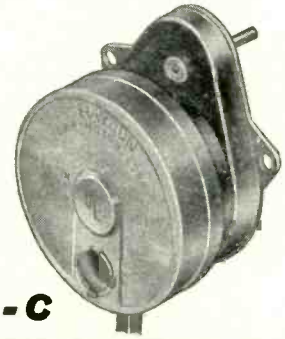

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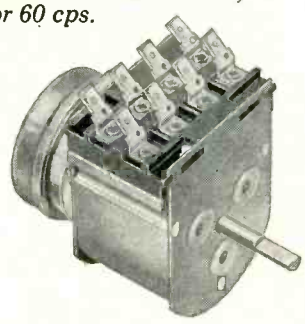

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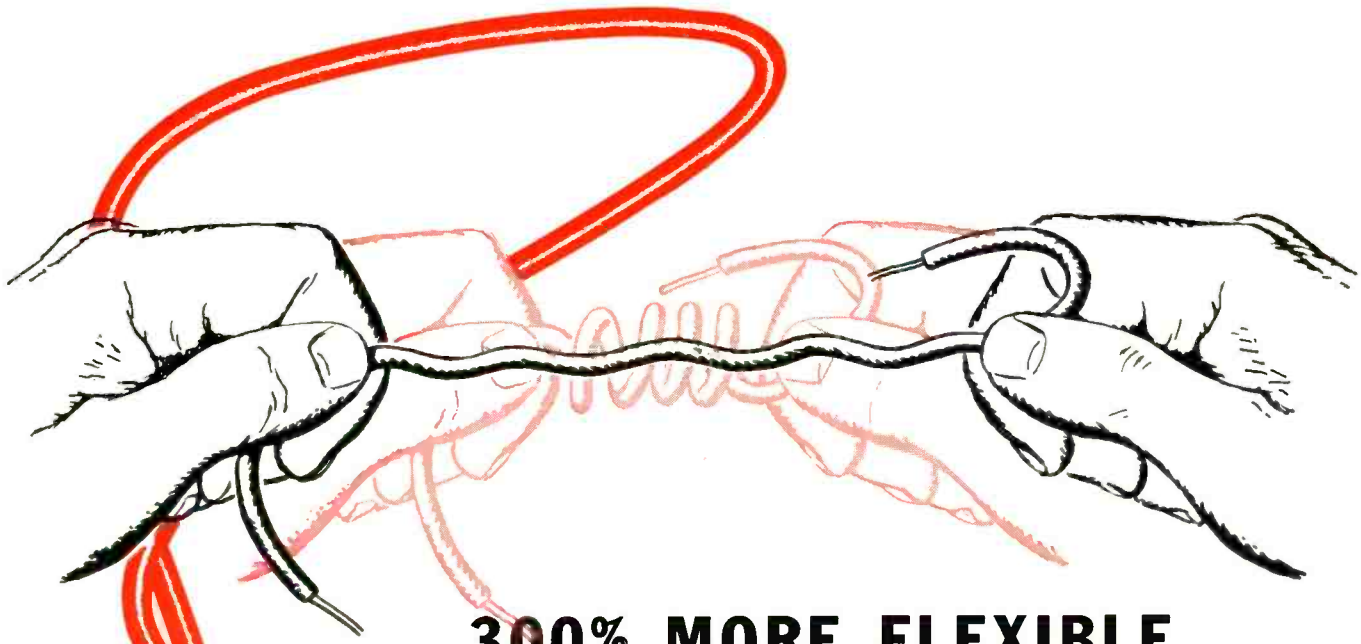

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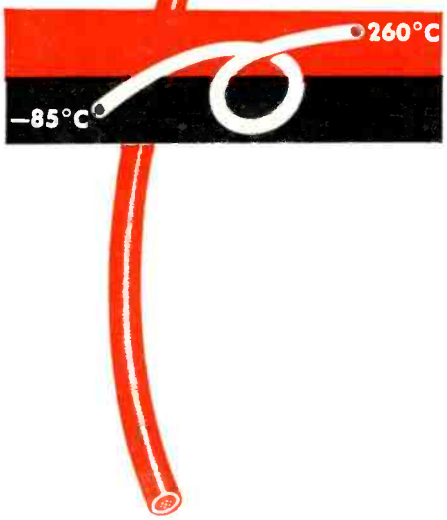

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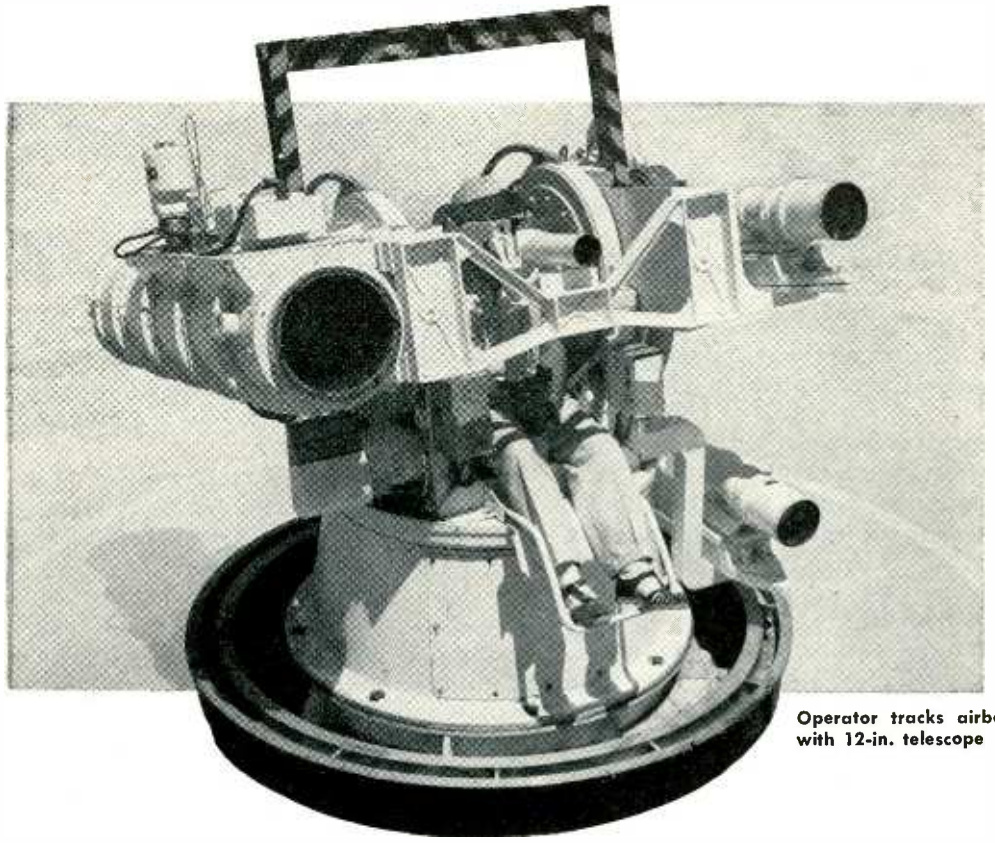

Operator tracks airborne object with 12-in. telescope

Joy-Stick Control Aids Telescope Tracking

Operator manipulates control stick, commanding servo positioner of telescope. Servo's response matches physical and psychological response of operator. Telescope is positioned on remote object by radar and then is directed by operator

By RICHARD L. SCHAUM, Circuits and System Designer,
and D. W. SAVAGE, Package Designer, Sandia Corporation, Albuquerque, New Mexico

AIDED-TRACKING SYSTEMS help operators of fire-control equipment and theodolites to follow a moving target by supplying control functions which are not found in simple operator-turret servo loops. Aided tracking in this system is accomplished by replacing a simple rate signal with a composite of displacement, acceleration, and rate functions. Thus the operator only has to add corrections to a tracking vector if the tracking rate changes. He no longer has to crank in a vector corresponding to the varying displacement produced by a moving target.

The aided-tracking system to be described is supplemented by a radar acquisition system which automatically positions the turret on a remote target. When the operator sees the target he takes control with the aided-tracking system.

OVERALL OPERATION—The aided-tracking sys-

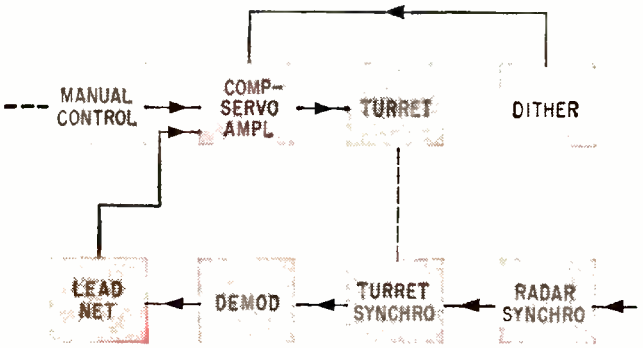

FIG. 1—Manual and radar inputs control operation of aided tracker's two channels. Only one channel is shown

tem contains one azimuth and one elevation channel. Since the channels are identical, only one will be described.

Each channel consists of a manual control, computer, servo amplifier and a hydraulic-valve solenoid which actuates a turret-drive mechanism (Fig. 1). The operator deflects a control stick in the direction he wishes to move the telescope, much in the manner that one operates an aircraft control stick. This output is applied to a computer network which shapes the signal to provide a composite of displacement, rate, and acceleration functions. Thus modified, the signal is applied first to a servo amplifier and then to the turret drive mechanism which in this application is electrohydraulically operated.

MANUAL CONTROL—The manual control is a differential capacitor transducer C_1 in Fig. 2. Fore and aft deflections of the stick provide down and up signals; lateral deflections provide left and right signals. Vector movements produce both azimuth and elevation outputs. Full output in any direction is produced by a stick deflection of about 0.095 in, which requires 16 pounds of force. The force exerted by the operator gives him a sense of the magnitude of the output signal.

A sine wave is applied to the grid-cathode circuit of V_{1A} and V_{1B}. When the stick is moved, a signal is developed across resistor R_1 by the capacitance to ground (16 to 23 $\mu\mu$f) at the grid of V_{1A}. The signal magnitude depends on the phase shift introduced by varying differential capacitor C_1. The amplified signal at the plate is rectified by voltage doubler D_1 and D_2. This doubler produces a positive voltage output. Similarly the doubler of V_{1B} produces a negative output. When C_1 is in the neutral position, the voltages are equal and the output voltage to the computer is zero.

Electrical balance and circuit sensitivity are both adjusted with potentiometers R_2 and R_3, which vary the amplitudes of the modulation voltages. Ripple at the output is minimized by the use of balanced modulation.

The output impedance of the manual control is about 1 megohm. Figure 3A is a plot of the output voltage of the manual control measured with no load. A capacitance differential of about 14 $\mu\mu$f develops 15 v. Figure 3B shows the voltage output of the manual control versus a constant force exerted through 360 deg. Although the vector outputs at 45, 135, 225, and 315 deg are reduced, the reduction does not noticeably change the output control characteristics.

COMPUTER-SERVO AMPLIFIER—A typical input voltage is shown in Fig. 4A and the corresponding output voltage is shown in Fig. 4B. The hump starting at t_1 is caused by bumping the stick and produces the displacement component of the signal. The rate component is developed by a continuing pressure on the stick. Once a correct rate has been established, the operator reduces the stick output to zero until a new rate correction is required.

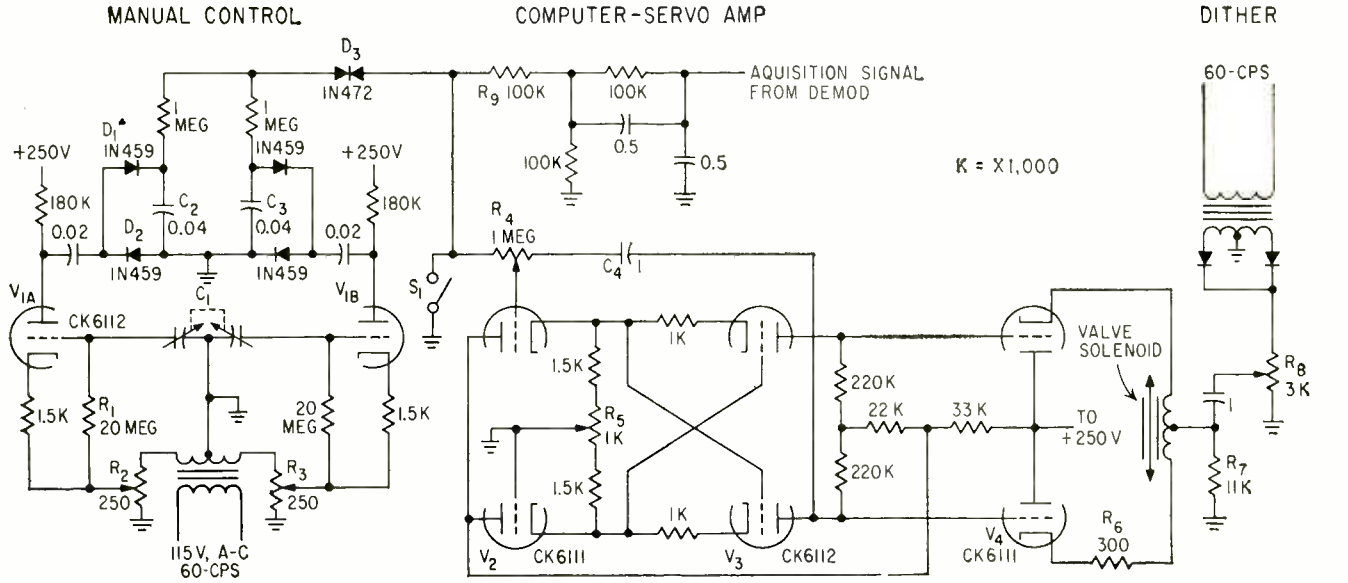

FIG. 2—Section of capacitor C_1 controls the current through the solenoid. After passing through the lead network and R_1, the radar acquisition signal is applied to a grid of V_2

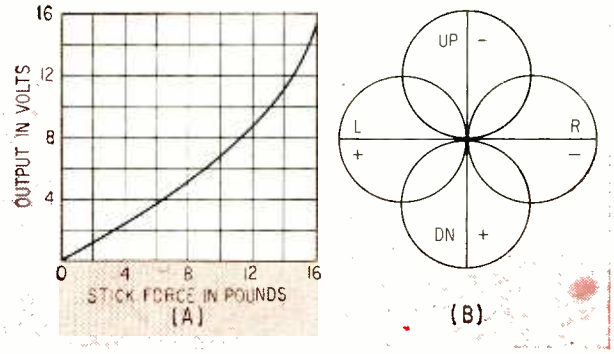

FIG. 3—The two manual control outputs are determined by the stick (A). Relative voltages produced when the stick is deflected by a constant force in a 360-deg arc (B)

was probably traveling at a slower rate than the target rate.

The input signal is applied to the integrating circuit, which includes D_3, R_4, and C_4 (Fig. 2). Zener diode D_3 is a voltage-variable resistor capable of being changed from about 20 megohms to thousands of ohms by a voltage difference across it. In effect, this provides a short time constant in the integrating circuit when a change of rate is desired, and an extremely long time constant when no change is required. The resistance versus voltage characteristic of a typical 1N472 diode is plotted in Fig. 5. Potentiometer R_4 adjusts the ratio of the displacement voltage to the rate voltage.

The servo amplifier consists of a cross-coupled amplifier and cathode followers. Stage V_4 of Fig. 2 drives the hydraulic-valve solenoid to a 10-ma maximum differential current. Potentiometer R_5 balances the current through the solenoid coils. Although the bias point is not critical, neither output triode should conduct more than about 5 ma to avoid over driving the coil. Exceeding the rated current through the coils of some types of valves causes sticking, which can result in serious transients in the hydraulic system.

The hydraulic valve coils are center tapped, but since the outer coil has higher resistance than the inner coil, resistor R_6 is added in series with the low resistance coil to balance the amplifier load.

When new amplifiers or stick modules are installed, it is difficult to perform the initial balance operations without isolating the stick output from the amplifier. Switch S_1 is therefore provided to ground the amplifier input. The manual control may then be balanced by releasing the switch and adjusting R_2 and R_5 until the desired sensitivity and balance are attained.

If the target moves out of angular range during tracking, a limit stop applies a reversed rate signal to the computer, thus causing the turret to back away.

Dither is applied at R_7 to counteract stiction effects at slow speeds. A 120-cps ripple voltage is used because the hydraulic system is sensitive to 60 cps. Potentiometer R_8 adjusts dither amplitude.

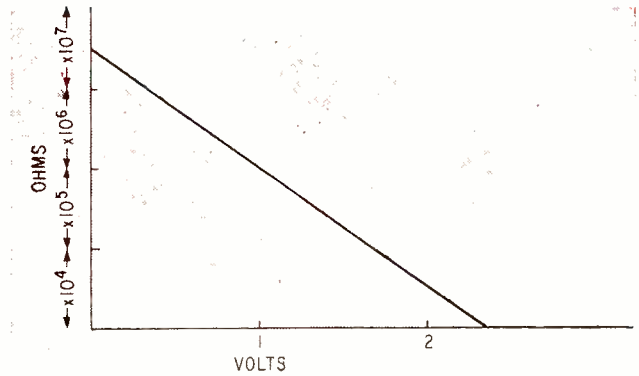

FIG. 5—A linear voltage increase across a 1N472 diode causes a logarithmic decrease of diode resistance

RADAR ACQUISITION—Radar acquires the target at long ranges. The radar synchro signal is demodulated, and then applied to a lead network whose output goes to the computer (Fig. 1). The lead network stabilizes the operation of the acquisition system.

Since the acquisition signal is applied through a resistance, R_{11}, the operator can override it with an aided signal. Resistor R_{11} lowers the response of the turret to an acquisition signal, but this is not an important factor.

Radar rate signals are stored in the computer thereby minimizing discontinuities in tracking when the operator assumes control.

APPLICATIONS—The aided-tracking system has greatly improved the quality of photographic data used in solving ballistic problems. The system's successful use in several telescope turrets suggests its application to other tracking operations. For example, the system could be modified for effective naval gun laying where one operator, rather than two, would perform both azimuth and elevation operations. By adding variable angular displacement between the operator's telescope and the gun, target lead would be automatic.

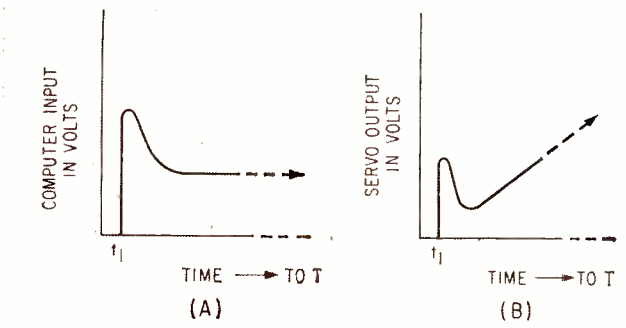

FIG. 4—Output obtained for a typical input voltage (A). During the first portion of the time constant of the computer, the output rate (B) is proportional to voltage input and stick displacement

Series Diode Increases

Triggering sensitivity of monostable multivibrators may be greatly increased by using a semiconductor diode as a series nonlinear element in the feedback loop. Good stability can be achieved

By MIRKO M. VOJINOVIC,* Visiting Research Engineer, Carnegie Institute of Technology, Pittsburgh, Pa.

SOLUTION OF MANY electronic switching problems, such as registration of nuclear radiation, pulse analysis, counting and time modulation, would be facilitated if triggering sensitivities much higher than those offered by conventional monostable multivibrator circuits were available.

To improve the triggering sensitivity of the conventional monostable multivibrator, the stable-state loop gain must be increased to a value only slightly smaller than unity, which is the condition of self-triggering.[1] Stability and reliability requirements, however, demand a small stable-state loop gain. These conflicting conditions limit the triggering sensitivity of practical circuits to the order of volts.

To improve triggering sensitivity, conventional multivibrator circuits may be redesigned to avoid the normally encountered sensitivity limiting factors.[2,3] In this article, the details of such circuits, using a series nonlinear element as a switch in the feedback path are discussed.

Main Requirements

To improve the triggering sensitivity of the monostable circuit, more efficient loop-gain control than that achieved with the gradual curvature of vacuum-tube characteristics is desired. However, the advantageous gain characteristics of vacuum tubes may be retained if the loop gain is triggered by switching the characteristics of a passive nonlinear element added to the vacuum-tube circuit, instead of the gain of the tubes themselves.

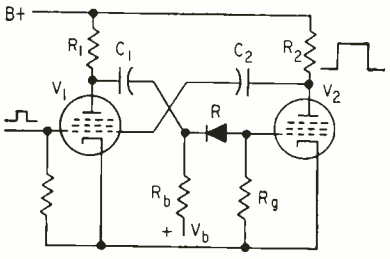

FIG. 1—Basic monostable multivibrator circuit using a nonlinear resistance

A way in which a nonlinear passive element can be used for loop-gain control of a plate-to-grid-coupled monostable multivibrator is shown in Fig. 1. The resistance R of the nonlinear element placed in the feedback loop together with ordinary resistor R_g represents a nonlinear voltage divider. If both tubes V_1 and V_2 are normally on supplying a constant gain, the values of R and R_g can be adjusted so that the loop gain has a desired value less than unity; this is the condition for maintaining the stable state. The circuit can be triggered by applying a signal to the nonlinear voltage divider to change its voltage attenuation factor and consequently, the loop gain of the circuit.

The effect of the nonlinear voltage divider is shown in Fig. 2 which gives curves of loop gain for different input signal amplitudes in the case of the conventional and the sensitive multivibrator. The rate of change of the sensitive circuit loop gain acounts for its high sensitivity.

Ideal Element

Best results dictate an ideal nonlinear element with resistance equal to zero when conducting and an infinite resistance when nonconducting. Therefore, an element exhibiting the highest rate of change of resistance in the range used in the circuit is required. A second requirement is that the capacitance of the nonlinear element should be small to avoid capacitive closing of the feedback loop.

For this application, semiconductor diodes provide suitable nonlinear elements. Figure 3 shows average resistance as a function of voltage for a typical germanium point-contact diode and a similarly rated silicon junction diode. In the range from a few thousand ohms to several megohms, both diodes exhibit a similar rate of change of resistance with respect to voltage. However, germanium point-contact diodes commonly have capacitances one order of magnitude smaller than similarly rated silicon junction diodes. Germanium diodes are thus more suitable. When there is a choice of germanium diode type, those exhibiting higher back resistance and smaller capacitance are preferable.

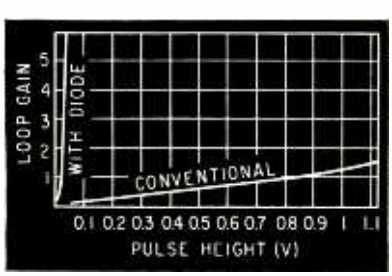

FIG. 2—Loop gain plotted as a function of input signal amplitude for conventional and modified multivibrator

Design Considerations

Design of highly sensitive trigger circuits is straightforward with a diode as the nonlinear element;

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Multivibrator Sensitivity

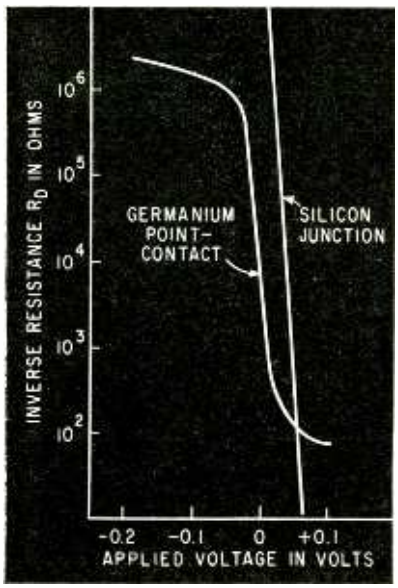

FIG. 3—Typical curves of average diode resistance as a function of applied voltage

only small parameter changes need be made. Since both V_1 and V_2 (Fig. 1) are conducting in the stable state, it is necessary to adjust the amplification to some specific value. The next step is to select the diode and the linear resistance R_g and to ascertain that the diode can exhibit an inverse resistance R_d high enough to satisfy the condition of stability $R_d > R_g (A - 1)$, where A is the amplification of tubes V_1 and V_2, R_g is the linear resistance of the voltage divider and R_d is the inverse resistance of the diode. At the same time it is necessary to insure that the rate of change of R_d with respect to applied voltage is high.

As an example, consider the circuit of Fig. 4A. Assuming that the transconductance of each tube is 5×10^{-3} mhos, the total amplification A in the stable state is approximately $A = g^2_m R_1 R_2 = 56$. The resistances R_g and R_d must satisfy the condition of stability; accordingly, if $R_g = 5{,}000$, $R_d > 275{,}000$ ohms. Figure 3 shows that a 1N34A germanium diode satisfies this condition. Furthermore, the rate of change of R_d in the range to be used is fairly high. According to the curve in Fig. 3, the voltage across the diode for critical resistance should be about -0.02 v. By changing the bias voltage V_b it is possible to control the diode inverse resistance and thus the triggering sensitivity. Figure 5 shows the threshold sensitivity for various values of bias voltage for the circuit of Fig. 4A.

Example

Triggering sensitivity of the cathode-coupled trigger circuit can be increased with similar methods. The second tube need not necessarily be a pentode and this offers the possibility of using triode-pentode tubes, making the circuit compact. One practical circuit using a type 6U8 triode-pentode is shown in Fig. 4B.

Circuit stability against self-oscillation and threshold stability, which are important properties of trigger circuits in general, become critical in high-sensitivity trigger circuits.

Since small signals on the grids can trigger the circuit, it is important to minimize capacitive coupling between grids and plates of the tubes. In fact, the use of triodes allows only small improvements in sensitivity and a really high-sensitivity trigger circuit can be realized only with pentodes.

Semiconductor diode properties depend somewhat on ambient temperature, and if the circuit is to be designed for maximum sensitivity, it is necessary to compensate for temperature variations or to regulate the temperature. An advantage of semiconductor diodes in comparison with thermionic diodes is the absence of heater supply voltage variations. Differences between diodes are easily compensated by changing the bias.

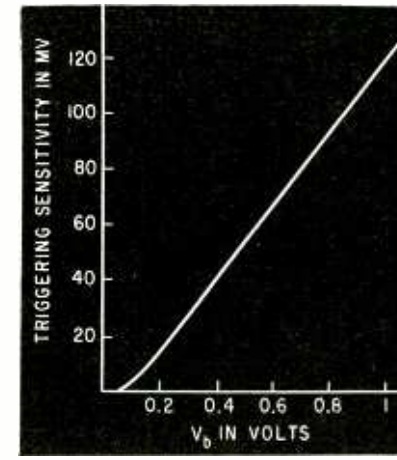

FIG. 5—Threshold sensitivity characteristics of Fig. 4A

In most cases, without special design precautions a stability of about 5 percent is achieved with threshold levels of a few millivolts and a stability of about 1 percent between 5 and 20 mv for ±5 percent line variation.

The author expresses his thanks to E. M. Williams for discussions and help in carrying out this work.

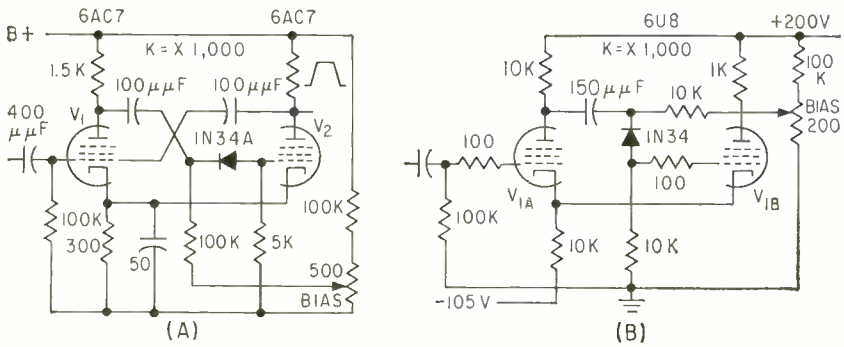

FIG. 4—Examples of sensitive multivibrator design: (A) satisfies stability criterion; (B) is a cathode-coupled version of circuit

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Photoemissive Television

Seventeen commercially available photoemissive camera tubes are listed, including image orthicons, iconoscopes, image converters and image dissectors

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Table I—Commercially Available Photoemissive Camera Tubes

Tube Type and Manufacturer	Description	Deflection/Focus	Sensitivity	Spectral Response in Angstroms
Diamond U330AF	Cold-cathode image dissector	Both magnetic	Luminous sensitivity is 12 μa/2,870 K tungsten lumen	Peak at 7,800
RCA RCA 7037	Image orthicon	Both magnetic	Good color picture with 175 ft-c illumination on scene	Peak at 4,250; good from 3,500 to 5,300
RCA 6474/1854	Image orthicon	Both magnetic	Good color picture with 350 ft-c illumination on scene	Peak at 4,250; good from 3,500 to 5,700
RCA 1850-A	Iconoscope	Magnetic deflection Electrostatic focus	20 ft-c highlight gives 0.25 μa signal output	Peak at 4,600; good from 4,200 to 5,300
RCA 6849	Image orthicon	Both magnetic	Can produce signal information with 0.00001 ft-c	Peak at 4,250; good from 3,500 to 5,700
RCA 5820	Image orthicon	Both magnetic	Can produce signal information with 0.0001 ft-c	Peak at 4,250; good from 3,500 to 5,700
RCA 6032	Three-electrode image converter	Electrostatic focus	5 μa/lumen (infrared)	Peak at 8,000; good from 6,700 to 9,200
RCA 6914	Two-electrode image converter	Electrostatic focus	Conversion index is 15	Peak at 8,000; good from 6,700 to 9,200
RCA 6929	Two-electrode image converter	Electrostatic focus	Conversion index is 10	Peak at 8,000; good from 6,700 to 9,200
Westinghouse WL-7198	Image orthicon	Both magnetic	Can produce signal information with 0.00001 ft-c	Peak at 4,250; good from 3,500 to 5,700
WL-5820	Image orthicon	Both magnetic	Can produce signal information with 0.0001 ft-c	Peak at 4,250; good from 3,500 to 5,700
GE GL-5820	Image orthicon	Both magnetic	Can produce signal information with 0.0001 ft-c	Peak at 5,500; good from 3,300 to 6,000
GL-6849	Image orthicon	Both magnetic	Can produce signal information with 0.00001 ft-c	Peak at 5,500; good from 3,300 to 6,000
ITT Labs IC6	Unipotential image tube		20 μa/lumen	
6839	Image tube	Electrostatic focus	30 μa/lumen	
6411/1C-16-3	Image converter		25 μa/lumen	Peak at 8,100; good from 6,700 to 9,250
D(30)TR	Image dissector	Both magnetic	Luminous sensitivity is 15 μa/2,870 K tungsten lumen	Peak at 8,000; good from 6,900 to 9,000

Camera Tubes

LAST WEEK'S ISSUE listed commercially available vidicon camera tubes. Table I here lists commercially available camera tubes other than vidicons—image orthicons, iconoscopes, image converters and image dissectors. These are photoemissive tubes rather than photoconductive, as was the vidicon.

Conversion index referred to in the table is the ratio of the luminous flux from the fluorescent screen to the product of the luminous flux incident on the infrared filter and the filter factor of 11.6 percent.

Resolution	Special Considerations	Applications and Features
300 lines for 30-mil aperture	Overall gain of 11 stages of electron multiplication is 680,000	For industrial closed-circuit tv
500 lines (color)	Maximum illumination of photocathode is 50 ft-c	For color cameras using simultaneous pickup of studio or outdoor scene
500 lines (color)	Maximum illumination of photocathode is 50 ft-c	For color cameras using simultaneous pickup of studio or outdoor scene
	High signal-to-noise ratio	For tv pickup from motion-picture film or slides
450 lines	Minimum operating temperature of target section is 35 C	For industrial and scientific research with extremely low light levels
500 lines	Maximum operating temperature of any part of bulb is 50 C	For tv broadcasting with either outdoor or studio pickup
18 line-pairs/mm	Minimum diam of fluorescent screen is $\frac{5}{8}$ in	For viewing of a scene with infrared radiation using suitable optical systems
25 line-pairs/mm	Anode supply voltage (d-c or peak a-c) is 16,000 v	For viewing of a scene with infrared radiation using suitable optical systems
25 line-pairs/mm	Anode supply voltage (d-c or peak a-c) is 12,000 v	For viewing of a scene with infrared radiation using suitable optical systems
At least 500 lines	Maximum operating temperature of any part of bulb is 71 C	For service in industrial, airborne or other military applications where standard image orthicons cannot be used
	Maximum operating temperature of any part of bulb is 50 C	For broadcast use in both studio and outdoor applications
	Maximum operating temperature of any part of bulb is 50 C	For broadcast use in both studio and outdoor applications
	Maximum operating temperature of any part of bulb is 50 C	For observation of fluoroscopic screens, starlit scenes and direct star images
20 line-pairs/mm	Maximum anode operating voltage is 6,000 v	For viewing of a scene with infrared radiation using suitable optical systems
40 line-pairs/mm	Maximum ambient temperature is 75 C	Functions as an electronic shutter for photographing short-duration events
20 line-pairs/mm	Maximum cathode-to-anode voltage is 16,500 v	Inspection of photographic film, medical and biological research, temperature distribution in heated objects
	Overall gain of 11 stages of electron multiplication is 1,300,000	For use as a slide or facsimile scanner

D-C Operational Amplifier

Transistor operational d-c amplifier meeting military requirements for airborne computer applications is described. Circuit includes a low-level silicon transistor chopper with input impedance of approximately 1 megohm and a highly efficient output stage

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OPERATIONAL amplifiers are the important component building blocks in analog computers. When equipped with appropriate feedback networks and drift-compensating circuits, these devices are generally capable of voltage or current summation, integration and differentiation with computing accuracies on the order of 0.01 percent under laboratory conditions.

Development of a completely transistorized amplifier to meet equivalent accuracy requirements under airborne environmental conditions presents a number of problems. Foremost of these are the provision of input current sensitivity in the region of 100 $\mu\mu$a and a dynamic output range on the order of ±50 v d-c. Furthermore, a filter with a time constant of about 10 seconds is normally required in this type of amplifier. This filter is difficult to obtain with inherently low transistor circuit inpedance levels. The amplifier to be described here uses silicon transistors throughout, including the chopper circuit, to achieve computing accuracies of 0.005 percent over an ambient temperature range of −55 C to +85 C.

