electronics

SEPTEMBER 1, 1957

A McGRAW-HILL PUBLICATION
PRICE ONE DOLLAR

AUTOMATIC STATION CHANGEOVER

. . . page 138

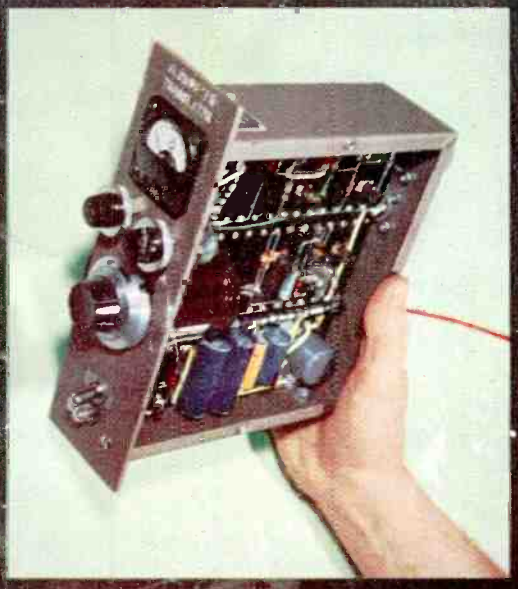
Video Recorder for Radar

. 146

Transistorized Teletypewriter

. . 150

TRANSISTORS METER JET FUEL FLOW



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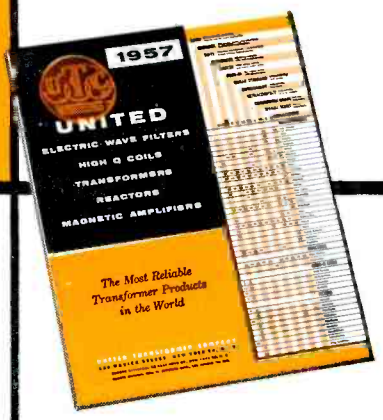

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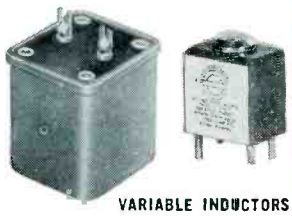

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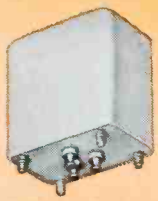
Hermetic, MIL-T-27A
Highest Q, accuracy and stability



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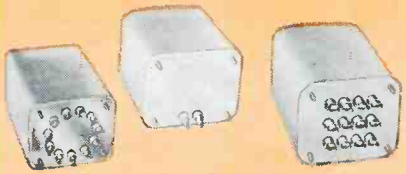
BAND PASS FILTERS
Hermetic, MIL-T-27A

AUDIO COMPONENTS
Hermetic, MIL-T-27A
for every application



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Power, Plate, Filament Transformers,
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Transistor transformers .1 oz.
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TRANSFORMERS
Wound Cord, MIL-T-27A

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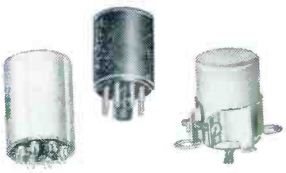
TRANSFORMERS
Audio and
Transistor



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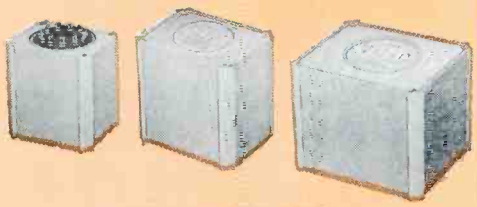
Wide Range Audios

EQUALIZERS
Broadcast and Hi-Fi



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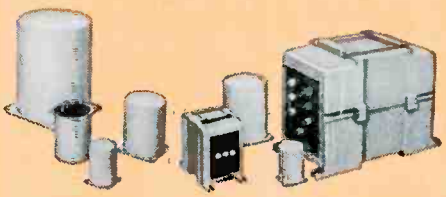

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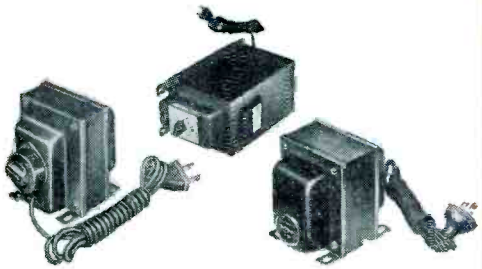

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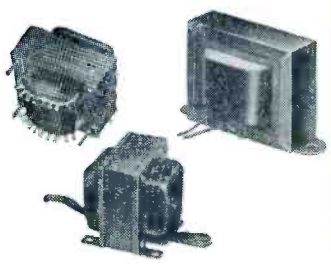

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electronics

SEPTEMBER 1 • 1957

A McGRAW-HILL PUBLICATION

TRANSISTORS METER JET FUEL FLOW—Impulse signal from flowmeter in J-57 jet engine's primary pump outlet is translated by transistorized unit into d-c signal proportional to rate of fuel flow; translator output is monitored visually or recorded for later analysis. Test installation is at United Aircraft's Pratt & Whitney division in East Hartford, Conn. (See p 194) ..... COVER

CONTINUED ON NEXT PAGE

contents

continued

SHOP

▶THIS MONTH'S COVER . . . It shows a Pratt and Whitney J-57 jet engine and the transi ized jet fuel translator that m ures the rate of fuel flow. The latter was designed at the electronics section of the Pratt and Whitney Division of United Aircraft, E. Hartford, Conn.

Arnold Waterman, who heads up the section that designed the instrument, has been a reader of ELECTRONICS since he graduated from college in 1936.

He has back issues for twenty years stored in his attic. This has insured a certain modicum of privacy for perusal and avoids copies being mislaid in other parts of the household.

Recently he noticed that the weight is causing the ceiling below to sag. Faced with the choice of getting rid of back issues or reinforcing the ceiling, he decided in favor of our magazine.

▶PRECIOUS COMPRESSION . . . The October 1 issue will contain a comprehensive 28-page Special Technical Report on Miniaturization. In doing research for the article, associate editor Findlay received manufacturers' prices on some of the smallest of the small in components.

There seems to be an inverse square relationship between price and size.

After studying data, which included potentiometers of less than 0.25 cubic inch selling for $6.50 and

electronics

SEPTEMBER 1, 1957 Vol. 30, No. 9

Member ABC and ABP

TALK

interstage transformers of 0.375 cubic inch for 15 dollars each, the staff decided to build (on paper) transistor portable using the smallest parts.

Our cost estimate ran to $474.00 including batteries and headphones; size estimate is on the order of a regular-size cigarette package. This figures out to a cost of $82 per cubic inch.

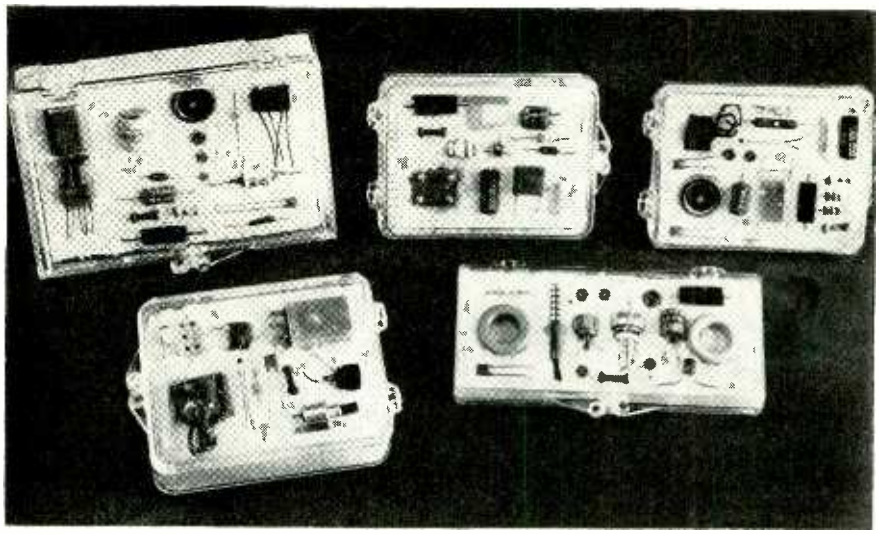
►REMEMBER THE COHERER . . . Not many electronic engineers are left who had first-hand experience with the coherer of the early days of radio. At least 60,000 coherers have been put into operation in the world during the past year, however.

We stumbled across the story last fall, but didn't recognize it immediately. While doing some Christmas shopping, associate editor Manoogian found a radio-controlled bus in a toy store. Containing no tubes or transistors, it seemed worth investigating. Best he could obtain from the store manager was an instruction booklet that contained the basic circuit.

The transmitter was readily identified as a spark transmitter, complete with spark gap and short antenna. The receiver circuit had a small rectangle drawn between antenna and ground, which we assumed to be a diode "detector". But that's all we had of data.

Quite by coincidence a Japanese engineer, Tatsuo Tsuboi, stopped in a short time later and saw Haig about getting some technical information on tube characteristics. He didn't know about the bus circuitry but promised to get more data when he returned to Japan.

He did a good job and the technical story appears in *Electrons At Work*, in this issue. He tells us that the confusing symbol is that of the coherer. Like the old-time device, it consists of a glass envelope having electrodes at both ends, and containing nickel powder. It conducts when the radio signal is picked up, so that the batteries operate the relay and then the motor. The motor is arranged mechanically to tap the glass and disturb the line-up of metallic particles to break the circuit and set it for the next impulse. This provides the decohering action.



DUAL PURPOSE, to serve as a display for edification of visiting engineers to our editorial offices, and to prevent losing any of the tiniest components, supplied by manufacturers for our Special Technical Report on Miniaturization for the October 1 edition, the editors mounted the units in plastic boxes as shown above

►MENTIONS ABROAD . . . From Copenhagen, one of our correspondents, Else Balslev, tells us about *Danske Radio Industri*, a quarterly review of the Danish Association of Radio Manufacturers.

As part of its service to subscribers this review runs a column called "Transistor Literature" which calls attention to articles of interest in other magazines. In the June number, there are 36 articles from ELECTRONICS mentioned. These were published in issues from February to May of this year.

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Single copies $1.00 for Technical Edition and 50¢ for Business Edition in United States and possessions, and Canada; $2.00 and $1.00 for all other foreign countries. Buyers' Guide $3.00. Subscription rates—United States and possessions, $6.00 a year; $9.00 for two years. Canada, $10.00 a year, $16 for two years. All other countries $20.00 a year, $30.00 for two years. Three-year rates accepted on renewals only, are double the one-year rate. Entered as second-class matter August 29, 1936, at the Post Office at Albany, N. Y., under act of Mar. 3, 1879. Printed in U.S.A. BRANCH OFFICES: 520 North Michigan Avenue, Chicago 11; 68 Post Street, San Francisco 4; McGraw-Hill House, London E. C. 4; National Press Bldg., Washington, D. C. 4; Architects Bldg. 17th & Sansom Sts., Philadelphia 3; 1111 Henry W. Oliver Bldg., Pittsburgh 22; 1510 Hanna Bldg., Cleveland 15; 856 Penobscot Bldg., Detroit 26; 3615 Olive St., St. Louis 8; 350 Park Square Bldg., Boston 16; 1321 Rhodes Haverty Bldg., Atlanta 3; 1125 West Sixth St., Los Angeles 17; 1740 Broadway, Denver. ELECTRONICS is indexed regularly in The Engineering Index.

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Regulation accuracy is within a maximum tolerance of .5%*, and ripple is held to five millivolts RMS or below (except for 20 mv. maximum on the 200-1000 VDC model). Input range is 105 to 125 VAC, with frequency of 50, 60, or 400 cycles. B-Nobatrons may be used in either cabinet or rack mountings, and are a handsome contribution to their quarters. Your local Sorensen representative will be glad to tell you all about these B-Nobatrons. Write directly for technical data, to

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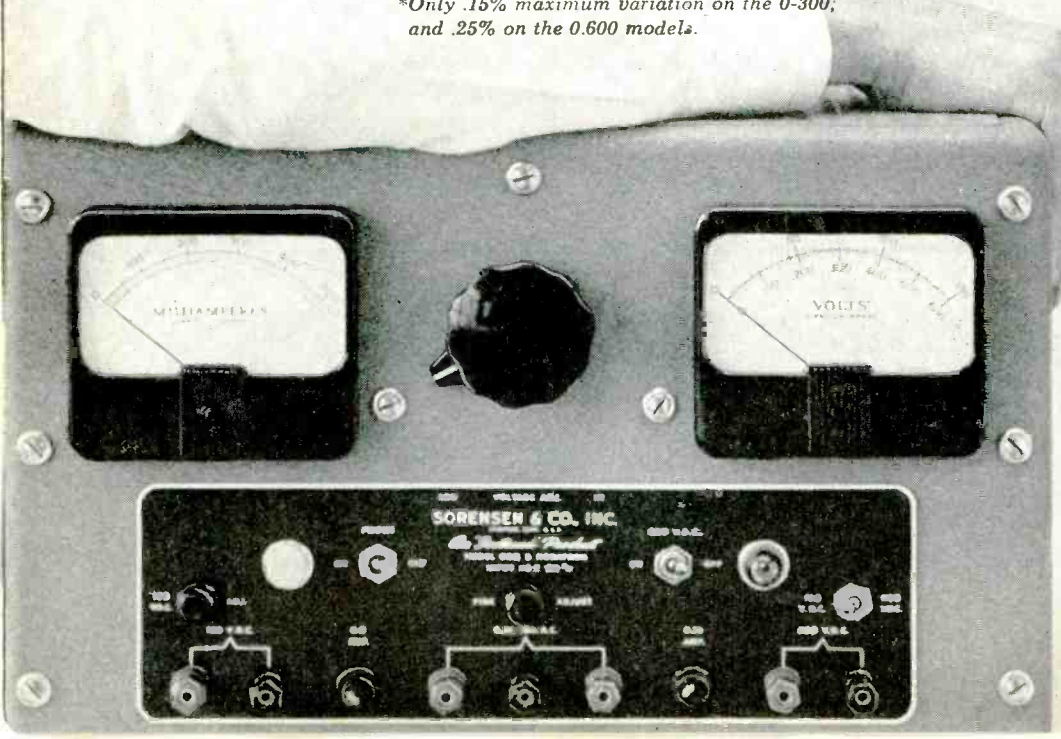
**Only .15% maximum variation on the 0-300, and .25% on the 0.600 models.*

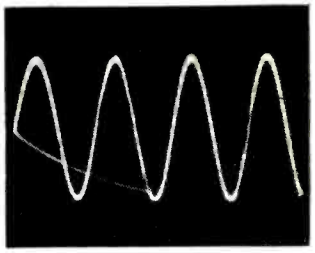


SPECIFICATIONS

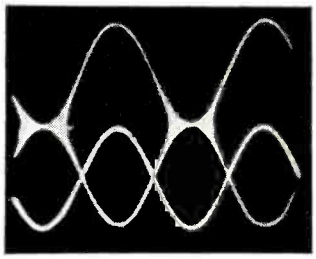
Model	300B*	325B	500B	600B	100
Output Voltage VDC	0-300	0-325	0-500	0-600	200
Output Current Ma	0-150	0-125	0-300	0-500	0-5
Regulation Accuracy	±0.15%**	±0.5%	±0.5%	±0.25%	±0
Ripple (MV RMS)	5 max.	5 max.	5 max.	3 max.	20 n
Bias Supply (VDC)	—	0-150	0-150	0-150	–
Max. Bias Circ. Imp. (Ohms)	—	25000	25000	50000	–
Max. Int. Imp. (Ohms)	2.0	2.0	2.0	2.0	2
AC Voltage (CT Unreg.)	—	6.3/10 amps	6.3/10 amps	6.3/15 amps	–
Filament Voltages (Unreg.)	6.3 at 5 amps, series or parallel (two outputs)	—	—	—	–

**may be connected positive or negative, in series or pa*
***or ±0.3 volts, whichever is greater*

Sorensen



Test Oscillogram 15 kc Unmodulated Carrier showing good waveform.



Test Oscillogram 320 kc Carrier modulated at 400 cps—audio source on lower trace shows fidelity.

MARCONI

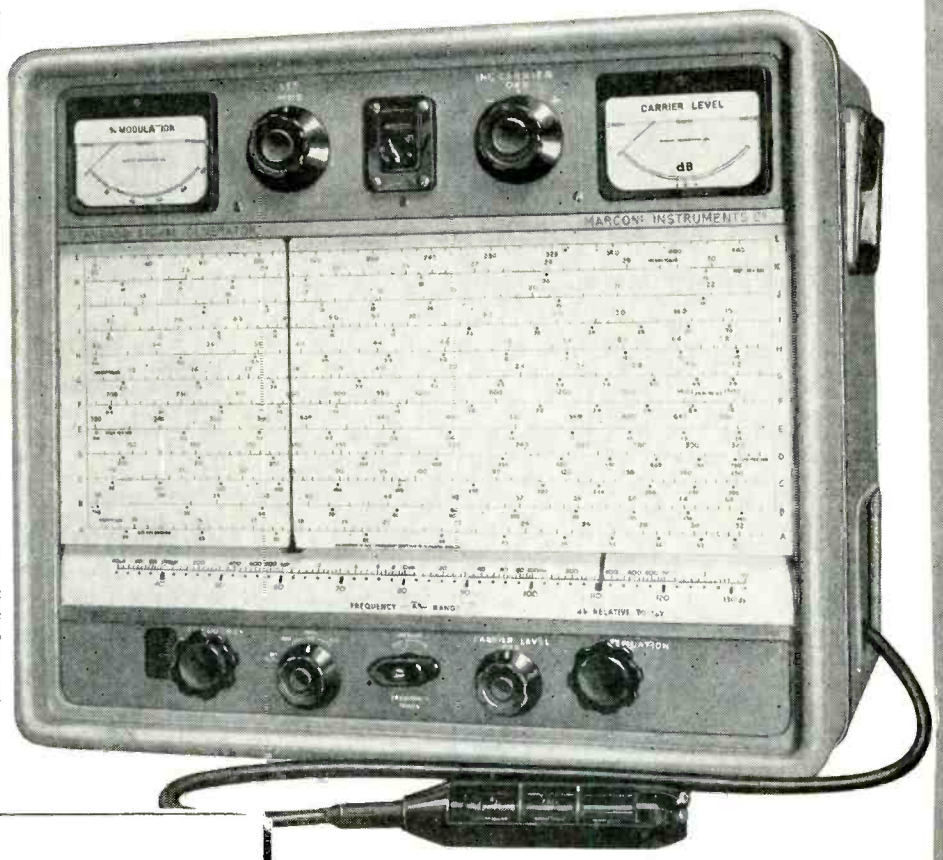
Standard Signal Generator

MODEL TF 867

UNDISTORTED 100% MODULATION

AM WITHOUT FM

A signal generator also ideal as a video oscillator for wide-band television systems.