Summing Amplifier

Figure 1 is a simplified schematic diagram of the amplifier connected as a summing amplifier with two inputs.[1] The input-output relationship will be independent of amplifier characteristics and approach the ideal relationship $e_o = -e_1Z_f/Z_1 - e_2Z_f/Z_2$ if the gain of the amplifier is sufficiently high and the effects of d-c drift in the transistor circuits are made sufficiently small. This is accomplished by a chopper amplifier, integrating amplifier, a-c preamplifier and output power amplifier forming the overall d-c operational amplifier.

The amplifier sections are connected to provide two signal paths for the small input error signal e_i. The d-c and low-frequency components are amplified in the chopper amplifier-integrating amplifier combination while the higher frequency a-c components are amplified in the preamplifier. The two signals are combined at the input of the output power amplifier and further amplified in this section. Effective preamplification of d-c input signal components in the essentially drift-free chopper section minimizes the effect of d-c drift in the succeeding direct-coupled circuits, while provision of the alternate a-c signal path achieves amplification of high-frequency signals beyond the capabilities of the chopper amplifier-integrator combination.

The integrating amplifier permits obtaining the long time constant filter at the output of the chopper amplifier with relatively low resistor and capacitor values, since time constant multiplication by the gain of the integrating amplifier is effectively achieved. The filter thus formed is required to remove chopper frequency signals originating in the chopper amplifier.

Chopper Amplifier

The chopper amplifier is the most critical portion of the entire amplifier and its accuracy is largely determined by the characteristics of the transistor chopper. A *pnp* microalloy silicon transistor was chosen for use as the chopper (Q_3 of Fig. 1) because of its excellent high-frequency characteristics and the inherently small magnitude and stable nature of the internal sources of offset errors. A 350-cps chopper was selected as a compromise between frequency-dependent offset errors in the transistor and time constant considerations in the amplifier.

Transistor chopper Q_3 is operated in the inverted connection to minimize internally generated offset voltages. Offset effects are further reduced by actuating the collector-base control junction with a half-wave rectified square wave which alternately provides sufficient base current for the closed-switch state or zero voltage for the open-switch state. This rectified square wave is provided by the flux oscillator circuit Q_1 and Q_2 and diode D_1. Operation with zero voltage across the control junction of the transistor chopper for the open-switch state is possible since the transistor open-switch resistance is greater than 50 megohms for the normally small d-c input signals to the chop-

With Transistor Chopper

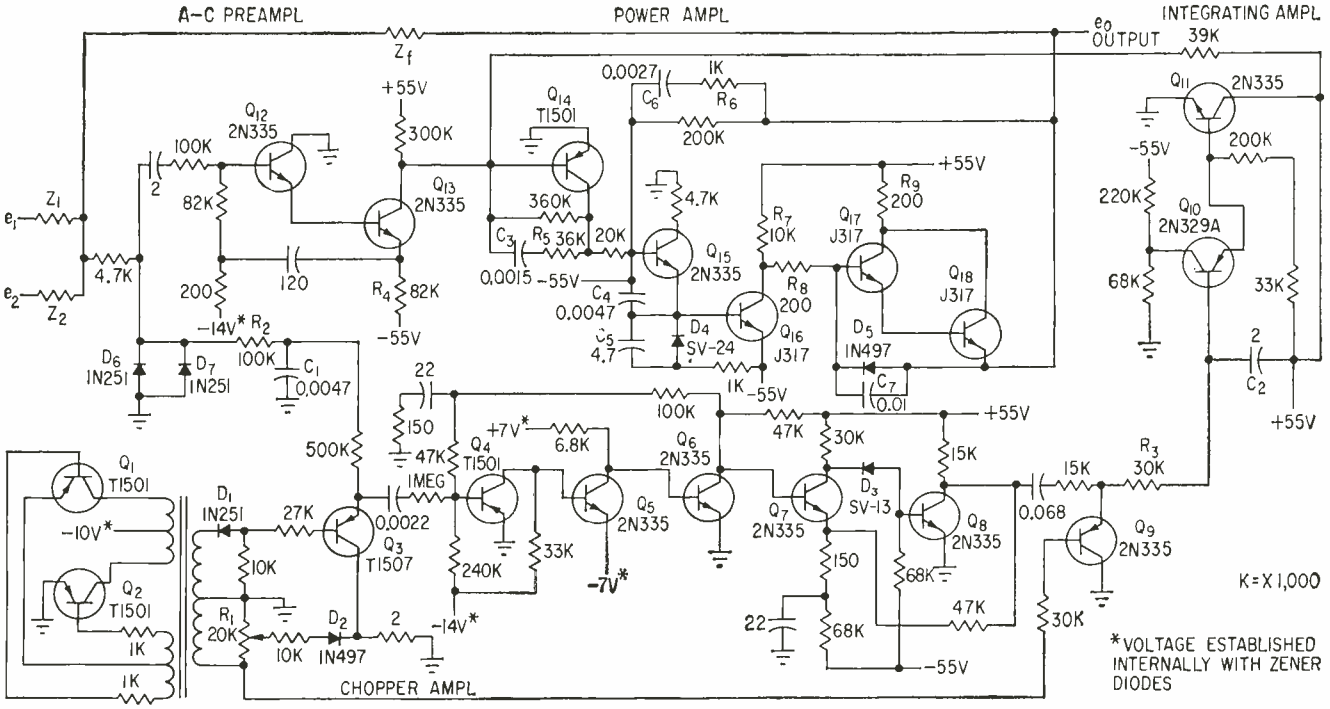


FIG. 1—Schematic of the operational amplifier. Drift compensation achieves accuracy of 0.005 percent or less in analog computers

per. This mode of operation avoids temperature dependent leakage current errors normally observed in back-biased chopper circuits.

Offset Effects

The zero control R_1 for nulling the nominal effects of offset in the modulator circuit inserts a variable square wave into the collector circuit of the transistor chopper. This method corrects the voltage offset directly at the source. The zeroing voltage is applied only during the instant when the transistor chopper is in the conducting state, thus again eliminating errors from leakage variations which would otherwise occur during the nonconducting state of the chopper. The low-pass filter R_2C_1 is incorporated to prevent a-c components of the input signal from overdriving the high-gain a-c amplifier.

The effects of switching transients or spikes from junction capacitance and carrier storage effects in the chopper transistor are reduced in the design of the a-c amplifier. Accurate clipping of the spike is provided at the output of the amplifier by saturation of Q_8 and control of the amplifier a-c input impedance and gain. This reduces the offset caused by the switching transient by an approximate factor of 3.

Bias stability in the a-c amplifier is provided using a minimum of capacitance. Two feedback networks are incorporated—a low-pass network from the collector of Q_6 to the base of Q_4, and another from the collector of Q_8 to the emitter of Q_7. This arrangement also provides the stable input impedance and gain essential for setting the accurate clipping level of the switching transient mentioned previously.

Demodulator Q_9 is used to recover the d-c component of the signal. Blocking of large positive voltages is accomplished by providing a large switching voltage at the base of Q_9. As mentioned previously, the amplifier has an internal chopper power supply, consisting of stages Q_1 and Q_2 and a saturable transformer in a flux oscillator configuration. However, the square-wave voltages required to actuate the chopper, demodulator and zero control circuits are all referenced to ground. It is therefore possible if desired to provide a single chopper supply for multiple installations without a separate isolation transformer in each d-c amplifier.

Integrating Amplifier

Figure 1 includes a schematic of the integrating amplifier. A time constant of approximately 12 seconds is obtained by use of a two-transistor circuit and a feedback network comprising a 2-μf capacitor C_2 and a 30,000-ohm resistor R_3. The amplifier employs an *npn* and *pnp* transistor circuit, which provides cancellation of the base-to-emitter voltage variations which are functions of ambient temperature. Base current level of the input stage of the amplifier is minimized by employing a *pnp* silicon transistor which has high d-c β at low collector currents.

Minimization of base-to-emitter voltage variations and reduction of the base current with resultant smaller magnitude variations are essential, since these variations effectively represent offset errors. These can be appreciable in spite of the fact that this portion of the circuit is preceded by the d-c gain of the chopper amplifier. The direct-coupled amplifier is bias-stabilized automatically since it is in the d-c signal path of the overall amplifier, which is normally stabilized by external feedback networks.

A-C Preamplifier

Again referring to Fig. 1, the a-c preamplifier consists of an emitter follower Q_{12} driving a common-emitter amplifier Q_{13}. This arrangement provides an a-c input impedance of approximately 300,000 ohms. The large emitter resistor R_4 provides sufficient bias stability to reduce offset variations referred to the input of the overall amplifier to a negligible value. Because of their inherently high frequency response characteristics, *npn* silicon transistors are used which permit extension of useful overall amplifier gain to frequencies above 100 kc.

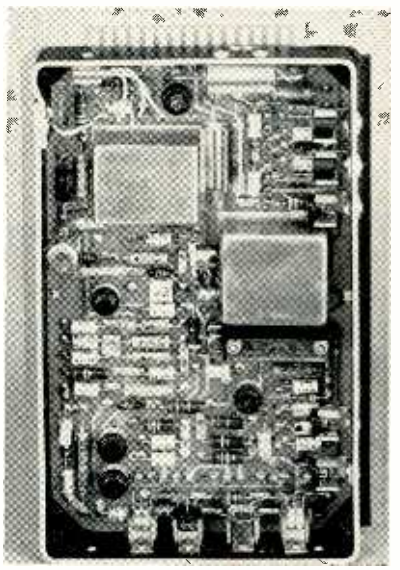
Output Power Amplifier

Essential feature of the output power amplifier is efficient provision of a large dynamic voltage range and sufficient current capacity to drive a number of computing networks or other useful loads. Utilization of large dynamic voltage range effectively minimizes percentage errors from offset and drift in an operational amplifier.

To achieve these objectives the output power amplifier included in Fig. 1 was selected. This circuit consists of composite emitter-follower Q_{17} and Q_{18}, common-emitter amplifier Q_{16} and diode D_5. For positive output, the diode is back-biased and may be considered an open circuit. The circuit then consists of the composite emitter-follower stage Q_{17} and Q_{18} driven by common emitter stage Q_{16}.

For negative outputs, the diode is forward-biased providing a low resistance path from the collector of Q_{16} to the load. The base-emitter junctions of Q_{17} and Q_{18} are back-biased and are therefore nonconducting. The circuit then functions as a common-emitter output stage. This arrangement results in a great improvement in efficiency compared to conventional single transistor common-emitter or common-collector power output stages.

Other salient features of the output power amplifier are: two power resistors R_8 and R_9 limit the output current and thereby provide protection of circuit components in the event of accidental shorting of the output; two additional gain stages Q_{14} and Q_{15} are included to perform voltage level shifting operations and achieve the required power gain; negative feedback is used in amplifier stage Q_{14} and also from the emitter of Q_{18} to the base of Q_{15}.



Layout of operational amplifier avoids closing of feedback loops through stray capacitances

This arrangement provides gain stability over the entire passband of the amplifier, which is essential for proper high-frequency cutoff control. Cutoff of the entire amplifier at 100 kc is accomplished by networks R_5-C_3 and R_6-C_6. These phase-control networks are designed to reduce the effects on frequency response of beta-cutoff and collector capacitance in the transistors of the a-c preamplifier and output power amplifier, as well as parasitic capacitances in the layout. Capacitors C_4, C_5 and C_7 stabilize the local feedback loop around Q_{15}, Q_{16}, Q_{17} and Q_{18}.

Connection of Q_{14} as a common-emitter amplifier with negative feedback provides the low input impedance required for efficient summation of the two signals from the integrating amplifier and the a-c preamplifier, respectively.

Power Supply

The amplifier circuit requires only two supply voltages, namely, ±55 v, although several convenient lower voltage levels are derived internally by Zener diode voltage-divider networks which are not shown in Fig. 1. The d-c input resistance of the amplifier is approximately 1 megohm. The nominal d-c gain of the chopper amplifier is 1,300, the d-c gain of the output power amplifier is 50 and that of the integrating amplifier, 200; this results in a d-c open-loop gain of approximately 13×10^6. The voltage gain of the a-c preamplifier and power output amplifier combined is approximately 3,000 at 100 cps, and 2,500 at 400 cps. The output voltage range is +45 v to −45 v into a 1,500-ohm load.

Extensive tests of the amplifier have shown that the offset remains consistently less than 300 μv referred to the input when the amplifier is operated over an ambient temperature range of −55 C to +85 C. The offset has been found to remain less than 50 μv over periods of several hundred hours under laboratory conditions. Care in mechanical layout and guarding of the critical input circuit portions by grounded circuit lines have resulted in leakage current errors of less than 10^{-9} amp, referred to the input under conditions of high humidity.

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(1) Patent pending on this circuit.

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Induction Potentiometers

Twenty-six commercially available induction potentiometers in five frame sizes are listed with their important characteristics in Table I

By **FRANKLIN G. FINK,** Senior Development Engineer, Loral Electronics Corp., New York, N. Y.

INDUCTION POTENTIOMETERS are resolver-type synchro components which can provide an accurate linear indication of shaft rotation about a reference position. This voltage takes the form of a polarized voltage whose magnitude is proportional to angular displacement and whose phase relationship indicates the direction of shaft rotation from a known reference position.

Since these potentiometers have no sliders, there are no circuit interruptions or wear. The units are used as potentiometers within the linear range where high sensitivity, high resolution and low wear at high speeds are called for.

A resolver may be used as an induction potentiometer with excellent linearity over a ±45-deg range. This may be accomplished by shorting one pair of stator leads and applying the input voltage to the other pair of stator leads through a resistor of 500 to 2,500 ohms. If one of the rotor leads is terminated in the proper resistor, the other rotor winding will have an output that increases linearly with shaft rotation.

Table I—Commercially Available Induction Potentiometers

Manufacturer Model Number	Frame Size	Input in volts	Length in in.	Input Power in watts	Input Impedance in ohms	Linearity in percent	Max Linear Range in deg	Sensitivity in v/deg	Phase Shift in deg	Residual Null Volts in mv
LTC 8-A1 (C)	8	115	1.241	0.320	1,170 + *j*6,660	0.5	50	0.20	15	15
LTC 8-A4 (C)	8	26	1.241	0.275	110 + *j*530	0.5	50	0.30	6.5	15
LTC 10-A4 (C)	10	26	1.241	0.304	47 + *j*430	0.5	50	0.48	5	15
LTC 10-A5 (C)	10	26	1.241	0.430	74 + *j*330	0.5	50	0.46	9.5	15
LTC 10-A6 (C)	10	115	1.241	1.120	776 + *j*2,930	0.5	30	0.33	8	15
LTC 11-B2 (C)	11	115	1.600	0.230	1,900 + *j*10,700	0.5	50	0.216	3.4	15
LTC 11-B3 (C)	11	115	1.600	0.138	2,330 + *j*14,500	0.5	50	0.33	3.8	15
LTC 11-B4 (C)	11	115	1.600	0.138	2,330 + *j*14,500	0.5	50	0.215	3.8	15
LTC 11-B5 (C)	11	26	1.600	0.144	160 + *j*854	0.5	50	0.34	5.5	15
LTC 11-B6 (C)	11	115	1.600	0.221	1,310 + *j*875	0.5	50	0.02	5	15
LTC 11-B7[a] (C)	11	16	1.600	0.322	746 + *j*145	0.5	45	0.113		15
R915-01 (K)	11	26	1.704	1	37 + *j*100	0.25	60	2.308	9	80
R915-02 (K)	11	115	1.704	1	479 + *j*2,217	0.25	60	0.522	9	80
F11M-16-A/1 (M)	11	115		0.5		0.25		0.5		
F11M-16-A/2 (M)	11	26		0.5		0.25		0.5		
(T)	11	26	1.775	0.15	24 + *j*123	0.25	85	0.107	5	7
(T)	11	26	1.775	0.15	265 + *j*1,240	0.25	85	0.346	5	20
(T)	11	115	1.775	0.45	265 + *j*1,240	0.25	85	0.620	5	40
B1P15A (A)	15	26	1.631	1		2	35	0.394	1.5	
B1P15CT (A)	15	26	1.631	1		2	35	0.45	1.5	
B1P15D (A)	15	26	1.631	1		2	35	0.45	1.5	
B1P15G (A)	15	26	1.631	1		2	30	0.50	1.5	
B1P15P (A)	15	26	1.631	1		2	30	0.45	1.5	
AY210S-42 (B)	15	10	1.631		32.7 + *j*144		60	0.32	9	18
AY210S-43 (B)	15	15	1.631			5	30		11	40
FJE 43-16-1[b] (D)	25	50	2.875	4		1.5				

All units 400 cps except those marked (*a*) 50 cps (*b*) 60 cps
(A) American Electronics (B) Bendix (C) Clifton (D) Diehl (K) Kearfott (M) Muirhead (T) Transicoil

Automatic Control With

By juggling logical-circuit building blocks, a designer can devise reliable automatic controls for industrial equipment. Basic static-switching elements and some typical applications of these elements to automatic-control operations are described

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COMPLICATED INDUSTRIAL equipment and processes require extremely reliable and versatile automatic controls. Circuits that use static components such as semiconductors and magnetic amplifiers and perform logic operations provide such controls.

Logic elements are shown in Table I and compared to interlock or relay arrangements that perform the same operations. Each example of a logic element indicates the input conditions that are required to produce an output.

The logic elements that will be described consist of semiconductors and magnetic amplifiers which operate at low power and voltage levels.

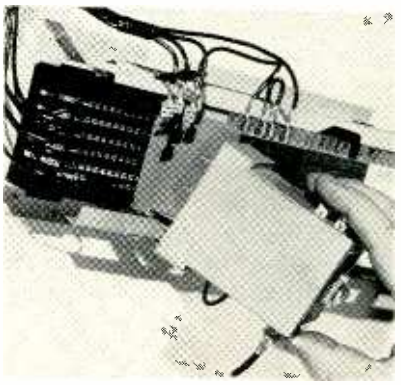
Multipurpose Block

Multipurpose blocks, which are composed of static components, have flexible input-signal and biasing arrangements. The multipurpose block shown in Fig. 1 can be set up to perform various logic operations by manipulating these arrangements.

The magnetic amplifier in the multipurpose block consists of two load windings and three control windings. A positive signal at terminals *A* or *B* tends to turn the amplifier on by passing current through the ON control winding. A positive signal at terminals *C, D* or *E* tends to turn the amplifier off. The third control winding is connected to a bias supply that tends to turn the amplifier off. Thus the relative amounts of current through the control windings determine whether an output is or is not present at *F*. The output is a full-wave-rectified pulsating voltage, whose average value is 6 v.

Input signal and bias magnitudes are expressed in control units such as −1, 0 and +1. Each unit is equal to 2.4 ampere turns. A six-volt signal at an input terminal supplies 2.4 ampere turns to a control winding and is therefore equivalent to one control unit.

Figure 2A shows the input signal arrangement. When input device S_1 goes on, it generates a 6-volt input signal that is applied to a building block circuit. Switch S_1 may be a limit switch.



Inserting a multipurpose block in mounting bus

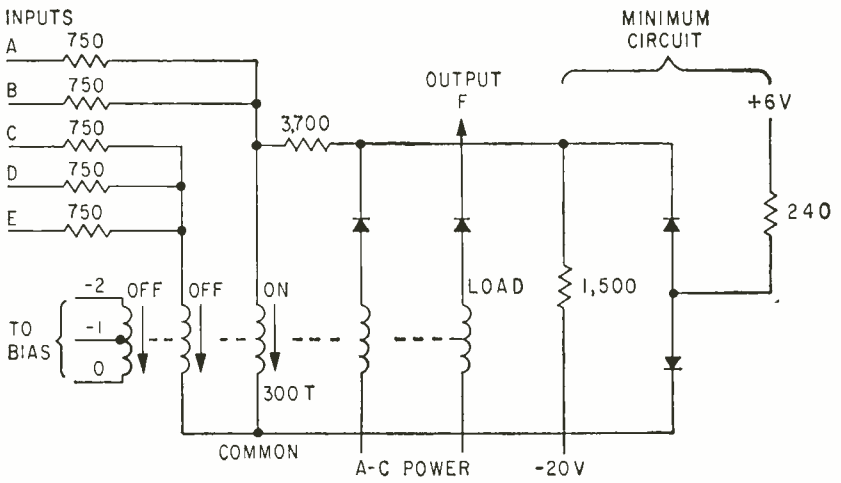


FIG. 1—Multipurpose circuit; the control-winding arrows denote the direction of current flow that produces an ON or OFF effect on the output

Since the saturation curve, Fig. 3, of the magnetic amplifier is approximately square, the amplifier is switched on or off sharply. The bias-winding setting determines the number of input control units that turns the amplifier on or off.

When a magnetic amplifier goes off, its output normally does not drop all the way to zero. The minimum circuit indicated in Fig. 1 brings the output near zero by circulating current through control windings of the amplifier.

Time Delay

The main difference between the time-delay unit, Fig. 2C, and the multipurpose block is the absence of OFF windings on the delay. Connecting a capacitor between terminal *B* and common causes a time delay when the unit is deenergized. The time delay in energizing the unit is negligible as the resistance from *A* to *B* is small.

Static-Switching Circuits

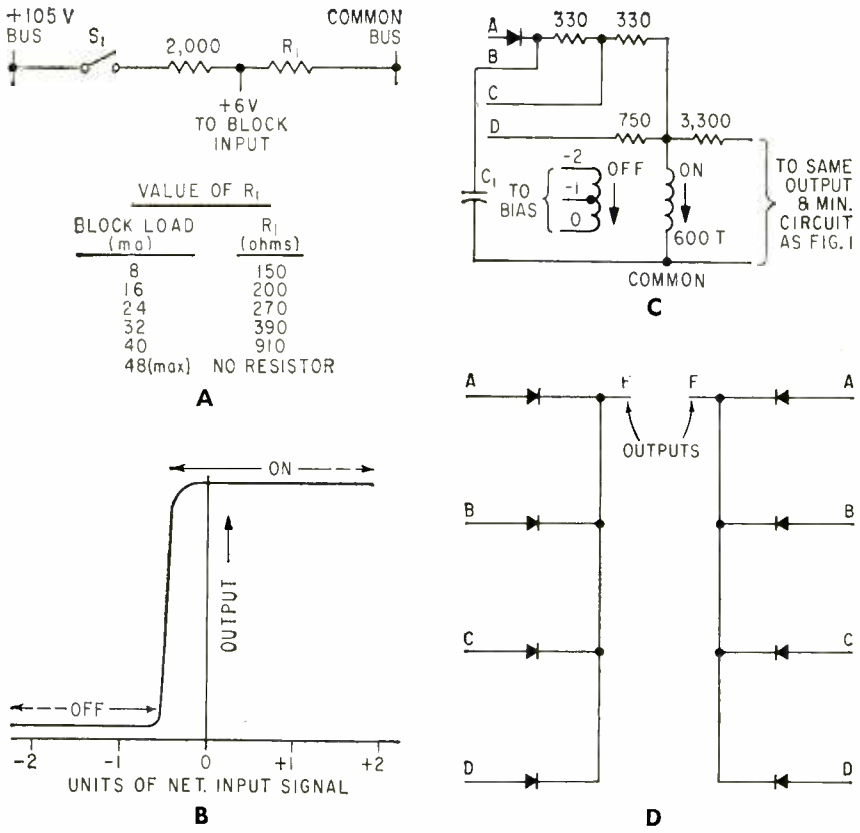


FIG. 2—Input bus circuit to logic circuits (A), saturation curve of magnetic amplifier (B), time-delay circuit (C) and OR block (D)

Other units provide delays when they are energized and others provide two delays: one when energized and one when deenergized.

The *OR* block in Fig. 2D consists of a set of rectifiers so connected that a signal on any input terminal brings an output to terminal *F*.

Figure 3 shows an npn transistor switch. The output of a magnetic amplifier, which is pulsating d-c, passes through a d-c blocking capacitor into the primary of transformer T_1. The secondary voltage is rectified and then applied to transistor Q_1, switching Q_1 into saturation. Rectifiers 1N91 and 1N536 prevent reverse current flow in the transistor.

Relay-to-Static Conversion

Figure 4A shows a relay control circuit and its conversion to a static-switching circuit. The relay circuit is a raise-lower arrangement that is controlled by control switches S_1 and S_2 and limit switches S_3 and S_4, and is so interlocked that raise and lower relays K_1 and K_2 cannot both be energized at the same time. Switch S_5 can stop operation at any time.

Here is how the circuit operation that energizes raise-relay K_1 is described in logic terms: NOT stop switch, AND raise switch, AND S_3 AND NOT relay K_2. The corresponding expression for relay K_2 is similar. Figure 4B shows logic symbols that represent these expressions. The raise and lower blocks in the static-switching circuit (Fig. 4C) are multipurpose blocks that perform the operations shown in Fig. 4B.

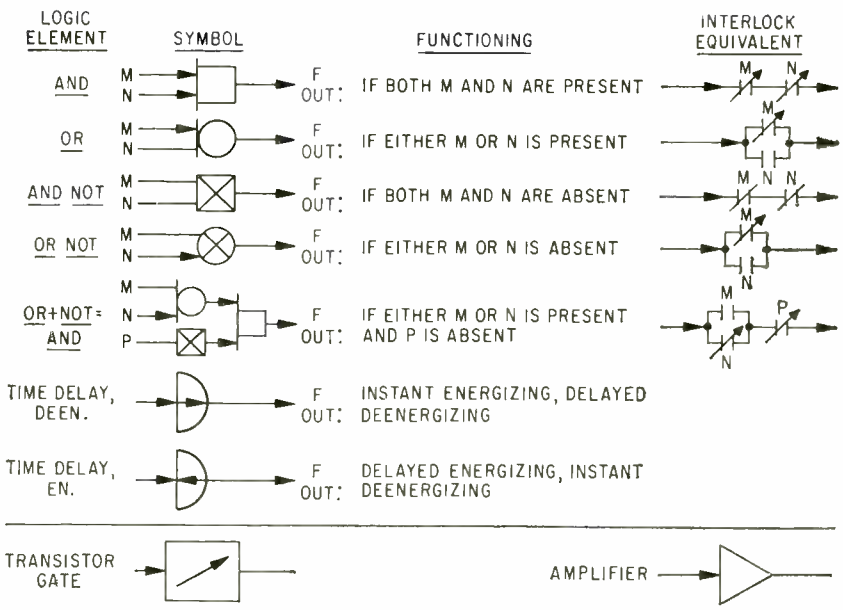
Sensing Voltage Levels

Figure 5 (left) shows a static circuit that turns on transistor switch Q_1 when the voltage across the rectifier bridge reaches 50 v. Input-winding *GJ* of the multipurpose block that is used in this circuit isolates the output. This winding can receive as much as 750 v. Positive feedback through winding *CD* causes more of a snap action when multipurpose-block *A* switches on transistor Q_1.

Interval Timer

The output voltage of the timer shown in Fig 5 (right) goes on and off for intervals determined by capacitors C_1 and C_2. Blocks *A*, *B*, *D* and *E* are multipurpose units and *C* and *F* are time-delay units (on deenergizing). Bias and input arrange-

Table 1—Logic Symbology Used in This Article



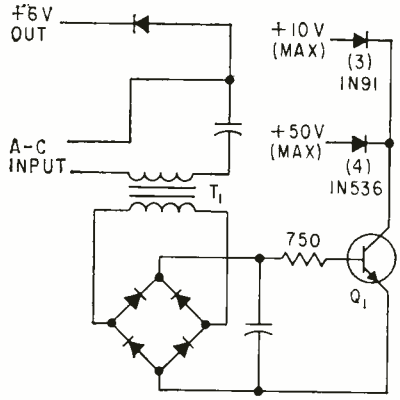


FIG. 3—Input to this switch is pulsating d-c whose average value is 6 v

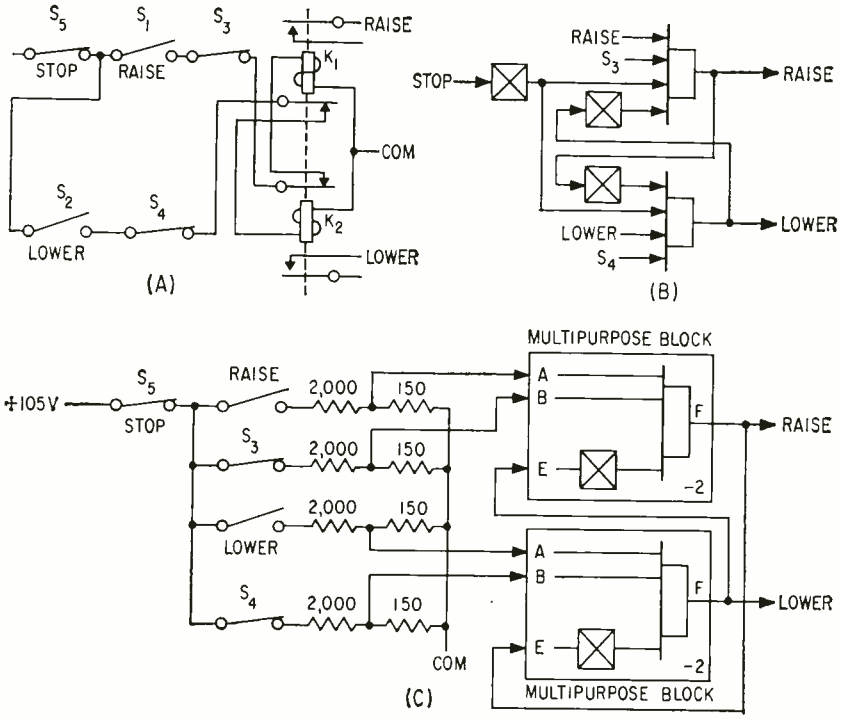


FIG. 4—Example of conversion of relay to static-switching circuits: (A) relay circuit; (B) logic symbolism; and (C) static-switching circuits. Number in lower right-hand corner of a block indicates bias

ments of the units determine their logic function. Block A is an AND gate because it requires a signal from terminal A and requires the absence of a signal from terminal E to produce a voltage at F.

Before the start of operation, which is begun by applying a steady voltage to terminal A of block A, blocks B, C, E and F are on, and blocks A and D are off. When the start voltage is applied, block A goes on. Its output is the output of the interval timer.

The output signal turns off block B, permitting capacitor C_1 of time-delay C to discharge. When the output of C_1 drops, the current through the OFF coil of block D stops, removing a negative unit of input signal. Now the bias (-1) of block D is completely offset by the positive unit applied to terminal B (Fig. 2B), and block D produces a voltage at F. This voltage turns off block A, ending the ON time of the output voltage.

The voltage at F brings the net input signal of block D to $+1$, and turns off block E. Capacitor C_2 now discharges until it switches off the output of time-delay F.

When the output of block A drops, block B goes on, instantly charging capacitor C_1. Block C then applies a negative unit of signal to block D, bringing the net input signal of block D to zero. Thus as soon as time-delay F removes its plus signal from block D, the net input of D drops to -1, turning off block D. Block A goes on, ending the OFF and starting the ON period of the output voltage.

Capacitor C_1 controls the ON and C_2 controls the OFF times of the output. The capacitance values shown in Fig. 5B produce a 2-sec ON, and an 8-sec OFF time interval. All ON and OFF times that are set up between 0.3 and 10 sec repeat with high accuracy.

Code Converter

Because binary or binary-decimal numerical systems are easy to manipulate and to punch into cards or tape, the programming signals to industrial equipment are seldom decimals.

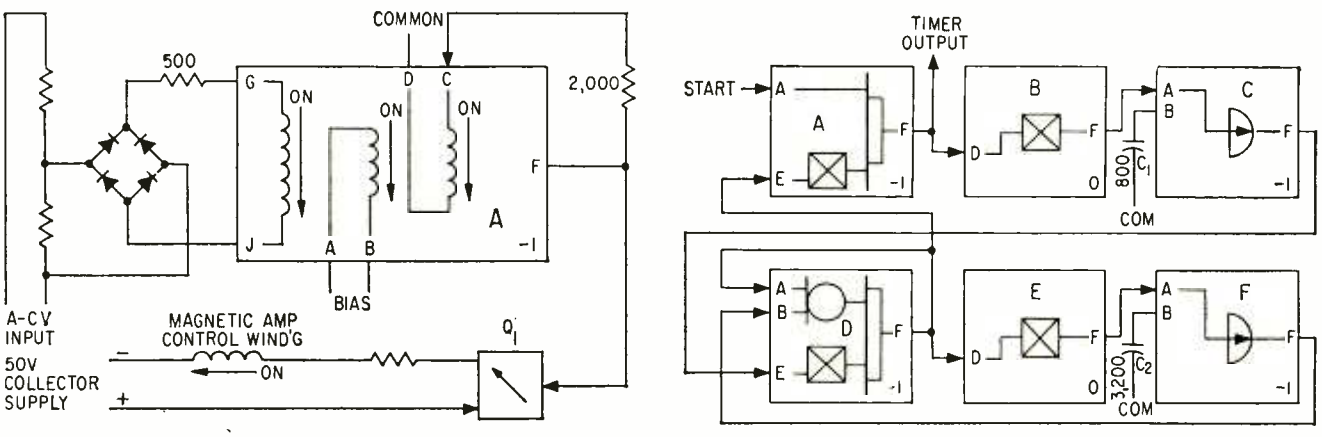


FIG. 5—High-voltage multipurpose block with isolated control winding (left); adjustable timer (right)

Figure 6 shows a readout circuit that converts binary-decimal information into decimal indications. Busses 8, 4, 2 and 1 are energized, each to 6 v, according to the value of input.

Each multipurpose-block output represents a specific number from 0 to 9. Only the zero to 5 blocks are shown. Assume none of the input busses is energized. Since block *zero* has no input, it is on. No other block is on since every other block has at least one negative unit of bias.

When bus 1 is energized, block 1 receives one plus signal. Since no other inputs are available, the one unit of input cancels the one unit of bias, and block 1 goes on.

Other numbers are read out in a similar way. Note that only one unit at a time goes on.

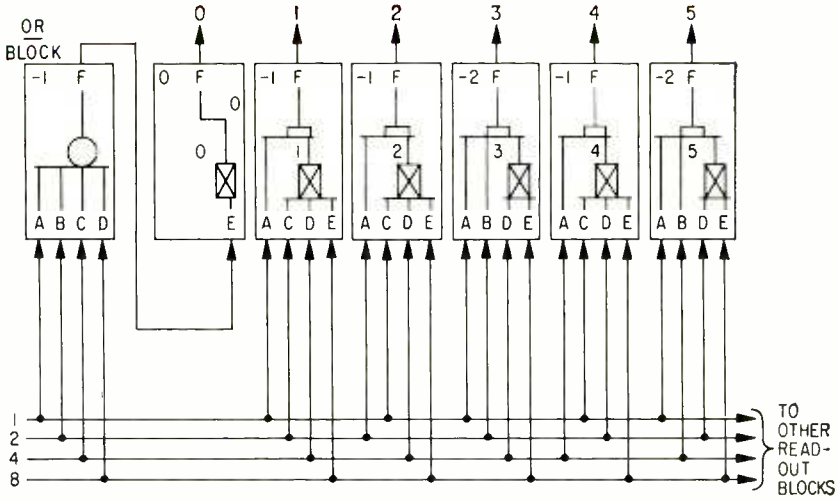


FIG. 6—Outputs of blocks go to indicators such as lights or a printer

Static-Stepping Control

Programming often calls for a sequence of operations to occur. Figure 7 shows a static-stepping switch that produces an output voltage at terminal F of block A, B and C in sequence. Two input signals drive the stepping control. A reset signal resets all blocks to off, and a step signal turns on blocks A, B and C, successively.

A momentary reset signal turns on time-delay block R. Block R turns on block S, and applies an ON signal to time-delay TD_1 and block A_1.

Block S turns on amplifier Q_1, which applies an OFF signal to blocks A, B and C. Any capacitor unit such as CU_1 or CU_2 that is charged, discharges, thus resetting the stepper.

When time-delay TD_1 is charged, it energizes time-delay TD_2. When TD_2 is charged it turns off block S. Transistor Q_1 switches off, removing the reset voltage.

Now block A_1, which was turned on by the output signal from block R, turns on block A. The feedback loop from block A to block A_1 keeps these blocks energized after the output of time-delay R drops to zero. Block A charges capacitor C_1 of CU_1 and produces output-voltage step No. 1.

Subsequently a momentary signal at the input of time-delay TD_3 turns it on. Time-delay TD_3 turns on block S and slowly energizes time-delay TD_2.

Block S switches on Q_1, which resets block A. Shortly after this reset, time-delay TD_2 goes on and turns off block S and amplifier Q_1.

Capacitor C_1 of CU_1 now discharges, and the negative pulse across C_2 turns on block B. To make sure block B goes on, two OFF windings (Fig. 1) receive the pulse. The feedback path of block B keeps it energized as its output produces voltage step No. 2.

The number of steps, or sequences, that can be obtained by adding successive blocks and capacitor units is limited only by the load that transistor amplifier Q_1 can supply.

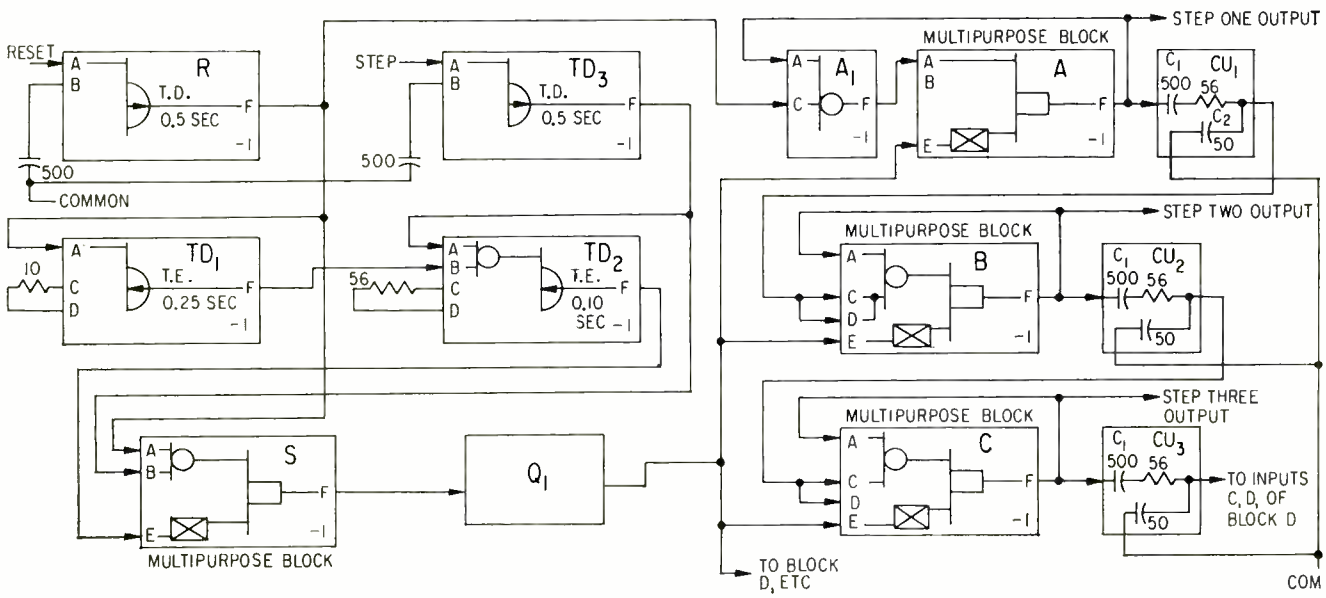


FIG. 7—Blocks A, B and C are switched on in sequence, in the manner of stepping-switch operation. As in previous diagrams, a number in the lower right-hand corner of a block indicates the bias of the block

Amplifier Design Charts

Series of nomograms saves time and effort in designing complete resistance-coupled amplifiers. All design equations are reduced to simple charts and a design example is included

By **DONALD MOFFAT,** Senior Electronics Designer, Motorola Inc., Phoenix, Arizona

ALTHOUGH resistance-coupled amplifiers are both common and elementary, their design remains a time-consuming, step-by-step process. With the nomograms presented here, resistance-coupled amplifiers, including those with shunt compensation, can be designed with a minimum of time and effort.

For a given bandwidth and gain, the design of a multistage amplifier is as follows: (1) estimate the number of stages and the required bandwidth of each; (2) determine the effect of shunt compensation; (3) determine values of plate loads; (4) determine the individual stage gains; and (5) determine the value of compensation inductance.

A nomogram is given for each of these steps and a design example illustrates their use.

Design Example

Assume with an overall bandwidth from 300 cps to 2.5 mc, a low-frequency roll-off at 150 cps and an overall gain of 2,000 using three stages of 6111 triodes.

On Fig. 1, join overall bandwidth f_t of 2.5 mc to 3 stages. The bandwidth f_i of each stage is found to be 5 mc.

As the number of stages is increased, any peak in the frequency response will be amplified. For maximum flatness of response, use a Q of 0.414.

On Fig. 2, join $Q = 0.414$ to 5 mc on the f_c scale. Each stage then should be initially designed as an uncompensated stage with a bandwidth f_u of 2.88 mc.

Calculation will show that the shunt capacitance is approximately 22 $\mu\mu$f. On Fig. 3, draw a straight line between capacitance C_u of 22 $\mu\mu$f through bandwidth f_u of 2.88 mc and note that a dynamic resistance of 2.6 K is found on the R_u scale. When the following grid resistor is large, the dynamic resistance is the parallel combination of plate load R_L and the internal plate resistance. As the plate resistance of the 6111 is 4 K,

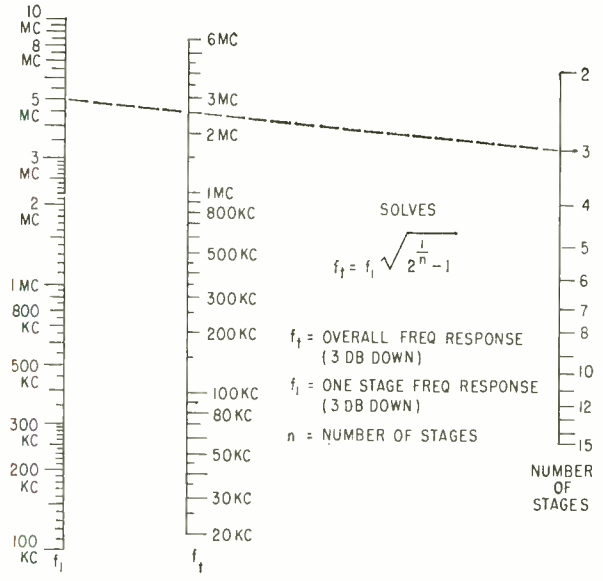


FIG. 1—Nomogram determines individual stage bandwidth of amplifier when number of stages and frequencies are known

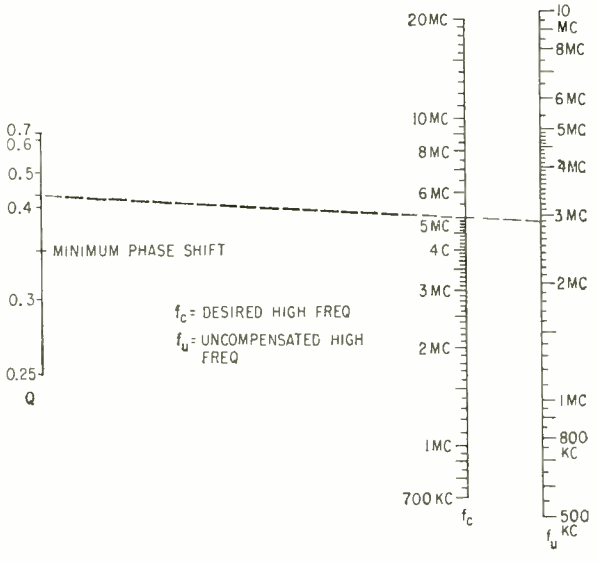
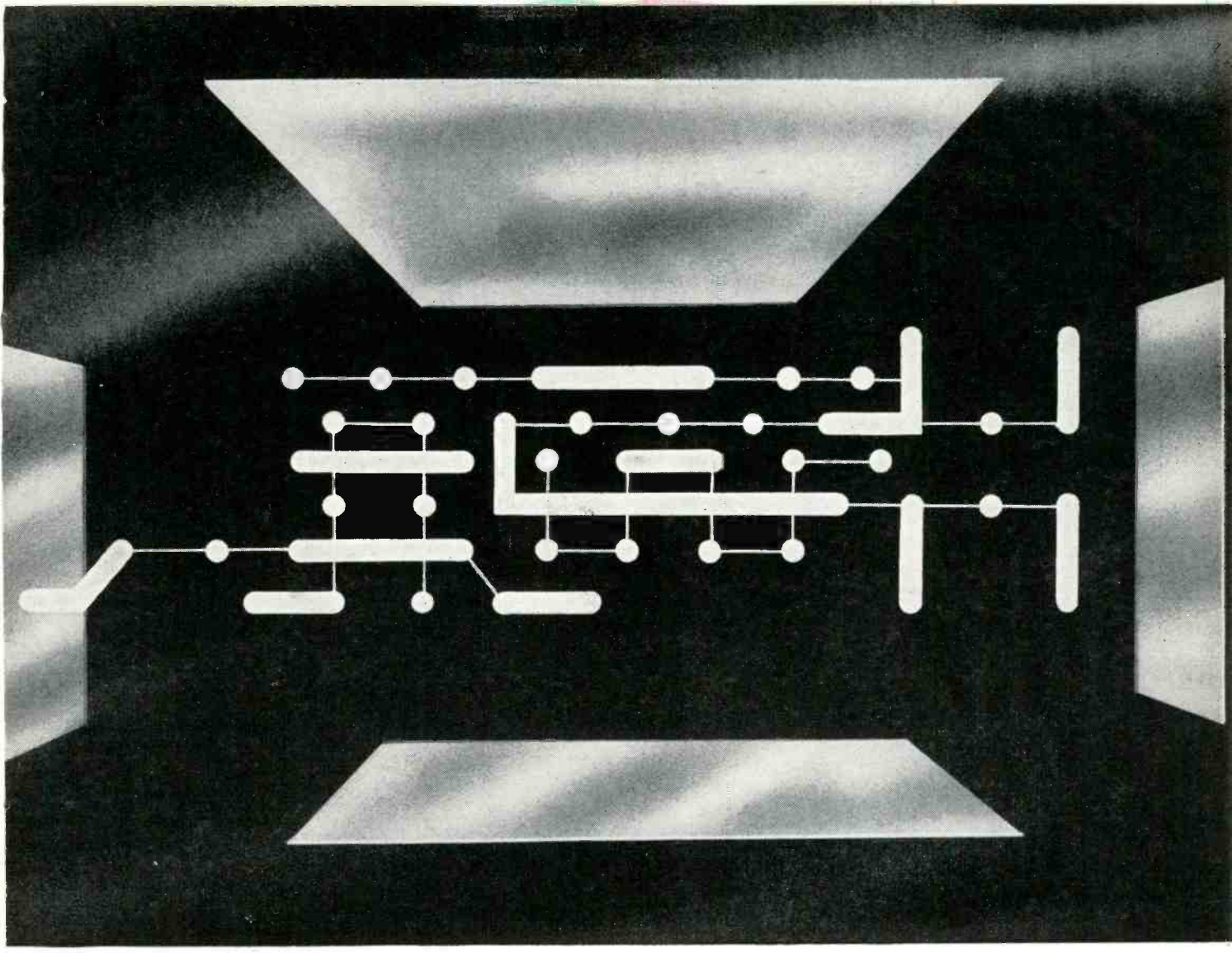


FIG. 2—This nomogram finds uncompensated bandwidth of single stage when Q and stage bandwidth are known



Report from IBM *Yorktown Research Center, New Yor*

LOW TEMPERATURES FOR HIGH-SPEED CIRCUITRY

Certain metals and alloys lose their resistance to electricity at temperatures close to absolute zero. They become "super-conductors." Investigations by Dr. D. R. Young and others at the IBM Yorktown Research Center are directed toward the utilization of this unique property in the development of small-size, high-speed switches with increased logical capacities.

Interestingly, when a "super-conductor" is exposed to certain magnetic fields, it reverts instantly to an ordinary conductor. One experimental switching device that takes advantage of this property has been constructed at IBM. In essence, it is a "sandwich" of glass, tin, silicon monoxide and lead. The device is immersed in liquid helium to bring it close to absolute zero. The tin strip becomes a "super-conductor," so current flows readily through it. When a current is applied to the lead strip it creates a magnetic field. As a result, the tin strip is no longer a "super-conductor" and now has electrical resistance . . . it is "off." Remove the magnetic field and it is "on" again. This then is an "on-off" device, or switch, that is expected to work at speeds much greater than present switch capacities. There are no moving parts to wear out and 1,000 such devices can be mounted on a bit of glass only a few inches square.

In addition to these experiments, the study of matter at very low temperatures is being applied to other areas at IBM. The immediate objective is to apply the results to the development of device formulations which will greatly accelerate arithmetic speed and increase the logical capacity in electronic computers of greatly reduced size.

IBM® RESEARCH

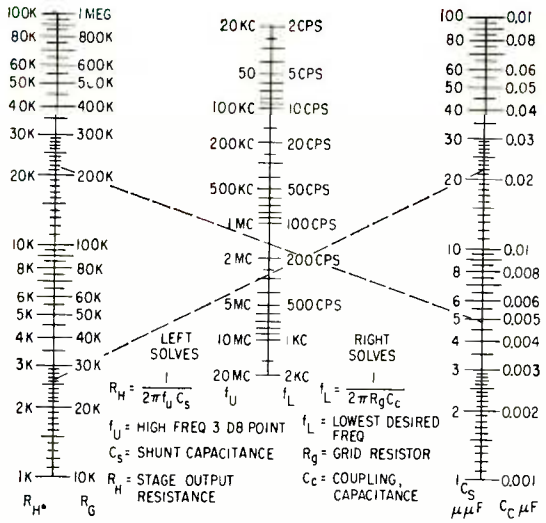


FIG. 3—Left sides of dual scales find stage output resistance. Right sides find interstage coupling capacitance

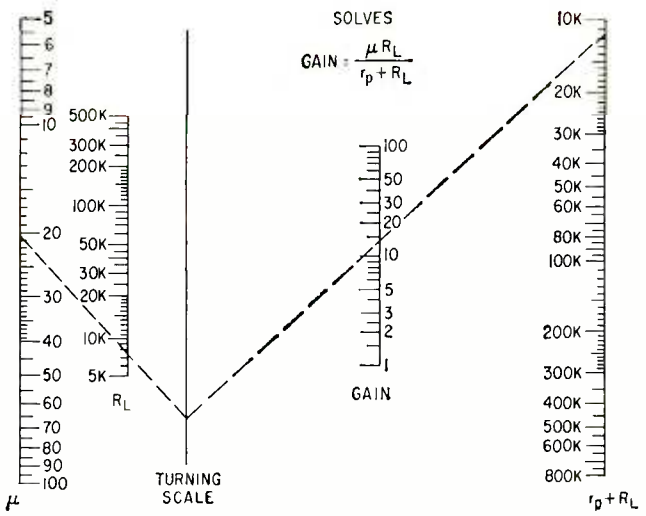


FIG. 4—Triode stage gain nomogram used when amplification factor, load resistor and plate resistance of stage are known

the plate load resistor then becomes 7.5 K.

Use the values of $\mu = 20$ for the 6111, $R_L = 7.5$ K and $r_p = 4$ K. On Fig. 4, draw a straight line between $\mu = 20$ through $R_L = 7.5$ K to the turning scale. Draw a straight line between the turning scale and $r_p + R_L = 11.5$ K. The 3-stage gain then becomes 13^3 or 2,197.

On Fig. 5, draw a straight line between $Q = 0.414$ through $R_L = 7.5$ K to the turning scale. Draw a straight line from the turning scale through $C_s = 22$ μμf and note that the peaking coil should have a value of 500 μh on the L scale. This completes the design for high-frequency considerations.

For a low-frequency response of 300 cps, each stage should be designed for 150 cps, Assume a grid resistor of 220 K. On Fig. 3, draw a straight line from 220 K on the R_G scale through 150 cps on the f_L scale and note that coupling capacitor C_c has a value of 0.005 μf.

To calculate the value of cathode bypass capacitance, use Fig. 6. The tube manual calls for a 220-ohm cathode resistor. Draw a straight line between $R_K = 220$ and $f_L = 150$ cps. Note that the cathode bypass capacitance should have a value of 50 μf.

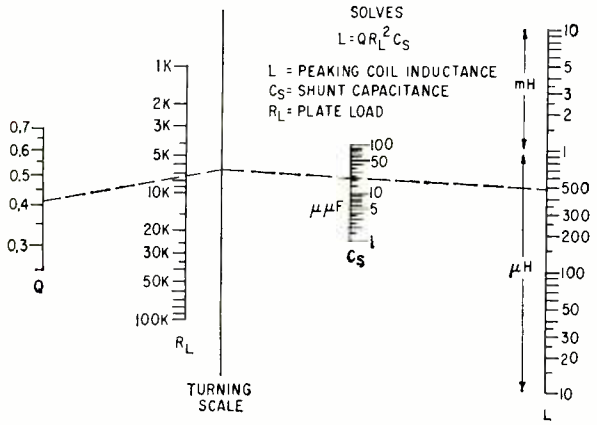


FIG. 5—Peaking coil nomogram finds value of inductance required when Q, R_L and total shunt capacitance are known

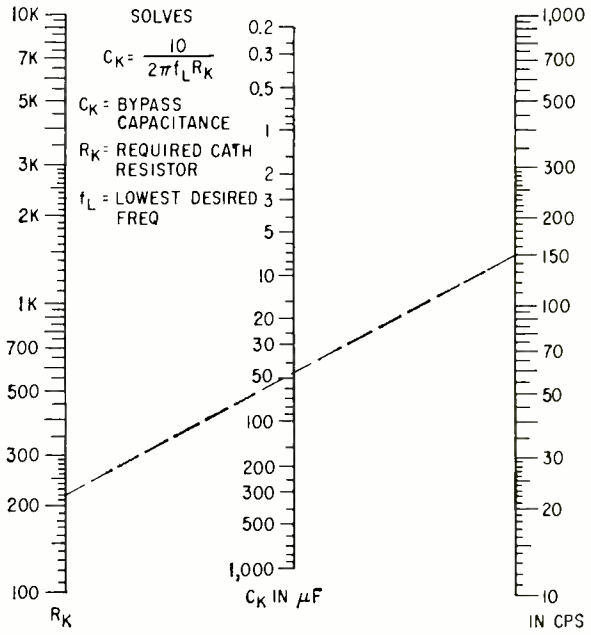
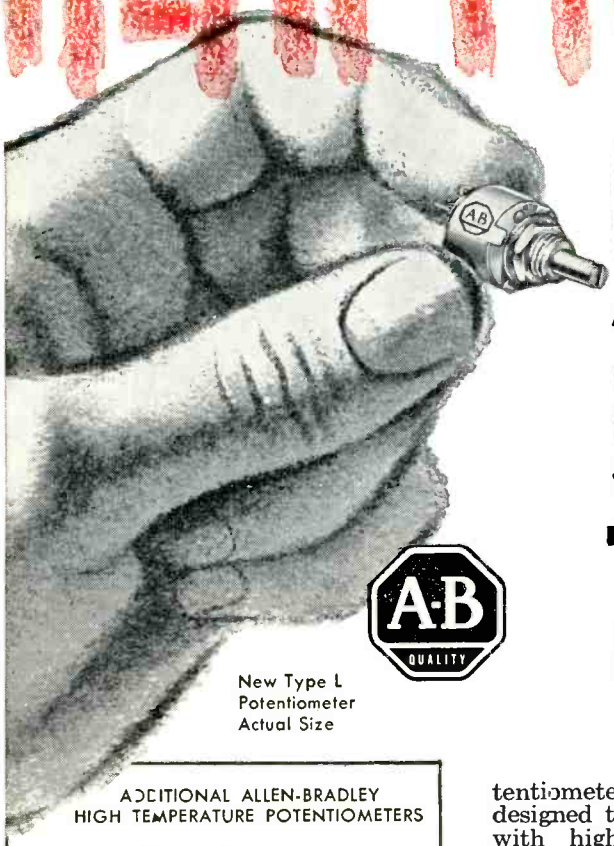


FIG. 6—Cathode bypass nomogram finds value of cathode bypass capacitance when cathode resistor and lowest frequency of interest are known

HEAT PROBLEMS?



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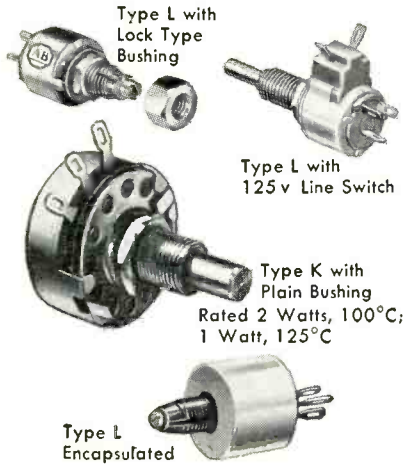

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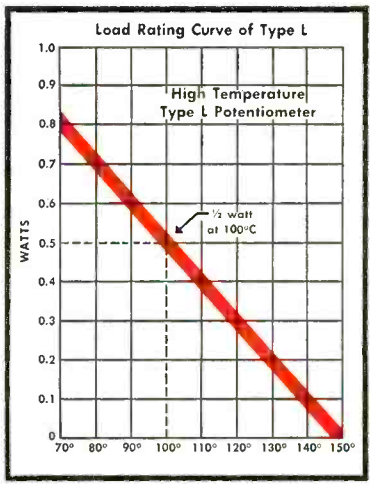
The new Type L control features the same solid, *hot molded* resistance element that has proved unequaled for long life, smooth operation, and low "noise" characteristic in Allen-Bradley's popular Type J, Type K, and Type G potentiometers. When temperature and space problems in your designs plague you, this new A-B "high temperature" potentiometer is a reliable answer. Please send for complete information, today.



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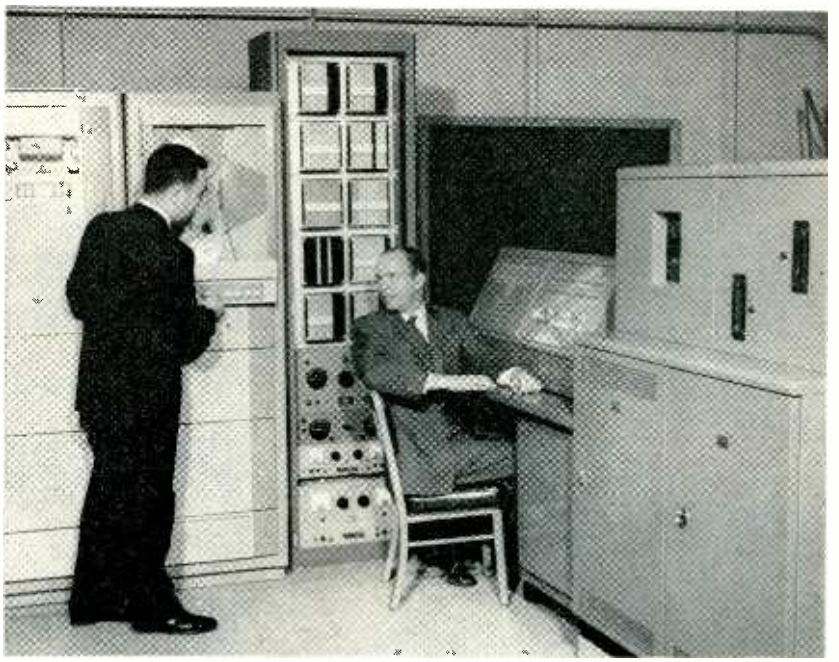
Pattern-Recognition Spurs Developments

FLEXIBLE scanner for studying pattern-recognition systems has been developed and put to work by Bell Telephone Labs. The research tool, in conjunction with a digital computer, can be used to study any logical pattern-recognition system that could be devised.

A new pattern-recognition system has also been invented at Bell. It uses a neuron-field system to transform complex patterns into simple patterns or dots.



Scanner for evaluating pattern-recognition systems includes program tape machine at left, logic unit, and at right of console, flying-spot light source and pickup unit

Scanning System

The scanner, described at the Western Joint Computer Conference, was developed as the most economical means to determine which of a variety of pattern-recognition systems could best achieve the ultimate goal, to feed visual information into machines without human intervention.

The device is suitable for scanning handwriting as well as various patterns, large or small, and has sensitivity to any two selected colors. A crt flying-spot light source scans the pattern to be studied. The scan is programmed to move from any given point on the pattern to any other point in 200 μsec, and then to succeeding points in the same constant time. Any path can thus be programmed into the scan.

The light source actually scans two areas at once—one containing the document under study, the other a blank piece of paper. Light reflected from a particular spot on the document is focused on a pair of multiplier photo tubes, each sensitive to a different color.

Meanwhile, light reflected from a corresponding spot on the blank paper in similarly focused on another pair of multiplier photo tubes. Outputs for each color are then subtracted, compensating changes in crt intensity, angles of reflection and multiplier photo tube sensitivity. This difference is then quantized into two intensity levels. A second color is particularly useful for providing position reference marks on the document.

The scanner has a resolution of 100 lines with 10,000 resolvable points and a scan field variable from $\frac{1}{8}$ in. sq to 3 in. sq. With magnetic tape input, it has a capacity of 60,000 instructions and can execute these instructions at a rate of 4,000/sec.

Output, which is also on magnetic tape, is compatible with a digital computer. First, the program for the scanner is written by the computer on tape. This reel is placed on the output tape machine, and the program is transferred directly to the program tape machine under control of a logic unit. During the scanning program, timing of the output tape is controlled by the program tape, so that although speeds of the tape machines may differ from each other and from the computer, the output tape will be compatible with the computer.

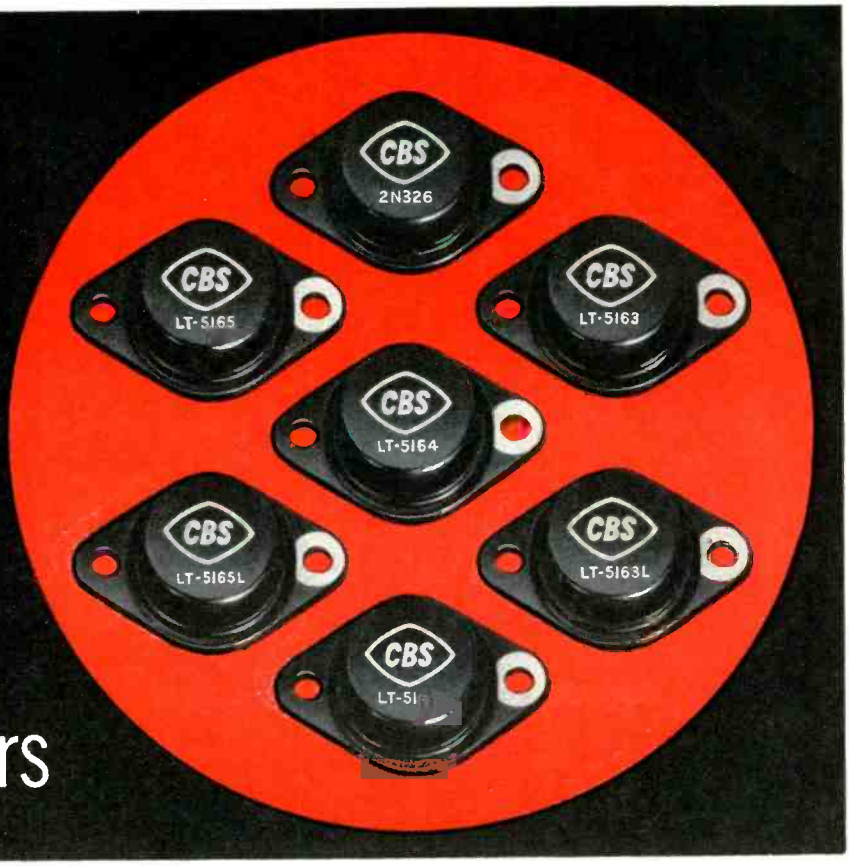
Before a pattern is scanned, a code identifying that particular pattern may be set into a toggle-switch pattern-identification register. This code is written on the output tape during scanning of the character and identifies it in later processing by the computer. Scan information also includes the quantized multiplier photo tube output information and the end-point coordinates for each scan segment.

Neuron-Net System

The pattern-recognition system is based on an array of neuron-like elements arranged in vertical and horizontal rows. The system can reduce line width, filter noise from the pattern or extract identifying features of the pattern, such as intersections and corners. It performs these translations without the usual bit-by-bit operations of a digital computer or the complex logic and storage circuitry of earlier spatial systems. Each of the neuron-like translation modules will take inputs from many sources.

Each module has a responsive element whose threshold can be varied according to the program. An array of individual sources of input information corresponds to the neuron array. In a typical connection, each input source has a connection to its corresponding neuron and also to each of the four

MY CUIT GN with new NPN power transistors



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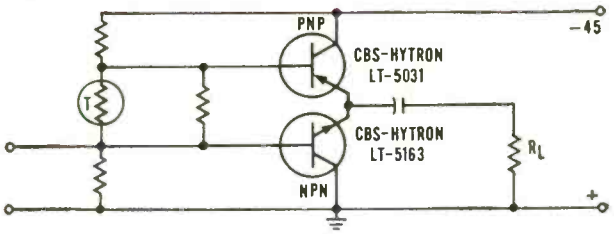
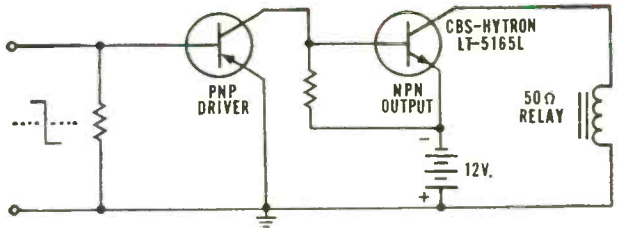
CBS-Hytron NPN power transistors are also intended for single-ended cascade output circuits, and three types are designed for use with inductive loads such as output transformers, motors and relays. The simplified direct-coupled circuits permit economies through elimination of components.



COMPLEMENTARY CLASS B AMPLIFIER



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FOR RESISTIVE-LOAD CIRCUITS						
2N326	7	35	35†	30	8	LT-5025
LT-5165	12	35	30‡	30	5	LT-5025
LT-5163	12	60	45‡	30	5	LT-5031
LT-5164	12	80	60‡	30	5	LT-5039
FOR INDUCTIVE-LOAD CIRCUITS						
LT-5165L	12	35	30φ	30	5	LT-5031
LT-5163L	12	60	45φ	30	5	LT-5039
LT-5164L	12	80	60φ	30	5	LT-5048

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

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sources that correspo
their nearest neighbors,
own corresponding input

In the case of the *T*, t
neuron to respond would b
one at the intersection of the h
zontal line with the vertical lin
Thus the *T* pattern is transformed into a single dot at the top center of the field, which could be used as a recognition feature for the *T*.

In a complete recognition operation, a sequence of similar spatial transformations is programmed. The revealed presence and absence of various features are recorded as bits in a features store. A set of these features provides a code that identifies the pattern.

Ultrasonics Produced At 10 Kmc

Waveguide that directs microwave pulses at a quartz crystal is adjusted by E. H. Jacobsen, who produced 10-kmc sound

SOUND WAVES with a frequency of 10 kmc have been produced at the General Electric Research Laboratory. The new ultrasonic frequencies will find their first applications in the laboratory in the area of solid-state research.

It is expected that the extremely high frequency vibrations will be used initially to investigate phenomena such as the energy levels of

atoms and the interactions of electron spins in a crystal lattice.

The new research tool may open new vistas for exploration and discovery beyond those seen at the moment. It may have many important uses in the study of solids, but science and technology will probably feel the greatest impact of this achievement through discoveries yet to be made with it.