Precise high-quality a.m. with truly negligible f.m. Rock-steady carrier frequency for narrow-band testing. Other features include:

WIDE RANGE

15 kc to 30 mc on 15 ft. high-discrimination full-vision scale.

CRYSTAL ACCURACY

0.01% with built-in 1 mc harmonic source.

HIGH OUTPUT

4 volts down to 0.4 microvolts.

FLEXIBLE MODULATION

Internal 400 and 1,000 cps; external 50-10,000 cps within a db.

Also incorporated: Automatic level control, overall negative feed-back from r.f. output to modulation input, modulation monitoring by dual rectification, and variable impedance termination with animated diagram.

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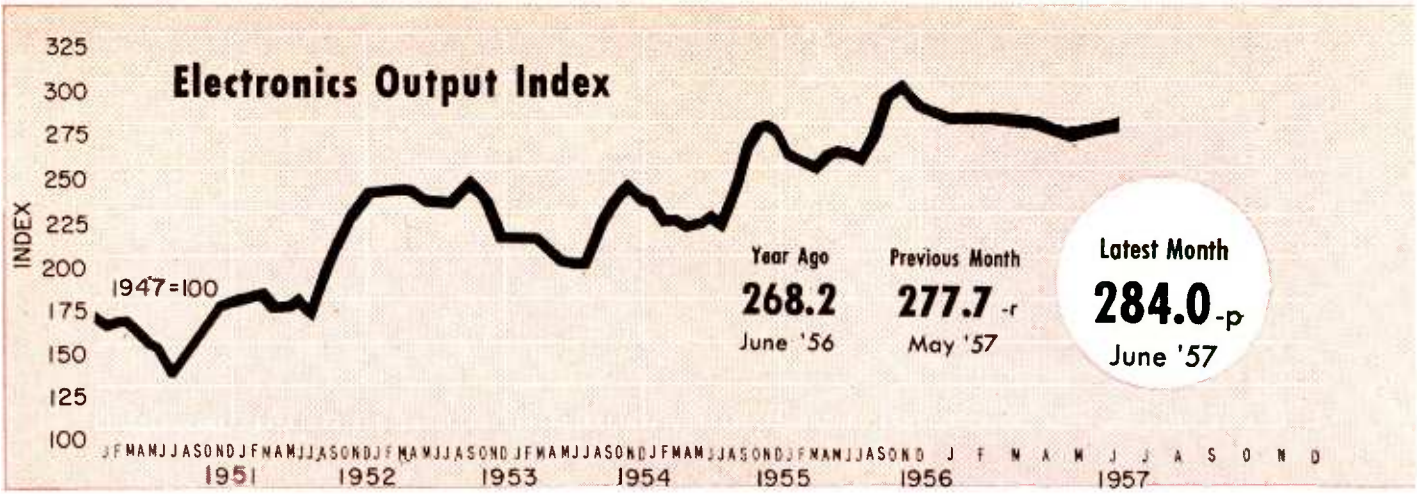


FIGURES OF THE MONTH

RECEIVER PRODUCTION

(Source: RETMA)	Latest Month June '57	Previous Month May '57	Year Ago June '56
Television sets, total	543,778	342,386	553,025
With UHF	72,766	41,596	78,512
Color sets	nr	nr	nr
Radio sets, total	1,088,343	1,023,771	1,073,775
Auto sets	416,058	396,151	296,256

RECEIVER SALES

(Source: RETMA)	June '57	May '57	June '56
Television sets, units	389,770	399,757	439,362
Radio sets (except auto)	729,421	547,480	839,830

RECEIVING TUBE SALES

(Source: RETMA)	June '57	May '57	June '56
Receiv. tubes, total units	35,328,000	32,836,000	39,037,000
Receiv. tubes, value	$31,314,000	$28,955,000	$32,176,000
Picture tubes, total units	1,104,013	758,328	776,601
Picture tubes, value	$19,981,319	$14,031,519	$13,663,408

INDUSTRIAL TUBE SALES

(Source: NEMA)	Quarterly Figures: Latest Quarter 1st '57	Previous Quarter 4th '56	Year Ago 1st '56
Vacuum	$11,224,707	$12,408,371	$8,754,054
Gas or vapor	$3,332,357	$3,223,612	$3,394,059
Magnetrons and velocity modulation tubes	$15,359,108	$15,890,681	$15,136,522
Gaps and T/R boxes	$1,409,463	$1,242,745	$1,455,558

MILITARY PROCUREMENT

(Source: Defense Dept.)	1st '57	4th '56	1st '56
Army	$69,381,000	$56,185,000	$40,490,000
Navy	$21,426,000	$34,210,000	$28,700,000
Air Force	$159,829,000	$145,962,000	$124,828,000
Total—Electronics	$250,636,000	$236,357,000	$194,018,000

BROADCAST STATIONS

(Source: FCC)	Latest Month June '57	Previous Month May '57	Year Ago June '56
TV stations on air	519	519	496
TV stations CPs—not on air	132	126	113
TV stations—new requests	79	77	43
A-M stations on air	3,079	3,060	2,896
A-M stations CPs—not on air	159	167	124
A-M stations—new requests	322	311	274
F-M stations on air	530	532	530
F-M stations CPs—not on air	31	27	16
F-M stations—new requests	24	21	10

COMMUNICATION AUTHORIZATIONS

(Source: FCC)	June '57	May '57	June '56
Aeronautical	49,699	53,413	48,745
Marine	63,844	63,025	56,915
Police, fire, etc.	23,270	23,103	20,718
Industrial	35,711	35,313	30,597
Land transportation	9,592	9,580	8,990
Amateur	160,000	162,533	150,549
Citizens radio	27,931	26,930	18,602
Disaster	347	352	327
Experimental	788	783	706
Common carrier	2,790	2,731	2,308

EMPLOYMENT AND PAYROLLS

(Source: Bur. Labor Statistics)	May '57	April '57	May '56
Prod. workers, comm. equip.	384,500-p	380,300-r	381,900
Av. wkly. earnings, comm.	$78.60 -p	$79.19	$75.14
Av. wkly. earnings, radio	$76.21 -p	$76.61	$72.22
Av. wkly. hours, comm.	40.1 -p	40.2	40.4
Av. wkly. hours, radio	39.9 -p	39.9	39.9

SEMICONDUCTOR SALES ESTIMATES

	June '57	May '57	June '56
Transistors, Units	2,245,000	2,055,000	1,130,756

STOCK PRICE AVERAGES

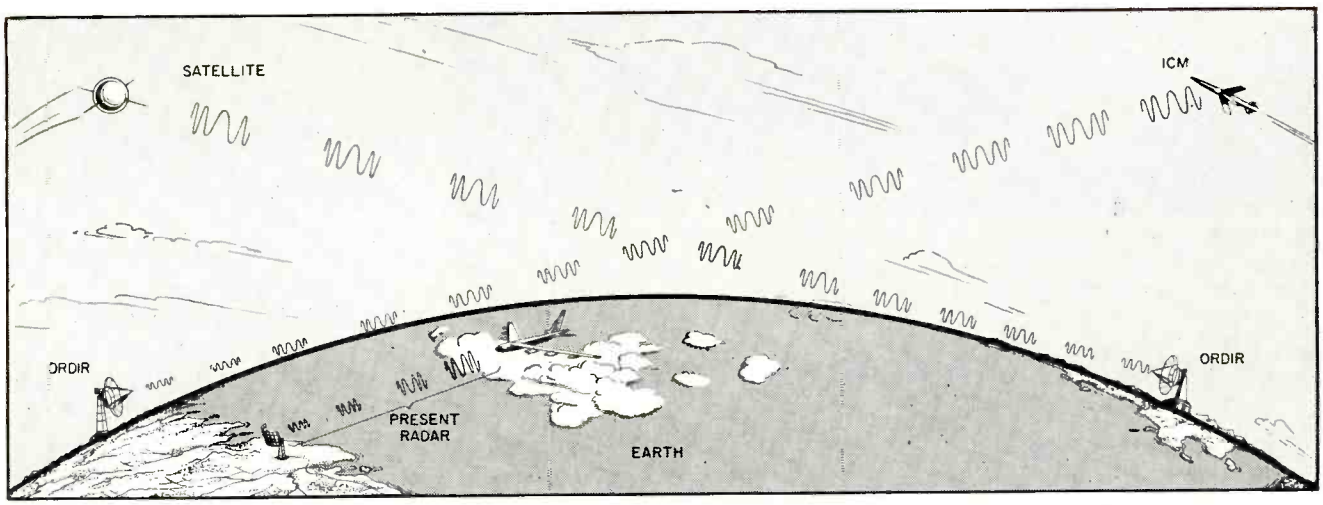
(Source: Standard and Poor's)	June '57	May '57	June '56
Radio-tv & electronics	51.42	51.69	57.73
Radio broadcasters	66.56	69.18	68.60

p—provisional r—revised nr—not reported

FIGURES OF THE YEAR

TOTALS FOR THE FIRST SIX MONTHS		
1957	1956	Percent Change
2,722,139	3,415,202	—20.3
7,187,294	6,659,165	+ 7.9
2,810,403	2,868,250	— 2.0
3,638,969	3,391,102	+ 7.3
221,175,000	227,656,000	— 0.3
3,814,659	5,152,743	—26.0

Television set production
Radio set production
Television set sales
Radio set sales (except auto)
Receiving tube sales
Cathode-ray tube sales



ORDIR, for OmniRange Digital Radar, is the name given a new radar technique using f-m that is also applicable to pulsed systems and may be applied to radar system engineering as . . .

Signal-Enhanced Radar Adds DX, Plies Outer Space

Technique makes feasible radar tracking of earth satellites and intercontinental missiles

RESULTS of a three-year research program on ORDIR at Columbia University, sponsored by Rome Air Development Center, USAF, have been partially disclosed. Most encouraging and noteworthy fact is that the scientists engaged in this work were able to successfully dodge around the basic radar receiver sensitivity limit—noise. Exactly how done is still classified information.

► **System Characteristics** — The new technique may best be explained by resorting to a lock and key analogy given by John Bose, former assistant to Major Armstrong. The radar transmitter contains a specially designed modulator that places a certain identifying characteristic (key) on the f-m/c-w carrier. The received echo is operated on by special circuits (tumblers) in the receiver (lock) which enable the signal to be recognized even though its signal strength is many times less than that usable by present systems.

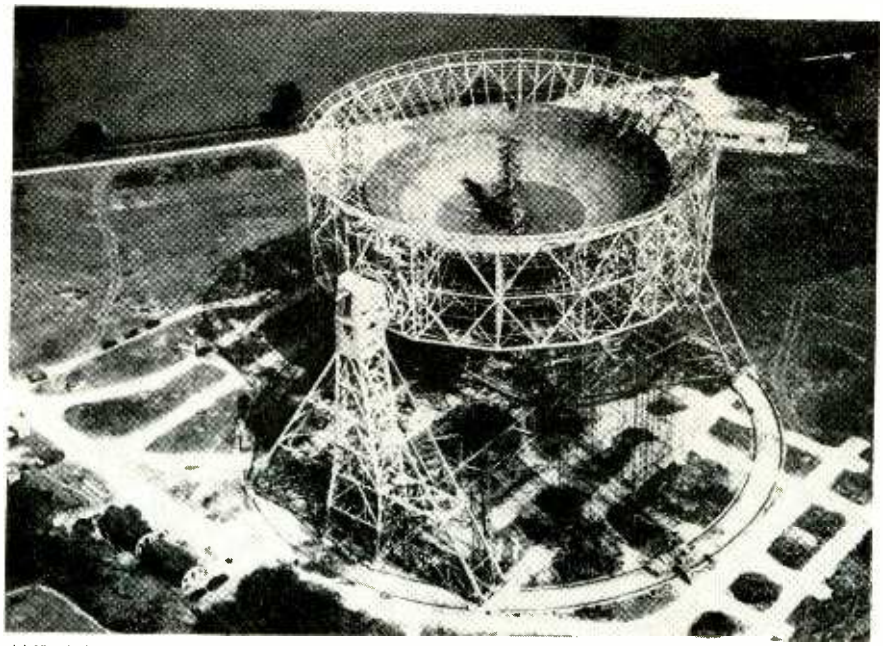
► **Facts**—Owing to the classified nature of the project, little detail on operating characteristics could be gleaned. However, this much can be told.

The transmitter uses special modulation, does not use a magnetron but can use a klystron or platinotron. Wideband operation is used.

The receiver has a wideband front end. New circuits use a combination of the following techniques to detect the signal, transient filtering, coherent integration and spectrum analysis. How these techniques are employed was not disclosed, except that the result is called signal-enhancing.

► **Applications**—It is not too difficult to envision the use to which this hypersensitive radar system could be put. The line-of-sight distance for a target about 600 miles high is approximately 2,500 miles. This range would allow detection of the earth satellite as it swings through its orbit (300 to 700 miles high) as well as a reentering ICM. In the latter case, detection at 2,500 miles would provide only a few minutes advance warning—minutes we now lack.

(Continued on page 8)



ANTENNA, mounted on tower in center of a reflecting surface cradled in a 250-ft diameter bowl, will pick up sources of radio emission 200 million light years ago when latest development in . . .

Radio Astronomy Maps The Universe

Largest computer-controlled radio telescope is now ready to increase astral knowledge

CLAIMED to be the most sensitive short-wave radio receiver and the most far-reaching radio transmitter ever constructed, this $2.5-million radio system, used by England's University of Manchester, features a computer-controlled servo system that makes it possible to track the course of a star in the sky, to scan any three coordinates of an arc in space, or to traverse rapidly from one preset position to another.

▶ **Geometrics**—The 2,000-ton structure consists of a bowl which pivots between two 180-ft towers and the bowl can be rotated around a fixed axis parallel to the earth. The towers themselves ride on railway cars, which travel on the ground on a 352-ft diameter circular railway track, so that complete spherical coverage of the sky is obtained.

▶ **Tasks** — A team of 36 men, headed by Professor A. C. B. Lowell, will work in the one to two-meter band where an antenna with a beam width of one degree and a power gain of 16,000 will be used to locate sources of radio emission 200-million light-years back. Future work is planned to operate in the 21-cm band with a beam width of 25 minutes, to detect emission from hydrogen clouds of a density of one atom per cc at distance of 10,000 light-years away. This emission results from a reversal of electron spin in a neutral hydrogen atom and is computed to occur only once in 11-million years.

▶ **Controls**—One man, sitting at a control desk located in a building about 200 yards away from the center of the huge radio telescope, can control the entire mechanism. Azimuth speed,—or ground—track travel ranges between 8 minutes of arc per minute up to 20 degrees per minute. Elevation speeds range from 9.6 minutes of arc per minute up to 24 degrees per minute.

The computer, designed by Dunford and Elliott of Sheffield, is accurate to within four minutes of arc and the drive system is accurate to within 5 minutes of arc.

▶ **Computer** — The electromechanical analog computer solves 14 trigonometric equations from the inputs of sideral time and astronomical coordinators, to give azimuth and elevation-command signals to the main-drive system. Computer design was solved for scanning requirements in any one of three sets of coordinates: the rate of scan is variable and the elevation rate is either time controlled or position controlled. In addition, controls indicate the actual position of the system in terrestial, galactic and cellestial coordinates.

Training Device Fakes Fallout

Transmitter simulates gamma radiation, receivers are calibrated in roentgens

ELECTRONIC EQUIPMENT for faking fallouts may mushroom into a substantial business by winter.

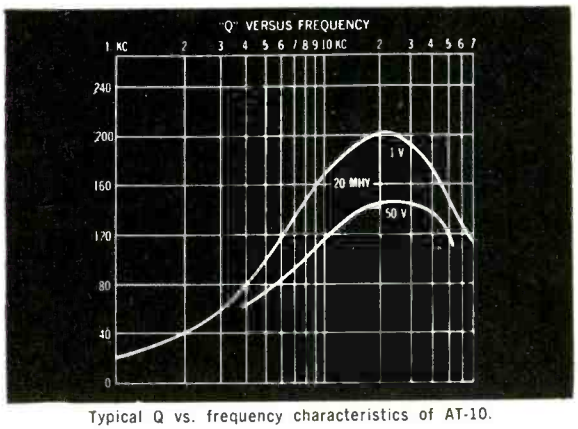
Requested by the Army for training personnel how to operate in contaminated areas, a Radiation Survey Training Set was created by the Naval Training Device Center, Port Washington, N. Y. to stimulate radioactive contamination and the radiometers (1M 108) troops will use to detect it. Admiral Radio was awarded the contract for development and production and will deliver a development model to the Center this month. First 225 complete units will go to Army.

▶ **Potential market**—Navy and Marine Corps have also expressed interest in the equipment for their own personnel. Air Force and Civil Defense will probably request such equipment later. Civil Defense now has radiacmeters with no safe way to train personnel to use them.

Equipment and training procedures devised by the Center are both simple and effective. Following a loud but harmless explosion with accompanying white flash and mushrooming cloud, a radio transmitter located beneath the trick atomic explosion starts beaming

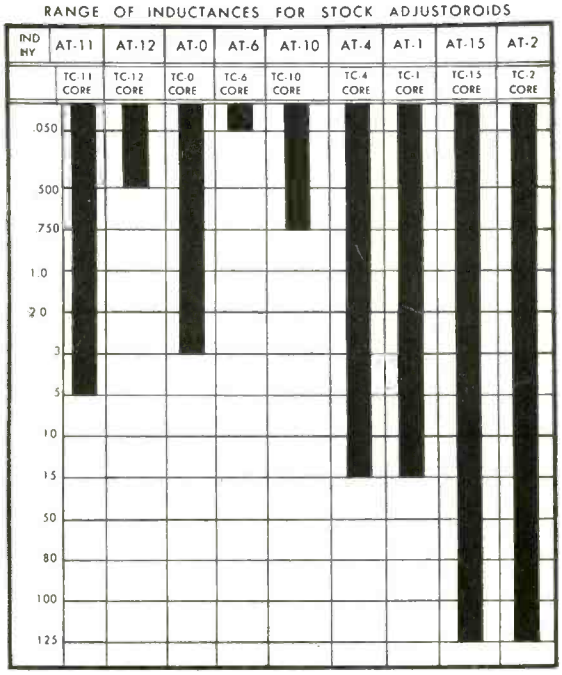
(Continued on page 10)

variable "L" by BURNELL



Typical Q vs. frequency characteristics of AT-10.

RANGE OF INDUCTANCES FOR STOCK ADJUSTOROIDS



For nominal D. C. R. values refer to Burnell catalog No. 103.

COMPLETE TECHNICAL INFORMATION UPON REQUEST.
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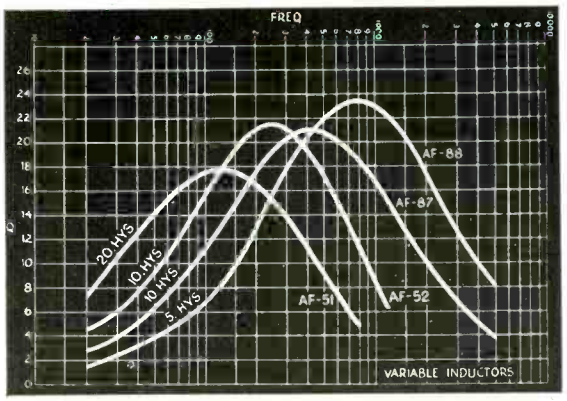

Typical Q vs. frequency characteristics of Variable Inductors.