The 10-kmc sound waves are created by combining techniques used in the propagation of microwave electromagnetic radiation with those of conventional ultrasonics. Microwave pulses are applied to a quartz crystal in a specially designed cavity-resonator device.

The crystal is kept at temperatures as low as 2 K to assist in keeping the ultrasonic vibrations from degenerating into vibrations associated with the heat content of the material. This unusual type heat barrier is one of the biggest problems in achieving higher and higher frequencies.

One-Watt Transistor Telemetry Transmitter

ALL-TRANSISTOR 20-mc telemetering transmitter, designed for possible use in space satellites, has been built by Philco for the U. S. Army. It weighs less than 10 ounces, is five inches in diameter and one inch high.

New Philco high-frequency power transistors are used to provide up to one watt of output power. This is in contrast to one to two hundredths watt from transistorized transmitters in present U. S. satellites.

The transmitter consists of three sections. One high-frequency power transistor is used in the crystal-controlled oscillator circuit. The power amplifier uses four transistors in parallel and provides a power gain of 8 to 10 db.

One transistor in the modulator is used as an audio amplifier and two in class B push-pull. Power gain of the modulator is in excess of 50 db. Modulation is applied to the collector of the r-f amplifier. Modulation frequency is 400 to 2,000 cps.

Vacuum-Diode Microwave Detection

By N. E. DYE, J. HESSLER, JR., A. J. KNIGHT, R. A. MIESCH and G. PAPP, ITT Laboratories,* Fort Wayne, Ind.

ATTENTION has been given in the past few years to the theory of microwave detection using hard vacuum diodes. In an attempt to verify the theory and to produce an efficient detector, several types of diodes were built.

In an attempt to concentrate the field near the cathode, coaxial-type diodes were constructed as shown in Fig. 1 and 2. The diode was excited by extending the center conductor into (Fig. 1) or across (Fig. 2) the input waveguide making a waveguide-to-coaxial transition.

To optimize design parameters, tubes were made with different inner and outer diameters. Also, the active length of the diode was varied.

Tube Designs

Cathodes were generally oxide-coated nickel tubing 0.060-in. in diam. A few tubes were made with 0.005-in. tungsten directly heated cathodes. In order to reduce r-f losses in the former type, a portion of tubing with high thermal resistance known as a heat bridge was used to isolate the active cathode from the remainder of the coaxial center conductor. The lower temperature of this major portion of the center conductor permitted it to be copper-coated. In addition, the anode was coated with either copper, silver or gold.

Finally, planar diodes were built and mounted in waveguide as shown in Fig. 3. The anode-cathode spacing was about 0.10 in. with a cross-sectional diam of 0.250 in.

Experimental Results

It was proved conclusively that detection of microwaves by hard-vacuum diodes was certainly possible. But the quality of detection did not compare with that of present-day crystals. In mixer applications, typical noise figures were near 50 db, conversion loss 35 db; in video detector applications, typical tangential sensitivities were near —25 dbm. These figures can be compared with crystal perform-

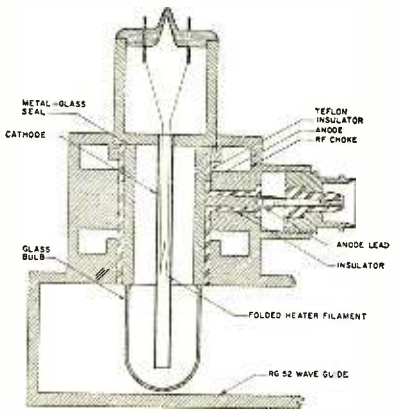


FIG 1—Probe-type cylindrical diode mount assembly

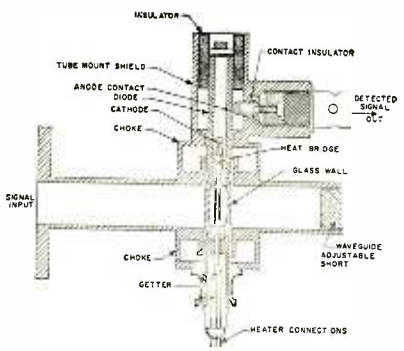


FIG 2—Crossguide diode and mount assembly

ances of 12 db, 6 db and —45 dbm for the corresponding quantities.

An attempt to correlate theory with experimental evidence led to the conclusion that the diodes failed to live up to expectations because of several factors. For example, microwave losses (mostly ohmic) were large so that Q was in the order of 100 rather than 1000 as expected. Diodes were noisier than anticipated with noise ratios increasing with bias current to an amount 10 to 20 times greater than anticipated.

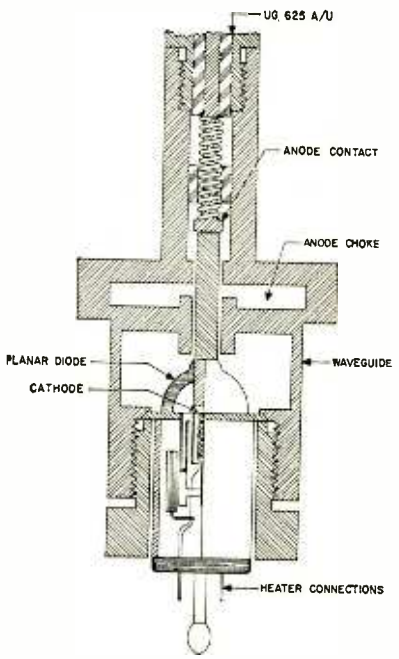


FIG 3—Planar diode and mount assembly

More research is required before definite conclusions can be reached regarding the explanation for low signal output. It is possible that different physical designs can produce higher Q's and hence large outputs for a given input.

The problem of noise is equally serious. The diode produces optimum output for large bias currents. However, the noise ratio of the diode increases with current. It is possible that a new design of the cathode, as well as the tube structure, would decrease tube noise permitting a better over-all signal-to-noise ratio.

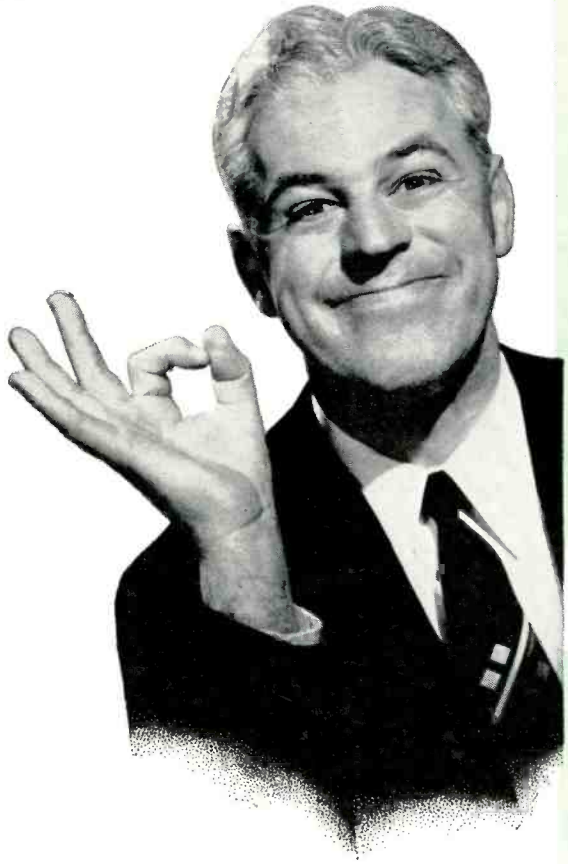
Work described in this article was supported by Rome Air Development Center under Contract AF30(635)-2863.

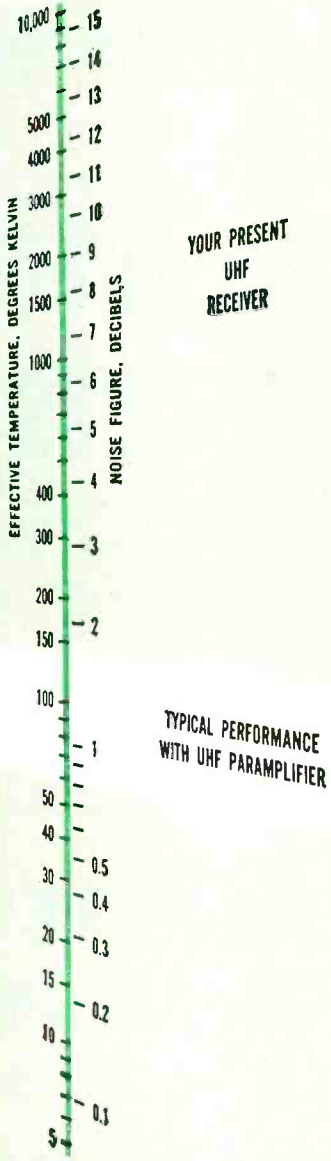
Molecular Electronics—Hope for the Future

ONE OF THE most interesting talks in the Component Parts Sessions

*Formerly Farnsworth Electronics

...looking for low noise at UHF?





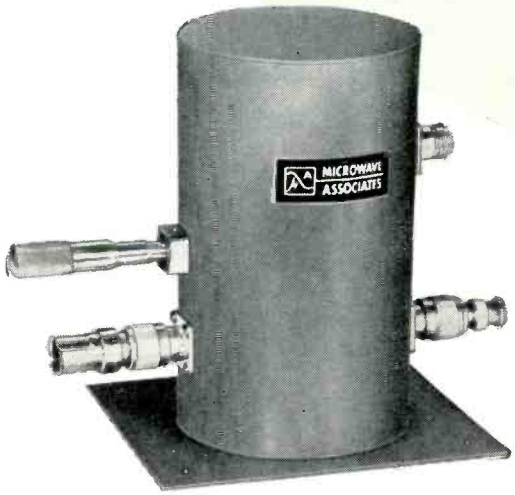
GET 4 to 14 DB IMPROVEMENT IN YOUR PRESENT RECEIVER!

. . . with Microwave Associates new compatible parametric amplifier

Simply inserting this new MA Paramplifier in your present antenna circuit provides you with immediate low noise preamplification from 100 to 1000 mcs.

The MA Paramplifier utilizes the new Microwave Associates silicon varactor diodes operating at room temperature in a negative resistance circuit to achieve these advantages:

- **Extremely low noise — less than 1 db (80°K)**
- **Gains of approximately 20 db**
- **Wide dynamic range**
- **Reduced cross modulation**
- **Bandwidths of approximately 1%**
- **Highly resistant to RF pulse burnout**



Write for additional information.

MICROWAVE ASSOCIATES, INC.
BURLINGTON, MASSACHUSETTS • BRowning 2-3000

at the recent IRE Convention was that of Col. C. H. Lewis, Director of Electronics, Air Research and Development Command, Andrews Air Force Base.

Col. Lewis' paper, "Trends of Things to Come," had as its theme the premise that we are at the beginning of a revolution in the concept of building electronic equipment. And the function of conventional components will be taken over by specially designed materials capable of performing single and multipurpose functions.

Problems with Components

Col. Lewis emphasized the following components problems and needs:

(1) Reliability of present-day components cannot meet future requirements even though these components have been improved greatly in some cases.

(2) Guided missiles should be 20 to 30 times more reliable than commercial gear such as tv sets.

(3) The human being is now the poorest component in an electronic system.

(4) Solar cells will really not come into their own until the number of heat dissipators in equipment is reduced.

(5) It should be our objective to design equipment with inherent dependability.

(6) Energy consumers should be eliminated wherever possible so that total dissipation is in milliwatts rather than watts.

(7) Population function per unit volume should be increased to about one-half million functions per cubic foot.

(8) The micro-miniaturization program is short of our ultimate goal in the final analysis.

(9) A fresh approach is needed with answers to such questions as, "Why does matter behave like it does?" and "How can we control this behavior?"

The Answer

The answer to these problems, according to Col. Lewis, seems to be with molecular electronics*. This is the concept of combining many active and passive circuit functions into a single, solid semi-

* Sometimes referred to as integrated molecular electronics

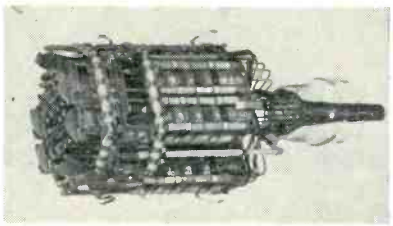
conductor package. Col. Lewis stated that the three principal advantages of this technique are that inherent reliability is probable; size and weight are reduced and much less power is required.

There is now a need for a new kind of engineer, Col. Lewis said, a molecular materials engineer. He would be a man concerning himself with such areas as fields, charges and molecular spin resonances. What will his problems be? Merely the development of materials with controlled impurities of one part in 10^{12}, for example, according to the Colonel. This control is needed if we are to be successful in our conquest of space, he stated further.

For more information on one electronic firm's activity in the molecular electronic area, see the item "Semiconductor Solid Circuitry", p 82, April 10. Air Force sponsorship of research in molecular electronics is discussed in this issue, p 38, in the story, "Circuits Shrinking Fast".

CRT Has Eight Independent Guns

EIGHT completely independent guns are contained within one envelope in a cathode-ray tube developed by 20th Century Electronics Ltd., Croydon, Surrey, England. All deflecting plates are brought out to



Electron gun assembly before sealing into the crt envelope

the same connections and brightness and focus can be varied independently on each gun.

Face diameter of the crt is six in. It is operated with a final anode potential of five kv and frequencies up to 100 kc can be displayed. The tube is fitted with a special 24-pin base and is being employed in applications where continuous recording of low-frequency is required.

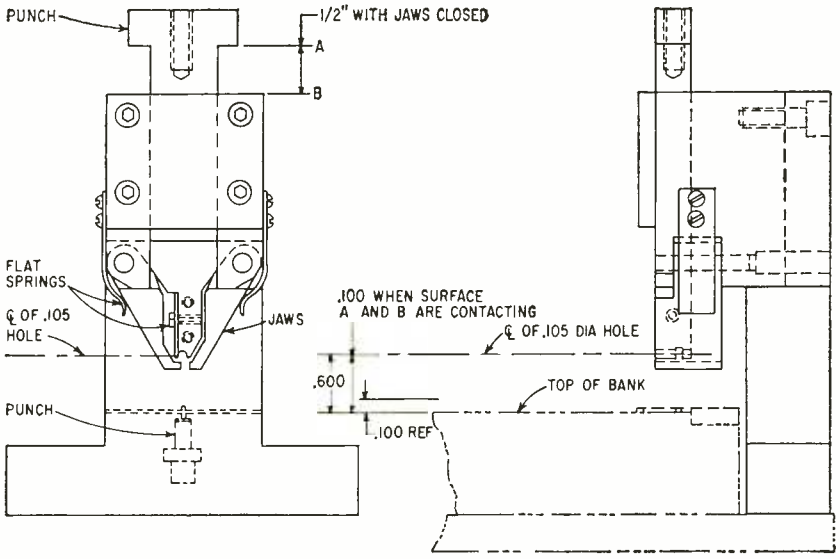
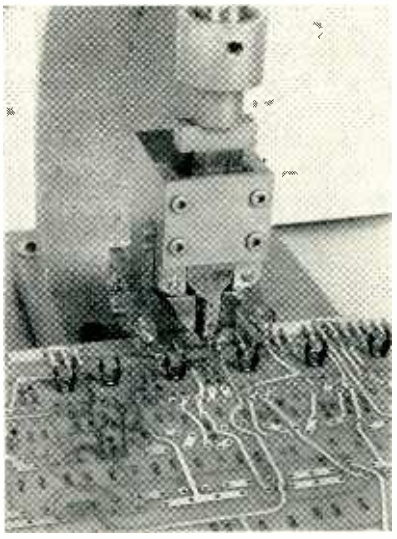


FIG. 1—Front and side views of upper punch mechanism in loading position



Hand-loaded press in use

Press Edge-Mounts Board Terminals

PUNCH PRESS which positions printed wiring board terminals, lines up the board with the terminals and mounts the terminals on the board edge is used at Arma Division, American Bosch Arma Corp., Garden City, N. Y.

The upper punch, shown in Fig. 1, is fastened to the ram of an air press with an adapter and stop to produce a ½ inch stroke. As the punch comes down through its housing, the stud broaches the board and is peened and the prong of the terminal slips into its board hole.

Terminals are loaded into the punch through a gap between the spring-mounted locator jaws. The stud fits into the gap, placing the terminal in mounting position.

As the punch descends to board level, its shoulders force open the locators. When the punch retracts, the flat spring permits the terminal to slip free while the other 2 flat springs close the locators.

The bed is bolted to the base of the press. A raised bank, which includes a strip guide for the board edge, runs the width of the bed's rear. The lower mechanism, seen in Fig. 2, is fitted into the center of the bank. The bed is 8 by 6 inches. A bar is mounted on its front edge to hold the board level.

Medium pressure springs are placed under the locating pin and lower punch. The pin projects to find the board hole and depresses as the terminal is inserted. The punch also projects in loading position, but a stop limits its travel.

Terminals used in the press are shown in Fig. 3. The air press is fitted with fingertip control valves. A vibratory feeder and board indexer may be used to automate the press.

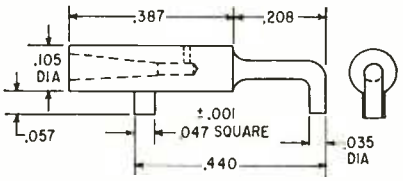
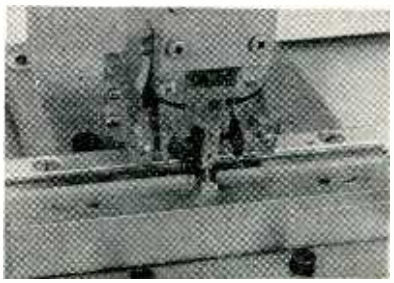


FIG. 3—Outline of edge-mounted terminals



Jaws have snapped open and press is in mounting position

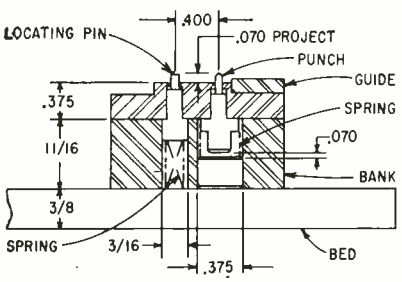


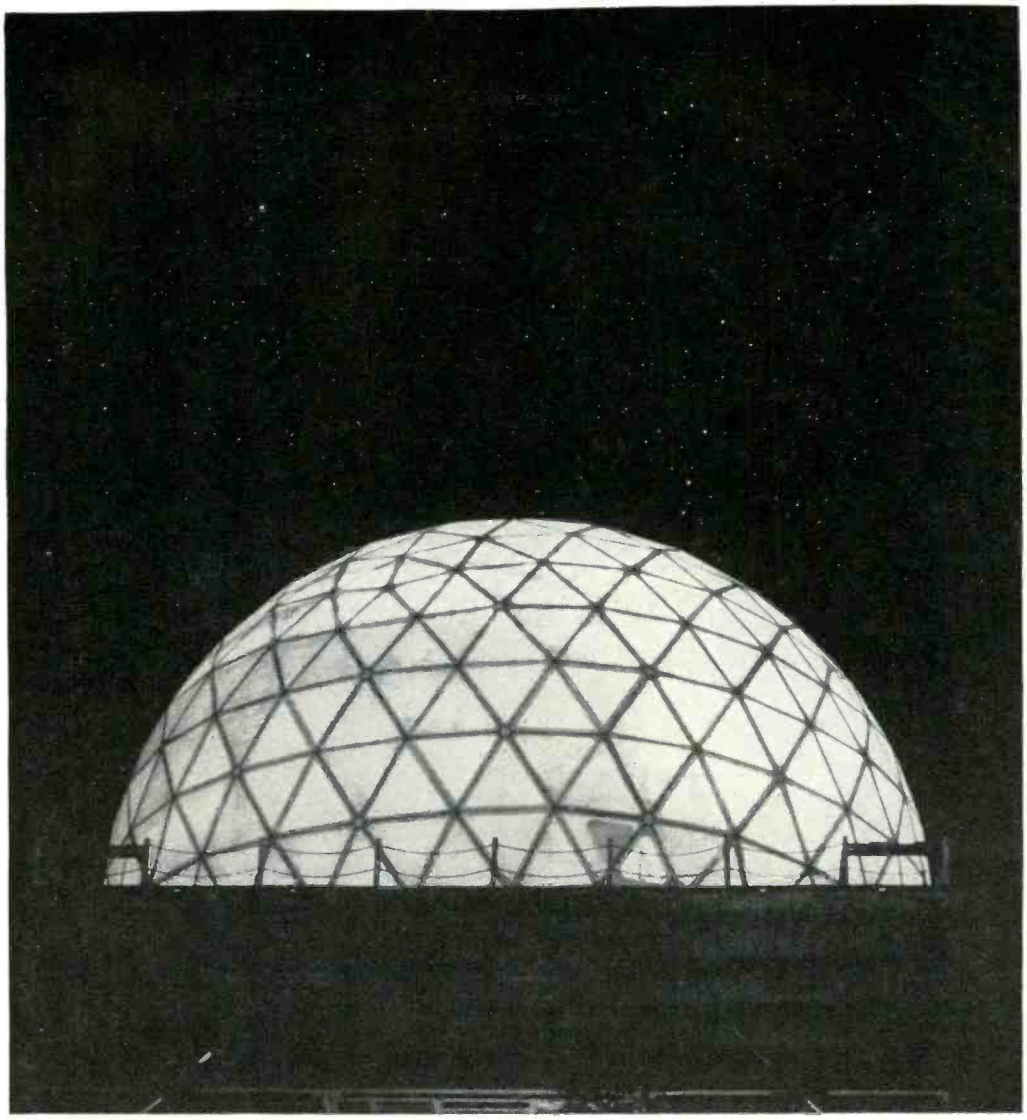
FIG. 2—Lower mechanism in loading position

Lazy Susan Brings 100 Wires into Easy Reach

LAZY SUSAN wire racks are used at Collins Radio Co., Cedar Rapids, Iowa, to facilitate cable building. They are used at the beginning of an operation, when many types of wires are needed and little connecting work is done. Each wheel of a rack holds about 100 types of precut wires.

Construction materials are aluminum, plain pipe and wood. The base is wood with a metal flange attached. A pipe flange is set into the metal and pipe is screwed into the pipe flange. The wheel is supported by 4 triangular spokes which are

THE ARCTIC EYE THAT NEVER SLEEPS



This plastic radome houses a radar antenna constantly scanning the skies to detect the presence of aircraft. A line of these radars provides early warning of any threatening approach to the North American continent.

The Distant Early Warning Line is now on perpetual guard duty. Spanning the Arctic from Baffin Island to Alaska, this great system was conceived at the Lincoln Laboratory of M.I.T. and produced under the leadership of Western Electric.

But first the DEW Line had to be engineered into a workable system. This was done at Bell Telephone Laboratories.

The obstacles were formidable. Conventional means of communication—telephone poles, cables and even line-of-sight microwave radio—weren't feasible. A complicated system had to be made to operate reliably in a climate so cold that outdoor maintenance is impracticable farther than a few hundred feet from heated habitation.

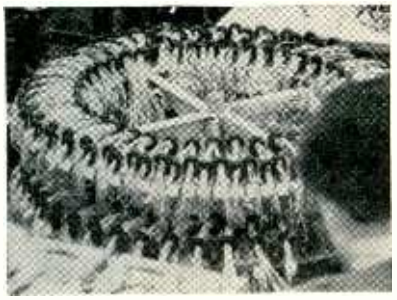
Whenever possible, Bell Laboratories engineers utilized well-proven art. But as it became necessary, they innovated. For example, they designed and directed the development of a new and superior radar which automatically scans the skies, pinpoints a plane and alerts the operator.

To reach around the horizon from one radar station to another, they applied on a massive scale a development which they pioneered—transmission by tropospheric scatter. Result: at a DEW Line Station you can dial directly a station more than a thousand miles away and converse as clearly as with your home telephone.

Bell Laboratories' contribution to the DEW Line demonstrates again how telephone science works for the defense of America.

BELL TELEPHONE LABORATORIES

WORLD CENTER OF COMMUNICATIONS RESEARCH AND DEVELOPMENT



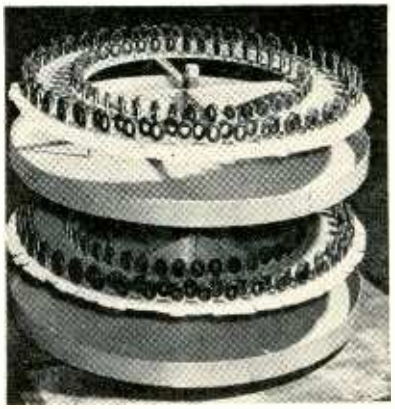
Rotating rack puts wires at working level in proper sequence

spotwelded to a sleeve. A circular tray fits under the wheel. The sleeve fits over the pipe so the wheel is free to turn. The pipe is capped.

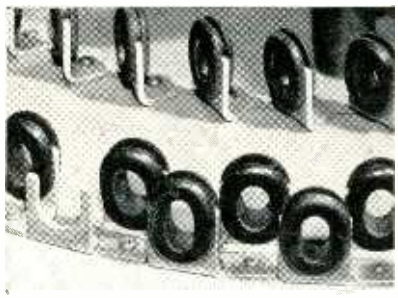
A second wheel can be placed on the same pipe. Washers between the sleeves enable each wheel to turn independently. More than 1 person can use the same wheel, but it is better to provide a second wheel.

The wires are held in plain rubber grommets. The grommets fit into half circles which are cut into metal forms mounted vertically around the rim. Grommet positions are overlapped to allow more positions on the wheel. Wire ends hang loose. Shorter wires hang down inside the wheel while longer wires tend to curl around the center sleeve without tangling.

Wires are preloaded into 2 rubber grommets and kept ready for placing on the racks as needed. The utility worker has only to push the grommets in place on the rim forms when a fresh supply of a wire type is needed. If the number of wires needed in a position is small, more than 1 type of wire can be loaded into the back grommet and the various wires run through 2 grommets on the outer rim.



Two wheels mounted on same rack. Wire identifications are written on tabs below grommets



Grommet arrangement. Grommet has been removed from form at left

Wires are arranged on the wheels in the order they will be used and the positions are numbered for identification. A tug as a wire is pulled from the grommets is sufficient to turn the wheel to the next station.

Use Weight to Measure Soft Material Parts

SEVERAL TECHNIQUES for inspecting and handling very small parts are used by semiconductor manufacturers. Among those of general interest are:

Accurate Specialties Co., Woodside, N. Y., uses weight and volume in checking dimensions of semiconductor alloying preforms. The method may also be used to inspect other flat parts made of compressible materials which would be deformed by pressure type gages.

Within-tolerance volume and weight of the part is calculated. Diameter is measured with filar microscope, optical comparator or suitable jig. If diameter is correct, the part is weighed. The weight indicates thickness.

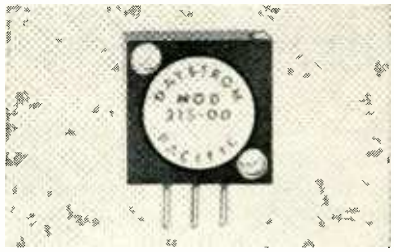
To check sizes of alloying spheres, samples are viewed through a filar microscope. Slides are quickly prepared by putting cellophane tape over a large metal washer and sprinkling the samples over the adhesive. After inspection, tape and samples are discarded.

To lift and position small parts without damage, a vacuum tip is used. This may be a glass tube through which air is exhausted. The hole at the pickup end is smaller than the part. The part is dropped in place when the vacuum is relieved by baring a finger hole in the side of the tube or by some similar method.

ON THE MARKET

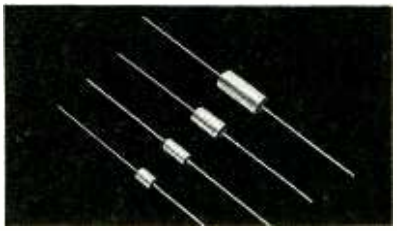
Potentiometers trimming type

DAYSTROM PACIFIC, 9320 Lincoln Blvd., Los Angeles 45, Calif. Series 315 printed circuit Squaretrim subminiature trimming potentiometers feature maximum density packaging. They can be stacked side by side on printed circuit board in areas of only 0.114 sq in. per unit. Increased length of winding provides up to twice the resolution of other trimmer designs. Friction-loading technique locks wiper in place after every adjustment. **Circle 190 on Reader Service Card.**

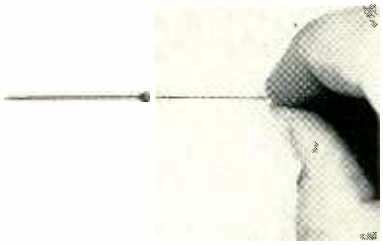


Tantalum Capacitor subminiature

FANSTEEL METALLURGICAL CORP., North Chicago, Ill. A new subminiature STA solid tantalum capacitor is available for applications requiring extremely small size,



higher capacitance and extended operating temperatures. The STA line can be supplied in ranges of 0.0047 to 330 μf, from 6 to 60 v (wvdc)—with maximum stability and reliability at temperatures ranging from −55 C to 125 C. **Circle 191 on Reader Service Card.**

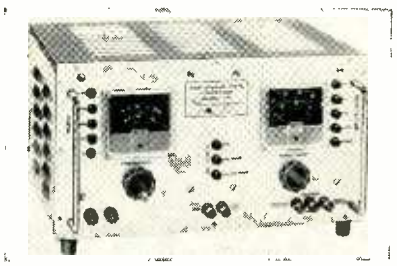


Regulator Diode gallium arsenide

TEXAS INSTRUMENTS INC., P. O. Box 312, Dallas, Texas, has available a new gallium arsenide regulator diode which extends semiconductor capabilities to a new high of 325 C. It can operate at double its power dissipation capability at normal ambient temperatures. Packaged in a hard-glass subminiature package the unit dissipates 800 mw at 25 C as compared to a maximum of 400 mw for a similar silicon unit in an identical case. The diode features a Zener breakdown voltage in the 11-v range and a low leakage current of 200 μa at 325 C. **Circle 192 on Reader Service Card.**

Generator sine/square wave

THE HICKOK ELECTRICAL INSTRUMENT CO., 10527 Dupont Ave,. Cleveland 8, Ohio. Both sine and square wave are now available in one generator, with coverage of 20 cps to 1 mc. The instrument is



adaptable to many uses in the fields of audio, high fidelity, acoustics, ultrasonics, power line and telephone line carrier, microwave subcarrier, i-f and broadcast carrier equipment or general laboratory applications. Price of the model 710 is $495. **Circle 193 on Reader Service Card.**

Test Unit read Zener voltage

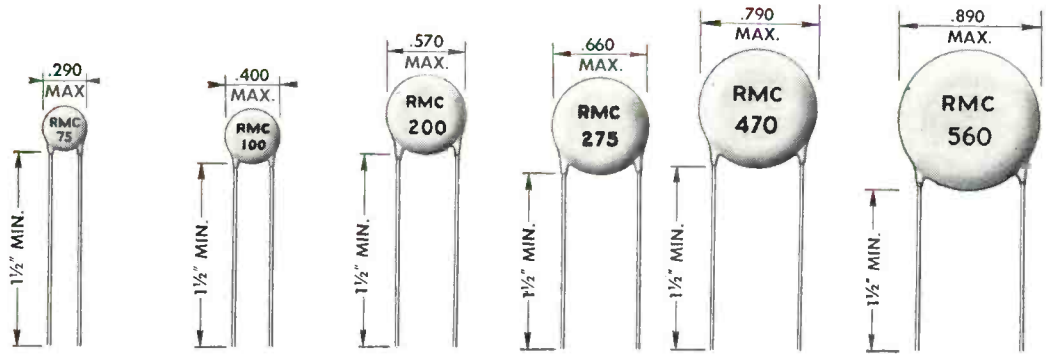
ELECTRONIC RESEARCH ASSOCIATES, INC., 67 Factory Place, Cedar Grove, N. J. Model DT100 Zener voltage tester is intended for both laboratory and factory measurement of Zener diodes, transistor breakdown voltage characteristics, semiconductor rectifiers and similar solid state elements. Zener current may be set at any value within the ranges 0-50 μa, 500 μa, 1 ma, 10 ma, 50 ma. Zener voltage range covers 0-1, 3, 10, 30, 300 v d-c. **Circle 194 on Reader Service Card.**

(Continued on p 120)

THE *PROVED* REPLACEMENT

for tubular ceramic and mica capacitors . . .

RMC DISCAPS



TC	1/4 Dia.	5/16 Dia.	1/2 Dia.	5/8 Dia.	3/4 Dia.	7/8 Dia.
P-100	1- 5 MMF	6- 10 MMF	11- 20 MMF	—	—	—
NPO	2-15	16- 33	34- 69	70- 85 MMF	86-115 MMF	116-150 MMF
N- 33	2-15	16- 33	34- 69	70- 85	86-115	116-150
N- 75	2-15	16- 33	34- 56	57- 68	69-125	126-150
N- 150	2-15	16- 33	34- 67	68- 75	76-140	141-200
N- 220	3-15	16- 33	34- 75	76-100	101-140	141-200
N- 330	3-15	16- 47	48- 75	76-100	101-150	151-200
N- 470	3-20	21- 51	52- 80	81-120	121-200	201-250
N- 750	5-30	31- 75	76-150	151-220	221-300	301-470
N-1500	10-56	57-120	121-220	220-300	300-470	471-560
N-2200	20-75	76-150	151-200	201-300	301-680	—

Temperature coefficients up to N-5200 available on special order.

SPECIFICATIONS

POWER FACTOR: Over 10 MMF less than .1% at 1 megacycle. Under 10 MMF less than .2% at 1 megacycle

WORKING VOLTAGE: 1000 V.D.C.

TEST VOLTAGE (FLASH): 2000 V.D.C.

CODING: Capacity, tolerance and TC stamped on disc

INSULATION: Durez phenolic-vacuum waxed

INITIAL LEAKAGE RESISTANCE: Guaranteed higher than 7500 megohms

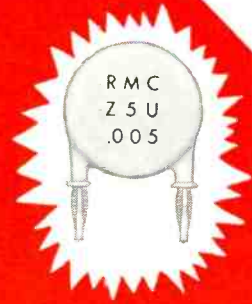
AFTER HUMIDITY LEAKAGE RESISTANCE: Guaranteed higher than 1000 megohms

LEADS: No. 22 tinned copper (.026 dia.)