ADJUSTOROIDS®

The Adjustoroid, a low cost adjustable toroid, exclusively developed by Burnell & Company, Inc., contains an actual complete toroid which relays all the excellent characteristics of the non-adjustable types. Adjustment is obtained by a completely stepless function with magnetic biasing.

The nominal inductance value for an Adjustoroid is the **maximum** value, and the inductance range is the nominal value minus approximately 10%.

Hermetically sealed to meet Government MIL specifications. Many types of networks in tuned circuits are being produced which employ the Adjustoroid in completely hermetically sealed packages.

Intermediate inductance values as well as special taps and extra windings available on special order with minimum delay.

For additional technical data on Adjustoroids, refer to equivalent toroid in catalog.

AT-0, AT-6, AT-10, AT-4

AT-1, AT-2, AT-11, AT-12

ADJUSTOROID & VARIABLE INDUCTOR DIMENSION CHART

	LENGTH/DIA.	WIDTH	HEIGHT
AT-0, AT-6	1-1/16"		1"
AT-10, AT-4	1-19/64"		1-1/4"
AT-15	1-31/32"		1-7/8"
AT-11, AT-12	45/64"	45/64"	3/4"
AT-1	1-3/4"	1-3/4"	1-1/4"
AT-2	2-3/4"	2-3/4"	2-1/4"
AF-51, AF-52	1-19/64"		2"

and now . . .

NEW SUBMINIATURE VARIABLE INDUCTORS

AF-87 (30-500 cycles) maximum Q at 400 cycles

AF-88 (50-1000 cycles) maximum Q at 800 cycles

Burnell subminiature variable inductors are especially designed for low frequency applications or where proportionately high inductance values are required. Except for low frequency, high inductance values, subminiature inductors are similar to Adjustoroids and measure 1¼" in height and 45/64" in width and depth. Variable inductors are available in all inductance values up to 80 Hys.

BURNELL & CO., INC.
Dept. E97, 10 Pelham Parkway, Pelham Manor, New York
Pacific Division: 720 Mission St., S. Pasadena, Calif.

out harmless radio propagation in elliptical patterns similar to those created by wind spreading fallout material.

Field strength of this radio transmission varies in relation to distance from receiver to source just as radioactive propagation.

Terrain irregularities, first thought to be a problem, actually distort radio propagation just as they do movement of radioactive material.

Ten trainees, scattered within the ten-mile range of the transmitter, will check their portable transistorized receivers for field strenth of the radio transmission. Receiver meters (device 48E1A) will look and operate like real radiacmeters (IM 108) with field strength calibrated in roetgens.

Special hot spots will be simulated by oscillators, miniature transmitters that emit signals on the same frequency.

TELLUROMETER with radiotelephone is latest boon to surveyor as . . .

Microwaves Map Rough Terrain

Light-weight instruments cut surveying tasks two to ten times

Two suitcase-sized tellurometers, microwave mapping instruments, are in operation in Canada. They replace conventional transverse and triangulation distance surveying methods.

▶ **Light-weight**—Developed by the South African Council for Scientific and Industrial Research, the tellurometers weigh 24 pounds. Light-weight equipment is necessary in the rough country where most Canadian mapping is done today.

Purchasers are Photographic Survey Corp., of Toronto, commercial surveyors, and the surveys and mapping branch of the Canadian Department of Mines. PSC says tellurometry can increase mapping productivity two to 10 times.

▶ **Microwaves** — Working with a master station, the instruments measure the time it takes microwaves to travel from the master to remote and return. Range is 50 miles. Voice contact between stations is maintained by a built-in duplex radiotelephone.

PSC is a member of Hunting Associates, a group of 50-odd engineering, geophysical, oil, transport and manufacturing firms. The latest associate is Photronix, a Columbus, Ohio, highway engineering firm.

▶ **Highways** — Photronix was formed recently to exploit a computer method of photogrammetry. Information gathered from aerial photos and ground surveys is transferred to computer punch cards.

The computer accounts for shoulders, ditches, side slopes and super-elevations and tabulates earthwork volumes, seeding areas, slopes and mass diagrams. Savings of up to 60 percent in planning time and 40 percent in costs are claimed.

Business Briefs

▶ **Merger** plans of Vitro Corp. of America and Nems-Clarke, Inc., electronic design company of Silver Spring, Md., announced. Consolidation terms call for Vitro to acquire Nems-Clarke through payment of 115,000 shares of its common stock, worth about $3 million

▶ **New company** founded to develop inertial navigation systems, Dynamic Research Corp. of Woburn, Mass. Dynamic is one of the first firms to be devoted exclusively to science of inertial navigation. John S. Anderegg, Jr., heads company executives who have been drawn from MIT Instrumentation Laboratory

▶ **Milestone** recorded by American Airlines Magnetronic Reservisor, the 50 millionth reservation inquiry. It was built by Teleregister Corp. of Stamford, Conn. The first airline reservisor was installed by American in 1952

▶ **New stock** issued planned by Siegler Corp. for some time this or next month. A maximum of 200,000 additional shares of common stock will be sold

▶ **Common stock** of Foote Mineral was listed on New York Stock Exchange last month. Foote manufactures chemical, metallurgical and ceramic raw materials used by the electronics industry

▶ **Sale** of George Rattray & Co. of Richmond Hill, N. Y. to Hardwick Hindle, Inc. of Newark, N. J., announced. Rattray manufactures precision potentiometers. Hardwick Hindle is an American Seal Cap subsidiary

(Continued on page 12)

surface barrier transistors from SPRAGUE

2N344/SB101
for Medium Gain Amplifiers

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

2N345/SB102
for High Gain Amplifiers

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


actual size

2N346/SB103
for High Frequency Oscillators

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

2N240/SB5122
for Computer Switching

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

IN VOLUME PRODUCTION *Now!*

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

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

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

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

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CAPACITORS • INTERFERENCE FILTERS • PULSE NETWORKS
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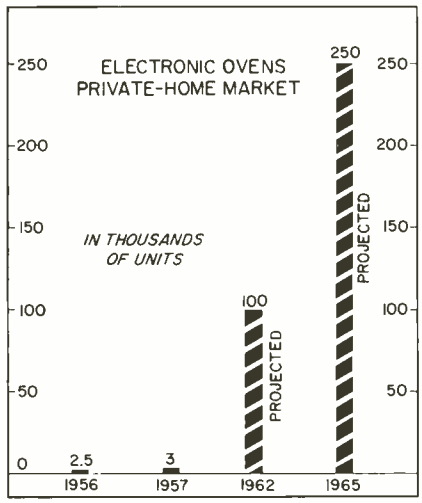

ELECTRONIC cooking ranges have been reduced from five-foot kitchen monsters to wall-sized inserts as . . .

Microwave Cooking Warms Up

Estimate for 1962 sees 100,000 sold, 1965 climb to 250,000

MICROWAVE cooking ranges for the home, according to General Electric estimates, will reach an annual market figure of 100,000 in 1962. Ratheon sees it booming along at a 250,000 annual rate in 1965.

The first serious attempt to crack the home market with electronic ovens came at the beginning of 1956. That year saw 2,500 of them move into homes. This year, those in the electronic range business see the total modestly lifted to a 3,000 rate. At least one company thinks it will be higher, though not much.

▶ **Producers** — Companies producing electronic ranges for homes include Tappan, Westinghouse, Hotpoint, Whirlpool, Kelvinator. General Electric plans to produce an oven early in 1958.

Raytheon is a supplier of the generating equipment, also makes complete microwave ovens of greater size for restaurants.

Microwave ovens have been reduced to home size just since 1950. In 1950 a unit stood 5 feet high, was water-cooled and weighed 750 pounds. Today, an electronic oven can be tucked into a wall space 24 in. x 21 in. x 22 in. It is air-cooled.

One of the safest features which is aiding sales appeal is that the oven is turned off immediately when the oven door is opened.

▶ **Bandwidth**—Microwave cooking is being done in the 2,400-2,500-mc bandwidth. Raytheon feels that it can produce the microwave equipment for less if the frequency were extended. In the FCC hearings on the part of the spectrum above 890 mc, Raytheon has asked that the bandwidth be widened, making it 2,370-2,500 mc.

The present price of the ranges runs about $1,200. Raytheon estimates that mass production and improvements will eventually bring it down in the neighborhood of $600.

Tappan, Mansfield, Ohio, feels that there is no question of the electronic oven's acceptability among housewives if the price can be brought down to $800.

▶ **Meat and Potatoes**—The basic appeal that microwave cooking has for the housewife is time saving. The afternoon bridge party doesn't have to break up at four-thirty. It can go on until almost six.

The working wife doesn't have to tug a reluctant working husband to the restaurant because there isn't time to make dinner. A steak in a microwave cooker takes one and a half minutes. A baked potato is done in four minutes, a saving of 56 minutes over a gas oven.

The economics of using high frequency radio energy to cook food for large groups such as in hospitals and restaurants has recently been documented by the Kaiser Foundation Hospital, Walnut Creek, Calif. It estimated that annual savings by hospitals in the U. S. would be more than $100,000,000.

Tube Savers Extend Life Of I-O Tubes

Market Potential: 500 tv stations using 1,600 cameras

THREE COMPANIES are offering tv broadcasters for delivery this year devices designed to extend the life of tv camera image-orthicon tubes.

Principle of each is to wobble the image on the orthicon tube to prevent burn-in and sticking. Besides extending the life of the i-o tubes by wobbling the image, all three devices are expected to allow transmission of clearer pictures, without carryover from previous scenes.

IMAGE orthicon life extender

▶ **Deflection**—GE's tube saver is an electronic deflecting system. A

(Continued on page 14)

Arnold Magnetic Materials

. . . the most complete line in the industry

PERMANENT MAGNET MATERIALS

- Cast Alnico Magnets
- Sintered Alnico Magnets
- Vicalloy
- Cunife
- Arnox III

HIGH PERMEABILITY MATERIALS

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- "C" and "E" Cores of Silectron
- Bobbin Wound Cores
- Molybdenum Permalloy Powder Cores
- Iron Powder Cores
- Sendust Powder Cores
- Special Magnetic Materials

PRECISION-TESTED TO YOUR SPECS . . .

Arnold magnetic materials can answer all your requirements. It is the most complete line in the industry; and in addition, Arnold maintains complete control over every production step from raw materials to finished products.

Typical testing of Molybdenum Permalloy Powder Cores is illustrated above. Precision equipment and methods such as these accurately measure the properties of all magnetic materials before shipment, insuring ultimate performance in accordance with your specifications.

Such a source can bring you advantages in long experience and undivided responsibility, and in unequalled facilities for quality control and production.

• *Let us supply your needs!*

WSW 6781

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Repath Pacific Division Plant: 641 East 61st Street, Los Angeles, Calif.

District Sales Offices:

Boston: 200 Berkeley St. Los Angeles: 3450 Wilshire Blvd.

New York: 350 Fifth Ave. Washington, D.C.: 1001-15th St., N.W.

scanning beam inside the tube follows and automatically compensates the wobble, causing the transmitted picture to appear as a normal stationary image on home tv receivers.

Complete unit comprises about 50 small parts, including six capacitors, a synchronous resolver and a drive motor. With cover closed, it is similar in appearance to a cigar box. The unit mounts easily on the exterior of seven out of eight tv cameras now in use and provides maximum prevention without burn-in.

▶**Other types** — RCAs unit for monochrome cameras, called an orbiter, operates on an electromagnetic principle. Two coils are added in quardature around the image section of the tube yoke assembly. For color cameras, RCA uses a rotating prism, called an orbital wedge, which is located between the lens and the image orthicon tube.

Visual Electronics' equipment consists of a motor-driven mechanism that causes the lens of a tv camera to move in a small circular orbit. The image on the orthicon photocathode moves in turn in the same circular orbit.

The problem of holding the transmitted picture stationary is achieved by introducing suitable correcting signals to the centering circuits of the tv camera. The correcting signals are sine and cosine functions obtained from a sine-cosine potentiometer. Each function is amplified by a small transistor amplifier and applied to the correct deflection circuit.

Under average station use, life of i-o tubes without tube savers ranges from 200 to 1,000 hours. Tubes cost about $1,200 each and must be replaced two to ten times a year. One company believes its new device will double the life of I-O tubes.

Costs of tube savers, depending on the system, range from $750 to $2,400 each.

Market potential is big. There are about 1,600 cameras now in service in the nation's more than 500 tv stations.

Military Electronics

▶**New Falcon** GAR-2A, air-to-air infrared guided aircraft rocket, will travel with radar-guided Falcon GAR-1D. Mixed loads are said to give the interceptor greater attack versatility

▶**Hard glass** electron tube, capable of prolonged operation at 300 degrees C and reduced in price from $30 to $5, has been produced by Bendix under AMC contract

▶**Hawk,** low-altitude ground-to-air defense missile, is being integrated into Missile Master, electronic system for controlling and coordinating fire of Nike anti-aircraft batteries

▶**Improved d-c data** transmission system which utilizes ordinary telephone lines has been developed by Burroughs. Known as Cordat (Coordinate Data Set), the system is used both at transmission and reception points. At transmission, radar-furnished d-c analog voltages are converted to digital data transmission over telephone lines. At reception, digital data is reconverted into d-c analog voltages where it is used by a computer system for use in aircraft detection and target interception

TAPE REEL with recorded data normally contained in bulky 600-page binder is one way . .

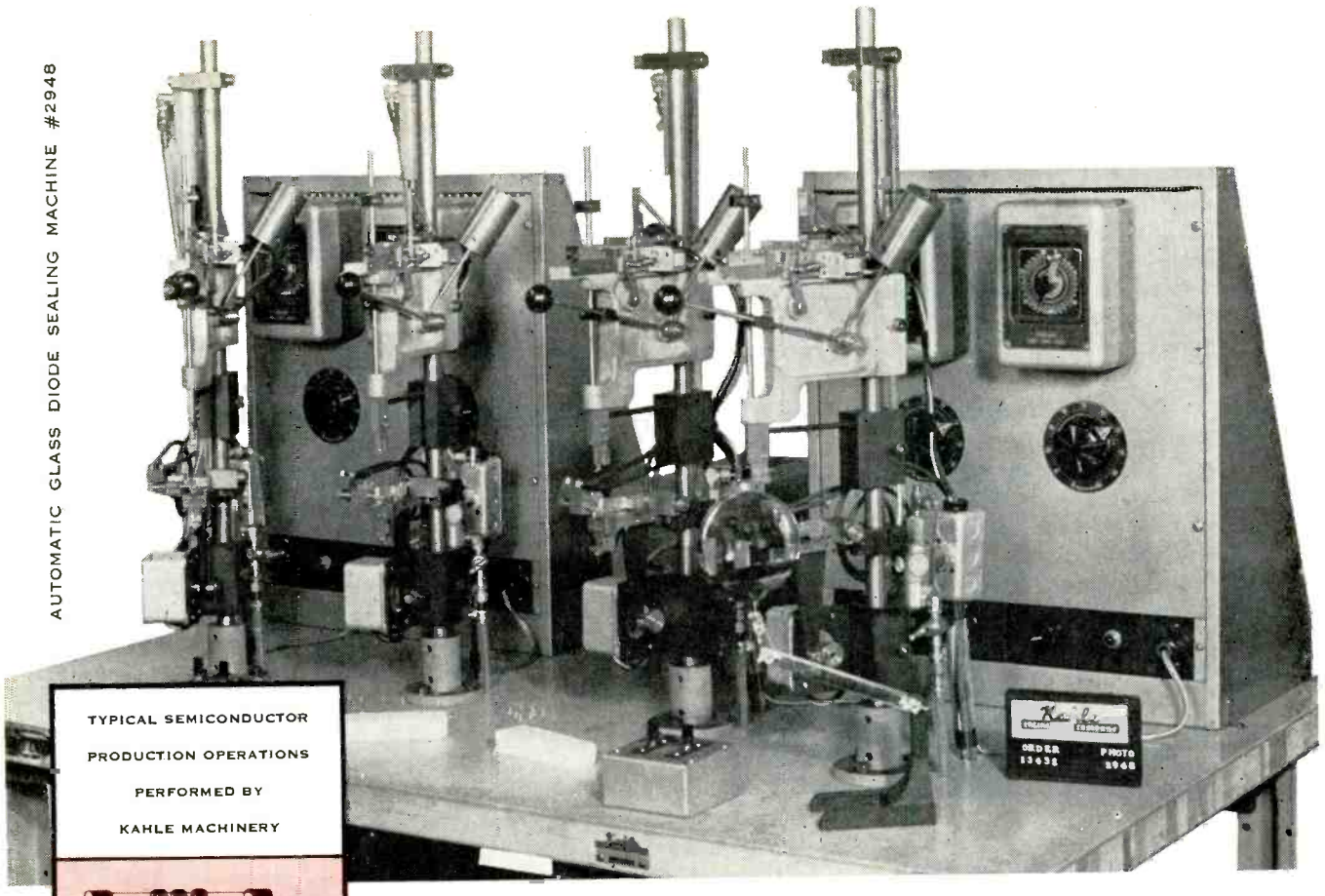
Computer Applications Increase

Wage reports and automatic mail sorting expand jobs computers can do for business

MAGNETIC tape is slicing into the time and money spent by industry in filling out government forms. The Federal Social Security Administration's accounting division in Baltimore has started the ball rolling.

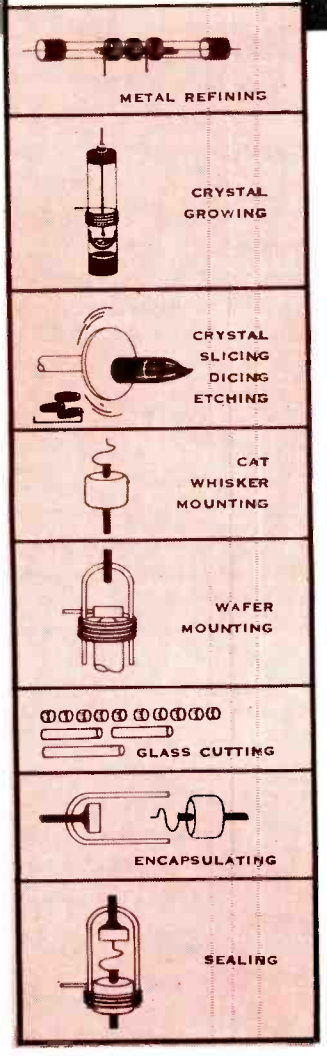
▶**Savings**—Previously, a 600-page binder prepared for 26,000 employees meant that the government agency had to prepare 26,000 key punch cards manually

(Continued on page 16)



AUTOMATIC GLASS DIODE SEALING MACHINE #2948

TYPICAL SEMICONDUCTOR PRODUCTION OPERATIONS PERFORMED BY KAHLE MACHINERY



FROM START TO FINISH . . .
WITH COMPLETE OR PARTIAL AUTOMATION

KAHLE MACHINERY

FOR EVERY STEP OF
SEMICONDUCTOR MANUFACTURING:

- TRANSISTORS
- GLASS DIODES
- RECTIFIERS

Kahle, the pioneer manufacturer of Automatic Semiconductor machinery, continues to set the pace in the design and development of newer, more efficient semiconductor production machinery. Typical of Kahle design advances is a new Semi-Automatic Glass Diode Sealing Machine #2948 now producing 700 glass diodes per hour for leading semiconductor manufacturers throughout the world. Modified versions of this machine are available for smaller and larger production quantities — a high speed, **Fully Automatic** model produces up to 2000 units per hour.
If you want to efficiently automate your semiconductor production — it will pay you to consult Kahle first. Kahle will design a semiconductor production machine to solve any requirement. There's no risk involved . . . every machine is tested to customer satisfaction before shipment. Learn why Kahle machinery is used by more and more semiconductor manufacturers. Write today.