TOLERANCES: ±5% ±10% ±20%

These capacitors conform to the E.I.A. specification for Class 1 ceramic capacitors.

The capacity of these capacitors will not change under voltage.



Leading manufacturers of electrical and electronic products have proved by their continued use that Type C DISCAPS replace tubular ceramic and mica capacitors at lower cost.

Type C DISCAPS are available for varied applications in a wide range of capacities and temperature coefficients. These capacitors feature smaller size, lower self inductance, and greater dielectric strength. Rated at 1000 working volts, Type C DISCAPS assure trouble-free performance and cost no more than ordinary 600 volt capacitors. Specify Type C DISCAPS for your product, their many mechanical and electrical advantages combine with a lower initial price permitting substantial production cost reductions.

. . . also available with Fin-Lock Leads for printed wire boards

DISCAP CERAMIC CAPACITORS

rmc

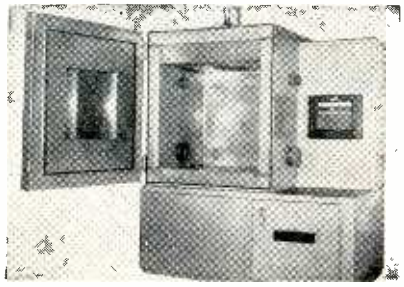
RADIO MATERIALS COMPANY

A DIVISION OF P. R. MALLORY & CO., INC.

GENERAL OFFICE: 3325 N. California Ave., Chicago 18, Ill.

Two RMC Plants Devoted Exclusively to Ceramic Capacitors

FACTORIES AT CHICAGO, ILL. AND ATTICA, IND.

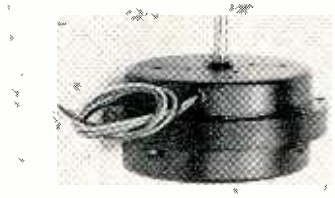


Test Chamber
30 cu ft

CONRAD, INC., 141 Jefferson St., Holland, Mich. Model FB-30-5-5 is a high low temperature test chamber with a range of +300 F to —100 F. Interior dimensions are 40 in. wide by 38 in. high by 36 in. deep. Standard equipment on the chamber include a 24 in. by 24 in. multipane viewing window, externally mounted ball bearing circulator motor, and an electrical panel equipped with two 3 hp, two 5 hp, or two 7½ hp refrigeration units, depending upon the user's requirements. **Circle 195 on Reader Service Card.**

Standard Resistors
four values

MID-EASTERN ELECTRONICS, INC., 32 Commerce St., Springfield, N. J., offers a line of certified laboratory standard resistors for use with the company's Megatrometer in measuring resistance in the ultra high megohm range. Standard resistors are available in four values: 10 megohms, 100 megohms, 1,000 megohms and 10,000 megohms. Each unit is certified to 0.2 percent and is supplied with a temperature curve. Prices range from $72.00 to $133.75 each. **Circle 196 on Reader Service Card.**



Hysteresis Motor
split-capacitor

DALE PRODUCTS, INC., Columbus, Neb. The Dalohm subfractional h-p hysteresis motor is a split-capacitor

K (STANDARD)

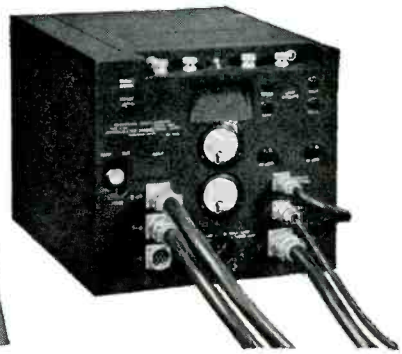
For Aircraft, Electronic, Instrument, Military, Missile, Industrial and Commercial Applications.

Standard K and RK...in straight and angle 90° plugs, wall mounting receptacles. Conduit and clamp entry types. 1 to 82 contacts in 213 different insert arrangements. 10-, 15-, 30-, 40-, 60-, 80-, 115-, and 200-amp. silver-plated brass contacts. High quality phenolic, melamine, and formica insulators. Cadmium-plated aluminum alloy shells. Flashover voltages: 1100 to 5000v 60cps ac rms.

connect with CANNON PLUGS

APPLICATION

Application of R and RK connectors on a recording oscillograph.



original aircraft, electronics, sound, and all-purpose line

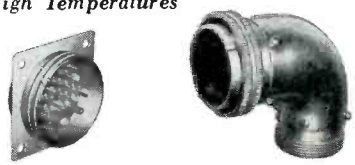
KH, RKH
(HERMETICALLY SEALED)

For Use Under Critical Pressure and Leakage Conditions

Hermetically sealed connectors... with steel shells, steel contacts, and Can-seal glass insulators, fused to shell and contacts. *True hermetic sealing.* Electro tin plating over cadmium plate over copper flash provides highly receptive surface for soldering and corrosion resistance.

STEEL SHELL FIREWALL

For Open Flame Protection Against High Temperatures



FW and FWR Cannon K Firewall Connectors... available in straight and angle 90° plugs, wall mounting receptacles. Inserts of phenolic or fireproof inserts of glass-filled materials. Crimp type contacts. Cannon made the first firewall connector and continues the leader in this important field.

RECORDER CONNECTOR

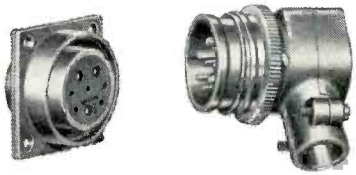
For Telephone "Beeper" Connectors

SK-M7-21C...Widely used on two leading makes of telephone recorded connector units known as "beepers" because of the signal required by law in such recordings.

special acme thread • rugged construction • variety of coaxials • integral clamps

RK
PLUG AND RECEPTACLE

For Flush or Semi-Flush Mounting



RK plug and pin assemblies are equipped with an external threaded coupling nut which is the reverse of the standard K series. Note, RK will not mate with K's.

RLKL and LKL
(TV SWITCHING PANEL)

For TV Panel Switching

Quick Connect and Disconnect RLKL Plugs... designed for one-hand fast disconnect use on TV station program switching panels. Feature a quick coupling means. Latchlock secures plug to mated fitting (RLKL receptacle). Thumb pressure releases it.

K ACCESSORIES

Straight and Angle 90° Junction Shells, Dust Caps, Bonding Rings, Gland Nuts, Clamps, Dummy Receptacles

Featuring High Quality Materials and Workmanship... Junction shells are designed to protect, shield, and carry wires through walls, panels or bulkheads to conduit. Dummy receptacles hold and protect plugs when not in use.

cannon plugs • standard of quality for the industry

TBF-K

For Carrying Circuits Through Bulkheads

TBF-K Bulkhead Connectors... feature a double-faced construction *allowing mating at both ends.* Pin inserts. Single piece shell. Five insert assemblies available.

Other Cannon Series... Mil. Spec. "MS" (full line)—External Power Connectors—Switching Types—dc Solenoids—Guided Missile Launching Connectors—Miniatures and Sub-Miniatures.

Please Refer to this Magazine or to Dept. 120

See "K" Bulletin for Engineering Data.

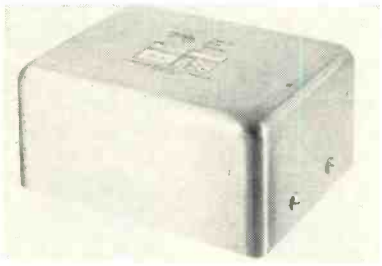
CANNON ELECTRIC

CANNON PLUGS

Where Reliability for Your Product Is Our Constant Goal

CANNON ELECTRIC COMPANY, 3208 Humboldt St., Los Angeles 31, California. Factories in Los Angeles; Salem, Massachusetts; Toronto, Canada; London, England; Melbourne, Australia. Manufacturing licensees in Paris, France; Tokyo, Japan. Contact our representatives and distributors in all principal cities. See your Telephone Yellow Book.

type. Totally enclosed it has a new space-saving pancake design giving great rigidity. It is ideally suited for such applications as facsimile machines, hi-fi turntables, tape recorders, telemetering and many other types of equipment where constant synchronous speed is essential. An outstanding feature is the exceptionally low heat rise. Other notable features are extremely low noise and no vibration or magnetic strays. It is low in cost due to advanced design and production techniques. **Circle 197 on Reader Service Card.**



Power Supply transistorized

SOUTHWESTERN INDUSTRIAL ELECTRONICS CO., 10201 Westheimer, Houston, Texas. The TPC-15 transistorized power supply is specifically designed for airborne use. It features a novel bridge-transistor circuit using low-voltage transistors to deliver 300 v d-c at 150 ma, or 150 v d-c at 300 ma from the aircraft 28 v d-c battery source. Regulation is better than 5 percent over the entire output range—no load to full load—and efficiency is better than 85 percent. Output is virtually free from ripple and noise. **Circle 198 on Reader Service Card.**

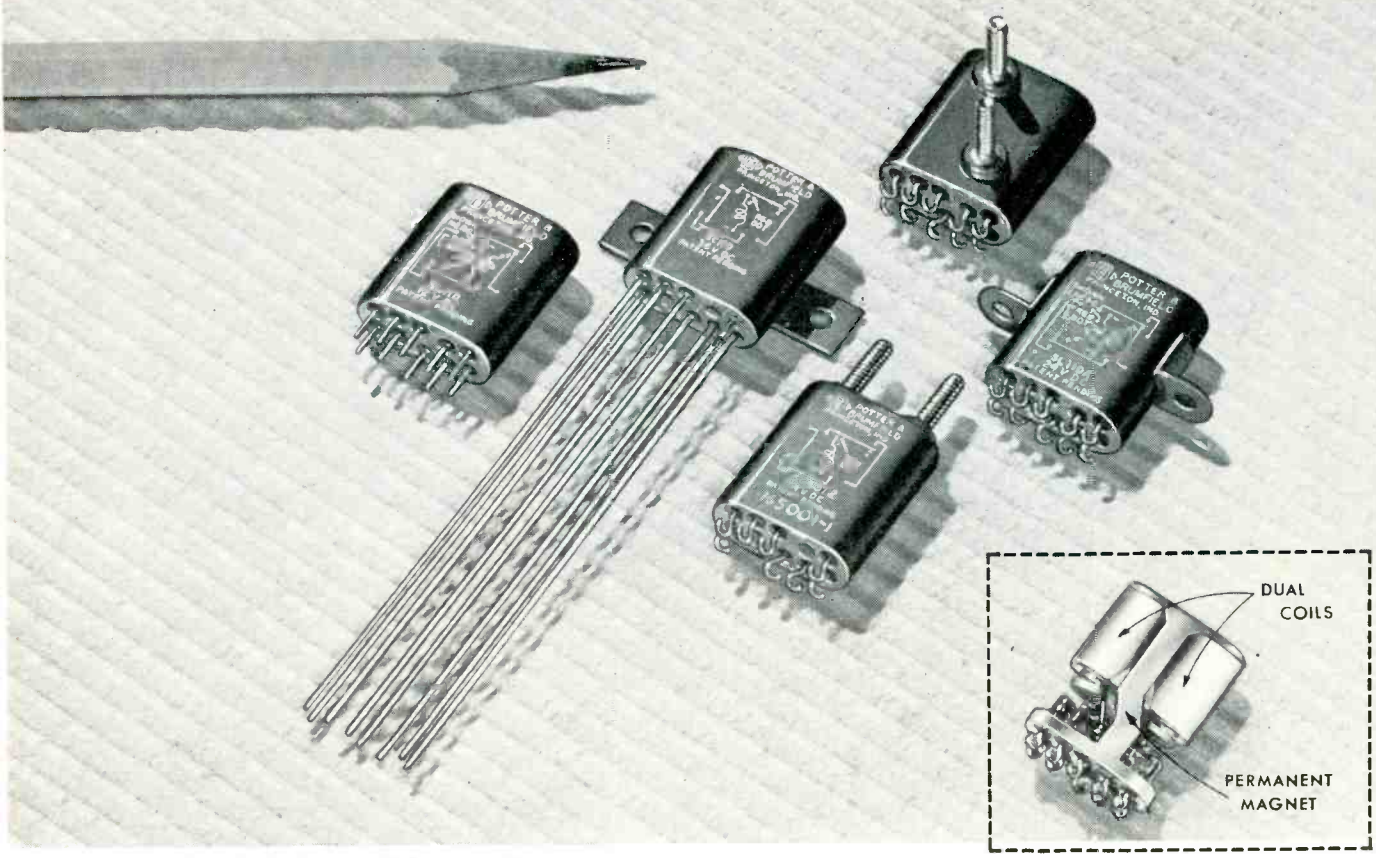
L-F Oscillator variable phase

GENERAL RADIO CO., 275 Massachusetts Ave., Cambridge 39, Mass. Type 1305-A oscillator covers frequencies from 0.01 cps to 1,000 cps in five ranges. Output amplitude

P&B MICRO-MINIATURE RELAYS LEAD IN

performance

SHOCK: 100g* VIBRATION: 30g to 2000 cps*

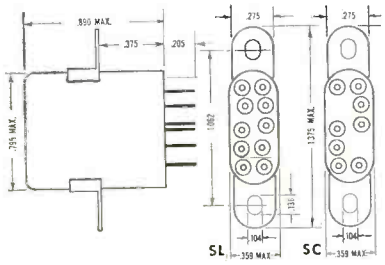


*NO CONTACT OPENING

New P&B crystal-case size relays, the SC and the SL (magnetic latching), show amazing shock and vibration capabilities. They absorb shocks of 100g and vibrations 30g to 2000 cps. without contact openings!

A highly efficient magnetic structure utilizing a permanent magnet makes possible at least twice the contact pressure found in DPDT relays of comparable size. One watt of power for three milliseconds operates either relay. Transfer time is unusually fast —0.5 milliseconds maximum.

For more information, contact your P&B sales engineer, or write Potter & Brumfield, Princeton, Indiana.



SL—dual coil latching relay. Operates on a 1 watt, 3 ms. pulse at nominal voltage. Permanent magnet latch locks the armature in either position.

SC—non-latching relay with series-connected dual coils. Operates on approximately 1 watt at nominal voltage. Coils must remain energized to hold the armature in the operate position.

SC and SL Series Engineering Data

GENERAL:
Insulation Resistance: 10,000 megohms, min.
Breakdown Voltage: 1,000 V. RMS.
Shock: 100g.
Vibration: 30g 55 to 2000 cps.; 0.195" max. excursions from 10-55 cps.
Temperature Range: —65° C. to + 125° C.
Weight: 15 grams without mounting bracket.
Operate Time: 3 MS. max. with 550 ohm coil @ 24 V. DC. (SL: 630 ohm coil at 24 V. DC).
Transfer Time: 0.5 MS max.
Terminals: (1) Plug-in for microminiature receptacle of printed circuit board.
(2) Hook end solder for 2 #24 AWG wires.
(3) 3" flexible leads.
Enclosure: Hermetically sealed.

CONTACTS:
Arrangement: 2 Form C.
Material: Optional
Load: 2 amps. @ 28 V. DC, resistive; 1 amp @ 115 V. 60 cycles AC, resistive.
Pressure: SC—16 grams min.; SL—20 grams min.

COIL:
Power: Approx. 1.0 watt at Nominal Voltage.
Resistance: SL—40 to 10,000 ohms; SC—35 to 20,000 ohms.
Duty: Continuous.

MOUNTINGS:
Bracket, stud and plug-in.

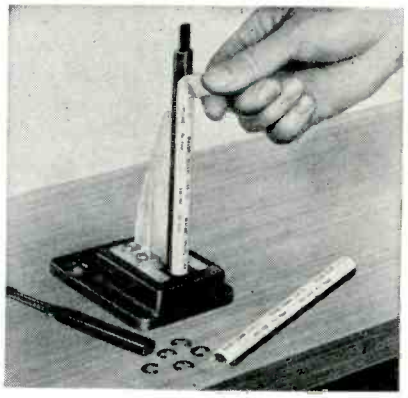
P&B STANDARD RELAYS ARE AVAILABLE AT YOUR LOCAL ELECTRONIC PARTS DISTRIBUTOR

AMF

POTTER & BRUMFIELD INC.

PRINCETON, INDIANA • SUBSIDIARY OF AMERICAN MACHINE & FOUNDRY COMPANY

is essentially constant over the entire range. Unit features three-phase, four-phase and single-phase output. Additional output is continuously variable in phase from 0 to 360 deg and can be used for accurate phase shift measurements at low frequencies. Use of a six-phase rectifier in the output meter circuit makes accurate readings of output voltage possible even at lowest frequencies. **Circle 199 on Reader Service Card.**



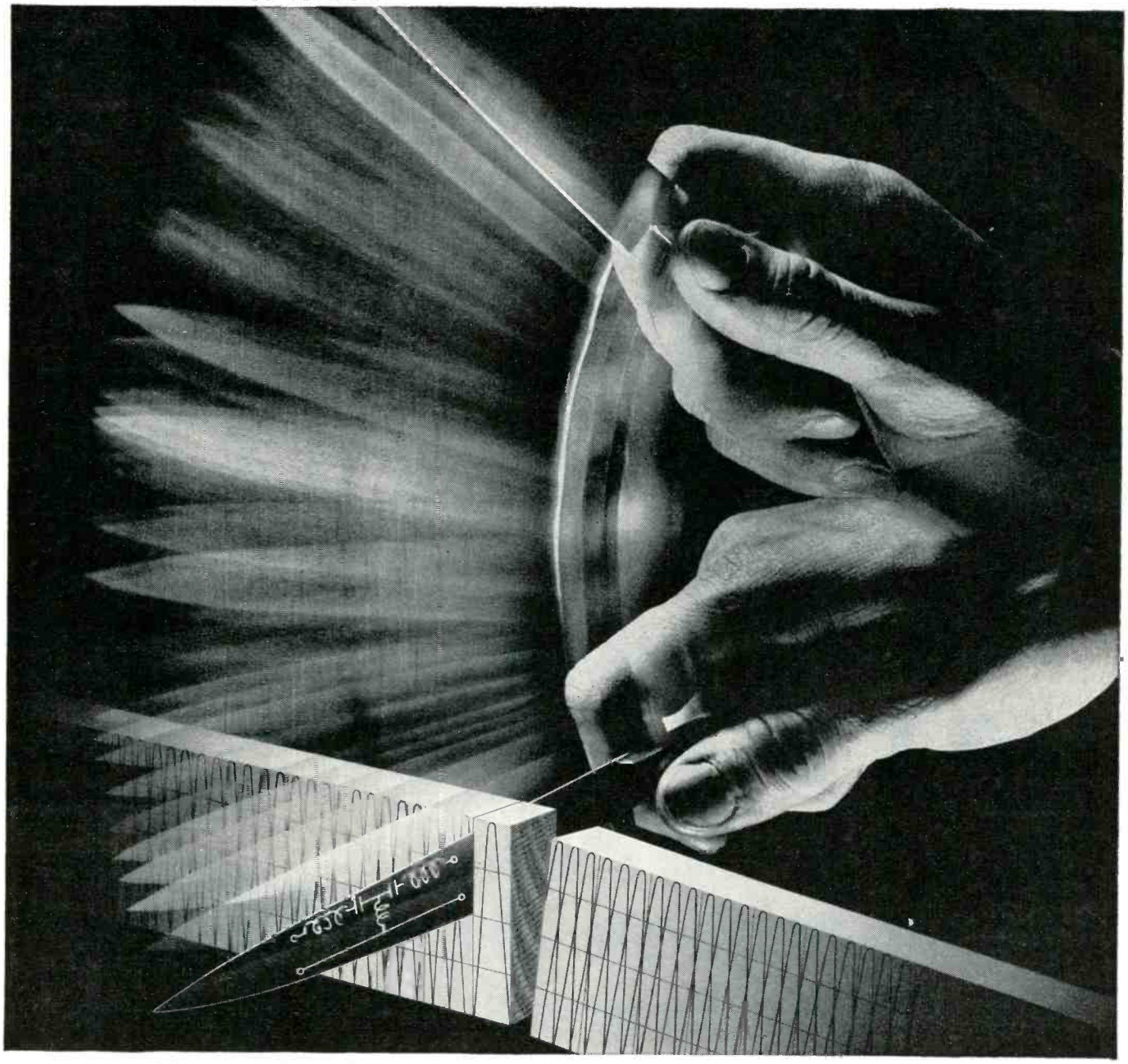
Tape Wrapper for retaining rings

WALDES KOHINOOR, INC., 47-16 Austel Place, L. I. C. 1, N. Y., has developed the Rol-Pak, a pressure sensitive tape wrapper which replaces a metal stack-rod and cotter pin formerly used to stack Truarc retaining rings for assembly with the company's applicators and dispensers. The tape is color coded by ring type and, for further identification, bears both the ring series and size number. Rings are loaded into the dispenser by sliding the entire Rol-Pak over the spring rail and permitting the pack to slide down to the base. The tape extension at the top permits the wrapper to be removed in a single downward motion. **Circle 200 on Reader Service Card.**

Tritiated Titanium high density

RADIATION RESEARCH CORP., 1114 First Ave., New York 21, N. Y. Thin films of tritiated titanium on stainless steel or molybdenum are now available. Material consists of a titanium coating approximately 0.7 micron in thickness on a 2 mil back-

PUTTING MAGNETICS TO WORK



How to keep your cut-off sharp!

Audio filter designers use molybdenum permalloy powder cores when they want razor sharp attenuation that will hold

Audio filter designers, faced with a crowded frequency spectrum, specify molybdenum permalloy powder cores to rigidly define channel cut-offs . . . with sharp, permanent attenuation at channel cross-overs.

Moly-permalloy, with virtually no resistive component, makes a core with almost no core loss. The resultant high Q means sharp attenuation of blocked frequencies in both the high and low band pass ranges. This is permanent—moly-permalloy cores were developed specifically to provide a very long term inductance stability.

Compare molybdenum permalloy to powdered iron. See the smaller size and the superior stability despite unusual fluctuations in current or temperature. Even unstabilized permalloy powder cores are more stable with temperature swings than cores made of any other material. And . . . stabilized cores are at least four times more inductance-stable than unstabilized cores.

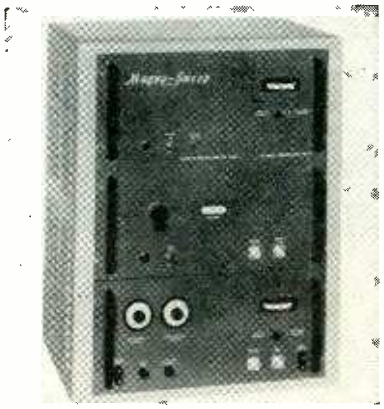
What's more, there's no longer any guesswork! We have published limits within which the designer can depend on core performance. These limits—and full information on our Performance-Guaranteed permalloy powder cores—await your inquiry. *Magnetics, Inc., Dept. E-61, Butler, Pa.*

MAGNETICS inc.

ing and containing 1 curie of tritium per sq in. It is completely stable in normal atmospheres, and is not appreciably affected by immersion in solvents or water or by exposure to acid fumes. The material produces ion current in excess of 10^{-7} amperes per sq in. in air and absolute beta emissions greater than 10^{-9} amperes per sq in. **Circle 201 on Reader Service Card.**

Molded Capacitors dual-dielectric

SPRAGUE ELECTRIC CO., 35 Marshall St., North Adams, Mass., has in production molded capacitors using a dual-dielectric of both polyester film and paper. Unique properties and advantages are completely described in engineering bulletin No. 2025, available on letterhead request.



Sweeping Oscillator wide range

KAY ELECTRIC CO., 14 Maple Ave., Pine Brook, N. J. The Magna-Sweep is an all-electronic sweeping oscillator capable of sweep widths of 1,000 mc and wider. It enables the user to get extremely broad coverage without once changing his setting. This beat frequency device employs the latest in h-f techniques and provides both continuously variable center frequency and sweep width. Frequency calibration is ob-

GENERAL TRANSISTOR

another

QUALITY PRODUCT
FROM GENERAL TRANSISTOR.

ACTUAL SIZE

new complete line of

GERMANIUM GOLD BONDED DIODES

GENERAL TRANSISTOR IS NOW MAKING GERMANIUM SUBMINIATURE GOLD BONDED DIODES

You may be assured that this new product line has the same high quality and reliability that has made General Transistor the Fastest Growing Name in Transistors. Experienced design engineers, quality materials, proven production techniques, and strictly enforced quality controls are your guarantees.

These diodes have been designed for computer, industrial and military applications where high reliability is of prime importance. They are hermetically sealed in a glass case with tinned leads. Their rugged construction makes them resistant to humidity, shock and vibration, and impervious to extreme environmental conditions.

Write today for Bulletin GD-10 showing complete specifications, diagrams and other engineering data.

GENERAL TRANSISTOR
C O R P O R A T I O N

91-27 138th Place
Jamaica 35, N. Y.

FOR IMMEDIATE DELIVERY FROM STOCK, CONTACT YOUR NEAREST AUTHORIZED GENERAL TRANSISTOR DISTRIBUTOR OR GENERAL TRANSISTOR DISTRIBUTING CORP. 91-27 138TH PLACE, JAMAICA 35, NEW YORK. FOR EXPORT: GENERAL TRANSISTOR INTERNATIONAL CORP. 91-27 138TH PLACE, JAMAICA 35, NEW YORK

tained by a unique system of frequency markers plus a precision wavemeter. **Circle 202 on Reader Service Card.**

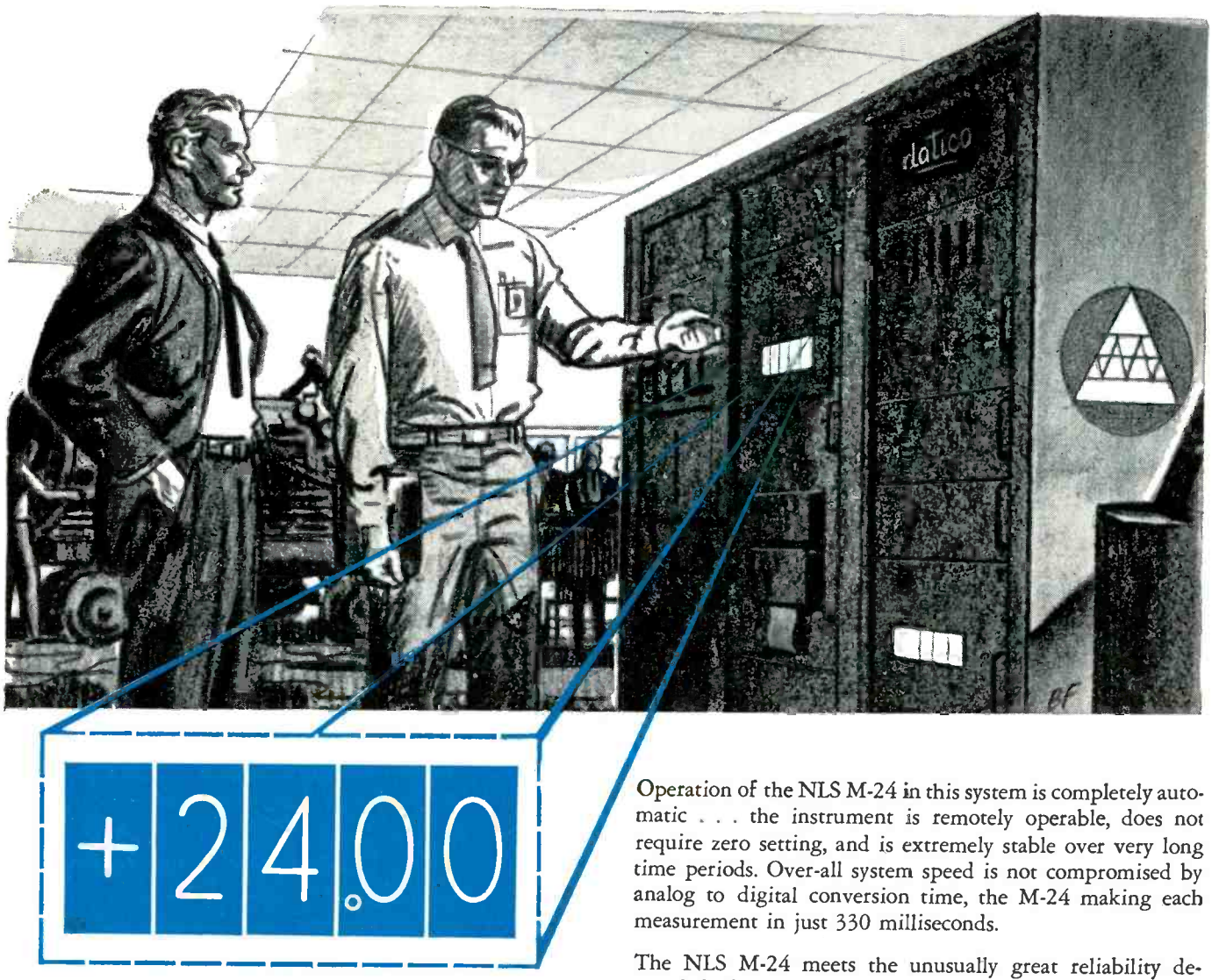
Miniature Jack
flat-mount

SEALECTRO CORP., 610 Fayette Ave., Mamaroneck, N. Y., has developed a miniature jack that mounts flat against a printed-wiring board, type SKT-103PC. With a double-prong steel strap in front, and connection lug at rear, this jack mounts in three small holes forming a triangle in a grid coordinate layout. It is dip-soldered from the underside of the board for mechanical and electrical requirements. Jack takes an 0.080 in. probe with no strain on the contacts because of the self-aligning Teflon hole. **Circle 203 on Reader Service Card.**

Klystron Supply
wide-range

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

Transistorized NLS M-24 Selected for Missile Checkout System



Analog to digital conversion in Nortronics' Universal Datico is accomplished by the ultra-reliable NLS M-24, the transistorized Digital Volt-Ohmmeter that automatically and accurately measures and displays AC and DC voltages, voltage ratio and resistance.

In Datico, program control is performed by a punched paper tape. Test stimuli are automatically controlled by Datico and output signals (voltage, voltage ratio, and resistance) from the system under test are automatically selected and fed to the NLS M-24. The M-24 digitizes the system outputs to 0.01%, and provides numerical data to the indicator and control chassis for distribution to the data recorder, digital comparator, and visual display on a special NLS in-line readout.

The tape also establishes the go-no-go limits for comparison with the M-24's digital output. It then directs the system to the next channel to be measured.

Operation of the NLS M-24 in this system is completely automatic . . . the instrument is remotely operable, does not require zero setting, and is extremely stable over very long time periods. Over-all system speed is not compromised by analog to digital conversion time, the M-24 making each measurement in just 330 milliseconds.

The NLS M-24 meets the unusually great reliability demanded of automatic test equipment for modern electronic weapons systems. This reliability is assured by transistors, mercury-wetted contact relays (rated at 10 billion measurements), advanced circuit design, and thorough production and field testing.

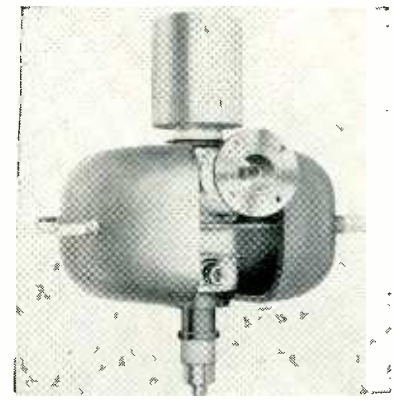
Proved in the field in a variety of applications, the NLS M-24 Digital Volt-Ohmmeter is in production and ready to go to work for you. Write today for detailed information concerning this outstanding example of NLS leadership in the development and manufacture of digital instruments. A complete catalog of NLS instruments will be sent upon request.

Originators of the Digital Voltmeter

non-linear systems, inc. DEL MAR (San Diego), CALIFORNIA

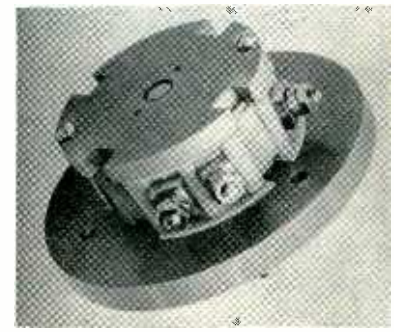
NLS—The Digital Voltmeter That Works...And Works...And Works!

on transferring from negative to positive grid voltage; and external triggering of internal pulse generator. **Circle 204 on Reader Service Card.**



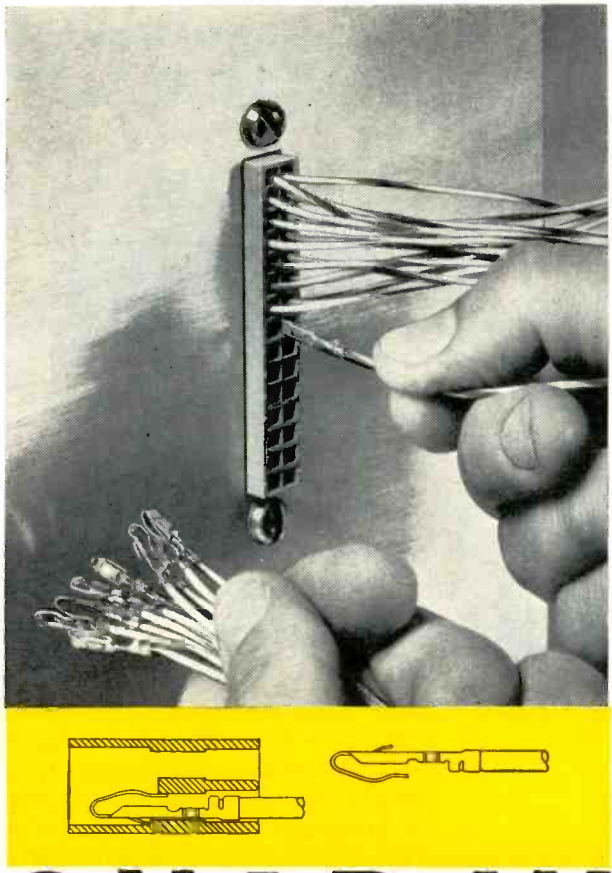
Amplifier Klystron air-cooled

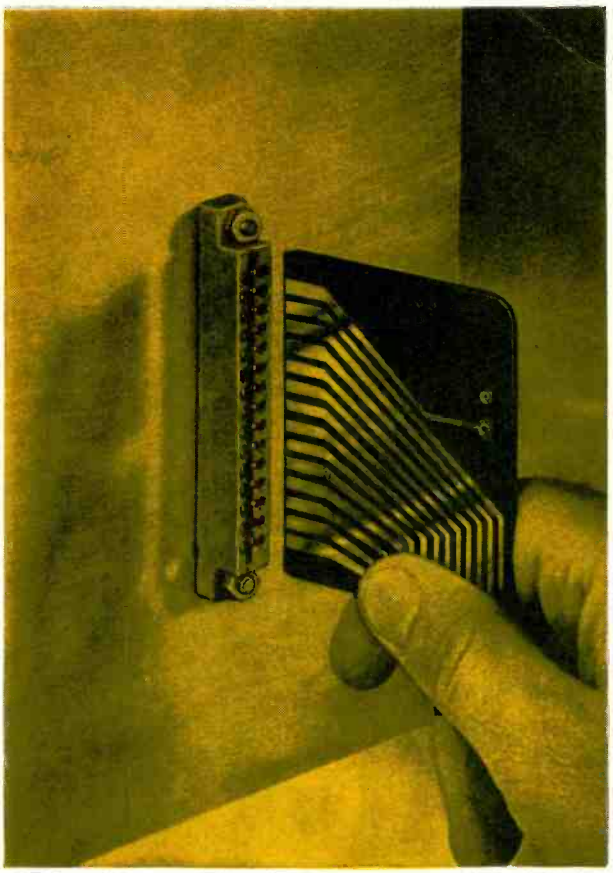
VARIAN ASSOCIATES, 611 Hansen Way, Palo Alto, Calif. The VA-802 is a 1 kw c-w, air-cooled, 4-cavity klystron. It can be continuously tuned from 1,700 to 2,400 mc and is focused with a permanent magnet. It has been designed specifically for application in forward scatter communication systems and is suitable for both fixed station and transportable service. **Circle 205 on Reader Service Card.**



Precision Pot high-temperature

CLAROSTAT MFG. CO., INC., Dover, N. H., announces the high-temperature version of its series 42 wirewound precision pot. It is designed to operate at temperatures up to 230 C with a wattage rating of 0.25. Resistance change after 255 hours at 230 C is less than 0.1 percent. Insulation resistance is 10 K megohms minimum (test data ran 90 K to 195 K megohms). Resistance tolerance is ±5 percent from 1 ohm to 100 K





SNAP IN CLIP IN

THE NEW AMP PRINTED CIRCUIT EDGE CONNECTOR

This A-MP unit is more than new—it is the only *solderless*, *direct-contact* connector on the market. Designed for both commercial and military requirements, it means faster assembly, greater reliability and versatility to you—at lower cost!

You get construction of unmatched close tolerances in both the contact and the one-piece molded housing. And—because each contact is wholly enclosed within its own housing barriers, there's no need for post insulation. Contacts feature spring-lock design which assures positive contact with board—yet will not cause damage to board paths, even after repeated insertions.

Assembly is easy: An A-MP high speed machine crimps contacts to circuit wires. Contacts are quickly and completely snapped into housing, locked in place with a lance to eliminate damage from shorts, bending or strain. The printed circuit board is then inserted for unlimited circuit combinations.

Snap in . . . clip in—it's that simple to save time, money and increase quality.

Send for full product information today.

AMP INCORPORATED

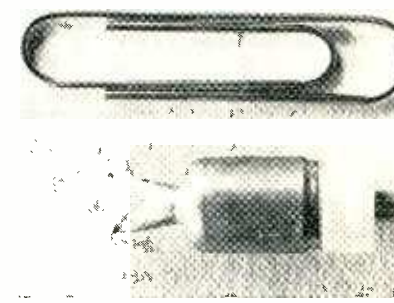
GENERAL OFFICES: HARRISBURG, PENNSYLVANIA

A-MP products and engineering assistance are available through subsidiary companies in: Canada • England • France • Holland • Japan

ohms; independent linearity, ±0.5 percent; noise less than 5μv. **Circle 206 on Reader Service Card.**

D-C Amplifier
continuous-gain

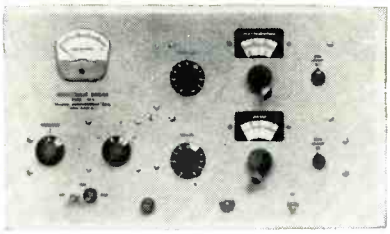
ALLEGANY INSTRUMENT CO., INC., 1091 Wills Mountain, Cumberland, Md., announces the model 512-A continuous-gain d-c amplifier. It is chopper-stabilized and, in addition to low noise and drift characteristics, features 11 fixed gain steps with continuously variable gain between each gain setting. It is used for the amplification of signals from wire strain gage transducers, thermocouples or other low-level, low and medium output impedance signal sources. **Circle 207 on Reader Service Card.**



V-R Tube
ruggedized

RADIATION RESEARCH CORP., 1114 First Ave., New York 21, N. Y. A line of subminiature metal-ceramic corona discharge voltage regulator tubes covers a wide range of voltages (400-4,000 v). Regulation of better than 1 percent is obtained over a current range of 10^{-11} to 10^{-7} amperes. The prebreakdown current is less than 10^{-12} amperes at room temperature. The tubes operate over

a temperature range of —55 C to 200 C. **Circle 208 on Reader Service Card.**



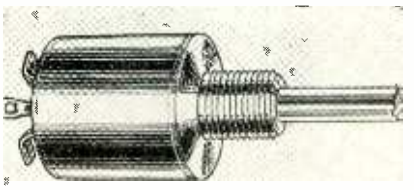
Inductance Bridge
high resolution

BOONTON ELECTRONICS CORP., 738 Speedwell Ave., Morris Plains, N. J. Model 63A inductance bridge measures inductance from 0.002 μh to 100 mh with an accuracy of the order of 0.25 percent. High resolution, approximately 0.01 percent, and good stability make it extremely useful for temperature coefficient and inductance matching work. An internal oscillator with several frequencies between 1 kc and 100 kc is provided along with an internal detector and a null indicator. Series resistance can be measured in the range of 0.01 to 10,000 ohms. **Circle 209 on Reader Service Card.**

E-I-R Meter
portable unit

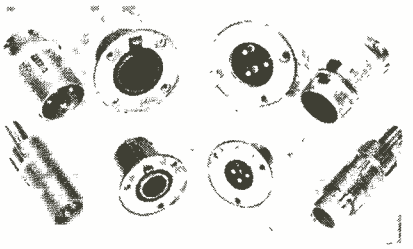
BELLEVILLE-HEXEM CORP., 638 University Ave., Los Gatos, Calif., announces a new battery powered portable E-I-R meter with transistorized circuitry designed to d-c voltage, current, and resistance. Model 110A measures voltages of 1 mv to 1,000 v full scale in 13 ranges; input resistance is 101 megohms. Eighteen current ranges pro-

vide measurement of full scale values from 1 millimicroampere to 300 ma; voltage drop for all ranges is 100 mv. Direct reading resistance scales indicate resistances from 10 ohms to 100 megohms, center scale. **Circle 210 on Reader Service Card.**



Potentiometer water-tight

WATERS MFG., INC., Wayland, Mass. This ½ in. water-tight potentiometer has a glass-to-metal solder sealed header, including terminal lugs installed with a glass-to-metal seal, and positioned for easy wiring. The brass case is plated in conformance with military requirements. Unit is sealed against moisture and salt spray by means of an "O" ring shaft seal, as specified in MIL-E-5272A and other military specifications, and the terminal board is sealed to the case, thus assuring a water-tight seal. The pot is derated to zero watt at 125 C. **Circle 211 on Reader Service Card.**



Audio Plugs and receptacles

ELCO CORP., "M" St. below Erie Ave., Philadelphia 24, Pa., announces two new series of audio plugs and receptacles. The B series is a 30 ampere connector available in cable or panel types with 2 to 6 contacts. Test voltage for all contact configurations is 1,600 v a-c; rated voltage 300 v a-c. The EL series is available in cable or panel types with 3 or 4 contacts. Contacts are made of silver plated brass, with a silver plated beryllium cop-

FOR TEST AND INSTRUMENTATION

VARIAN KLYSTRONS

X-13
X-13B

WIDE FREQUENCY RANGE • HIGH POWER OUTPUT

Long recognized as the standard for laboratory test applications at X-band, these reflex klystrons are designed especially for use as bench oscillators and laboratory signal generators. Tuned by micrometers, they cover the full X-band frequency range with power output of 250 mW. Small and light, the X-13 and X-13B feature new low-current filaments for longer tube life.

Varian makes a wide variety of Klystrons and Wave Tubes for use in Radar, Communications, Test and Instrumentation, and for Severe Environmental Service Applications. Over 100 are described and pictured in our new catalog. Write for your copy.

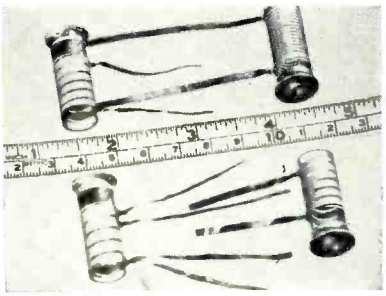
X-13	8.2 to 12.4 kMc	250 mW
X-13B	7.5 to 11.0 kMc	250 mW
V-39B	10.0 to 15.5 kMc	50 mW
V-40B	15.0 to 21.0 kMc	50 mW
V-58	8.5 to 10.0 kMc	600 mW

VARIAN associates
TUBE DIVISION
PALO ALTO 1, CALIFORNIA
Representatives thruout the world

KLYSTRONS, TRAVELING WAVE TUBES, BACKWARD WAVE OSCILLATORS, HIGH VACUUM PUMPS, LINEAR ACCELERATORS, MICROWAVE SYSTEM COMPONENTS, R. F. SPECTROMETERS, MAGNETS, MAGNETOMETERS, STALOS, POWER AMPLIFIERS, GRAPHIC RECORDERS, RESEARCH AND DEVELOPMENT SERVICES

CIRCLE 93 READERS SERVICE CARD

per spring added to the female contacts. **Circle 212 on Reader Service Card.**



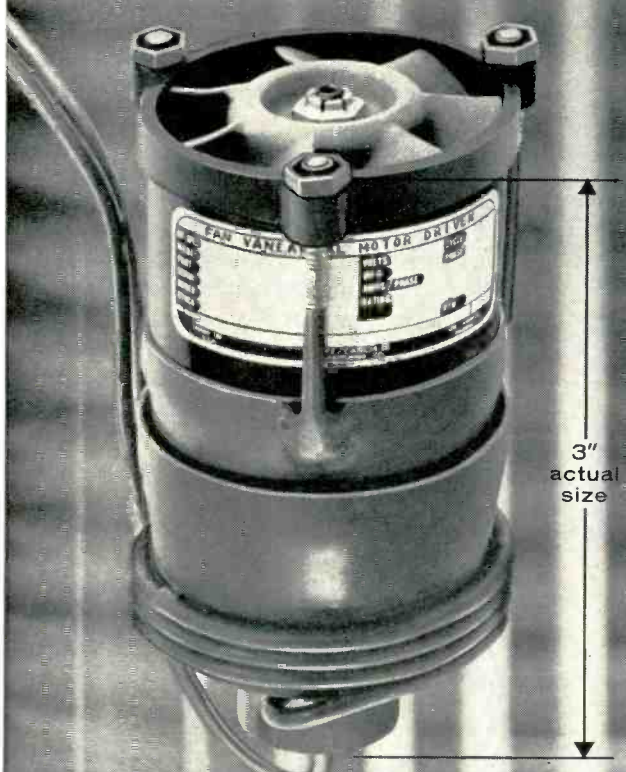
Standard Inductors
metallized glass

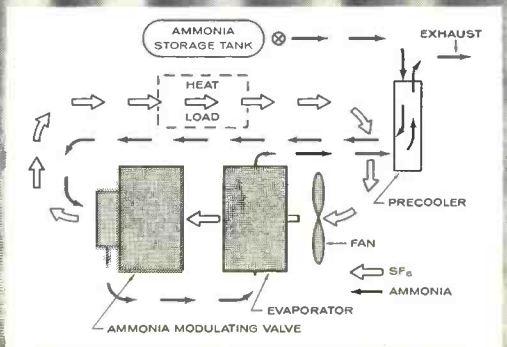
CORNING GLASS WORKS, Corning, N. Y., announces a new, standard line of metallized glass inductors. Designed for tuned circuit applications above 30.0 mc, the standard inductors provide a consistently low temperature coefficient of inductance from —55 C to 125 C. The temperature coefficient ranges from 8 to 16 ppm per deg C for an inductor without cores or tuning devices. Inductance values range from 0.05 to 0.10 μh in increments of 0.01 μh, and from 0.10 to 1.3 μh in increments of approximately 0.10 μh. **Circle 213 on Reader Service Card.**

Tv Camera
fully automatic

DAGE TELEVISION DIVISION, Thompson Ramo Wooldridge, Inc., Michigan City, Ind. Model 333 fully automatic tv camera relies on transistors and printed circuits designed around separate potted, plug-in modules to achieve small size without sacrificing quality. Weighing in at 4 lb (exclusive of lens), it is said to outperform high definition tv systems weighing up to several hundred pounds and comprising separate control equipment, power supply and sync generators, in addition to camera. Featured is automatic light adjustment, which compensates for light level

LIGHTWEIGHT airborne electronic cooling package





PERFORMANCE CHARACTERISTICS—
Heat Rejection: 200 watts... Inlet Gas Temperature to Component Housing: 130°F.... Weight of Fan, Evaporator and Controls: 1.25 lb.

Spans the gap between direct ambient cooling and closed cycle systems

• *This AiResearch open-cycle cooling unit* is designed for environmental conditioning of electronic and electromechanical equipment in problems of low total heat dissipation aboard aircraft and missiles.

Much lighter and less complex in operation than closed cycle systems, this compact package is recommended when required total heat dissipation is low... large heat loads for short periods of time, or small heat loads for long periods of time. It also replaces direct ambient cooling systems when ambient sink is not low enough or not easily available.

Ammonia in this expendable evaporative system cools sulfur hexafluoride (SF_6) which passes over the hot electronic components. The SF_6 then recirculates for cooling, and the ammonia is dumped overboard.

Applications of this system include: inertial guidance system cooling, missile transient cooling, and spot cooling where ambient sink is not available.

AiResearch has designed and manufactured cooling systems of all types ... direct ambient, closed and open-cycle systems handling all magnitudes of cooling loads and utilizing various working fluids. We invite you to send us details of your problem.

THE GARRETT CORPORATION

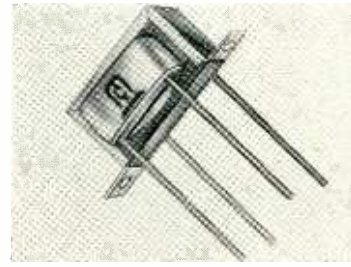
AiResearch Manufacturing Divisions

Los Angeles 45, California • Phoenix, Arizona

Systems, Packages and Components for: AIRCRAFT, MISSILE, ELECTRONIC, NUCLEAR AND INDUSTRIAL APPLICATIONS

CIRCLE 96 READERS SERVICE CARD

changes as high as 250 to 1. **Circle 214 on Reader Service Card.**



Transformers for transistor circuits

MICROTRAN CO., INC., 145 E. Mineola Ave., Valley Stream, N. Y., has added five microminiature transistor transformers to its catalog line. Units are available in open frame construction with standard channel or plug-in tab mounting channel. Size is less than ½ cu. in. with a weight of approximately 4/10 oz. Impedance ranges were designed to meet the requirements of many new transistors. **Circle 215 on Reader Service Card.**

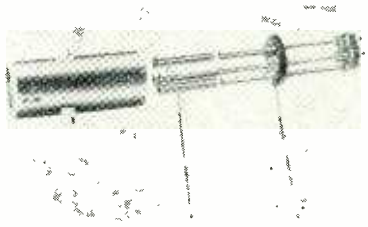
Limiting Amplifier high dynamics range

LEL, INC., 380 Oak St., Copiague, N. Y. Incorporating novel circuitry, the IF90 limiting amplifier now permits design of a radar or missile receiving system capable of accommodating an extremely wide range of input signals without overload. Recovery time from a high level pulse is less than 0.1 μsec and the dynamic range is greater than 120 db for an essentially constant output. The IF90 will amplify c-w or pulse signals from 0.1 μsec up. **Circle 216 on Reader Service Card.**

Fiberglass Tape pressure-sensitive

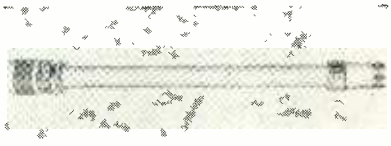
THE CONNECTICUT HARD RUBBER CO., 407 East St., New Haven 9, Conn., has developed Temp-R-Tape TGV, a thermal curing, pressure-sensitive Teflon impregnated fiber-

glass tape which meets Class C temperature requirements in electrical applications. It can be used as a bundling tape under clamps to provide convenience in application, as a splicing tape for high temperature wire, and as a residual glass insulating layer should the Teflon and adhesive burn out at temperatures peaking over 700 F. **Circle 217 on Reader Service Card.**



Variable Capacitors
trimmer piston type

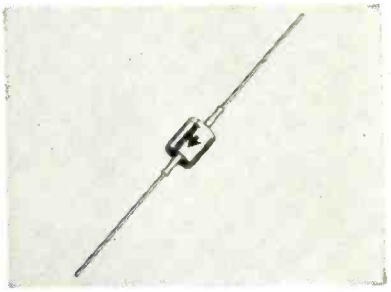
JFD ELECTRONICS CORP., 6101 Sixteenth Ave., Brooklyn 4, N. Y. These new variable trimmer piston capacitors combine the unique characteristics of Sealcap construction and miniature quartz capacitor design. Each is filled with dry nitrogen under pressure and then sealed to maintain the compression, prevent corona and voltage breakdown at high altitude. Linear tuning with fine resolution is assured permanently, without breaking of seal. Sealcap design also blocks the formation of moisture inside the unit, increases insulation resistance and dielectric strength. Units feature high Q and ultra low loss h-f operation. **Circle 218 on Reader Service Card.**



Coax Attenuators
in stainless steel

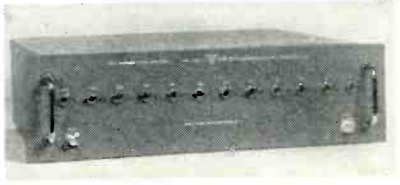
WEINSCHEL ENGINEERING, 10503 Metropolitan Ave., Kensington, Md. Stainless steel body and connectors are new features of model 210 fixed coaxial attenuators. The attenuators are made with Weinschel film resistors for maximum stability under pulse power as well as humidity and temperature cycling. Fre-

quency range is 1 to 10 kmc; attenuation range, 1 to 20 db; impedance, 50 ohms; connectors, type N. **Circle 219 on Reader Service Card.**



Reference Element unusually small

U. S. SEMICONDUCTOR PRODUCTS, INC., 3536 W. Osborn Road, Phoenix, Arizona. Featuring a temperature coefficient of up to 0.0005 percent per deg C from —55 to + 185 C, in a case only 0.290 in. long by 0.250 in. in diameter, the new reference silicon diode offers extreme accuracy, performance and reliability. The tiny element is rated from 9 to 9.8 v at 10 ma, with Zener impedance of 15 ohms. Its very small size is due to a newly developed diffused triple wafer construction method which permits more efficient use of materials, higher production and extra ruggedness. **Circle 220 on Reader Service Card.**

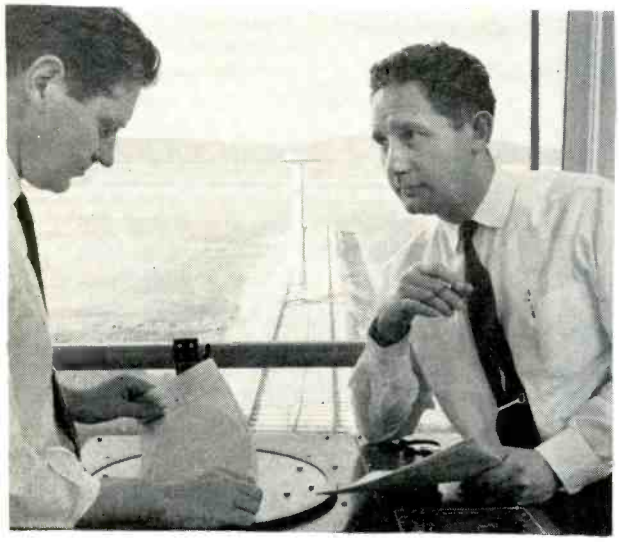


Time Delay Standard wide-band unit

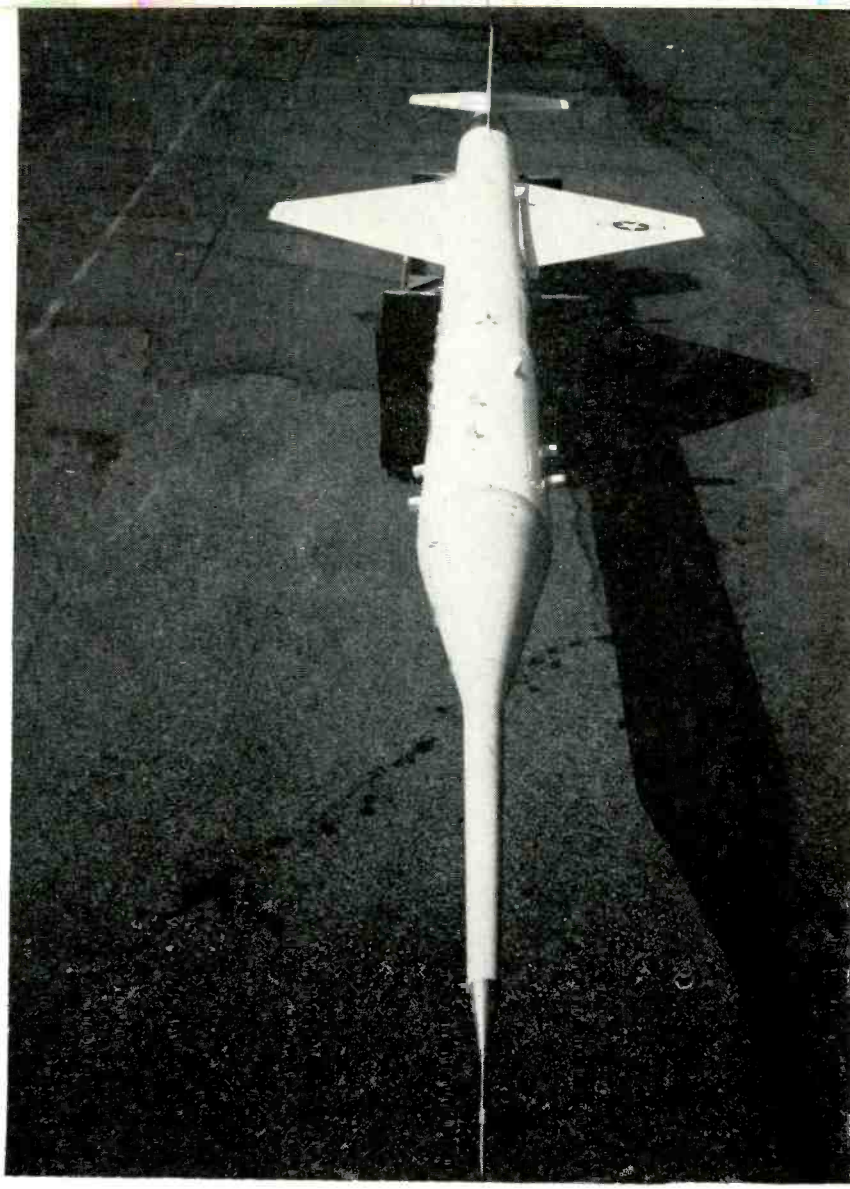
AD-YU ELECTRONICS LAB., INC., 249 Terhune Ave., Passaic, N. J. This device was developed to meet the need for an accurate and wide-band time delay standard useful up to 1,000 mc. It is coaxially constructed from input connector to output connector. It consists of only bilateral passive network and no active devices, such as vacuum tube or transistor. As a result it is extremely stable and has no time jitter at all. Both input and output impedances

(right) Lockheed Q-5 target missile features telemetry that registers miss-distance and theoretical hits in testing accuracy of other missiles.

ANTENNA— TELEMETRY



Studying results of antenna pattern measurements — part of the activity of the Space Communications laboratory.



Expanding the Frontiers of Space Technology

Lockheed maintains extensive research capabilities for the development of antennas and telemetering systems and spacecraft applications.

Laboratory studies in antennas and electromagnetic propagation include the application of solid state materials to microwave transmission line components; the design of antennas to survive the rigors of space flight; the effects of space on radio signals and radar detection; and the scattering from missile shapes and space vehicles. Research is also being conducted in the application of ferrites and MASERS; on problems of radio transmission between space vehicles and Earth, re-entry scattering and diffraction by man-made objects and ionized gases; and development of antennas for data link systems between satellites and ground stations.

Telemetering has been brought to a high degree of successful application in the integration of circuits and components into high-performance systems. A completely sub-miniaturized FM-AM system has been developed, along with a complete PAM-FM system characterized by highly efficient band-width utilization, low power consumption and economy of size and weight. This represents a significant achievement in the field of high capacity telemetry.

Scientists and engineers of outstanding talent and inquiring mind are invited to join us in the nation's most interesting and challenging basic research and development programs. Write: Research and Development Staff, Dept. D2-22, 962 W. El Camino Real, Sunnyvale, California.

"The organization that contributed most in the past year to the advancement of the art of missile and [illegible]

Lockheed

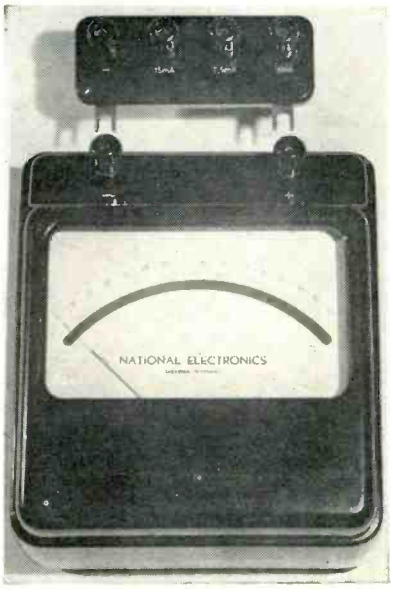
MISSILES AND SPACE DIVISION

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

are equal and the low frequency limit can be extended down to d-c. **Circle 221 on Reader Service Card.**

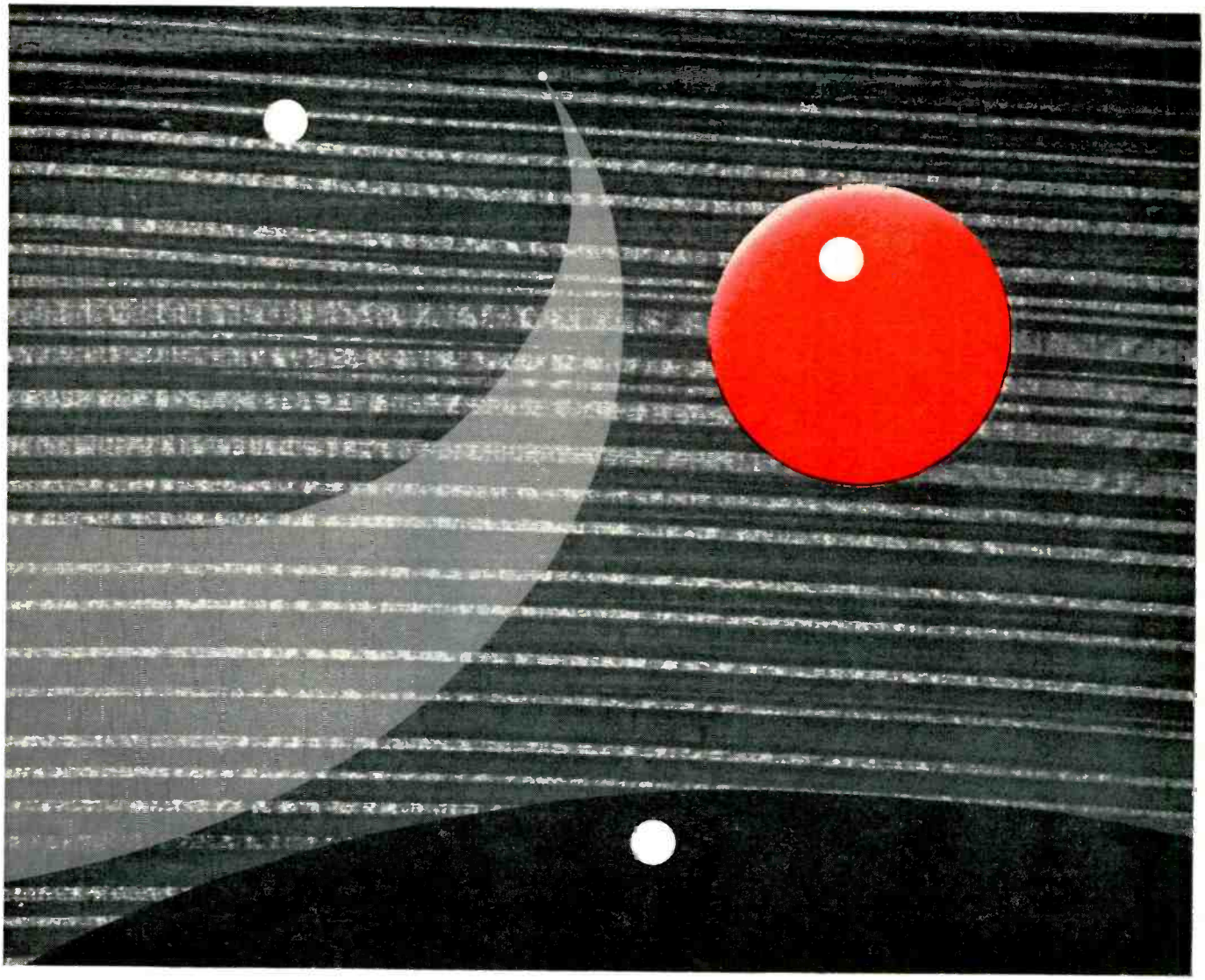
Titanium Foil
corrosion-resistant

TITANIUM METALS CORP. OF AMERICA, 233 Broadway, New York 7, N. Y., has placed on the market nonmagnetic, corrosion-resistant titanium foil in gages from 0.000125 in. to 0.010 in. In the extremely thin gages, it is available in widths to 36 in. The foil has applications for firms engaged in the manufacture of capacitors and various kinds of metal-ceramic electronic tubes. **Circle 222 on Reader Service Card.**



Ammeter-Voltmeter
precision unit

NATIONAL ELECTRONICS, Sheridan, Wyoming, has announced its universal precision portable d-c ammeter-voltmeter, with 49 possible ranges in one instrument. This versatility is possible by use of precision shunts and series resistances, housed



CONTROL IN SPACE

When World War II ended engineers and scientists of ITT Laboratories were putting on paper their dreams of the electronics needed for man's control of space. Today these dreams are reaching maturity and fruition.

Now long on experience, the Astrionics Laboratory of ITT Laboratories, domestic research arm of International Telephone and Telegraph Corporation, is responsible for ITT space technology research and development.

Today new techniques are evolving which will guide space vehicles safely to their landings on our own or other planets. Satellite communications systems are rapidly becoming a reality . . . investigations are underway of phenomena which affect guidance systems.

The capabilities of the Laboratory cover every facet of electronics in space technology. Principal endeavors are in space systems, space guidance and navigation, space flight control, space communications and instrumentation.

Backing the Laboratory are the nation-wide personnel and facilities of all ITT Laboratories. The technical staff work in a scientific environment of the most modern electronic laboratory equipment including analog and digital computers. Any endeavor in space electronics can be undertaken.

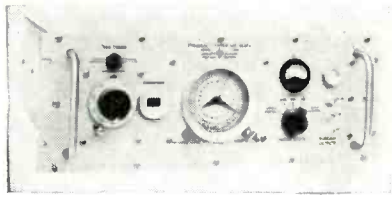
Engineers and scientists are invited to investigate positions of responsibility, challenge and reward. Write Mr. S. L. Smith, Manager, Staff Relations.