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DESIGNERS AND BUILDERS OF SPECIAL AUTOMATIC AND SEMI-AUTOMATIC EQUIPMENT FOR ALL INDUSTRIAL APPLICATIONS

Circle 6 Readers Service Card

to use the data. Now, it feeds the tape into its own computing system, makes a reproduction and sends back the master tape.

A Social Security spokesman said several other large employers are expected to join the program and that the agency wants as many participants as it can get.

▶ **Who** — General Electric, IBM and Consolidated Edison Company of New York are sending their employee payroll records to Baltimore on reels of tape rather than on piles of paper forms. The New York Power Company already had an IBM 705 handling its payroll and other financial records. It was only one more step to have the computer record employees' names, social security number, amount of taxable ages and other pertinent data on tape for this quarter.

▶ **Postman**—Envisioning a five-to-ten-year transition to electronics, the Post Office Department, in conjunction with the National Bureau of Standards, has been experimenting in various cities with electronic sorting machines. One such sorter, called trans-orma, under test at Silver Spring, Md., can sort 15,000 letters an hour into 300 chutes.

At Chicago, a five-year, $40-million modernization and automation program is under way. Sixty-six miles of electronically controlled conveyors are being installed.

▶ **Billion billion** — A mechanical blackboard that erases itself automatically to find the best of 2-billion-billion possible answers to a problem has been developed at the University of Michigan.

Called MITAB, for Michigan Transportation and Assignment Blackboard, the $5,000 device provides short cuts in 20 minutes to answers that would take a big electronic computer years to work out the long way.

Properly, it cannot be called a computer because it cannot remember instructions. It can be directed, however, to add, subtract and perform other functions.

▶ **Use**—The device has potential as a research and instructional tool. Its face is made up of 400 indicators arranged in 20 by 20 matrix, 800 lights and 400 switches. Each indicator registers from zero to ten.

▶ **Example**—If the rows represent the machines available for jobs in a factory and the columns the various jobs to be done, the indicators can be set to show the cost of each job on each machine.

With 20 jobs and 20 machines there are 2,432,902,008,176,640,000 possible ways to assign the jobs. The problem is to find the best arrangement—the least total cost, the fastest operating time or some other criterion. It is possible to add and subtract from rows and columns and perform other mathematical tricks to arrive at the solution in minutes. Thus, shown the way, a computer could then solve the original problem.

OVERSIZE ROLLS of magnetic tape will not be here long before slitting and packaging at 3M plant, as demand rises steadily and . . .

Magnetic Tape Comes To Life

Originally audio medium, it now advances on many fronts beyond the sound sphere

WITH VOLUME OF AUDIO tape recorder sales now exceeding $100 million annually and raw tape sales for all uses approaching $12 million per year, informed sources in the tape industry look for their largest sales increases in the industrial field.

While recording equipment for instrumentation, automation, telemetering, computers and other types of data processing represents only about ten percent of the market, the tape consumed by such devices accounts for about one third of the total sales of the magnetic ribbons.

Although there has been some resistance in business to data-processing equipment using magnetic materials (If somebody accidentally erases a roll of tape we're ruined!), tape is nonetheless steadily supplanting punched-card information carriers. With the cost for a square foot of office or factory space showing no signs of going down, the fact that a 7-inch reel of tape can store as much information as a cubed stack of punched cards measuring a yard in each direction becomes a potent sales argument.

▶ **Video**—While industrial appli-

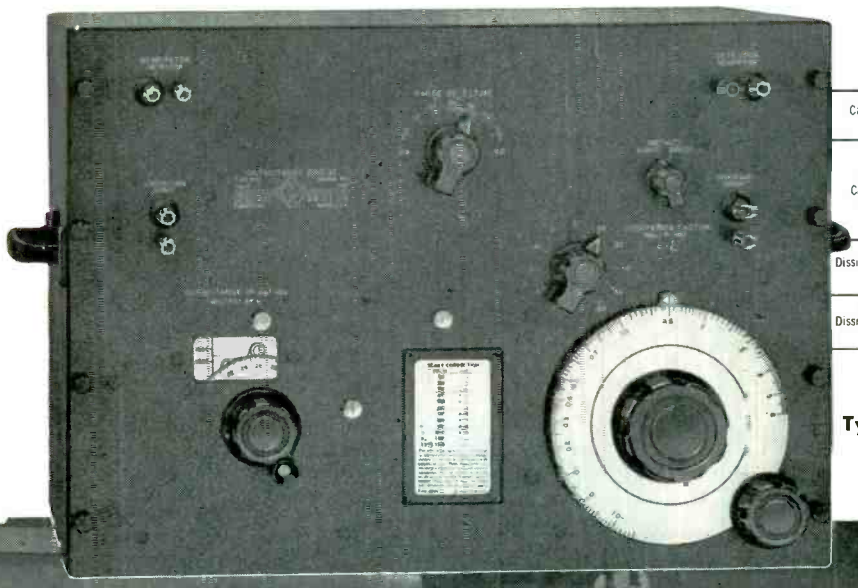
(Continued on page 20)

...the Standard of the Industry

...for Capacitance and Dissipation-Factor Measurements is the G-R Type 716-C Capacitance Bridge. This instrument is used the world over for the accurate measurement of these characteristics and their change with frequency, temperature, and humidity. In addition to the measurement of all types of capacitors and dielectric properties of insulating materials, the Bridge is capable of measuring resistance and parallel capacitance of high-valued resistors, up to several thousand megohms; inductance and storage factor of inductors, up to several thousand henrys; characteristics of electrolytes, and many other impedances by substitution measurements.

Type 716-CM Capacitance Bridge in Walnut Cabinet, $600

716-CR Relay Rack Model, $565



	Direct Reading Measurements	Substitution Measurements
Capacitance Range	100 μμf to 1.15 μf at 1 kc; 100 μμf to 1150 μμf at 100 c, 10kc, and 100 kc	0.1 μμf to 1050 μμf with internal standard; to 1 μf and higher with external standards
Accuracy Capacitance Readings	±0.1% ±[1 μμf times multiplier setting (1–1000)]; better than ±0.2% of full scale for each range	±0.2% or ±2 μμf, whichever is larger; ±0.1% or ±0.8 μμf using correction chart on panel ±0.1% or ±0.2 μμf with worm calibration available at $50 extra charge
Dissipation Factor Range	0.00002 to 0.56	0.56 times ratio of standard capacitance with unknown disconnected, to capacitance of unknown
Accuracy Dissipation Factor Readings	0.0005 or ±2% of dial reading, whichever is larger	±0.00005 or ±2% of change in dissipation factor observed

Accuracies given hold from 30 c to 300 kc

for use between 0.5 Mc and 3 Mc

Type 716-CMS1, $580 **Type 716-CRS1, $545**

Also available are oscillators, null detectors, filters, and a dielectric sample holder for measurement of solid materials.

Write For Complete Information

DISCAPS, manufactured by Radio Materials Corporation, meet the highest standards for ceramic capacitors. Every unit is tested for acceptable power factor, capacity, and leakage resistance with the aid of the finest measuring instruments of their kind . . . the G-R Type 716-C Capacitance Bridge for high-dielectric materials, Type 722 Precision Capacitor with worm-correction for low-dielectric materials. Capacitance measurements by substitution methods give accuracies of the order of 0.1%. The G-R Type 1691-A Test Fixture eliminates the effects of "lead" capacitance.

GENERAL RADIO Company

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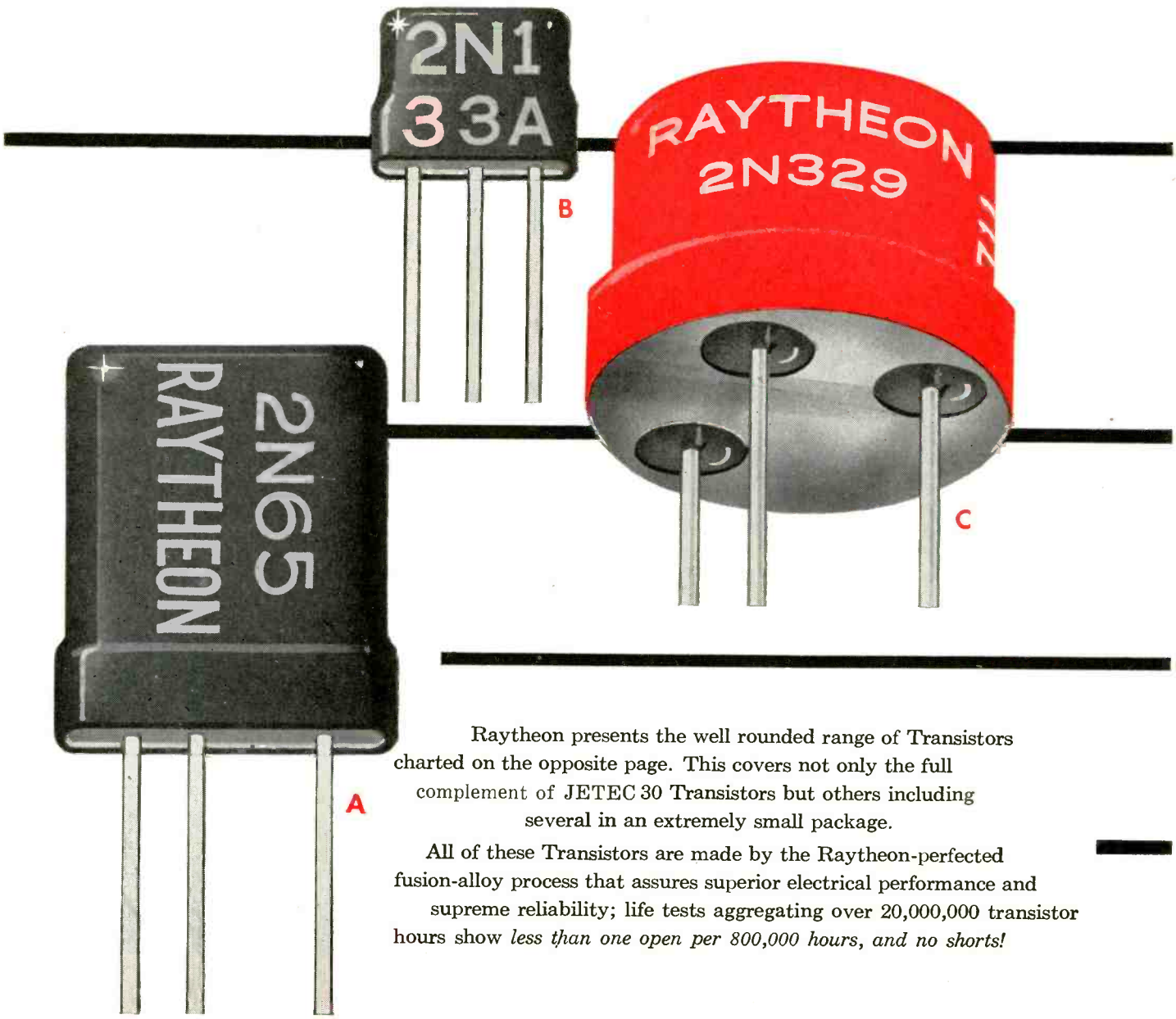
All G-R Products are now covered by a *2-Year Warranty*

NOW, in the JETEC 30 package

both Silicon and Germanium, including NEW AUDIO

RAYTHEON

FUSION ALLOY TRANSISTORS



Raytheon presents the well rounded range of Transistors charted on the opposite page. This covers not only the full complement of JETEC 30 Transistors but others including several in an extremely small package.

All of these Transistors are made by the Raytheon-perfected fusion-alloy process that assures superior electrical performance and supreme reliability; life tests aggregating over 20,000,000 transistor hours show *less than one open per 800,000 hours, and no shorts!*

RAYTHEON TRANSISTORS

for superior reliability . . . superior performance

RAYTHEON AUDIO TRANSISTORS

Temperature Range
−65°C to +85°C

Type	Case	Supersedes	Circuit Usage	V_{ce} max. Volts	Beta	I_{co} max. μA	I_{eo} max. μA	Power Gain Class A db	Diss. Coeff. °C/mw
2N63	A	—	Amplifier	22	22	20	15	39	0.59
2N64‡	A	—	Amplifier	15	45	20	15	41	0.59
2N65‡	A	—	Amplifier	12	90	20	15	42	0.59
2N130A	B	2N130	Amplifier	22	22	20	15	39	0.59
2N131A	B	2N131	Amplifier	15	45	20	15	41	0.59
2N132A	B	2N132	Amplifier	12	90	20	15	44	0.59
2N133A	B	2N133	Low Noise 6db max.	6	50	20	15	40	0.59
2N362	C	—	AF Driver	22.5	90	25	20	43	0.36
2N363	C	—	AF Driver	22.5	45	25	20	40	0.36
2N422	C	2N133	Low Noise 6db max.	22.5	50	25	20	40	0.36
CK754	B	—	High Gain	10	300	5	10	42	0.59

‡Available to Signal Corps specification

RAYTHEON AUDIO OUTPUT TRANSISTORS

Temperature Range
−65°C to +85°C

Type	Case	Supersedes	V_{ce} max. Volts	Beta	I_{co} max. μA	I_{eo} max. μA	Power Gain Class A db	Power Gain Class B db	Power Output Class A mw	Power Output Class B mw	Diss. Coeff. °C/mw
2N138B	B	2N138A	12	90	20	15	37	26-31	20	50	0.59
2N359	C	2N138A	22.5	100	25	50*	37	33	50	500	0.36
2N360	C	2N138A	22.5	70	25	50*	34	30	50	500	0.36
2N361	C	2N138A	22.5	40	25	50*	30	30	50	500	0.36

*$I_{eco} = (\beta_{rev.} + 1)\, I_{co}$

RAYTHEON RADIO FREQUENCY TRANSISTORS

Temperature Range
−65°C to +85°C

Type	Case	Supersedes	Circuit Usage	V_{ce} max. Volts	$f_{\alpha co}$ Mc	C_c μμf	Power Gain at 455 Kc db	Power Gain at 2Mc db	Conv. Gain db	Diss. Coeff. °C/mw
2N413	C	2N111/CK759	Oscillator	−15	3	12av.	—	—	—	0.4
2N413A	C	2N111A/CK759A	IF Ampl.	−15	3	12±2	32	—	—	0.4
2N414	C	2N112/CK760	Converter	−15	5	12av.	—	—	26	0.4
2N414A	C	2N112A/CK760A	IF Ampl.	−15	5	12±2	35	—	—	0.4
2N415	C	2N271/CK766	Converter	−10	10	12av.	—	—	30	0.4
2N415A	C	2N271A/CK766A	IF Ampl.	−10	10	12±2	39	—	—	0.4
2N416	C	2N113	Gen. Purp.	−10	10	12av.	—	18	—	0.4
2N417	C	2N114	Gen. Purp.	−10	20	12av.	—	25	—	0.4

For above eight types I_c = −200 mA max.

RAYTHEON COMPUTER TRANSISTORS

Temperature Range
−65°C to +85°C

Type	Case	V_{ce} max. Volts	$f_{\alpha co}$ Mc	h_{fe_1} (I_b = −1 mA)	h_{fe_2} (I_b = −10 mA)	Grounded Emitter Switching Data at I_c = −50 mA: I_b "on" and "off" mA	Rise Time μs	Storage Time μs	Fall Time μs	Diss. Coeff. °C/mw
2N425	C	−20	4	30	18	5.0	0.5	0.25	0.3	0.4
2N426	C	−18	6	40	24	3.3	0.5	0.25	0.3	0.4
2N427	C	−15	11	55	30	2.5	0.4	0.25	0.3	0.4
2N428	C	−12	17	80	40	1.7	0.1	0.25	0.3	0.4

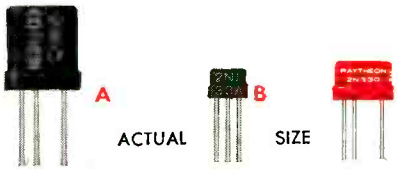
For above four types . . . I_c = −400 mA max.; Z_{sat} = 1.5 ohms for I_c of 100 mA

RAYTHEON SILICON TRANSISTORS

Temperature Range
−65°C to +160°C

Type	Case	Supersedes	Beta	I_{co} μA	I_{eo} μA	r_b ohms	r_c kilohms	C_c μμf	$f_{\alpha co}$ Kc	Noise Factor db (max.)	Diss. Coeff. °C/mw
2N327	C	CK790	14	0.005	0.005	1200	500	35	200	30	0.4
2N328	C	CK791	25	0.005	0.005	1400	500	35	350	30	0.4
2N329	C	—	50	0.005	0.005	1500	500	35	500	30	0.4
2N330	C	CK793	18	0.005	0.005	1300	500	35	250	15	0.4

Write for Data Sheets on individual types for complete ratings and test conditions.



ACTUAL SIZE

All ratings on this page taken at 25°C.
Dissipation coefficients shown are for free air.
All are hermetically sealed.

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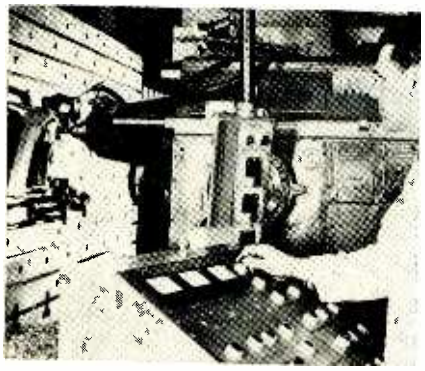
cations are expected to show the greatest growth spurt in the next few years, expansion in other areas continues apace. Video tape is now a commercial reality with Ampex in production and at least two other prototypes, by RCA and Bing Crosby Enterprises, have been demonstrated. RCA is reported to be aiming at the home-instrument market, while the Bing Crosby efforts have been taken over by tape-makers Minnesota Mining & Manufacturing. Further consolidation in this direction has seen the purchase by Ampex of a minority interest in Orradio, another tape producer.