ITT LABORATORIES

A Division of International Telephone and Telegraph Corporation

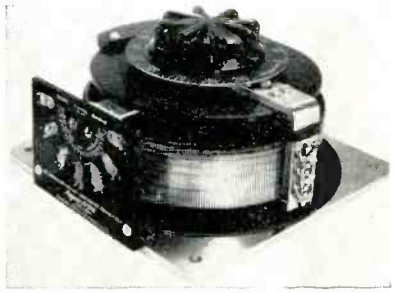
3700 East Pontiac Street, Fort Wayne, Indiana

in plastic clamp-on cases. A large easily read, hand calibrated mirrored scale, 6.1 in. long, with finely balanced knife edge pointer, combine to eliminate parallax errors in reading. Accuracy is better than 0.5 percent on all divisions of the scale at an ambient temperature of 25 C. **Circle 223 on Reader Service Card.**



Frequency Divider and clock

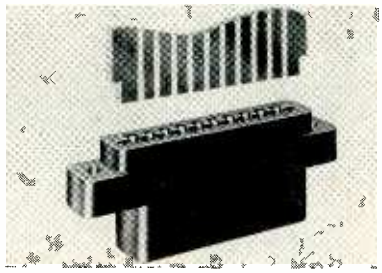
HEWLETT-PACKARD Co., 275 Page Mill Road, Palo Alto, Calif. Model 113X frequency divider and clock accepts a stable 100 kc frequency input and provides an essentially jitter-free tick output. Thus, it is possible to compare the tick, which represents the stable 100 kc frequency, with a standard time signal in a time comparator. Unit has a 3½ in. clock face, and includes minute and second hands. Minute hand is adjustable in 1-minute steps. Second hand is continuously adjustable with a differential tracking link to the minute hand. **Circle 224 on Reader Service Card.**



Variable Transformer heavy duty model

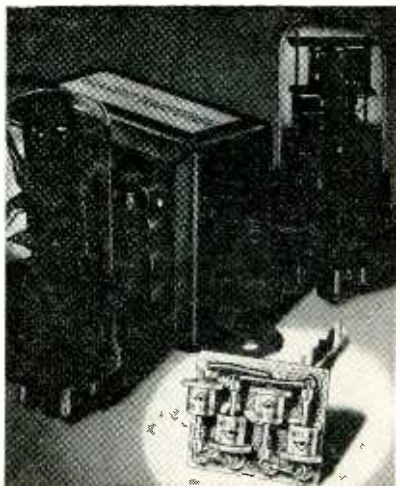
STANDARD ELECTRICAL PRODUCTS Co., 2240 E Third St., Dayton, Ohio, announces a new heavy duty model panel-mounted variable transformer for control of a-c voltage, heat, power, speed, and light. Type T502U has a load rating of 7.5 kva and is rated at 25 amperes. It is

interchangeable with other square base units. Input voltage is 230 v, output voltage is 0-270 v. **Circle 225 on Reader Service Card.**



P-C Receptacles beryllium-copper contacts

U. S. COMPONENTS, INC., 454 E. 148th St., New York 55, N. Y., is manufacturing printed circuit receptacles with features covered by U. S. Patent No. 2,853,689. Designated the UPCR series, they are made with resilient beryllium-copper snap-in contacts and polarizing snap-in inserts that position the board precisely. **Circle 226 on Reader Service Card.**



Bridge Rectifiers miniaturized

INTERNATIONAL RECTIFIER CORP., 1521 E. Grand Ave., El Segundo, Calif. Miniature silicon bridge rectifiers for the replacement of bulky vacuum tube units occupy only $\frac{1}{10}$ of the volume and weigh less than 1/60 of equivalent tube circuitry. Units measure 1.22 by 1.03 by 0.75 in. and weigh $\frac{1}{2}$ oz. Designed primarily to provide extreme miniaturization in missile, airborne and ground system cir-

MERCK HAS ALL FOUR FORMS OF Silicon IN PRODUCTION QUANTITIES

MERCK DOPED SINGLE CRYSTAL SILICON—offers doped float zone single crystals of high quality at low costs. Yields of usable material are reported to be especially high when device diffusion technics are used with these crystals. Float zone single crystals doped either "p" or "n" type with resistivities from 3 to 300 ohm cm. any range plus or minus 25% and a minimum lifetime of 100 microseconds are available in diameters of 18 to 20 mm., and random lengths of 2 to 10 inches.

NOTE: Doped single crystals in other diameters, resistivities, or lifetimes not listed above can be furnished as specials.

For additional information on specific applications and processes, write Merck & Co., Inc., Electronic Chemicals Division, Department E-3, Rahway, New Jersey.

MERCK HIGH RESISTIVITY "P" TYPE SINGLE CRYSTAL SILICON—offers float zone single crystals of a quality unobtainable by other methods. Available with minimum resistivity of 1000 ohm cm. "p" type and a minimum lifetime of 200 microseconds, diameter 18 to 20 mm., random lengths 2 to 10 inches.

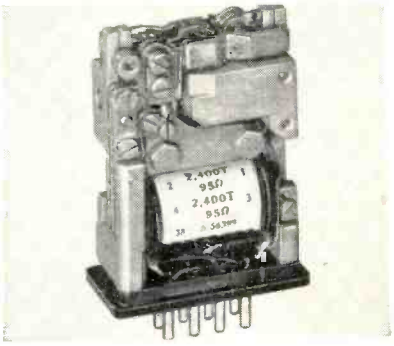
MERCK POLYCRYSTALLINE BILLETS—have not previously been melted in quartz, so that no contamination from this source is possible. Merck guarantees that single crystals drawn from these billets will yield resistivities over 50 ohm cm. for "n" type material and over 100 ohm cm. for "p" type material. Merck silicon billets give clean melts with no dross or oxides.

MERCK POLYCRYSTALLINE RODS—are ready for zone melting as received . . . are ideal for users with float zone melting equipment. Merck polycrystalline rods are available in lengths of 8½ to 10½ inches and in diameters of 18 to 20 mm. Smaller diameters can be furnished on special order. In float zone refining one can obtain from this material single crystals with a minimum resistivity of 1000 ohm cm. "p" type with minimum lifetime of 200 microseconds or the material can be doped by user to his specifications.

ULTRA-PURE Silicon —a product of **MERCK**

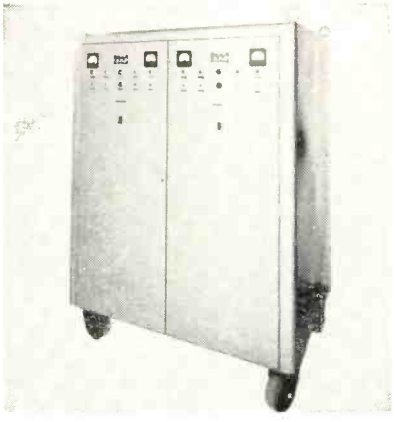
BASE BORON CONTENT BELOW ONE ATOM OF BORON PER SIX BILLION SILICON ATOMS

cuitry, the rugged, shock-resistant devices may be operated at temperatures up to 165 C. **Circle 227 on Reader Service Card.**



Polarized Relays
bi- or center-stable

C. P. CLARE & Co., 3101 Pratt Blvd., Chicago 45, Ill., has available polarized relays, either bi-stable (type 51A) or center-stable (type 51M). An ideal component in bridge circuits as a null-sensing device without amplifiers, in various military and aircraft installations, in electronic controls, in supervisory circuit monitoring, in servomechanisms, or in any application requiring impulse repetition, these relays produce a square-wave output from weak input signals. **Circle 228 on Reader Service Card.**



D-C Power Supply
dual output

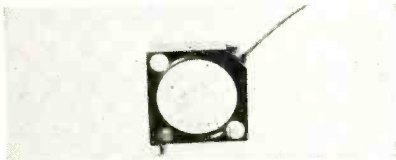
PERKIN ENGINEERING CORP., 345 Kansas St., El Segundo, Calif. A new d-c power supply used for industrial applications and research programs provides two outputs of 0-60 v at 200 amperes simultaneously and is controlled by a motor driven Powerstat. The two 12 kw

†These thermostats covered by patents issued or applied for.

400 cps, 50 w. **Circle 230 on Reader Service Card.**

Power Supplies
0 to 60 v

ELECTRONIC MEASUREMENTS CO., INC., Eatontown, N. J. A line of transistorized, short circuit proof power supplies can be used from a fraction of one volt to any voltage up to 60 without loss of regulation or stability. Three models are available with maximum current ratings of 2.5, 5, and 7.5 amperes. Regulation is 0.1 percent or 0.01 v from no load to full load and with 105 to 125 v lines. **Circle 231 on Reader Service Card.**



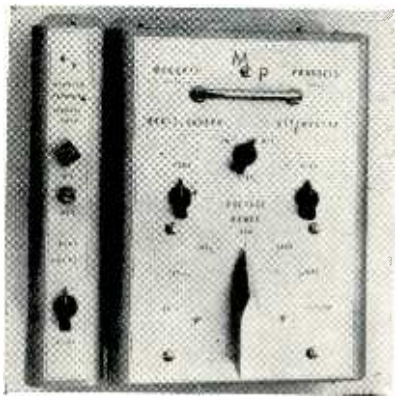
Trimming Pots
subminiature

DAYSTROM PACIFIC, 9320 Lincoln Blvd., Los Angeles 45, Calif. Series 313 Squaretrim subminiature trimming pots are high temperature units. New Kel-F insulation allows continuous operation from −55 to +200 C. They are available in resistance values from 10 ohms to 50 K ±5 percent. Rating is 1.5 w. One watt is dissipated at +95 C. The pots meet or exceed MIL-STD-202 Method 202 shock, vibration, and temperature cycling specifications. **Circle 232 on Reader Service Card.**

Range Computer
aid to pilots

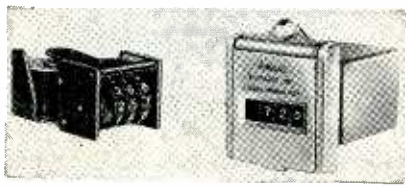
THOMAS A. EDISON INDUSTRIES, McGraw-Edison Co., 61 Alden St., West Orange, N. J., has developed a new launch range computer de-

signed to aid pilots in calculating the distance from the airplane to a target at any time. The instrument will aid in launching air-to-ground missiles and contains two control transformers, a servo motor, a transistor-magnetic amplifier, a gear train with slip clutch and push-button reset, and an indicator and indicator light, all in a package weighing only 44 oz. **Circle 233 on Reader Service Card.**



Attenuator and bias supply

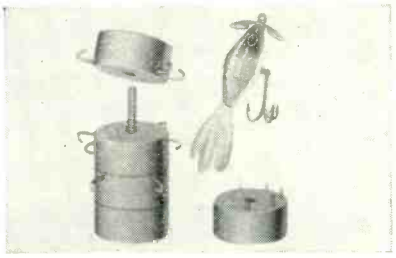
MARDUTH PRODUCTS, R.D. No. 4, Medina, Ohio. The RS-1 is a 100 watt attenuator for operating direct-writing oscillographs from h-v power equipment without the use of an amplifier. It is useful for the supervision and service of dynamic power equipment as well as experimental and laboratory use. The oscillograph can be offset by use of the bias supply RS-102, so that the full chart can be used for recording. **Circle 234 on Reader Service Card.**



Magnetic Counter serves as limiter

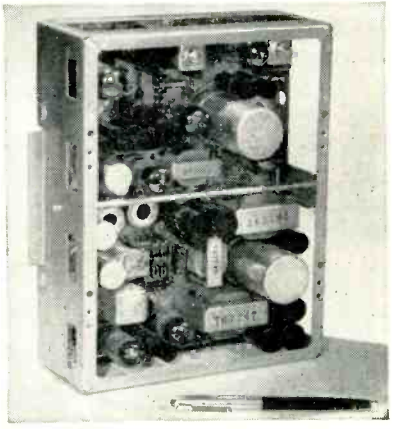
ABRAMS INSTRUMENT CORP., 606 E. Shiawassee St., Lansing 1, Mich. Model CV magnetic predetermining counter receives d-c pulses of any number from 1 to 899 as manually set. Operating as a subtractive counter, the remaining pulse count

is always visible. As the counter wheels pass zero count a set of contacts open. Model CV lends itself to many airborne control applications as a limiting device. **Circle 235 on Reader Service Card.**



Small Inductors with high Q values

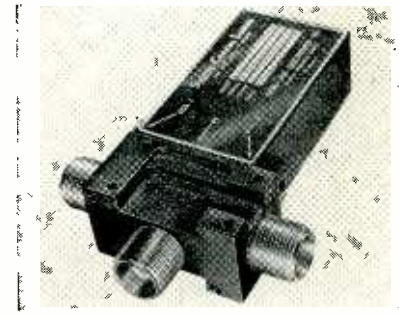
ARNOLD MAGNETICS CORP., 4613 W. Jefferson Blvd., Los Angeles 16, Calif. The series 785 toroidal inductors provide from 1 mh to 7 henries, with a useful frequency range of from 1 kc to 100 kc. Q values are very high—a typical 1-mh inductor operating at 40 kc has a maximum Q of 240. Units are designed for printed circuit applications or for stacking on a single screw for chassis mounting. Case size measures 1 7/16 in. diameter by ¾ in. high; weight is only 23 oz. **Circle 236 on Reader Service Card.**



Navigation Module lightweight unit

LEAR, INC., 3171 South Bundy Drive, Santa Monica, Calif. Advanced features of the new NAVPAC-100 navigation module for single and twin-engine private aircraft are highlighted by exclusive automatic omni and localizer switching, and an aural marker beacon receiver. Unit is adaptable

to any vhf receiver having VOR/LOC capability. It is capable of operating three meter loads and two flag alarms on localizer or omni. **Circle 237 on Reader Service Card.**

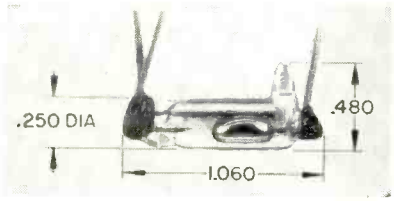


Coax Lobing Switch broadband device

DON-LAN ELECTRONICS CO., Santa Monica, Calif., has developed a new miniature r-f coaxial lobing switch which weighs only 0.7 lb. The broadband (100 to 10,000 mc) unit provides an optimum noise-free method of conveying r-f power from one input to alternate output positions. Vswr of the units is unusually low, with a 1.2/1.0 maximum. Isolation rating of 50 db down is achieved by the unique design. **Circle 238 on Reader Service Card.**

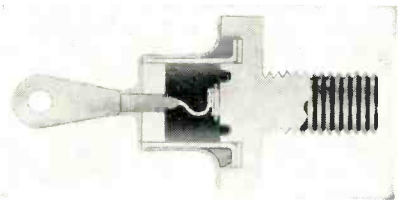
Tantalum Capacitor encapsulated

P. R. MALLORY & CO. INC., 3029 E. Washington St., Indianapolis 6, Ind., announces an encapsulated solid electrolyte tantalum capacitor. The disk-shaped unit offers savings in area, weight and cost. Grid type leads permit mounting above the chassis and allow the circuit designer to bridge other wiring. Encapsulation fully insulates the body and prevents short circuiting with adjacent components. **Circle 239 on Reader Service Card.**



Mercury Switch
low-angle

MICRO SWITCH, Freeport, Ill., offers a new low-angle mercury switch designed to meet the precise requirements of vertical gyros, stable platforms and rocket guidance systems. The AS603AI weighs only 3.8 grams, including three 7-in. Teflon-insulated leads. It features a differential angle of 0.15 deg maximum and a mass shift of 0.085 grams-cm, which makes it most sensitive. **Circle 240 on Reader Service Card.**



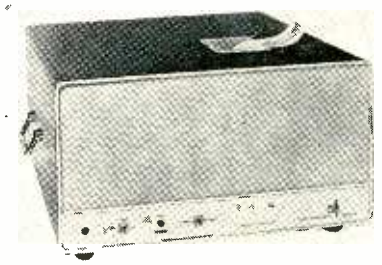
Silicon Rectifiers
reliable, uniform

VICKERS INC., 1815 Locust St., St. Louis 3, Mo., announces a line of silicon power rectifiers featuring low forward drop, superior reverse characteristics at all temperatures; higher insulation resistance; current ratings said to be up to 25 percent higher than other rectifiers of similar size and cost. New rectifier has solid copper base, hot tin dipped terminal; hermetic seal for silicon chamber, and tough epoxy coating. **Circle 241 on Reader Service Card.**

Magnetic Amplifier
high reliability

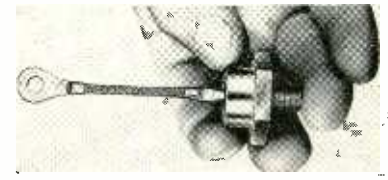
TELECOMPUTING CORP., 915 N. Citrus Ave., Los Angeles 38, Calif. A new magnetic amplifier features light weight and space savings over conventional types. Exceptional reliability has been gained by encapsulating the unit in a special epoxy molding resin which is resistant to shock, vibration,

humidity and temperature changes. The new encapsulating process eliminates the need for a heavy bulky case, and simplifies mounting. **Circle 242 on Reader Service Card.**



Digital Printer versatile unit

COMPUTER MEASUREMENTS CORP., 5528 Vineland Ave., N. Hollywood, Calif., has developed a new digital printer which automatically prints digital data from high speed counting, timing, frequency measuring and data handling equipment. Model 400 C features 4 lines per sec print-out; no stepping switches; and parallel entry. Analog output and 10 line output are among the many options available. **Circle 243 on Reader Service Card.**



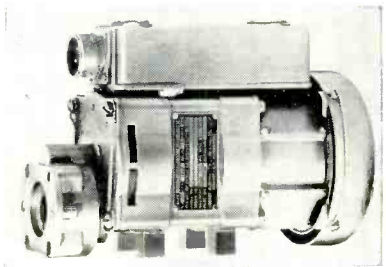
Silicon Recifiers small size

SYNTRON CO., Homer City, Pa. The SN-60 series silicon a-c to d-c rectifiers are designed for intermediate power applications. Rectification efficiency is demonstrated by their low maximum forward voltage drop (1.2 v at 10 amperes, 27 C). They are of rugged, all-weld construction, hermetically sealed. Prototype units on life tests for more than 7,000 hr have neither failed nor deteriorated. **Circle 244 on Reader Service Card.**

Junction Transistor for audio equipment

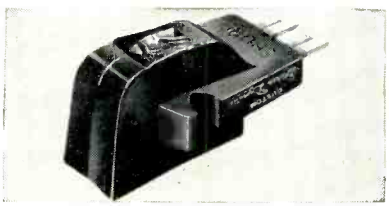
RADIO CORP. OF AMERICA, Somerville, N. J., has introduced the

2N1010 germanium *npn* alloy-junction transistor for the design of audio equipment operating from extremely small input signals. It features very low noise factor of only 5 db with a generator resistance of 1,000 ohms and an integrated noise bandwidth of 15 kc; typical small-signal current gain of 35; typical alpha-cutoff frequency of 2 mc, and freedom from microphonics and hum. **Circle 245 on Reader Service Card.**



D-C Motor
rugged duty

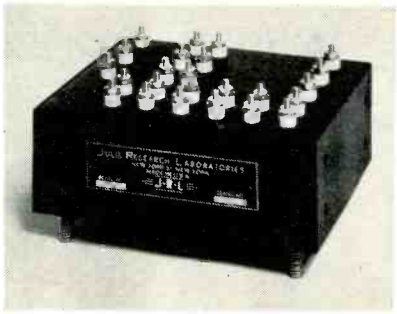
HOOVER ELECTRIC CO., Hangar Two, Port Columbus Airport, Columbus 19, Ohio, has available a new d-c motor for a wide range of applications on aircraft, missile, ordnance and industrial uses. Operating at 28 v d-c and 69 amperes, the motor delivers 1.6 horsepower at 2,000 rpm. Higher output speeds to 25,000 rpm are available by deleting the reduction gear box. Other voltages are available on request. **Circle 246 on Reader Service Card.**



Stereo Cartridge
high compliance

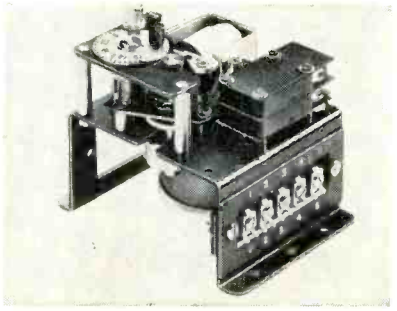
SHURE BROTHERS, INC., 222 Hartrey Ave., Evanston, Ill. The M7D custom stereo Dynetic cartridge has the following specifications: channel separation, more than 20 db at 1,000 cps; frequency response, 20 to 15,000 cps; output voltage, 5 mv per channel at 1,000 cps at a needle velocity of 5 cm per dyne; vertical and lateral compliance,

3.5×10^{-6} cm per dyne. Recommended load impedance is 47,000 ohms and recommended tracking force is 4 to 7 grams. **Circle 247 on Reader Service Card.**



Resistance Set ultrastable

JULIE RESEARCH LABORATORIES, INC., 556 W. 168th St., New York 32, N. Y. Model BDR-105 resistance set consists of 21 ultra-precise, ultra-stable resistors scaled in a modified binary-decimal sequence of 1, 2, 2, 4 by decades with an extra units digit, permitting synthesis of any resistance from zero to 100,000 ohms in one-ohm steps, with accuracies and stabilities of 0.0015 percent (15 parts per million) of the maximum value. **Circle 248 on Reader Service Card.**



Time Delay Relay adjustable

CRAMER CONTROLS CORP., Centerbrook, Conn. Type 471 time delay relay provides an accurate, adjustable time delay between the operation of a control circuit and the subsequent transfer of one or two load switches. Through selection of external wiring connections, the unit offers broad application flexibility and excellent accuracy at moderate cost. Time ranges

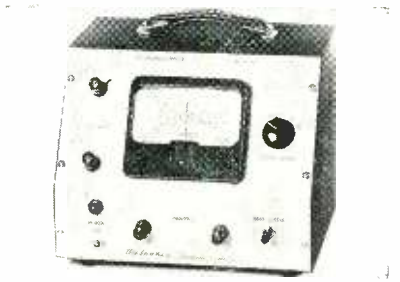
from 15 sec to 24 hr. Adjustment range is from about 10 percent to 100 percent of full scale. **Circle 249 on Reader Service Card.**

Rectifiers
high current

ITT COMPONENTS DIVISION of International Telephone and Telegraph Corp., Clifton, N. J., announces a line of Gold Crown high current power silicon rectifiers. They cover the current range from 5 amperes to over 70 amperes, at a stud temperature of 150 C, and are available in piv ratings up to 800 v. Proposed JETEC packaging is used, up to 30 amperes with a $\frac{1}{4}$-28 stud size and up to 70 amperes with a $\frac{3}{8}$-24 stud size. **Circle 250 on Reader Service Card.**

Coax Terminations
high power

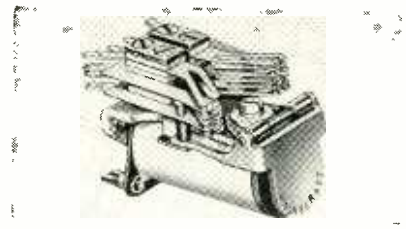
RADAR DESIGN CORP., Pickard Drive, Syracuse 11, N. Y. RDL-30N is a member of a line of high power coaxial terminations released to cover the range d-c to 10 kmc. It is rated at 200 w without forced cooling. Vswr is below 1.2 to 4 kmc. Price is $550. **Circle 251 on Reader Service Card.**



Comparison Bridge
many applications

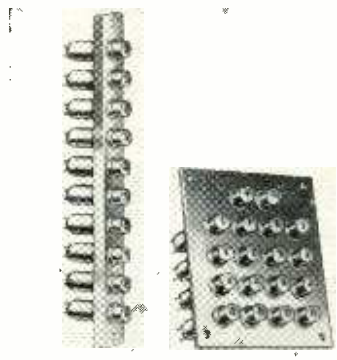
METRONIX, INC., Chesterland, Ohio. Parameter deviations as small as one part in 10,000 may be detected

between electronic components with the LCR comparison bridge. Designed for widespread use in laboratory, production or inspection applications, model 544 compares and measures resistances, capacitances and inductances over broad ranges, at a frequency of 60 cps. Direct reading of percentage deviation reduces operator fatigue. **Circle 252 on Reader Service Card.**



Relay telephone type

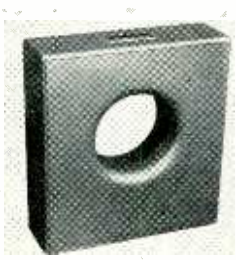
MAGNECRAFT ELECTRIC CO., 3350 B. W. Grand Ave., Chicago 51, Ill. Increased stability of adjustment for greater long term reliability and increased life expectancy are achieved in the small general purpose class 22 telephone type relay through improved hinge design. Relay has a new heavy duty full yoke type armature hinge with exceptionally large bearing surfaces. The bearing surfaces are precisely reamed for precision fit of a centerless ground stainless steel hinge pin. **Circle 253 on Reader Service Card.**



Data Strip and data matrix

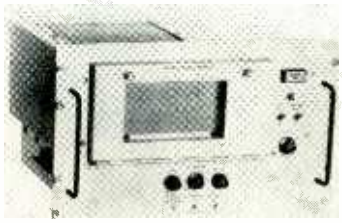
DIALIGHT CORP., 60 Stewart Ave., Brooklyn 37, N. Y. The Dialco data strip is designed to provide a number of ultraminiature indicator lights—as a unit—ready for mounting in a minimum of space,

as in computers, program boards, read-out panels and the like. The basic indicator light consists of a lampholder with a plug-in lamp cartridge. The data matrix is similar to the data strip but rectangular in shape. **Circle 254 on Reader Service Card.**



Transformer
pulse current type

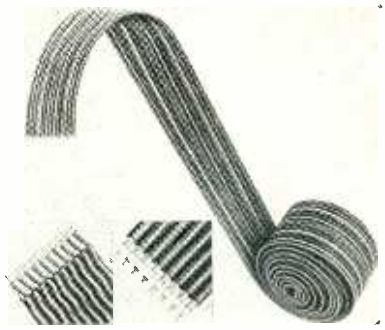
PEARSON ELECTRONICS, 707 Urban Lane, Palo Alto, Calif. Model PCT 325 pulse current transformer allows precision monitoring of both pulse amplitude and waveshape. It features extremely fast rise-time (20 mμsec) low droop (0.1 percent/μsec), and ability to monitor currents at very high voltages (300 kv pulse in oil, 30 kv a-c, d-c, or pulse in air) or where a large aperture is needed (3.5 in. diameter). **Circle 255 on Reader Service Card.**



Recorder
analog & sequence

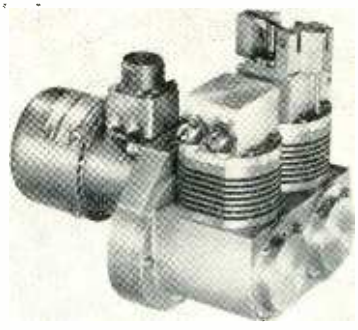
BRUSH INSTRUMENTS, Division of Clevite Corp., 37th and Perkins Ave., Cleveland 14, Ohio, announces an analog and operations recorder developed to exacting military requirements and specifications. Unit permits simultaneous recordings of two types: analog recording of the d-c to 100 cps range with wide amplitude and writing speeds; "on-off", "go and no-go" and sequential types of events on 10 separate channels. The recorder is a complete system,

with oscillograph, amplifier and power supply. **Circle 256 on Reader Service Card.**



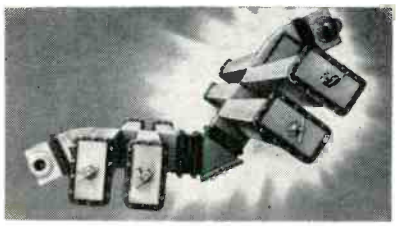
Multiconductor Cables
space-saving

PLASTOID CORP., 42-61 24th St., Long Island City 1, N. Y., is producing multiconductor ribbon cables. They are available in single conductors, twisted pairs and coaxial cables; and come in different widths and specifications. The color coded cables save time, space, strip and separate easily, and weigh less. **Circle 257 on Reader Service Card.**



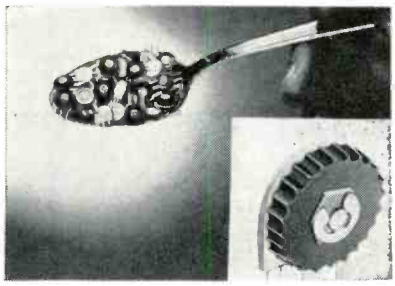
Air-Vacuum Pump
versatile unit

APPLIED DYNAMICS CORP., 32 North Main St., Natick, Mass. The Dynetics model 04-601 is a dual-piston air-vacuum pump designed for the simultaneous production of oil free compressed air from one cylinder and oil-free vacuum from the second cylinder. Pump is ideally suited for use in: aircraft ground test equipment, aircraft instrument and accessories testing, and pressurization of electronic systems (airborne or ground installations). Pump can be readily converted to either compound air or compound vacuum. **Circle 258 on Reader Service Card.**



Duplexer for 755-985 mc

D. S. KENNEDY & Co., Cohasset, Mass., has introduced a duplexer having a reject attenuation greater than 100 db. Designed for operation in the 755 to 985 mc band, it is especially suited to tropospheric scatter applications. The duplexer, made of high strength aluminum alloy, enables the same antenna to be used simultaneously for both transmitting and receiving. The transmitter and receiver ports are equipped with transitions which are fitted with coaxial inputs. **Circle 259 on Reader Service Card.**



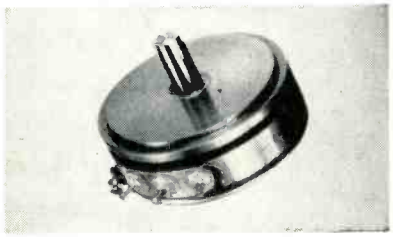
Variable Resistor microminiature

CENTRALAB, A Division of Globe-Union Inc., 90 E. Keefe Ave., Milwaukee 1, Wisc., has available a microminiature variable resistor measuring only 0.286 in. in diameter and 0.110 in. in depth. Model 8 Radiohm is rated at ⅛ w and has a component density of 188 per cu in. It is available in resistance values of 500 ohms to 10 megohms in a wide range of tapers. It has a minimum rotational life of 25,000 cycles. **Circle 260 on Reader Service Card.**

Stereo Cartridge ceramic element

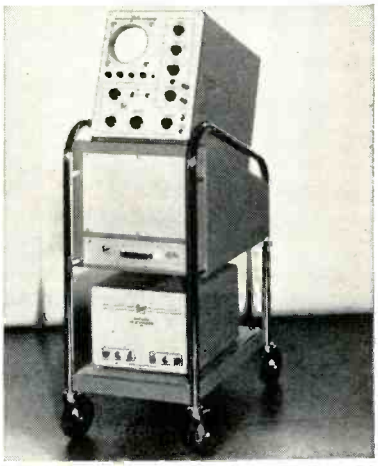
ERIE RESISTOR CORP., Erie, Pa., is introducing a truly advanced stereophonic cartridge with a dynamically balanced, single ceramic ele-

ment. Freedom from resonance peaks is obtained through oil damping. Model 1302 ST-ERIE-O cartridge has a 0.7 mil diamond and 3 mil sapphire styli, and the model 1301 has dual sapphires. ST-ERIE-O offers excellent separation of 20 db over full a-f range. Response is 20 to 16,000 cps with output voltage 0.5 v rms at 1 kc each channel. **Circle 261 on Reader Service Card.**



Single-Turn Pot all-metal

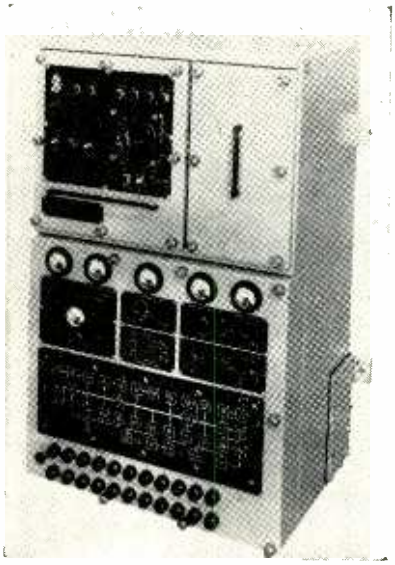
HELIPOT DIVISION of Beckman Instruments, Inc., 2500 Fullerton Rd., Fullerton, Calif., announces a new 1¾ in. single-turn precision pot. Designated series 5500, the unit has a standard power rating of 6 w at 40 C, derated to 0 at 150 C. The all-metal pot offers standard resistances ranging from 85 to 146,000 ohms, and standard linearity down to ±0.15 percent. The 4 in. coil provides resolution as high as 0.042 percent, or better on special order. **Circle 262 on Reader Service Card.**



Oscilloscope for surge testing

TEKTRONIX, INC., P. O. Box 831, Portland, Oregon. Type 507 is a specialized oscilloscope designed

primarily for h-v surge testing as applied to power transformers, h-v insulators, lightning arresters, and their associated designs and acceptance tests. The crt has a vertical-deflection factor of approximately 50 v/cm at 24-kv accelerating potential, and a viewing area of 6 cm by 10 cm. **Circle 263 on Reader Service Card.**



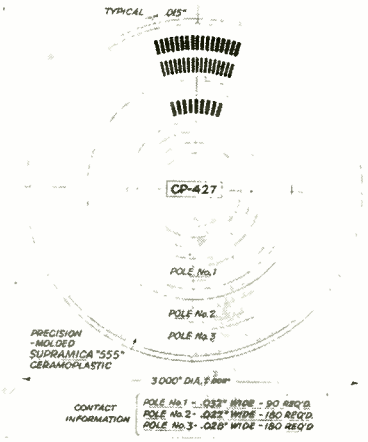
Search Radar high stability

WESTINGHOUSE ELECTRIC CORP., Box 2278, Pittsburgh 30, Pa. A new search radar departs from previous radar designs in that it is crystal controlled, thereby achieving extremely high stability. Also, instead of the usual rectangular pulse, a shaped pulse has been designed to decrease the required bandwidth for operation; this allows the high power system to work in crowded environments without interfering with other electronic devices. To simplify maintenance, the necessary testing equipment is built into the unit. **Circle 264 on Reader Service Card.**

K-Band Magnetron ruggedized

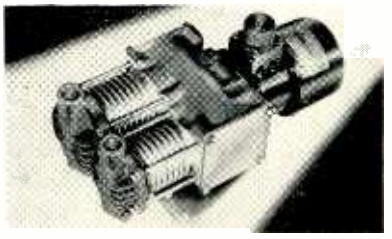
SYLVANIA ELECTRIC PRODUCTS INC., Mountain View, Calif., announces a new fixed-frequency K-band magnetron, ruggedized for missile applications. The M4154 delivers a minimum peak power output of 20 kw. The tube's adaptability to missile

applications has been achieved in part by cathode ruggedization, and special high pressure windows. **Circle 265 on Reader Service Card.**



Commutator Switch three-pole

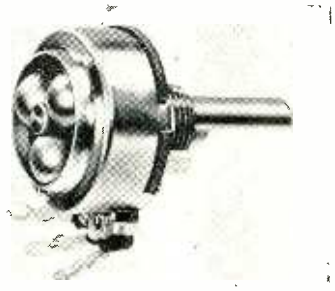
MYCALEX CORP. OF AMERICA, Clifton Blvd., Clifton, N. J. A new design has resulted in a commutator switch which can provide two rows of 180 contacts and one row of 90 contacts in a minimum space. The precision switch, incorporating rectangular contacts precision molded in Supramica 555 ceramoplastic, very easily exceeds the parameters of reliability and noise level achieved by segmented contact rings of p-c plates. **Circle 266 on Reader Service Card.**