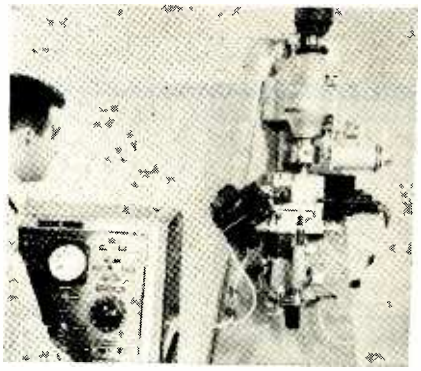
▶**Stereo**—Major breakthrough in the home field is expected this year, with most or all of the important phonograph record companies due to plunge into the stereo recorded tape field. Although stereo tapes have been available for several years, all of the producers have been small operators with the exception of RCA Victor.

Now Mercury, followed closely by Capitol and Columbia, has introduced a stereo tape line. This leaves Decca as the major holdout, at the present time.

The stereo disk is also definitely contemplated in the record industry, but it is unlikely that its introduction to the consumer market will be seen this year.

▶**Photo, too**—Although most magnetic recording business activity is centered around electronics manufacturers, it is interesting to note the movement into the field by names better known for photographic products. These include Bell and Howell, Berndt-Bach, Federal Mfg. and Eng., Stancil-Hoffman, Wollensak and Revere Camera. Eastman Kodak, which has been supplying plastic stock for tape base material for several years, is now reported to be on the verge of coating it as well and marketing the finished product.





TUBES make missiles (left) and radioactive parts as . . .

Controls Speed Defense Work

ELECTRONIC machine-tool controls are finding more applications in the atomic energy and air defense program. A numerically controlled milling machine designel by Bendix for Martin Aviation (ELECTRONICS, Feb. 1956, p 122) is now being installed for production work on the Matador missile and P6M jet seaplane.

▶**Tape Control**—Use of tape-recorded machining instructions permits quick change-over in production and faster production on new operations since templates and hand-made models are not required before production can start.

▶**Lathe Control**—A control system developed by Lear, Inc. for use in a General Electric plant for machining radioactive materials employs three servo systems to control a hand lathe from a distance. The system is sensitive to one-quarter degree change in position and can hold normal machining tolerances with remote operator behind shielding.

Devices Advance British Electronics

Mail is sorted; hearts are sounded; and life is sustained

NEWS FROM BRITAIN indicates that electronic aids are keeping pace on several fronts. Recent developments in diverse fields point up the widespread use of the electronic art for practical applications.

▶**Sorting Mail**—Twenty electronic letter sorters, developed by the British Post Office, will soon ease mail-sorting tasks in England. Letters of various mixed sizes pass across a window and an operator, sitting in front of one of the machines, presses one of twenty-four keys according to a memorized combination.

The letter is conveyed on roller tracks by an electronically-controlled memory to be correctly pigeon-holed for its destination.

▶**Bulk**—Another machine segregates letters and packages. Mail is tipped into a loading hopper and carried by a conveyor band to a segregator drum. Thin letters slip through the hinged flaps which make up the outside of the drum, on to a conveyor below. Bulk cannot pass through the flaps and emerge ready for hand stamping.

▶**Postal Orders**—An electrically-driven machine for counting postal orders, now in an experimental stage, can handle up to 300,000 postal orders a day. It occupies little more space than a typewriter.

▶**Sounding Hearts**—Three British medical men have collaborated in designing a stethoscope which amplifies sounds and shuts out unwanted noise. Based on the principle that all sounds have a certain frequency, a doctor manipulates two controls so that only sounds of a particular frequency are carried to ear pieces. With this stethoscope, a doctor can, for example, listen to the heart of a poliomyelitis patient in an iron lung while the

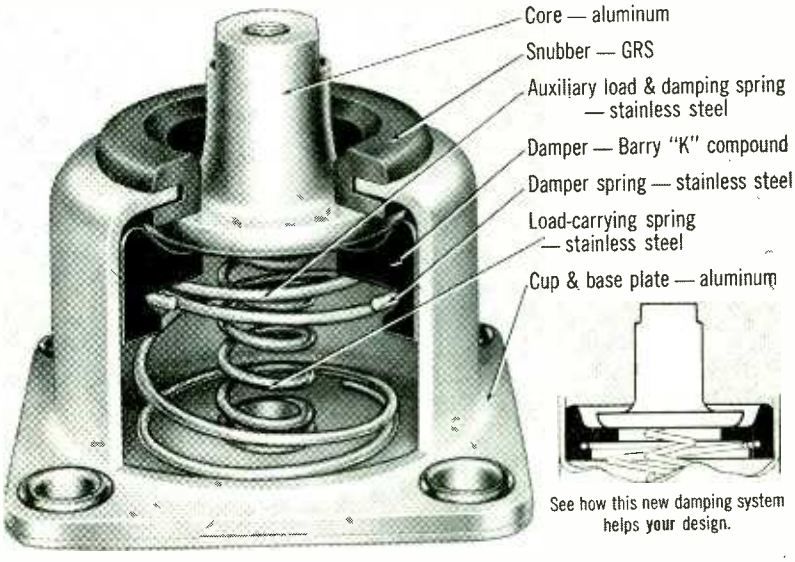
(Continued on page 22)

Barry's New "LO" Mount Meets MIL-C-172B at low cost

— with this extra vibration isolation that adds reliability to your design.

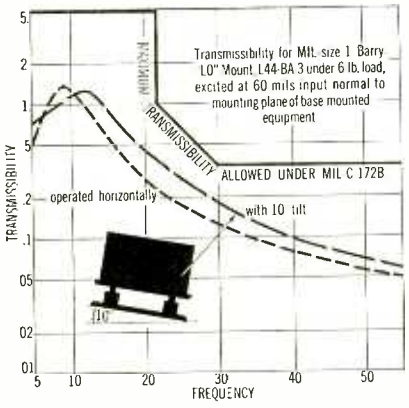
We designed for lower cost — *and developed a better mount for MIL-C-172B.* Even at 10° inclination, the new Model L44 Mount performs effectively. And its other characteristics, too, far exceed requirements of MIL-C-172B.

The basically simple and versatile construction of this new isolator lets us match characteristics to your specification. Your design now gains added reliability with a mount that more than satisfies MIL-C-172B — and at low cost.



MIL-size 1 "Lo" Mount shown 1½ times actual size

Extra-low transmissibility and low natural frequency



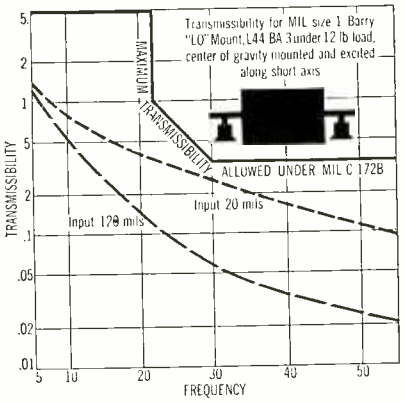
This low transmissibility — below 2 at resonance in all load ranges — is a major advantage of the Model L44 isolator. It accommodates high-amplitude inputs, even at resonance, without snubbing. Typical isolation at 10° inclination is also shown above.

Very low rocking modes

In base-mounted systems, transmissibility of rocking modes under horizontal vibration is reduced to the point where they are indiscernible. This is due to the combination of inherently low ratio of horizontal-to-vertical stiffness plus horizontal *self-centering* friction damping.

For center-of-gravity designs

Independent horizontal damping makes the "Lo" mount especially suited for installation in the plane



of center-of-gravity of the equipment. The natural frequency of the system shown above is below 5 cps.

Controllable characteristics

These exceptional characteristics result from the unique Barry spring and friction-damping design pictured above. And these characteristics can be controlled to give high performance with a wide variety of equipment. Horizontal and vertical damping can be controlled independently. Special versions of the "Lo" mount will control transmissibility at resonance for a given input . . . or handle very high-amplitude inputs at resonance without snubbing.

Physical characteristics

The L44 Mount is dimensionally interchangeable with MIL size 1 isolators. It is available in 7 load ranges from 0.25 to 10 pounds per mount in long- and short-core models. It meets all environmental as well as vibration requirements of Procedure I, MIL-E-5272A. Temperature range is −85F to 250F. Weight is 1½ ounces per mount.

Write today for data sheet 57-05

Barry's new Western Division, in Burbank, California, offers fast, on-the-spot design and prototype service, and production of special systems.

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latter is operating.

The brain of the instrument, contained in a compact box weighing only 18 ounces, is suspended from the neck. Two sets of ear pieces can be used simultaneously, and a tape recorder and a loud-speaker can also be connected. This last feature has an obvious value for teaching purposes. A special microphone conveys only wanted sounds. The instrument is produced by Airsonic Ltd., London.

▶**Sustaining Life**—An apparatus for coaxing new-born babies to breathe is in regular use at the Royal Maternity and Women's Hospital in Glasgow, Scotland. The electronic respirator is actually controlled by the infant. When the baby makes an effort to breathe, a small pressure change in his face mask operates a sensitive trigger valve and brings an electronic controller into operation.

The original impulse supplied by the baby is amplified and used to open a valve connected to an air or oxygen cylinder.

FCC Actions

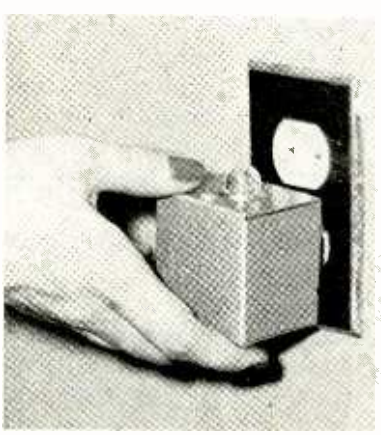
▶**Cracks** down on vessels under the jurisdiction of the Communications Act without radiotelephone installations. FCC will fine such vessels $500. Each day of navigation without radiotelephone constitutes a separate offense. In addition, the master of the vessel is fined $100 for failure to enforce or comply with the Communications Act

▶**Permits** West Coast Telephone Company to file comments in Commission's study of the portion of the spectrum at and above 890 mc, even though filing date has passed

▶**Studies** a switch in class B f-m allocations. It may give channel 231 to Cincinnati, Ohio, after removing channel 278 from Cincinnati and assigning it to Middletown, Ohio

▶**Grants** RCA Communcations permission to set up rates and regulations for 45-wpm printer subchannels between the United States and Switzerland

▶**Announces** the appointment of Irving Brownstein as Chief of the Law, Enforcement and Procedures Office of the Safety and Special Radio Services Bureau. Brownstein succeeds Douglas Anello, who resigned



PANIC ALARM plugs in wall, buzzes when . . .

Cold Cathode Signals Disaster

IF the Federal Civil Defense Administration has its way every home and office in the United States will have a small electronic device as an alarm for major disasters.

Toward this end the FCDA gave a $25,958 research and development contract to Midwest Research Institute, Kansas City, Mo. a year ago.

The result is expected to be tested on a wide scale in the next few months. It is called a National Emergency Alarm Repeater, nicknamed NEAR. About the size of a table model cigarette lighter, it is plugged into any 110-volt outlet. When the local panic button, located in a local Civil Defense Office, is pressed, a controlled 240-cycle signal is sent over power lines. This triggers the receiver, initiating a loud buzz. The device contains a capacitor and coil in series and one cold cathode gas tube.

The FCDA is considering other electronic devices to do a similar job. One would be an automatic relay that would turn on radios remotely.

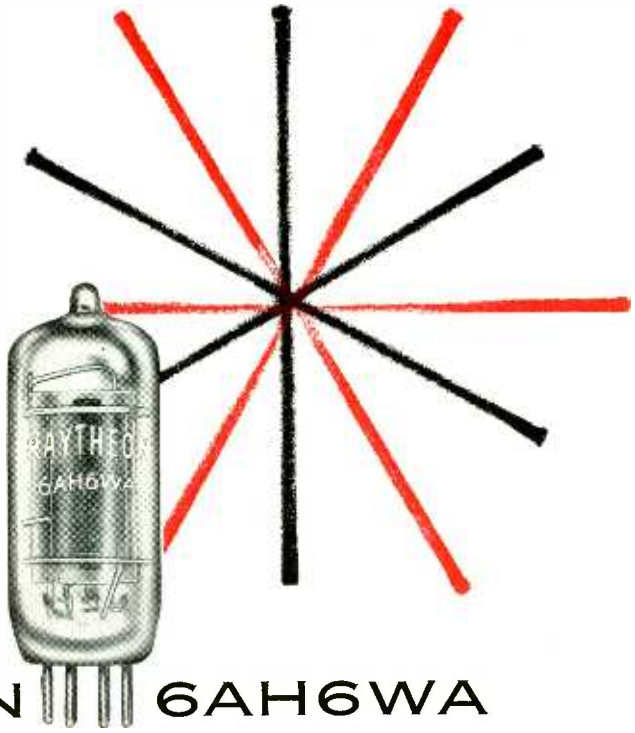
Utilities Eye Microwave Channels

Statistical microwave survey establishes reasonable basis for power utilities usage

ANSWERS to a questionnaire sent to 310 electric, gas, steam and water utilities operations indicate the extent and usage of microwave systems by such companies. The survey was conducted by L. E. Ludekens, National Committee for Utilities Radio representative on the Operational Fixed Microwave Council.

▶**Extent**—The report shows that as of April 1, 1957, there are 86 licensees in the Power Radio Service, having 1,028 microwave transmitters authorized in the three as-

(Continued on page 24)



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$E_f = 6.3v$ $E_p = 300v$ $E_{c_2} = 150v$
$I_f = 0.45A$ $I_p = 10mA$ $I_{c_2} = 2.5mA$

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Circle 11 Readers Service Card

signable frequency bands. In all, there are 13,700 radio-frequency route miles with transmitters located at 513 stations.

There are now in use over 41,000 voice circuit miles and approximately 69,000 circuit miles of combined voice, telemetering, supervisory control, relaying and other forms of transferred intelligence. The utilities now have constructed what might be called their main route microwave system, and are presently installing numerous specialized and wayside channels.

Response to the NCUR questionnaires indicates 72 equivalent voice circuits, as a present maximum for any one radio frequency path, and a statistical average of 10 equivalent voice channels for an average microwave path. On the subject of Mobile Radio Service repeat-control microwave stations; in the 960-mc band there are a total of 162 transmitters, with 24, or 19 percent, used for repeat-control. In the 2,000-mc band, there are 434 transmitters, with 8, or 2 percent, used for repeat-control. In the 6,700-mc band, there are 948 transmitters, with 11, 1 percent, used for repeat-control operations.

▶**Trends** — Analysis of existing microwave systems indicates that the major portion of the multiplex channelizing is represented in conventional voice circuits. However, recent trends indicate there will be a greater increase in installations involving high-speed protective relaying, area load frequency control, and various forms of computer and high speed business machine operations. There is also an indication that there will be a limited need for specialized television applications using both wide band and narrow band video circuits.

Comments on future applications definitely indicate a practical need for incidental control and alarm indication operations in the Mobile Service vhf frequency spectrum.

▶**Council**—The Operational Fixed Microwave Council is primarily a microwave system recording and fact-finding agency for applicants in the Safety and Special Services. It keeps books on current and proposed microwave communication systems and advises prospective microwave users of interference potentials. As of May 1, 1957, there were 3,012 operational fixed microwave beams being used or proposed in the United States.

Japanese Firms May Make U. S. Radios

A JAPANESE government source says the Ministry of International Trade and Industry expects to receive a formal proposal from a major U. S. manufacturer for the production of American radios in Japan. The radios would be for export to Southeast Asia and Latin America.

▶**Plan**—Under the plan, leading Japanese manufacturers now receiving technical assistance from the U. S. company will produce the radios, which would be bought and trademarked by the firm before shipment. At least ten Japanese firms are believed to be involved.

If the Japanese government approves the plan, subcontracts will probably be made with each firm according to production capacity.

It is believed that the U. S. company involved may also seek contracts for production of television sets, phonographs and other products. Japan's decision, if a formal proposal is submitted, is said to hinge on whether the proposed exports will interfere with the exports of Japanese items of a similar type.

Tube Tunes Radar Instantly

Helitron tube, displayed by its inventor D. A. Watkins and his assistant G. Wada. Tube is purported to be a major improvement over the backward wave oscillator and costs about half as much to produce. Operating frequencies range from 200 to 10,000 mc. Tube is voltage tuned and a two-to-one change in voltage causes a two-to-one change in frequency. Development was done at Stanford University

Financial Roundup

SIXTEEN out of 18 firms whose earnings were compared in this month's Financial Roundup showed improved earnings in 1957 over comparable 1956 periods.

Only one of the 18 lost money in its latest reporting period. Five companies reported losses in comparable periods, last year.

A more detailed analysis of 32 companies that recently reported six months earnings, printed in the August 20 *Business Edition*, also showed improved earnings.

Company	Net Profit 1957	1956
ACE Industries 12m	$9,818,000	$8,593,000
Advance Industries 9m	113,338	567,758*
Barry Controls 6m	130,148	108,486
Allen B. Du Mont 6m	997,900*	484,000*
Hoffman Electronics 6m	864,299	783,972
General Cable 6m	6,521,270	5,491,047
Laboratory for Electronics 12m	85,000	985,000*
W. L. Maxson 9m	191,378	329,151*
Muter Corp 6m	152,352	79,721
Otis Elevator 6m.	6,427,000	5,709,718
Packard-Bell 9m.	463.120	487,847
Robertshaw Fulton Controls 6m	2,553,029	1,959,098
Storer Broadcasting 6m	4,429,484	2,845,445
Topp Industries 12 m	466,796	92,062
Van Norman Industries 6m	433,153	396,645
Webcor Inc 6m	504,000	235,000*
Vitro Corp. of America 6m	774,333	263,729
Westinghouse 6m	30,615,000	11,713,000*

* loss

(Continued on page 26)

PERKIN

MISSILE AND RADAR
STANDARD DC POWER SUPPLIES

Perkin has developed Magnetic Amplifier Regulated DC Power Supplies for missile launching and check-out, with ratings of 30, 50, 100, 200, 300, 400, 500 amperes and above. The unit shown here is a 24-32V, DC @ 100 amp. unit, 19" rack panel mount, with a regulation of ±½% over the range of 24-32 volts. There are provisions for remote operation and sensing. Perkin ground power supplies are now being used in the Thor, Atlas, Bomarc, Vanguard and other missile programs.

Perkin airborne power supplies more than meet both military specifications MIL-E-5272A and MIL-C-7115. The use of silicon rectifiers provide a much more compact package with higher efficiency ratings and longer life expectancy. The unit illustrated provides 27.5 volts DC (26 to 30 volt range), 20 amperes continuous duty. The input is 115/200V AC, 3 phase; frequency range 400 CPS ±6 CPS. The regulation is less than ±0.5 volts.