Air Compressor and vacuum pump

GREAT LAKES MFG. CORP., 4223 Monticello Blvd., Cleveland 21, Ohio, has developed a compact, two-stage motor driven air pump for use in airborne radar systems, ground support, and electronic test equipment. The pump has a continuous duty cycle and is qualified to customer specification for 1,000 hr minimum life. Operation is entirely oil-free, and requires no lubrication (grease packed

bearing construction). The operating temperature range is −65 F to +200 F. **Circle 267 on Reader Service Card.**

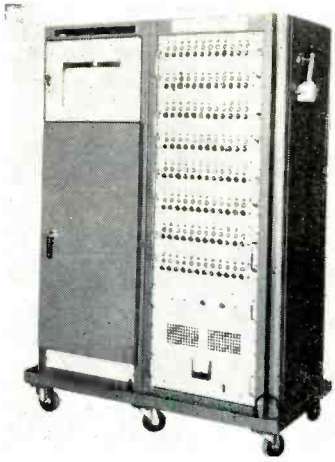


Variable Resistor compact device

CHICAGO TELEPHONE SUPPLY CORP., Elkhart, Ind., has developed a new compact vernier variable resistor with ball bearing rotation designed for fine tuning applications. The contact arm rotates only 1 deg for each 13.5 deg shaft rotation. Total contact arm rotation is 300 deg ±5 deg and total shaft rotation approximately 4,000 deg. Type VA-45 is a 15/16 in. diameter ¼ to ½ w variable composition resistor with only 5/32 in. more depth than standard non-vernier type 45. **Circle 268 on Reader Service Card.**

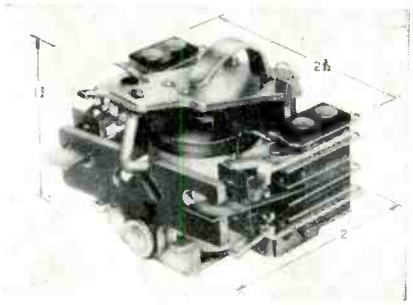
Cable Filler nonconductor

WICOA, INC., Santa Barbara Airport, Goleta, Calif. No-Con cable filler was developed to replace jute, cotton or other similar filler materials for environmental grade military electronic cables, where a high degree of electrical reliability is required over an extended period of time. It is a flexible rod of fungus resistant Vinyl, extruded over a central core of glass fiber, which prevents stretching. Named "No-Con" because it is a nonconductor rod and cannot, in error, be soldered to an electrical connector. **Circle 269 on Reader Service Card.**



Paper Loop System
plots strain vs load

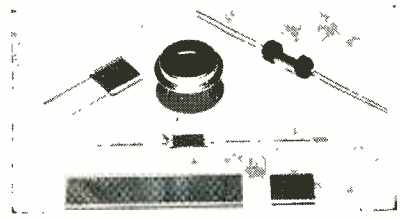
B & F INSTRUMENTS, INC., 3644 N. Lawrence St., Philadelphia 40, Pa., has developed a new strain gage recording and plotting system that plots strain vs load for 24 to 96 strain gage channels on a continuous paper loop. It can be obtained with a digital readout so that strains can be tabulated on a typewriter, IBM cards or punched tape. The paper loop system eliminates folding of chart paper or dumping it into a box; can be run automatically, without operating the printing mechanism, for quick scanning of results. **Circle 270 on Reader Service Card.**



Relay
alternate pulse

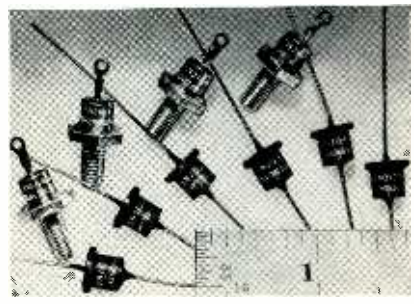
POTTER & BRUMFIELD, INC., Princeton, Ind., has modified an alternate pulse relay for easy installation on long production runs. The relay has also been reduced in size and weight. The original design (designated PC) requires two mounting holes drilled on 2⅝ in. center but a new one-piece frame permits mounting the PA relay with a single bolt in a tapped No. 8-32

core. The PA relay transfers contacts when pulsed for approximately 30 millisec; contacts are returned by the next pulse. No power is required once the contacts transfer. **Circle 271 on Reader Service Card.**



Photoconductive Cells
cadmium sulphide

NATIONAL SEMICONDUCTORS LTD., 146 Bates Road, Montreal 26, Canada, announces new cadmium sulphide photoconductive cells featuring several new physical cells designed to meet the most common mounting problems. They have a power rating considerably superior to previous types. Range of cells now available includes the unsealed types with or without pigtails. Another variety is the head-on type, hermetically sealed by a glass-to-metal seal. Still another is the tubular hermetically sealed cell about 1⅛ in. and ⅜ in. diameter with pigtails. Cells are intended primarily for use in 115 v a-c circuits but have a rating to 220 v a-c maximum. **Circle 272 on Reader Service Card.**



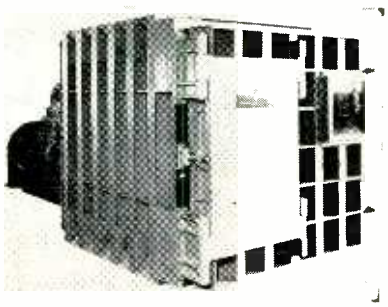
Silicon Rectifiers
high voltage

RAYTHEON MFG. CO., 55 Chapel St., Newton 58, Mass., announces 12 new h-v silicon rectifiers made by the diffused junction process. Working voltage ratings range from 800 to 2,000 v and all types have a maximum drop of 2 v at

the rated working voltage. Types 1N2120 through 1N2125 are in the 0.28 in. diameter case with wire-in construction. Types 1N2140 through 1N2145 are in the small stud package having a 10-32nd thread and $\frac{7}{16}$ in. hex nut. **Circle 273 on Reader Service Card.**

Silicone Rubber
fibrous in nature

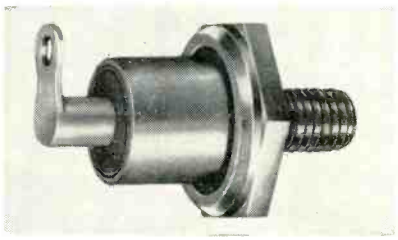
THE CONNECTICUT HARD RUBBER Co., 407 East St., New Haven 9, Conn., has developed Cohrlastic FSR, a mat of silicone rubber fibers, oriented in a completely random manner. This random orientation of fibers results in a product with tensile and tear strength superior to silicone sponge and foam. Other features are high permeability, density in the range of 20 lb/cu ft, good compression-deflection characteristics, and useable temperature range from—65 F to 500 F. **Circle 274 on Reader Service Card.**



Chambers
simulate altitude

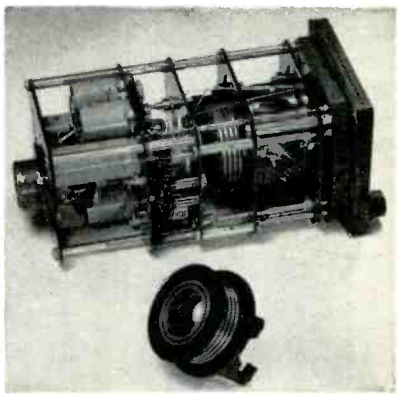
GENERAL VACUUM CORP., 400 Border St., East Boston 28, Mass., has announced the new series 900 high-altitude simulation chambers. Available in sizes from small laboratory units to large walk-in chambers, they simulate altitudes up to 100 miles. The type 988 illustrated

is 6 ft by 6 ft by 7 ft and the pumping system is sized to reach 285,000 ft altitude in 10 minutes. **Circle 275 on Reader Service Card.**



Power Rectifier
heavy-duty

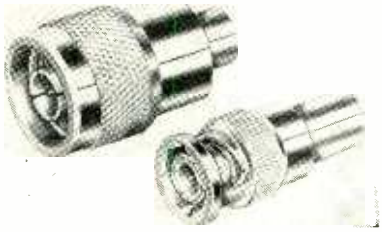
FANSTEEL METALLURGICAL CORP., North Chicago, Ill., announces type 4A heavy-duty 35-ampere silicon power rectifier. Unit carries a full 35-ampere load in half-wave service and up to 100 amperes in bridge circuits. It is available with peak reverse ratings from 50 to 400 v in 50-v multiples, and is applicable to all types of power circuits. It is capable of being operated at ambient temperatures up to 165 C and is unaffected by storage temperatures from −65 to 200 C. **Circle 276 on Reader Service Card.**



Slip Ring Assembly
molded phenolic

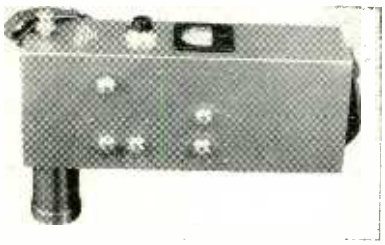
LEAR, INC., 3171 South Bundy, Santa Monica, Calif., announces a molded phenolic slip ring assembly designed for use in the company's automatic flight guidance and control system for private and commercial aircraft. Transfer molding of a phenolic compound provides for insertion of six machined slip rings and soldered-in terminals in a single plastic mold. This eliminates 8 manual assem-

bly operations formerly necessary, as well as an impregnated linen base previously used to cut down moisture absorption. **Circle 277 on Reader Service Card.**



Coax Termination d-c to 10 kmc

MICROLAB, 71 Okner Parkway, Livingston, N. J. A new line of coaxial terminations are miniaturized low power loads designed to operate from d-c to 10,000 mc. They are intended for airborne and other applications requiring compact, light weight components, and consist of a resistive film center conductor terminated within a carefully matched housing. They have a nominal power rating of 2 w which can be increased by providing an external heat sink or forced air cooling. **Circle 278 on Reader Service Card.**



Spectrometer portable unit

RADIATION INSTRUMENT DEVELOPMENT LABORATORY, 5737 S. Halsted St., Chicago 21, Ill. Model 50-8 is a versatile, lightweight unit which may be used for alpha, beta, gamma or neutron detection by a direct interchange of detecting crystals. Unit includes a 1½ in. by 2 in. NaI (T1) crystal, photomultiplier tube, amplifier, pulse height analyzer, count rate meter and pulse generator as well as the necessary batteries. Spectrometer measures approximately 17 in. by 5 in. by 12 in.; weighs 14 lb. **Circle 279 on Reader Service Card.**

Literature of

MATERIALS

Ferrites. General Ceramics Corp., Keasby, N. J., has available a paper on ferrites written by the discoverer of the square-loop ferrite materials which are the heart of the memory in most large high-speed digital computers. **Circle 280 on Reader Service Card.**

Machinable Ceramic. Duramic Products, Inc., 262-72 Mott St., New York 12, N. Y. Bulletin 118 is a one-page data sheet describing grade HT-2-M, a readily machinable high-temperature heat shock resistant ceramic suitable to 2,200 F. **Circle 281 on Reader Service Card.**

COMPONENTS

Servo Amplifiers. Magnetic Amplifiers, Inc., 632 Tinton Ave., New York 55, N. Y., has published an eight-page color brochure entitled "High Power Transistor Magnetic Serv Amplifiers." **Circle 282 on Reader Service Card.**

Variable Transformers. Ohmite Mfg. Co., 3681 Howard St., Skokie, Ill., describes its considerably expanded line of variable transformers in a colorful new bulletin, No. 151. **Circle 283 on Reader Service Card.**

Printed Circuits. Arthur Ansley Mfg. Co., New Hope, Pa., has available a new booklet entitled "Reliability and Cost in Printed Circuits." **Circle 284 on Reader Service Card.**

Ceramic Standoffs. Centralab, a division of Globe-Union Inc., 900 E. Keefe Ave., Milwaukee 1, Wisc. A new catalog of JAN ceramic standoff insulators lists detailed physical specifications and prices on 14 basic styles in a wide range of sizes. **Circle 285 on Reader Service Card.**

Transducers. Rosemount Engineering Co., 4900 W. 78th St., Minneapolis 24, Minn. Short form

the Week

catalog No. 115811 is mainly devoted to a line of temperature probes, with a brief section on deiced pitot-static tubes and precision pressure transducers. **Circle 286 on Reader Service Card.**

Time Delay. Industrial Timer Corp., 1407 McCarter Highway, Newark 4, N. J. A recent catalog bulletin covers the series TH time delay, an adjustable, thermally actuated snap action switching device. **Circle 287 on Reader Service Card.**

EQUIPMENT

Instrument Sensors. Magnetic Circuit Elements, Inc., 3722 Park Place, Montrose, Calif. A family of instrument sensors utilizing magnetic and static elements throughout, and featuring "go, no-go" operation is described in a new bulletin. **Circle 288 on Reader Service Card.**

X-Y Recorder. Houston Instrument Corp., 1717 Clay Ave., Houston 3, Texas. A well-illustrated 4-page folder describes the HR-92, a null-seeking servo-type plotter designed to draw curves in Cartesian coordinates on regular 8½ by 11 paper. **Circle 289 on Reader Service Card.**

Electronic Counters. Northeastern Engineering, Inc., 25 S. Bedford St., Manchester, N. H. A technical data catalog contains illustrations, description and applications of models 14-20A and 14-20AT electronic counters. **Circle 290 on Reader Service Card.**

FACILITIES

Capacitors and Filters. Astron Corp., East Newark, N. J., has published a catalog on its full line of capacitors and filters. The booklet also carries a photographic "guided tour" of the plant that explains product production from researching and engineering to testing and quality control. **Circle 291 on Reader Service Card.**

GE-Phoenix Gets New Plant

FIRST "home base" for GE's two-year-old computer department was recently dedicated in Deer Valley Park, Phoenix, Ariz. This brings together under one roof most of the operating functions of the department which previously had been housed in widely scattered locations in the Valley.

The new 104,000-sq-ft, $1.5-million headquarters and laboratory building will house approximately 700 executives, engineers and office workers. Even as this building was being dedicated, workers were in their second week of construction on an 87,000-sq-ft manufacturing facility behind the structure. Completion of this in September—plus the company's 50,000 sq ft of leased space and 10,000 sq ft in the Computer Center on the Arizona State U. campus—will give GE almost 250,000 sq ft in the Phoenix area.

Speaking at the official dedication, department general manager Clair C. Lasher said GE formed a computer department a little over two years ago when it became apparent industries the company served had developed a need for them. "The market for computers in these industries—industrial, transportation, and utility—developed slowly, compared to the market for computers used as business machines", he said.

He pointed out the department is presently working on an order backlog of around $50 million. "Our 1958 sales were double those of the previous year, and I expect our sales this year to be about twice that amount. We expect to add about 500 more employees during 1959, bringing our total to around 1,500. Approximately 50 percent of the added personnel will be in manufacturing, with product service being the next largest growth area."

Name Birochak Production Mgr.

EDWARD BIROCHAK has been appointed production manager for Weinschel Engineering Co., Inc., and for its subsidiary, Weinschel Engineering and Mfg. Corp., Kensington, Md., manufacturers of precision electronic testing equipment.

Prior to joining Weinschel Engineering in 1957, Birochak was employed for eight years at the standards and calibration section of the measurement development branch at Wright Air Development Center, Dayton, Ohio. There he was responsible for the development of microwave standards for power, impedance, attenuation and frequency measurement.

Itek Corporation Names V-P

APPOINTMENT of John H. Carter as vice president of Itek Corp., Waltham, Mass., is announced. He had been weapons systems manager of Lockheed Aircraft Corporation's satellite program since 1957.

With Itek, Carter's responsibilities will include the organization and operations of Vidya, Inc., which is being set up under Itek sponsorship for R&D work in the fields of aerophysics, electronics and thermodynamics. He will also represent Itek in its dealings with West Coast military centers and industries.

Barr Moves to Sales at Van Norman

APPOINTMENT of Paul Barr to the position of chief sales engineer at Van Norman Industries, Inc., Manchester, N. H., is announced. He will be responsible for liaison between Van Norman engineering and governmental and industrial purchasers of the company's electromechanical test instruments and systems.

Barr, formerly a senior project engineer, was active in the design

Two New oscilloscopes each with 3.5-millimicrosecond risetime

TEKTRONIX

TYPE 581

The new Tektronix Type 581 is a general-purpose oscilloscope with excellent transient response and high-speed sweeps. Risetime is 3.5 mμsec and sweep time is calibrated to 0.01 μsec/cm. Passband is dc to approximately 100 mc.

The vertical deflection system is designed for plug-in preamplifiers. A low-capacitance probe is an integral part of the Type 80 Plug-In Preamplifier, which provides a calibrated deflection factor of 0.1 v/cm. Sufficient signal delay is included in the main vertical amplifier to permit displaying the leading edge of the waveform under observation.

The wide sweep range of the Type 581 includes calibrated sweeps fast enough to take advantage of its risetime capabilities. Calibrated sweeps from 0.05 μsec/cm to 2 sec/cm are available in 24 steps, and a 5-x magnifier increases the calibrated range to 0.01 μsec/cm. Sweep time is continuously adjustable from 0.01 μsec/cm to 5 sec/cm. Versatile triggering includes amplitude-level control, and preset stability for operating convenience. Lockout-reset circuitry provides for one-shot sweep operation.

A new Tektronix cathode-ray tube with distributed-type vertical-deflection plates is used in the Type 581. 10-kv accelerating potential assures a bright trace, even at low sweep-repetition rates. An amplitude calibrator is also incorporated in the Type 581, with square-wave output from 0.2 mv to 100 v in 18 steps.

TYPE 585

The Tektronix Type 585 has, in addition to the identical general specifications of the Type 581, a second time base generator. This time-base generator, designated TIME BASE B, acts as a delay generator, providing a wide range of calibrated sweep delay. Two modes of sweep delay are available—triggered (delayed sweep is started after the delay period by the signal under observation), and conventional (delayed sweep is started at the end of the delay period by the delayed trigger). Calibrated sweep delay is continuously variable over the range of 1 μsec to 10 sec. Color-correlated controls eliminate confusion, making this new high-performance oscilloscope easy to operate.

PRICES

TYPE 581, without plug-in units **$1375**
TYPE 585, without plug-in units **$1675**
TYPE 80 Plug-In Preamplifier, with Probe **$ 150**

(Other plug-in preamplifiers are currently in development.)

Prices f.o.b. factory.

Tektronix, Inc.

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TEKTRONIX ENGINEERING REPRESENTATIVES: Hawthorne Electronics, Portland, Oregon., Seattle, Wash.; Hytronic Measurements, Denver, Colo., Salt Lake City, Utah.

Tektronix is represented in 20 overseas countries by qualified engineering organizations.

of the company's vhf/uhf sweep generator and the design of a test set for missile relay testing. He was also in charge of the development of advanced types of precision indicating meters.

Name President at Arnoux Corp.

NEWLY appointed president of Arnoux Corp., Los Angeles, Calif., is Richard W. Hodgson. He moves up from the position of executive vice president of the corporation.

Prior to joining Arnoux, Hodgson was chief of the engineering test department of Radioplane Co.

Granger Names J. T. Bolljahn

JOHN T. BOLLJAHN leaves his post as assistant director of engineering research at Stanford Research Institute to become executive vice

president of Granger Associates, Palo Alto, Calif.

Anticipated expansion of production facilities and increased contract work faced by the firm, which specializes in electronic systems, will immediately benefit from Bolljahn's participation and guidance, according to John V. N. Granger, president of the organization.

News of Reps

Santa Barbara Instrumentation Corp., Santa Barbara, Calif., announces six new reps for its line of miniature recorders and components. New reps and areas covered are as follows:

Emory Design & Equipment Co.—Florida, Alabama, Georgia and western Tennessee; **The Candor Co.**—North and South Carolina, and southern Virginia; **Thomas M. Mills Co.**—Pennsylvania and New Jersey; **The Norwest Co.**—Seattle, Wash.; **Roland Olander Co.**—southern California, excluding San Diego; **William H. Denny Co.**—San Diego.

Sales representation in the state of Michigan for Telemeter Magnetics, Inc., of Los Angeles, Calif., has been assigned to **Anderson Electronics Co.**, of Roseville, Mich.

Walter Barth has joined the sales staff of **S. A. Shaw Co.**, manufacturers' reps, of Yonkers, N. Y. He will call on industrial and military accounts for the firm which represents General Transistor, Sonotone, Sarkes Tarzian and Illinois Condenser.

Waters Mfg., Inc., Wayland, Mass., appoints **Simberkoff Sales Co.** of Hoboken, N. J., as its rep for the sales of Waters potentiometers, components and instruments in New York State excluding greater New York City and Long Island.

Ridgway Engineering, Inc. of Chicago, Ill., has been appointed as sales rep for Baird-Atomic, Inc., Cambridge, Mass. Rep firm handles B-A's transistor testing and semiconductor testing equipment lines in Indiana, Illinois, Wisconsin, western Kentucky and eastern Iowa.

COMMENT

Teflon Dangers?

We quote from ("Hot Iron Unharnesses Teflon-Covered Wire," p 77, Jan. 30):

"Wiring harnesses made up of Teflon-covered wire may be quickly opened by taking advantage of the heat resistance of the plastic. Originally, the harness is wrapped with a fabric or plastic with a melting temperature below 500 F. To open the harness for repair or replacement of a wire, the tip of a heated soldering iron is applied to the lacing. The lacing will burn off without affecting the sleeving, according to Polymer Corporation, Reading, Pennsylvania, a manufacturer of Teflon spaghetti tubing."

Also quoted is an article from the November 1958 issue of *Digest*, U. S. Naval Aviation Electronics, p 11.

"At normal temperatures Teflon is certainly one of the most inert substances known; it is used therapeutically for replacement of hip bearing in humans, for example.

"However, when heated to temperatures in the ranges of 550 to 580 F, the rate at which fumes are given off becomes sufficiently high that real danger to humans may exist. In fact, COMNAVAIRLANT Notice 5101 of 17 June 1958, states that death can result from inhaling fluorine compounds which can be released from even small pieces of heated Teflon. Such compounds may be released if Teflon is heated above 400 F. Extreme caution should be exercised to remove any Teflon chips, particles or dust from hands and clothing before smoking. The smoking of cigarettes contaminated by chips or dust of Teflon is most definitely not recommended.

"It is not known just what chemical (or chemicals) produced is the primary offender; hydrofluoric acid, which is used to etch glass, is known to be less toxic than the offending chemicals given off.

"Unfortunately, smaller concentrations than are required to produce a warning irritation may be harmful.

"Under severe overload conditions which result in wires burning their insulation, toxic fumes are given off from insulating materials such as silicones, vinyls, (wool) and

rubbers. Though Teflon is thought to be somewhat more toxic than other materials once overheated, it does not give off toxic fumes until heated to a much higher temperature than competitve products.

"The following precautions are dictated by common sense: 1) insure adequate precautions to prevent overheating of articles containing Teflon; 2) observe scrupulous cleaning procedures to properly dispose of Teflon scraps; 3) avoid breathing fumes if overheating occurs; 4) solder Teflon-insulated wire in adequately ventilated spaces only."

We believe the two quotes may represent a contradiction which may well affect safety of personnel.

S. F. HOGGE
ARINC RESEARCH CORP.
WASHINGTON, D. C.

Reader Hogge's letter went also to W. J. Davis, product development manager of Polymer Corporation of Pennsylvania, who sent this reply:

I might say first that there has been much unsupported publication and speculation regarding the toxic effects of fumes given off by the decomposition of Teflon. Unfortunately, this type of activity ofttimes generates erroneous popular opinions which become accepted as actualities.

I would like to point out that making some logical assumptions one can calculate the amount of gaseous products evolved in melting off the lacing on bundles of Teflon-covered wire. Assuming that the gases evolved are confined to one cubic foot of air, such calculations would indicate a concentration of less than one-tenth of a part per million. This is an exceedingly small amount and obviously would not be confined to an area so small as one cubic foot. A check of health regulations on the most reactive fluorine contaminates such as hydrofluoric acid shows a maximum allowable concentration for an eight-hour day of three parts per million. Keep in mind that this is a continuous three ppm for eight hours, whereas in the lace cutting operation 0.1 ppm exists only momentarily.

W. J. DAVIS
POLYMER CORP. OF PENNSYLVANIA
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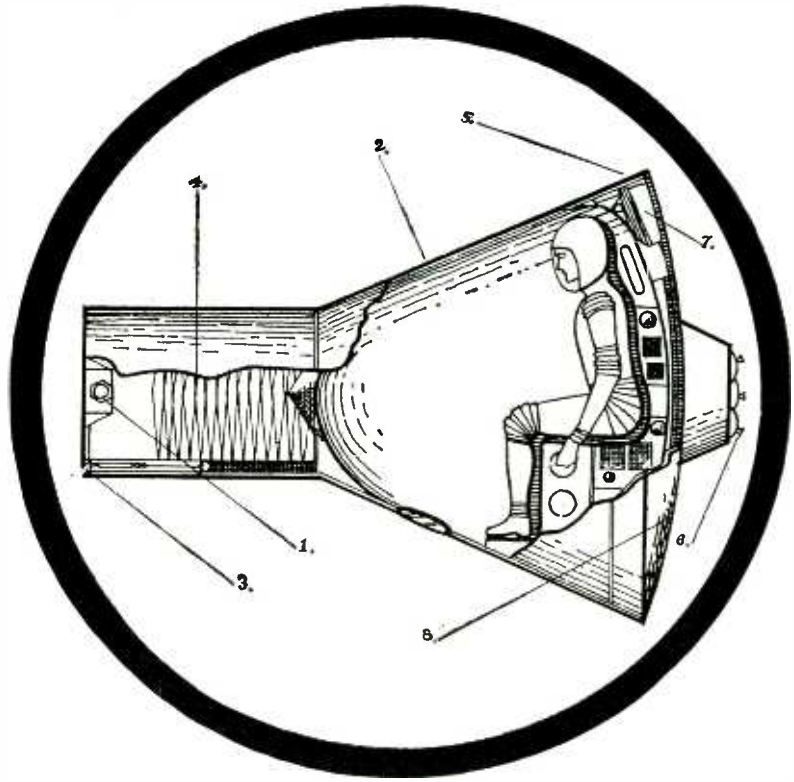

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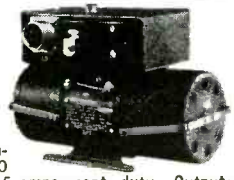

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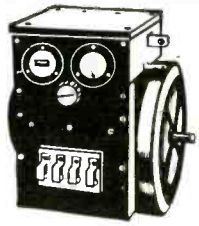

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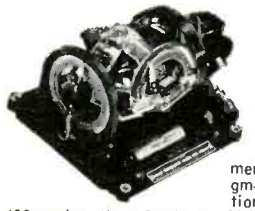
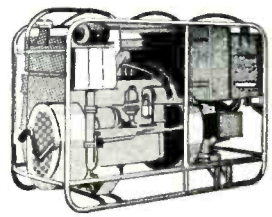


115 volts, 400 cycles, single phase, 35 watts. Pitch and roll potentiometer pickoffs 890 ohms, 40 volts max. AC or DC. Speed 20,000 rpm, ang. momentum 12,500,000 gm-cm ²/sec. Erection system 27 VAC, 400 cycles, time 5 min. to ½°. Weight 5.5 lbs. Price **$35.00** each

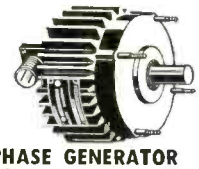


POWER UNIT PU-104/U

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**

400 CYCLE PM GENERATOR

115/200 volts A.C. 1- or 3-phase, 200 watts. 4,000 r.p.m. Approx. dimensions: 4¾" dia.; 3" long; ½" shaft, AN connector. **$75.00**



400 CYCLE ⅓ PHASE GENERATOR

115 VAC. 3 KVA. Mfg. Bogue Elect. Mod. 2800S. External excitation 107 VDC. 1.1 amp. 3450 rpm 1" shaft. **$200.00**

MINNEAPOLIS-HONEYWELL RATE GYRO (Control Flight)

Part no. JG7005A, 115 volts A.C., 400 cycle, single phase potentiometer take off resistance 530 ohms. Speed 21,000 r.p.m. Angular momentum 2½ million, CM²/sec. Weight 2 lbs. Dimensions 4-7/32 x 3-29/32 x 3-31/64. **Price $22.50**

VARIABLE SPEED BALL DISC INTEGRATORS

No. 145

Forward & Reverse 2¼-0-2¼. Input shaft spline gear 12 teeth 9/32" dia. ⅜" long. Output shaft 15/64" dia. x 15/32" long. Control shaft 11/32" x ⅜" long. Cast aluminum construction. Approx. size 3" x 3" x 2¾" **$17.50**

No. 146

Forward & Reverse 4-0-4. Input shaft 5/16" dia. x ¾" long: Output shaft 15/64" dia. x 9/16" long. Control shaft 11/64" dia. x 11/16" long. Cast aluminum construction. Approx. size 4½" x 4½" x 4". **(All Shafts Ball Bearing Supported)**

$18.50 ea.

SMALL DC MOTORS

(approx. size overall 3¾" x 1¼" dia.:)

5067043 Delco 12 VDC PM 1" x 1" x 2", 10,000 rpm.	$7.50
5067126 Delco PM, 27 VDC, 125 RPM, Governor Controlled	15.00 ea.
5069600 Delco PM 27.5 VDC 250 rpm	12.50
5069230 Delco PM 27.5 VDC 145 rpm	15.00
5068750 Delco 27.5 VDC 160 rpm w. brake	6.50
5068571 Delco PM 27.5 VDC 10,000 rpm (1x1x2")	5.00
5069790 Delco PM, 27 VDC, 100 RPM, Governor Controlled	15.00 ea.
5072735 Delco 27 VDC 200 rpm governor controlled.	15.00
5BA10A118 GE 24 VDC 110 rpm	10.00
5BA10AJ37 GE 27 VDC 250 rpm reversible	10.00
5BA10AJ52 27 VDC 145 rpm reversible	12.50
5BA10AJ50, G.E., 12 VDC, 140 rpm	15.00
5BA10FJ401B, G.E. 28 VDC, 215 rpm, 10 oz. in., .7 amp. contains brake	15.00
5BA10FJ421, G.E. 26 VDC, 4 rpm, reversible, 6 oz. in., .65 amp	15.00
S. S. FD6-21 Diehl 24 VDC PM 10,000 rpm. 1" x 1" x 2".	4.00

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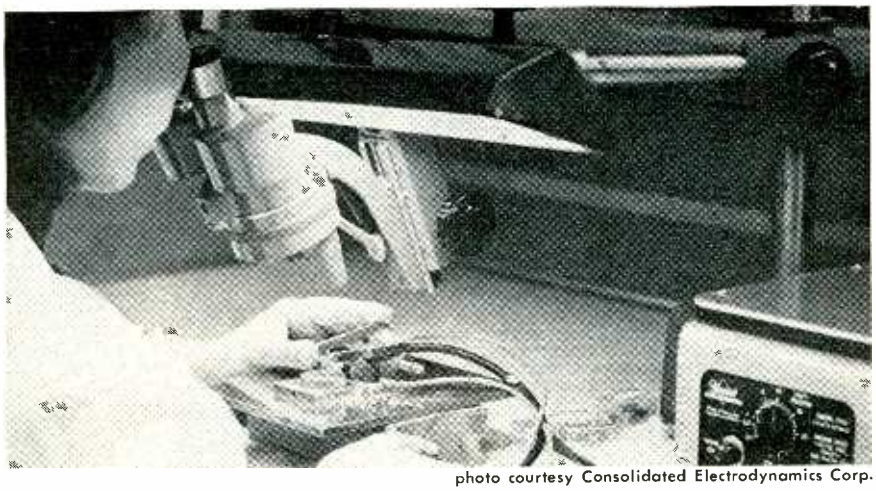

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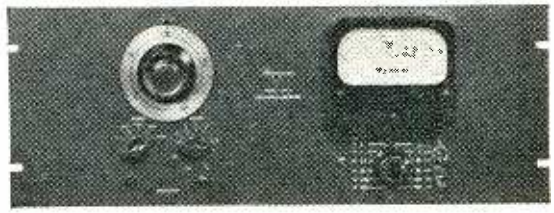

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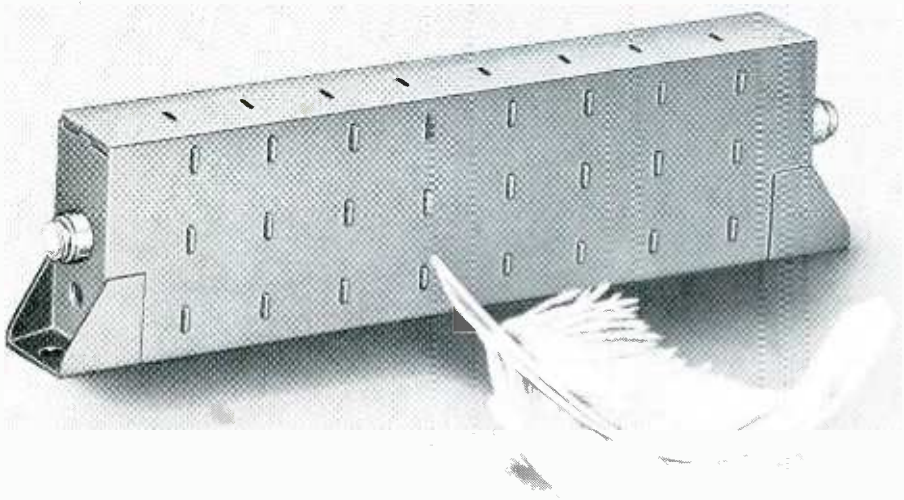

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Thumb through any stack of entertainment-equipment circuits. Go back a dozen years. Note the rf, if, af, and limiter stages and you'll find one thing especially common to a large number of the circuits... the 6AU6, an RCA original. As the result of continuing efforts to offer quality typical of all Preferred Tube Types, the RCA-6AU6 is still a steady design favorite. Here are some of the latest reasons why.

RCA-6AU6 is rugged... larger-than usual cathode diameter and rigid fit of the mica supports to the cage assembly increase sturdiness and reduce microphonics.

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