Perkin has designed and manufactured over 6,000 units operating in Military and Commercial Radar Systems. 6, 7, 8, 9, 10 KV and other ratings can be designed for your specific mechanical and space configurations. Typical 6KV specifications are: AC Input—100-120V, 380-420 CPS, single phase; DC Output—6KV, ±5% @ 100 microamperes; Temperature Range—−55°C to +125°C @ 50,000 feet altitudes and above. Weight—2¼ lbs.; no tubes or moving parts.

Hundreds of Perkin Ground Radar Systems are in operation throughout the country. Built to specifications MIL-E-4158, this unit was conservatively designed and will operate at 150% load continuously without damage to the unit. Specifications are: AC Input—120/208V ±10%, 3 phase, 60 cycle ±2 CPS, 4 wire system; DC Output—24-32V @ 100 amps.; Regulation—±½% (for any combination of line and load changes); Ripple—1% RMS or less.

Other Standard Perkin Products Include:

- Laboratory DC Power Supplies and AC Line Regulators
- DC-DC and DC-AC Static Inverters
- Magnetic Amplifiers
- Pulse Generators
- Servo Controls
- Transistorized B+ and Heavy Duty Power Supplies

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For further data return above coupon.

Models Mean Business

Market looks good for firms that make training-aid devices

Two scaled ship-models, now plowing through the waters of a 20-foot-square tank at Northwestern University, may be the forerunners of a substantial business in electronic equipment sales.

Devised by engineers at Naval Training Device Center, where development contracts amounting to $25 to $30 million a year are let, the precisely-scaled models react sufficiently like full-scale ships to be a valuable and inexpensive training aid. Technical details and circuits are described on p. 172, this issue.

► **Operation**—Characteristics such as response to the helm, response to the engine telegraph, acceleration and deceleration have time lags similar to those of the full-scale ship.

► **Business** — Prototype was built by Teletronic Lab. Gardner Displays was prime contractor for four AK's and four DE's. Electronic equipment transmitter, amplifiers and receivers was subcontracted from Fenske, Fedrick and Miller. Cost of electronic equipment for one complete set: about $3,000.

Link has made one 7-ft. submarine now in use at New London, Conn.

Market potential for ships looks good: ROTC units at all universities, Officers' Candidate Schools, the several hundred Reserve Training Centers, Fleet Training Centers, Coast Guard, Army, Merchant Marine, NATO countries and private training centers for yacht owners.

Meetings Ahead

Aug. 28-Sept. 7: National Radio and Television Exhibition, Earls Court, London.

Sept. 4-6: Special Tech. Conference On Magnetic Amplifiers, Penn Sheraton Hotel, IRE, AIEE, Pittsburgh, Pa.

Sept. 7-13: Twelfth Annual Conference Instrument-Automation Conference, Cleveland Auditorium, Cleveland, Ohio.

Sept. 17-18: National Technical Meeting on Machine Tool Automation, RETMA, AIA, NEMA, NMTBA, Ambassador Hotel, Los Angeles, Calif.

Sept. 23-25: Standards Engineers Society, Sixth Annual Meeting, Hotel Commodore, N. Y. C.

Sept. 24-25: Sixth Annual Conference On Industrial Electronics, IRE, AIEE, Morrison Hotel, Chicago, Ill.

Oct. 7-9: National Electronics Conference, IRE, AIEE, RETMA, SMPTE, Hotel Sherman, Chicago.

Oct. 7-11: American Institute of Electrical Engineers, Fall general meeting, Chicago, Ill.

Oct. 9-11: Fourth Annual Symposium on High Vacuum Technology, Committee On Vacuum Techniques, Hotel Somerset, Boston, Mass.

Oct. 9-12: Audio Engineering Society, 1957 Convention, N. Y. Trade Show Building, N. Y. C.

Oct. 16-18: American Institute of Electrical Engineers, Conference on Computers in Control, Chalfonte-Haddon Hall Hotels, Atlantic City, N. J.

Oct. 16-18: IRE Canadian convention Automotive Building, Exhibition Park, Toronto, Canada.

Oct. 21-26: Institution of Radio Engineers Australia, annual convention, IRE, Hotel Australia, Sydney, Australia.

Oct. 21-26: International Conference on Ultra High Frequency Circuits and Antennas, Societe Des Radioelectriciencs, Paris, France.

Oct. 31-Nov. 1: Professional Group on Nuclear Science, fourth annual meeting, Henry Hudson Hotel, New York, N. Y.

Oct. 31-Nov. 1: 1957 Electron Devices Meeting, PGED, Shoreham Hotel, Washington, D. C.

Nov. 2-10: 1957 International Congress of Measuring Instrumentation and Automation, Interkama, Dusseldorf, Germany.

Nov. 4-6: Third Annual Symposium on Aeronautical Communications, PGCS, Hotel Utica, Utica, N. Y.

Industry Shorts

► **British** radio equipment exports of $63.6 million in the first six months of 1957 show a 10-percent increase over the same period last year. Biggest jump has been made by sound reproducing equipment, with hi-fi exports at $14.4 million for the first six months, up 30 percent over last year.

► **Ionosphere** begins 50 miles above the earth and may extend 6,000 to 20,000 miles up instead of 200 as previously believed, says R. A. Heliwell, professor at Stanford University.

► **Scotland** tv will extend to more than three million people in August when the new Independent Television Authority station opens at Black Hill, Lanarkshire.

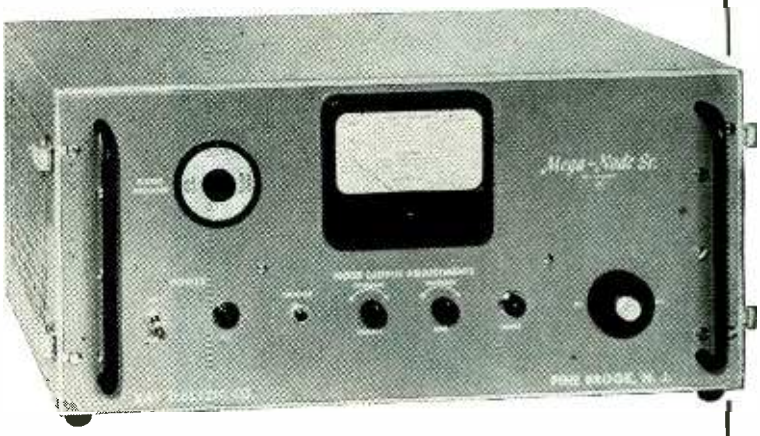
► **British** Government tv license now costs $11.20 per year, radio license remains at $2.50 per year. BBC gets $7.19 of tv tab, $2.18 of radio tab; Post Office and Treasury divide remainder.

► **AEC's** Hanford Operations will install a 17-mile two-terminal multi-channel microwave communications system at Richland, Wash.

► **Total** U.S. electronics exports for the first five months of 1957 were about $665,000 above the figure for the comparable period last year. This year's January-May exports amounted to $125,415,574 compared to $124,751,521 in the same period last year.

KAY

Noise Figure Measurement 10-3,000 mc



KAY *Mega-Node Sr.*

- **Absolutely no modulation on noise output**
- **Built-in stability**
- **Longer life on noise diode**
- **Ease of operation due to front panel design**
- **All power supplies regulated**

A calibrated random noise source providing an output from 10-3,000 mc, the *Mega-Node Sr.* may be used to measure noise figure and receiver gain and for the indirect calibration of standard signal sources.

At the lower end of the frequency, range noise figure may be obtained directly from the meter. For greater accuracy at higher frequencies, corrections for diode transit time and termination mismatch are available from charts supplied with each instrument.

SPECIFICATIONS

Frequency Range: 10 mc to 3,000 mc
Output Impedance: 50 ohms unbalanced into Type N Connector
Noise Figure Range: 0 to 20 db
Filament Voltage Supply: From regulated supply
Meter Calibration: Linear in db noise figure; logarithmic in D.C.M.A.
Fuse Protection: One Type 3AG, 2 amps
Tubes: 1 Eclipse Pioneer TT1 Diode
Power Supply Source: 117 Watts ±10% 60 cps a.c. Available for 50 cps
Power Consumption: 200 Watts
Price: $790.00 FOB Plant

Kay Electric Now Manufactures Improved Versions of New London Noise Figure Measurement Instruments. See Future Advertisements and Write for Detailed Specifications and Prices.

KAY *Microwave Mega-Nodes*

Calibrated random noise sources in the microwave range, used to measure noise figure, and receiver gain and calibrate standard signal sources in radar and other microwave systems. Available in following waveguide sizes to cover range of 960-26,500 mc.

RG-69/U	**$400**	**†RG-51/U**	**$195**
†RG-48/U	**$195**	**†RG-52/U**	**$195**
†RG-49/U	**$195**	**RG-91/U**	**$250**
†RG-50/U	**$195**	**RG-53/U**	**$250**

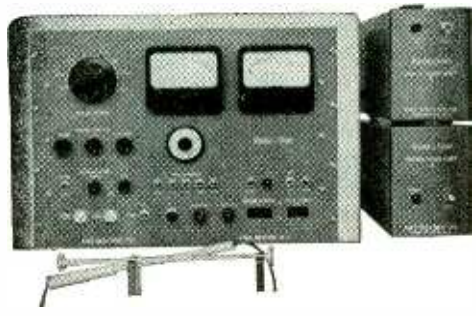
Available with fluorescent or inert gas (argon or neon) tubes. Noise output fluorescent tubes 15.8 db ±.25 db; argon gas tubes, 15.2 db ±.1 db*; neon tubes, 18.0 db ±.5 db*.
*Noise output of inert gas tubes independent of operating temperature. Universal power supply for both fluorescent or argon gas and all waveguide sizes: $100.

† $167. per Guide when 3 or more are purchased with $100. power supply.

NEW! WR-770, WR-650—**$595.00 each;** WR-510, WR-430, WR-340—**$495.00 each.** All WR numbers fluorescent only.

KAY *Mega-Node*

Calibrated random noise source reading direct in db, for measurement of noise figure, receiver gain and for indirect calibration of standard signal sources. Frequency Range, 5 to 220 mc; Output Impedances, unbalanced—50, 75, 150, 300, Infinity; balanced—100, 150, 300, 600, Infinity; Noise Figure Range, 0-16 db at 50 ohms, 0-23.8 db at 300 ohms. Price: $295.00 FOB Plant.



KAY *Rada-Node*

Complete radar noise figure measuring set for I-F and R-F, including attenuators, detector and noise sources. Complete with power supplies. Frequency range: 5 to 26,500 mc; noise figure range, up to 21 db, in lower part of spectrum.
Prices on request.

KAY ELECTRIC COMPANY

Dept. E-9 14 Maple Avenue Pine Brook, N. J.
CAldwell 6-4000

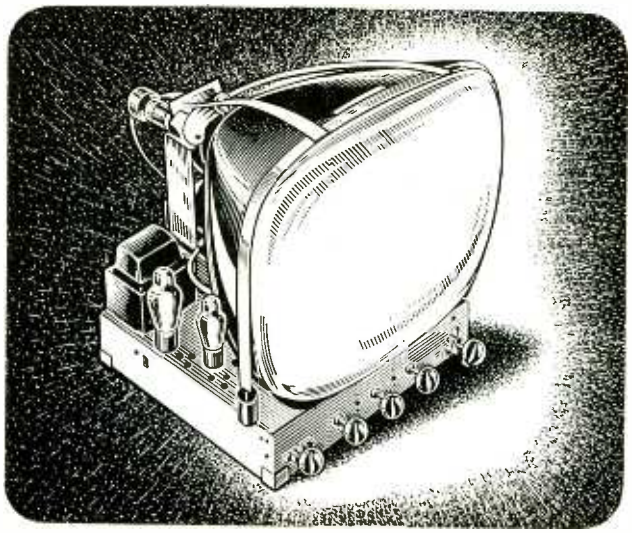
Acetic Acid
Acetone
Aluminum Nitrate
Aluminum Sulfate
Ammonium Carbonate
Ammonium Chloride
Ammonium Hydroxide
Ammonium Phosphate
Antimony Trioxide
Barium Acetate
Barium Carbonate
Barium Fluoride
Barium Nitrate
Benzene
Boric Acid
Cadmium Chloride
Cadmium Nitrate
Cadmium Sulfate
Calcium Carbonate
Calcium Chloride
Calcium Fluoride
Calcium Nitrate
Calcium Phosphate
Carbon Tetrachloride
Cobalt Carbonate
Ether, Anhydrous
Ether, Petroleum
Hydrochloric Acid
Hydrofluoric Acid
Hydrogen Peroxide
Lithium Carbonate
Lithium Chloride
Lithium Nitrate
Lithium Sulfate
Magnesium Carbonate
Magnesium Chloride
Magnesium Oxide
Manganese Dioxide
Manganous Carbonate
Methanol
Nickelous Chloride
Nickelous Nitrate
Nickelous Sulfate
Nitric Acid
Potassium Dichromate
Potassium Hydroxide
iso-Propyl Alcohol
Radio Mixtures
Silicic Acid
Sodium Carbonate
Sodium Chloride
Sodium Hydroxide
Sodium Phosphate Dibasic
Strontium Nitrate
Sulfuric Acid
Toluene
Triple Carbonate
Xylene
Zinc Chloride
Zinc Nitrate
Zinc Oxide

PURITY BY THE TON
-for production use

High Purity

Baker ELECTRONIC CHEMICALS

For your electronic tubes and screens—



STRONTIUM NITRATE, C. P. ANHYDROUS for Electronics

One of many controlled purity Baker production chemicals for the electronic industry. You may use Strontium Nitrate as a screen settling compound, or for emission coatings. Baker Strontium Nitrate, C.P. Anhydrous Powder for Electronics, is produced to the controlled purity standards that make it ideal for either of these important applications.

In the specifications shown below, note the low level of total alkali as an impurity. There is close control of the iron and heavy metals, because these are known to be critical impurities in electronic applications. This material is offered in the anhydrous form as a fine powder to facilitate the manufacture of emission suspensions.

Today, the increasing demands of the electronic industry for closer tolerances present ever-new challenges for higher chemical purity. Baker works closely with chemists and electronic engineers to aid in meeting these challenges. Look over the list of Baker electronic chemicals on this page—write for prices and samples of those which interest you in your production.

STRONTIUM NITRATE, C.P. Anhydrous Powder, for Electronics

$Sr(NO_3)_2$ F.W. 211.646

Calcium (as CaO)	0.55 %
Barium (as BaO)	1.00 %
Chloride (Cl)	0.005 %
Water Insoluble	0.010 %
Total Alkali (as SO_4)	0.60 %
Iron (Fe)	0.003 %
Heavy Metals (as Pb)	0.002 %

Maximum Limits of Impurities

J. T. BAKER CHEMICAL CO.
Phillipsburg, New Jersey

J.T.Baker CHEMICAL

BRANCH OFFICES

NEW YORK	CHICAGO	PHILADELPHIA	LOS ANGELES
122 E. 42nd St.	435 N. Michigan Ave.	6908 Market St., Upper Darby, Pa.	170 E. California St., Pasadena 5, Cal.

PYRAMID CQM

1. High reliability, ideally suited for computer requirements. 2. Highest purity aluminum used. 3. Molded terminals for tight permanent seal. 4. Low leakage current. 5. Long shelf life. 6. Low equivalent series resistance.

Computer circuits require electrolytic capacitors of the highest reliability. Pyramid type CQM capacitors fill this requirement. They are made with electrodes of the highest purity aluminum obtainable (99.99%) and specially formulated electrolytes. Carefully inspected materials, coupled with controlled manufacturing methods, produce a capacitor capable of meeting the most exacting computer specification.

The capacitors are made in high purity aluminum containers hermetically sealed with molded tops held in place by rolling the can rim securely over a buna rubber gasket. The terminals are molded into the top. These terminals and the buna rubber gasketing insure a tight, permanent seal.

Two types of terminals are available: (1) a screw type terminal with tapped inserts, (CQM); (2) a lug type terminal, with anti-rotational locks, swaged to solid aluminum inserts, (CQML).

Internal connections to the aluminum inserts are made with straps of the same high purity aluminum as the electrodes. This feature contributes to low leakage and long shelf life.

Pyramid type CQM capacitors may be ordered in various capacitance and voltage combinations ranging from 45,000 mfd at 5 WVDC to 850 mfd at 400 WVDC. Container diameters are 1⅜", 2", 2½" and 3". The height for all units is 4⅛". Other sizes, or units for special applications may be obtained by inquiring of Pyramid's Engineering Department.

NEW FROM PYRAMID

PYRAMID TQ

1. Designed for high reliability electronic equipment, telephone networks, and industrial control systems. 2. Wide temperature range: −20°C. to +85°C. 3. Hermetically sealed aluminum can. 4. Low leakage current. 5. Long life, trouble free operation. 6. Manufactured under quality controlled conditions.

Present day electronic equipment, telephone network systems, and industrial control systems, where a high degree of reliability is essential, require capacitors having a long life.

Pyramid Electric Company introduces type TQ, a high quality electrolytic capacitor which will meet the requirements of design engineers today and for some time to come.

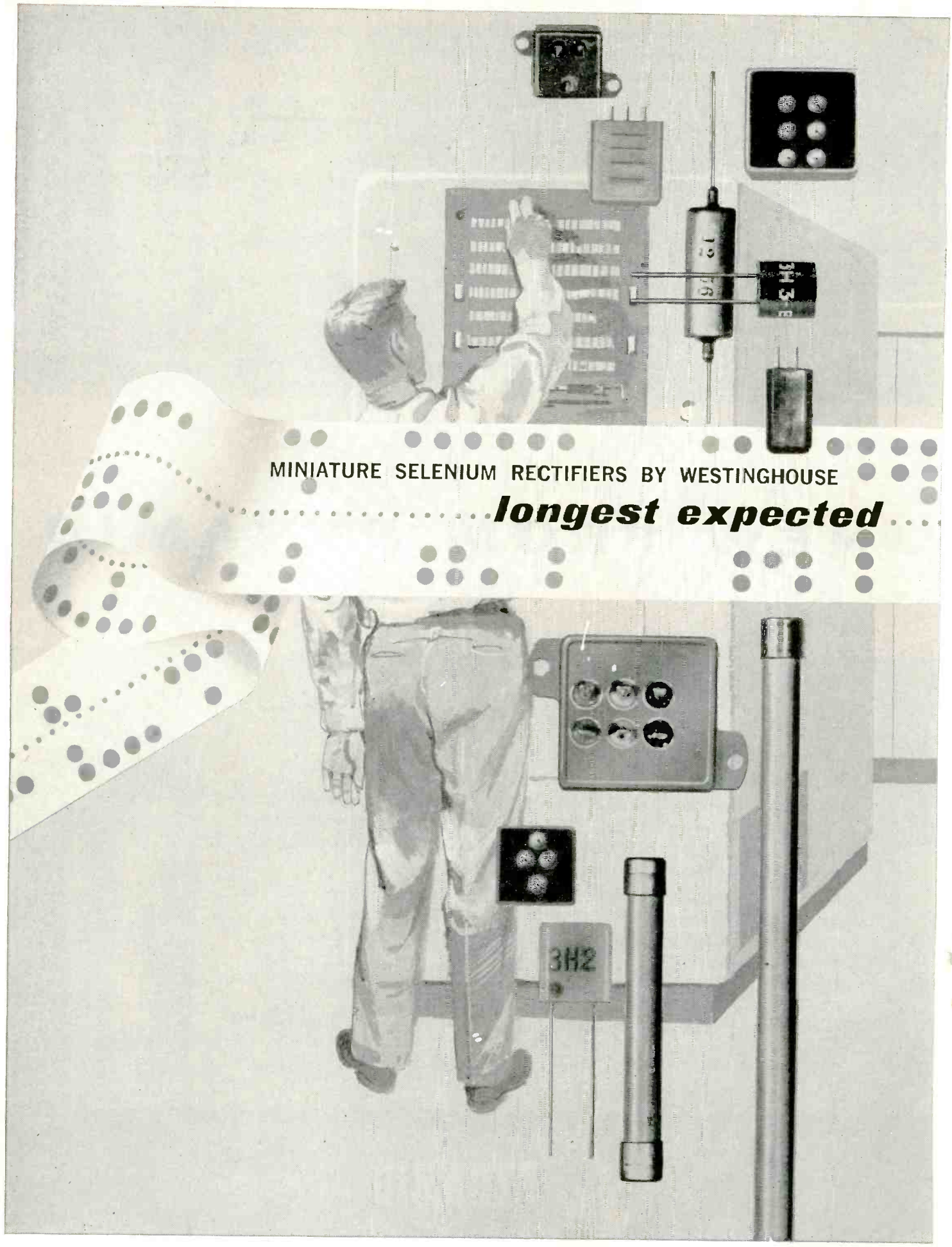
From raw material to finished product, the Pyramid type TQ is manufactured under controlled conditions and constant supervision.

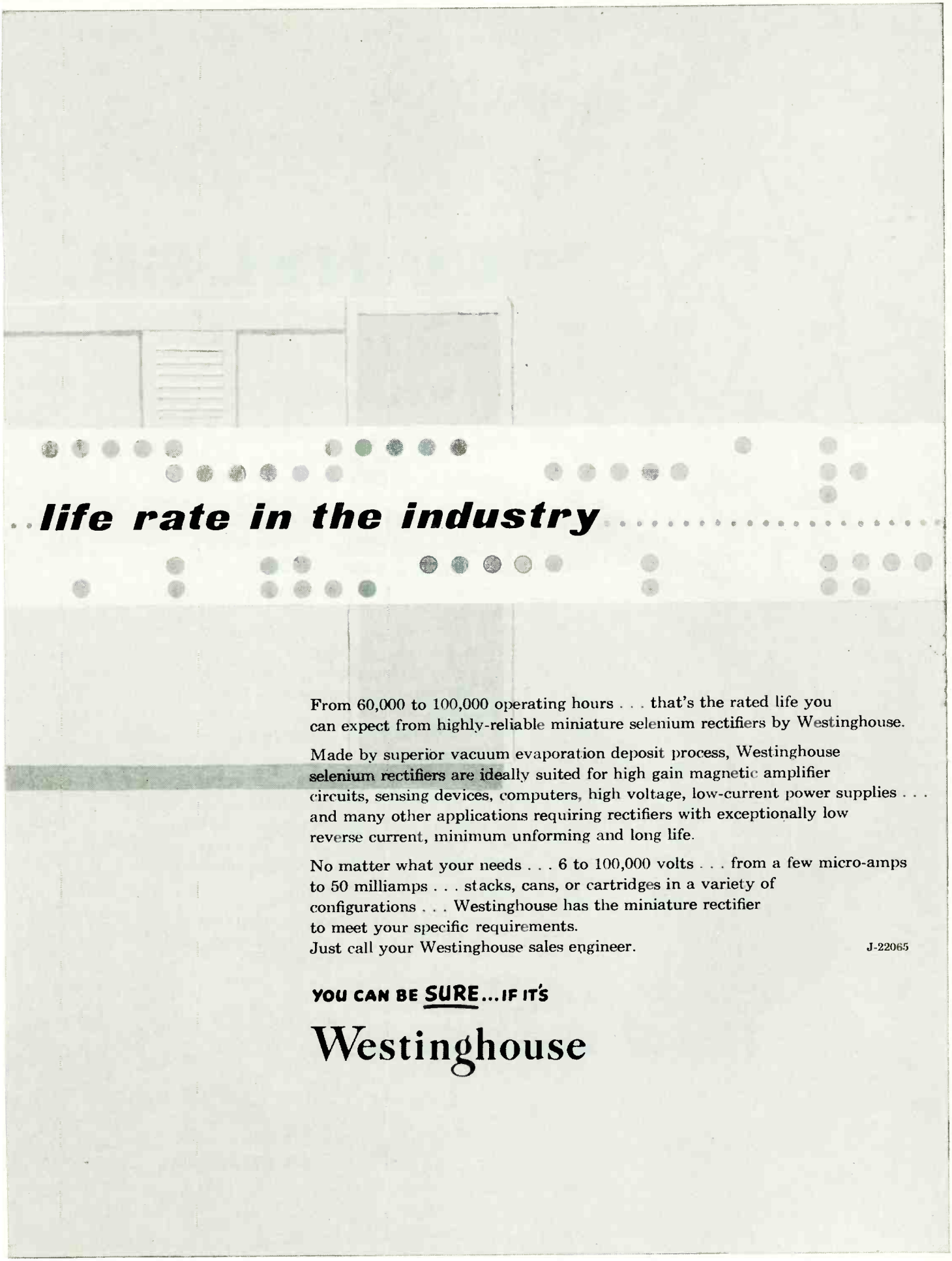
Type TQ Capacitors are available in single, dual and triple capacitances. They vary in voltage range from 6 to 450 working volts DC. Can sizes are available in 1" diameter x 2½" length, 1" x 3", 1" x 3½", 1" x 4", 1⅜" x 2½", 1⅜" x 3½" and 1⅜" x 4".

For complete specifications write for technical bulletin.

PYRAMID ELECTRIC CO.

NORTH BERGEN, NEW JERSEY


MINIATURE SELENIUM RECTIFIERS BY WESTINGHOUSE
longest expected
3H2



..life rate in the industry

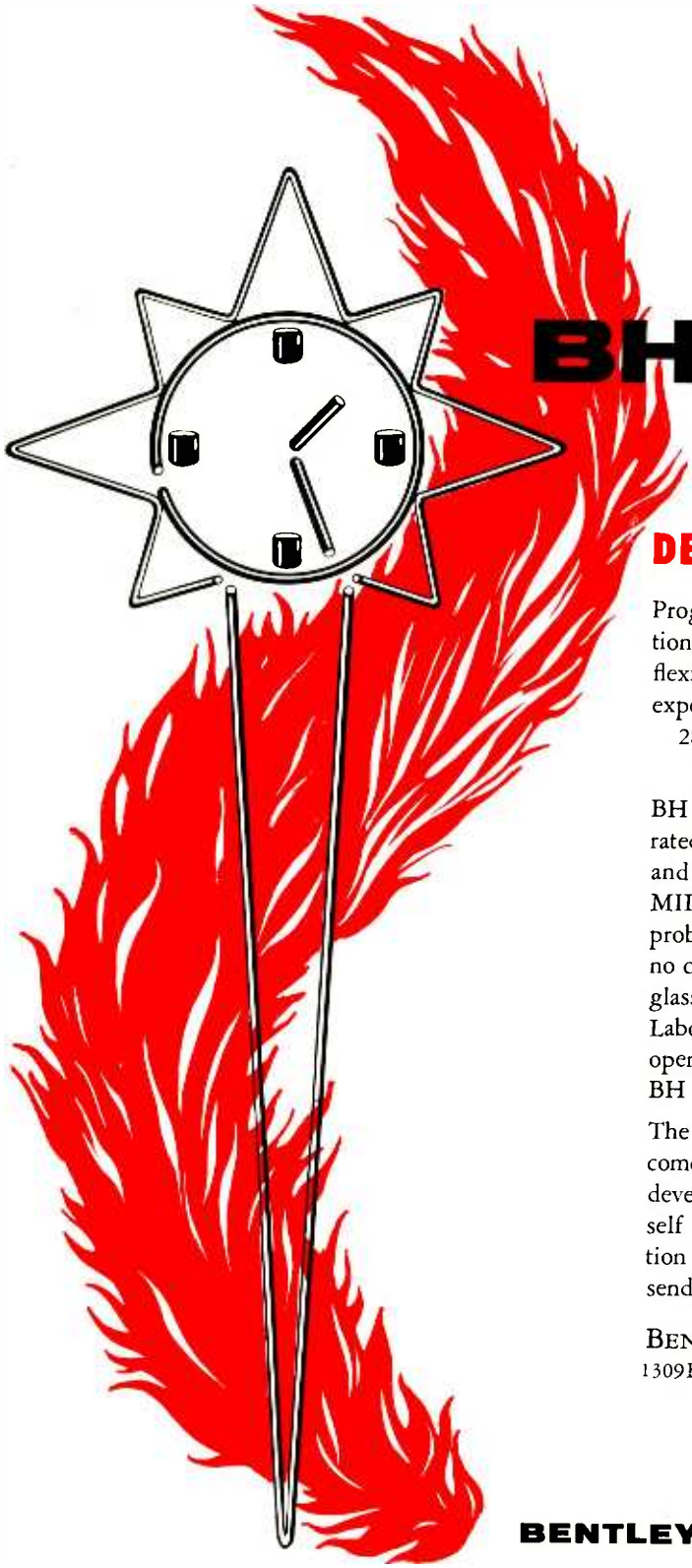
From 60,000 to 100,000 operating hours . . . that's the rated life you can expect from highly-reliable miniature selenium rectifiers by Westinghouse.

Made by superior vacuum evaporation deposit process, Westinghouse selenium rectifiers are ideally suited for high gain magnetic amplifier circuits, sensing devices, computers, high voltage, low-current power supplies . . . and many other applications requiring rectifiers with exceptionally low reverse current, minimum unforming and long life.

No matter what your needs . . . 6 to 100,000 volts . . . from a few micro-amps to 50 milliamps . . . stacks, cans, or cartridges in a variety of configurations . . . Westinghouse has the miniature rectifier to meet your specific requirements.
Just call your Westinghouse sales engineer. J-22065

YOU CAN BE SURE...IF IT'S

Westinghouse



BH VINYL-SIL

VINYL-GLASS SLEEVING DELIVERS LONGER FLEX-LIFE

Progressive stiffening under heat signifies deterioration of vinyl-glass sleevings — so retention of flexibility is important as a guide to ultimate life expectancy. Here are the figures on BH Vinyl-Sil:

2800 hours at 130°C. — 320 hours at 150°C.
115 hours at 180°C. — 4 hours at 232°C.

BH Vinyl-Sil is available in two types. Both are rated for 8,000-volt *minimum* dielectric breakdown and meet all requirements of ASTM, NEMA* and MIL-I-3190B* Class B-A-1 specifications. Moisture problems call for BH Vinyl-Sil 105, which offers no capillary attraction to water. It is the only vinyl-glass sleeving to be recognized by the Underwriters' Laboratories for 600-volt, continuous wet or dry operation at 105°C. For standard applications, use BH Vinyl-Sil 8000.

The outstanding dependability of BH Vinyl-Sil comes from over seven years' pioneering research, development and production testing. Prove it yourself — send us the facts on your electrical insulation problems — we'll make recommendations and send you appropriate samples.

BENTLEY, HARRIS MANUFACTURING CO.
1309 Barclay Street Telephone: TAylor 8-0634
CONSHOHOCKEN, PA.

BENTLEY, HARRIS

Flexible

SLEEVINGS

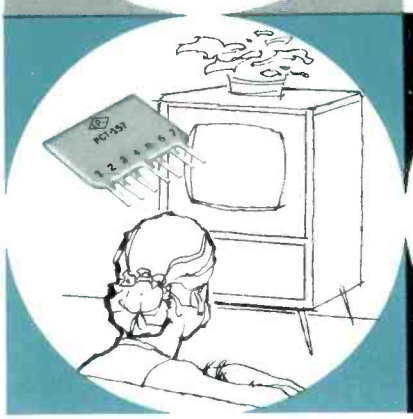
*New Revised Standards Available On Request From Bentley, Harris.

BH Non-Fraying glass fiber sleevings are made by an exclusive Bentley, Harris process (U. S. Pat. Nos. 2393530; 2647296 and 2647288).

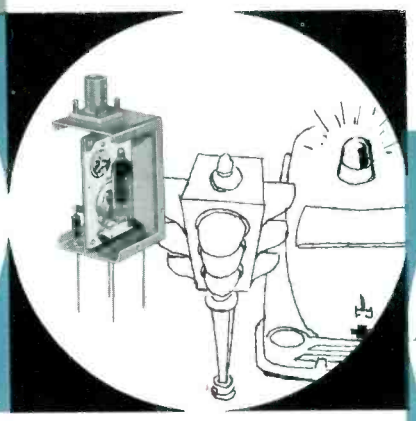
Centralab 1922 1957 35 YEARS

HEARING AIDS — PEC provided compact design, making attractive eye-glass hearing aid possible.

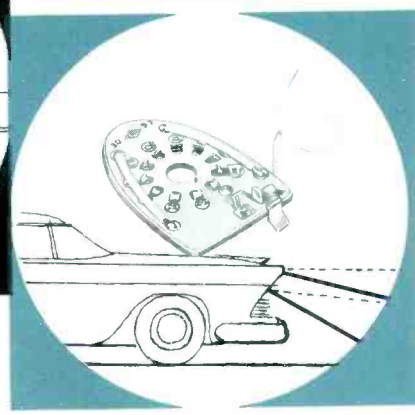
TV SETS — 17 PEC's replaced over 100 parts, simplifying assembly and improving performance.



TRAFFIC — PEC helps control flow of traffic for safe passage of emergency vehicles.



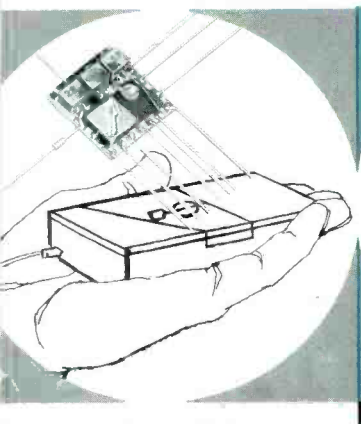
AUTOMOTIVE — PEC provides photo-multiplier tube socket and 20 resistors in one space-saving, packaged unit.

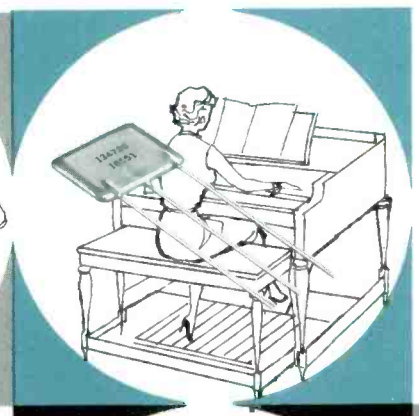


Centralab

Proof of Reliability and Versatility...

85,000,000 PEC's* (Packaged Electronic Circuits) used in these and other applications





Packaged circuits mark decade of electronic progress

Centralab PEC's — combining capacitors, resistors, inductors, and wiring in one compact sub-assembly — were originally designed for military applications. And due to their reliability and versatility, more than 85,000,000 have been used during the past ten years to guarantee circuit performance in countless electronic products. New developments promise even greater design flexibility for future applications.

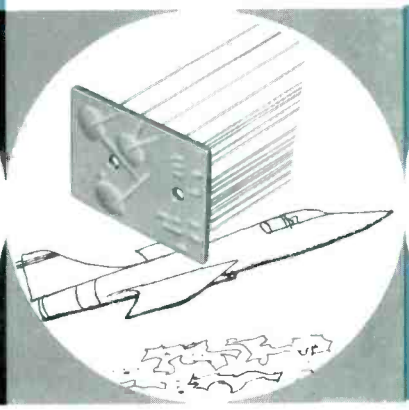
ELECTRONIC ORGAN — PEC filter reduces sharp transient of keying to give natural touch response.

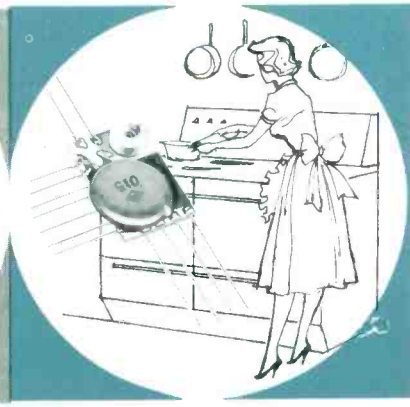
JET AIRCRAFT — PEC's simplify assembly of instrument panels . . . guarantee circuit performance.

APPLIANCES — PEC in surface burner control enables finer selectivity of temperature.

PORTABLE RECORDER — PEC amplifier provides large recorder quality to miniature tape recorder.

GUIDED MISSILES—Rugged, compact PEC's save space, are shock-proof and resist extreme heat.





Centralab

A DIVISION OF GLOBE-UNION INC.
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IN CANADA: 804 MT. PLEASANT RD. • TORONTO, ONTARIO

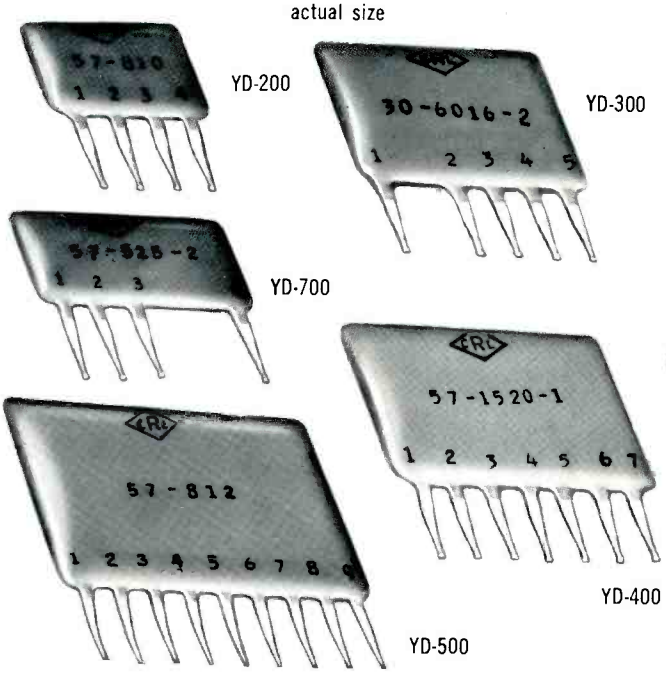
*Trademark

Continued on next page . . .

Centralab offers you TWO TYPES of PEC's*

STANDARD COUPLATES®

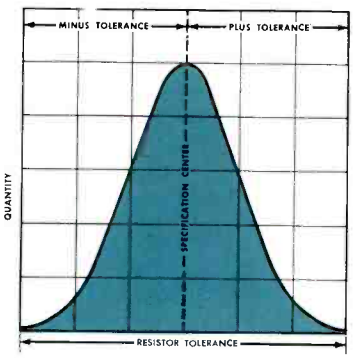
actual size



An infinite number of PEC combinations available from these five basic designs

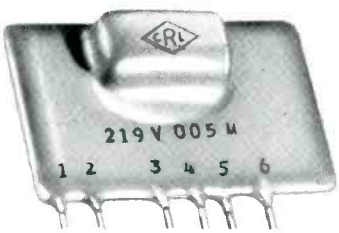
Centralab can adapt the basic shapes shown above to meet a broad variety of design requirements. These five basic Couplates can be furnished with any of five types of terminals . . . narrow tab as illustrated, or your choice of wide tab, long wire, stub wire, and crimped wire to meet your specifications.

All resistors are produced to nominal resistor values



Circuitry performance is more stable because the tolerance is a distribution over the nominal and not fringe values.

NOW! Extended Capacity Ranges



Maximum capacities:

150 to 600 volts up to .5mf
6 volts up to 2.0mf.

This increases the scope of P.E.C.'s for your applications.

*Trademark

Litho in U.S.A.

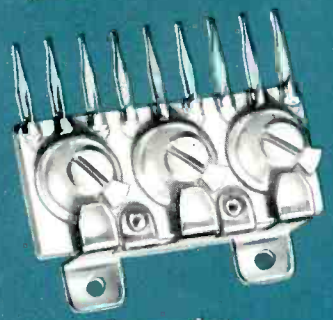
SPECIAL DESIGNS

Any shape and contour available for miniaturization and simplification

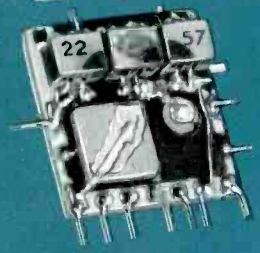
Centralab can produce special packaged electronic circuits to your requirements and to any applicable MIL. specifications. The PEC's shown below illustrate a few recent solutions to customer problems.

• POTTED AND MOLDED CIRCUITS
Provide long life and reliability under extreme operating conditions.

• THE ULTIMATE IN MINIATURIZATION
Micro-miniature PEC for printed-board insertion contains four ± 10% resistors and four .055 mf. ± 20% capacitors.



• TRIMMER RESISTORS
These CRL units save money by using bank of trimmers in applications not requiring frequent or continuous adjustments.



• INCORPORATE DIODES, COILS, AND SOCKETS
Cut assembly errors and costly procedure of purchasing, inventorying, and testing of individual components.

Centralab — originator and undisputed leader in P.E.C. development **— offers you a responsible source for your Packaged Electronic Circuits. You can rely on our expert engineering assistance and modern production facilities to meet your quality and quantity requirements. Most important, Centralab offers you 35 years of experience in design, manufacture, and application of electronic components. Write for complete information on products and service.**

Centralab®

A DIVISION OF GLOBE-UNION INC.
914 EAST KEEFE AVENUE • MILWAUKEE 1, WISCONSIN
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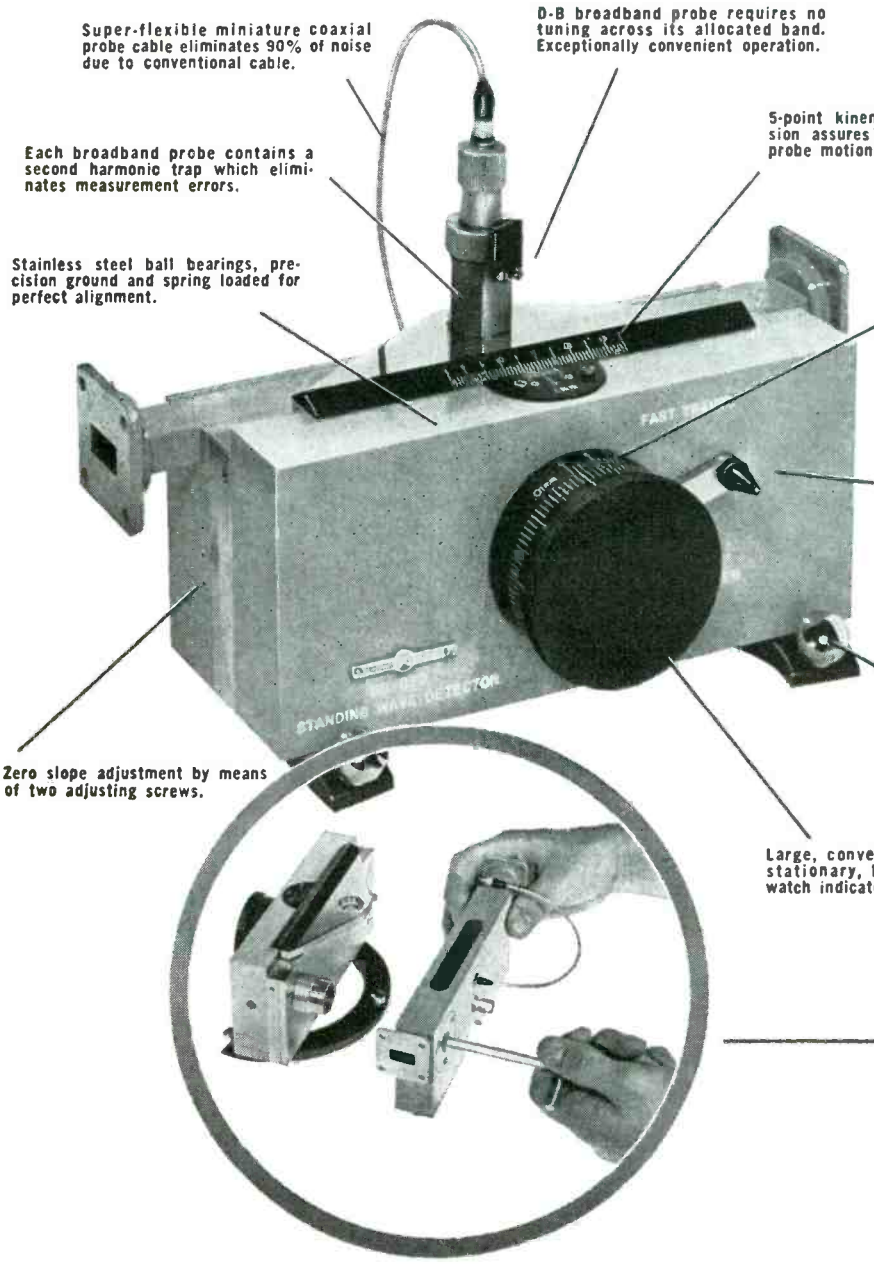
It's easy to obtain Precise Measurements with a D-B Standing Wave Detector

—easy because D-B units are built without the usual sources of error. You get perfect parallelism between slot and waveguide axis...between probe travel and waveguide axis. The waveguide is precision-formed in one piece to provide a uniform path for measured waves, thus minimizing residual VSWR. You can use any D-B slotted line to measure adjacent frequency bands. Merely substitute different-size waveguide blocks and probes—the alignment accuracy is guaranteed to remain unimpaired.

Check the unique features below for further proof of D-B convenience and exceptional accuracy. Literature on request.

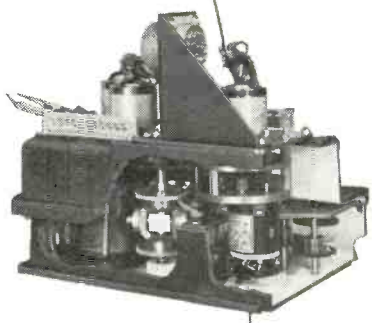


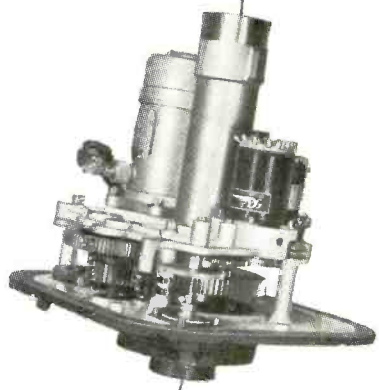
D E M O R N A Y - B O N A R D I

780 SOUTH ARROYO PARKWAY · PASADENA, CALIFORNIA

DE MORNAY BONARDI

This Is Where Atlas Can Help You In Your Missile Program





Where do you stand on your missile or aircraft program? Do you have a new contract for radar, computers or guidance control mechanisms? Then let Atlas help you from pilot stage to production efficiency.

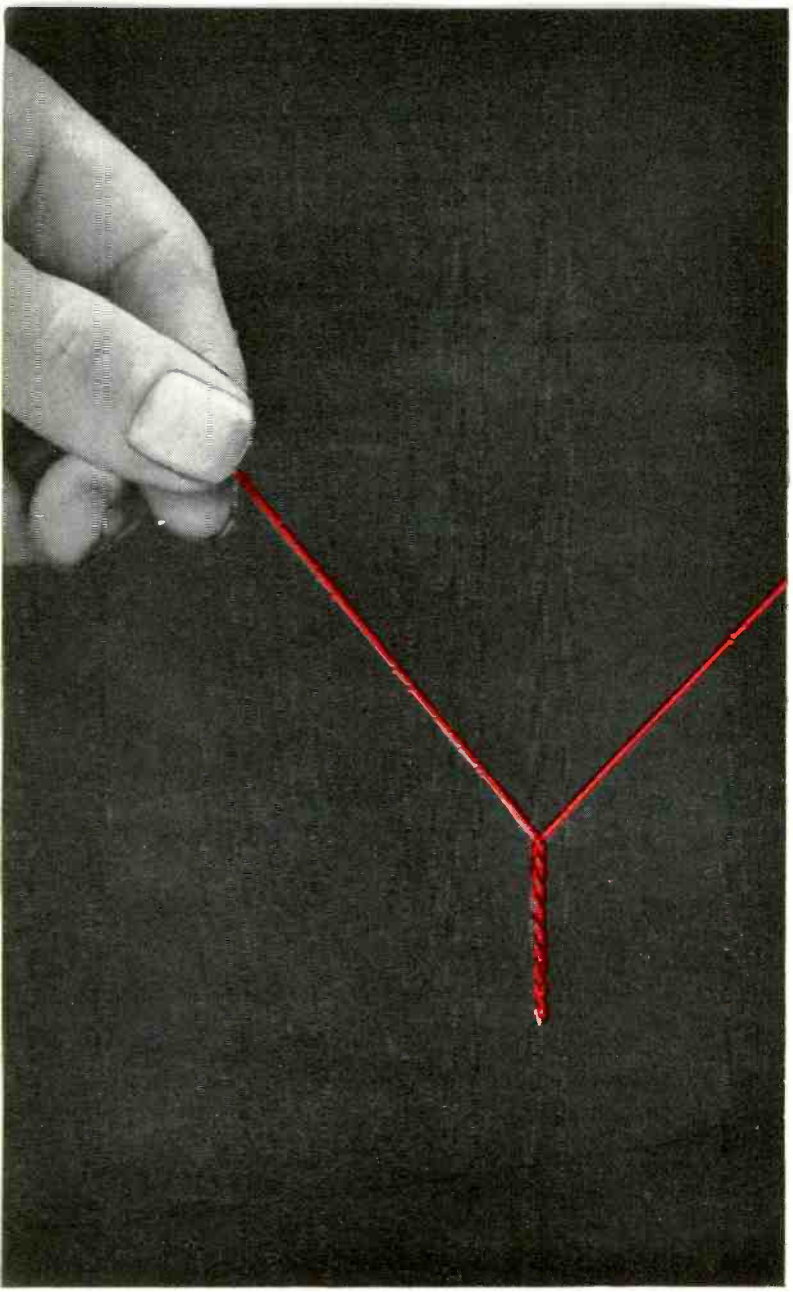
Atlas design, production and methods engineers, toolmakers and skilled mechanics are ready to work on your project on a job basis... as many men, machines and hours of work it requires and no more. Every modern, cost cutting tool, technique and quality control method is utilized. Atlas mechanical and electronic technicians thoroughly test your product.

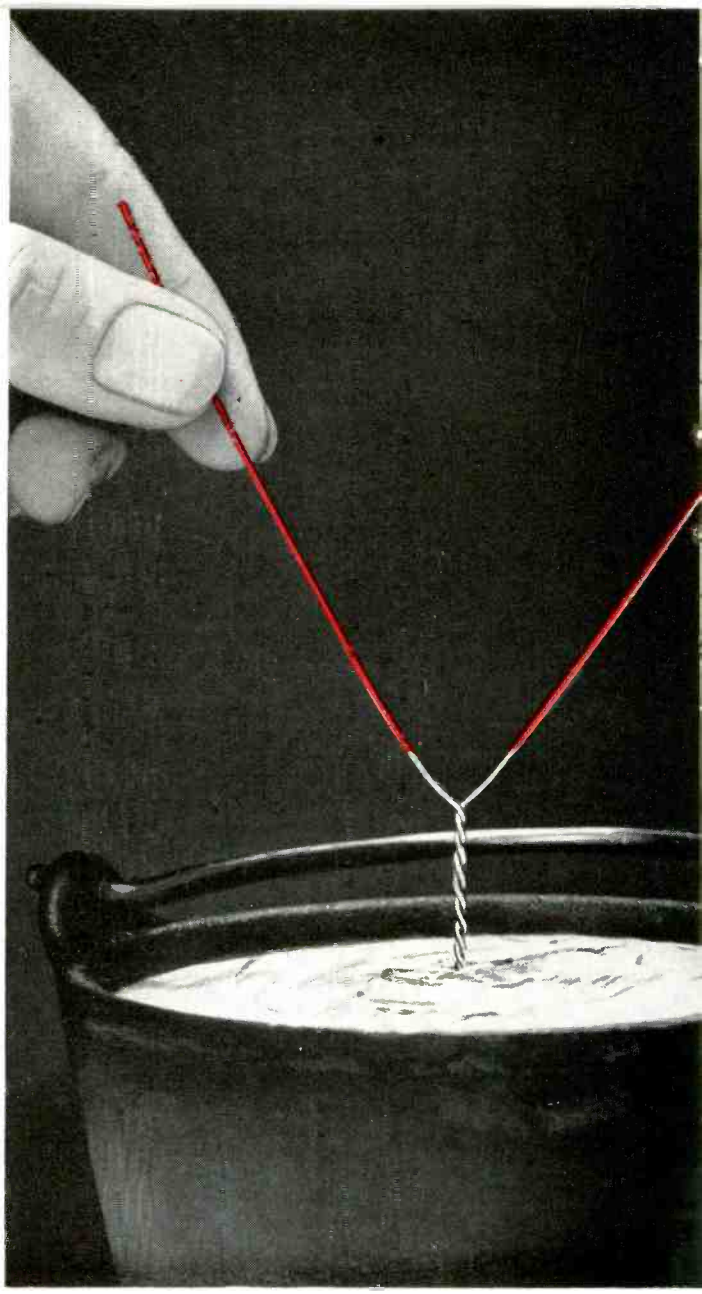
Let Atlas help you in your program. We've been "precision-eering" on a contract basis for more than a quarter of a century. May we work for you? Write to us with your production and design problems... get your copy of the booklet "Precision-eering Electro-Mechanical Equipment." Atlas Precision Products Co., Philadelphia 24, Pa. (Division of Prudential Industries).

"From Drawing Board... to Production Line"

SERVICE ATLAS DEPENDABILITY QUALITY

ATLAS
Precision Products





Anaconda announces Analac an improved

New Analac* film-insulated, solderable magnet wire can be used similarly to Formvar or Plain Enamel—except that it is solderable without stripping!

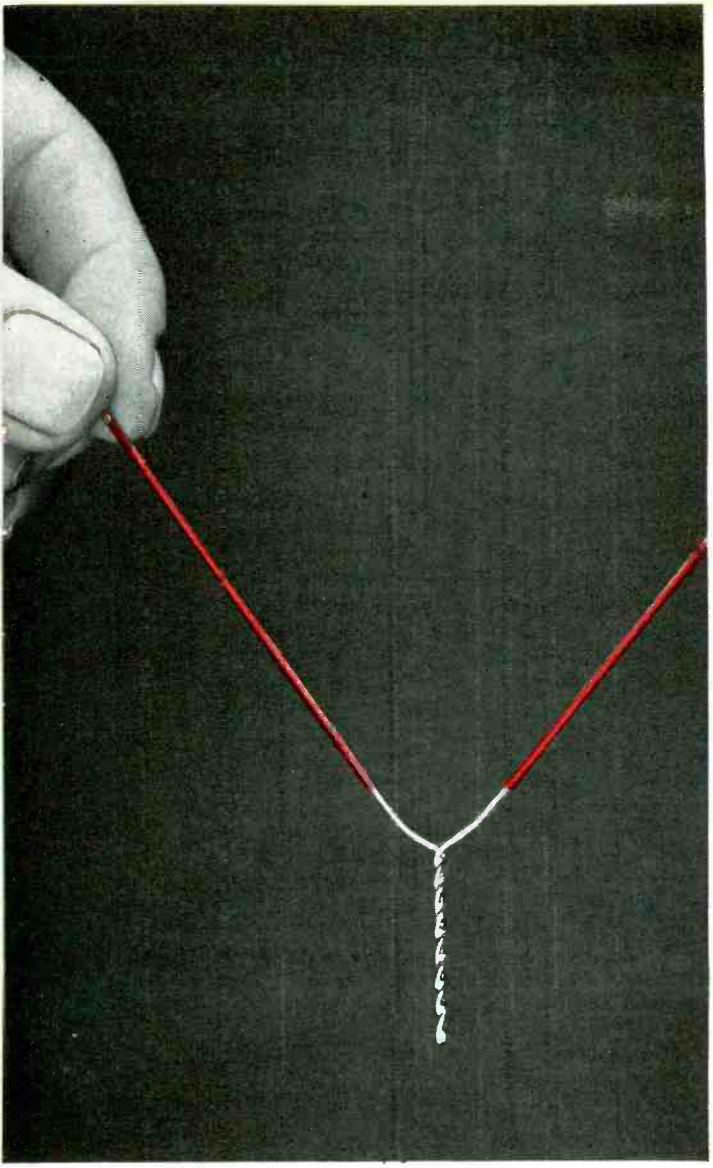
Soldering by dipping, iron or gun produces a perfect joint—in just one second in finer sizes—without prior removal of the insulation. Analac reduces labor, saves time and money wherever many soldered connections are made, or where small diameter wire makes other means of insulation removal hazardous to the insulation or wire.

Not only this, Analac has the excellent abrasion resistance and other good mechanical properties of the enamel wire you're now using. It handles readily, performs well in high-speed winding.

Analac is colored a bright red with stable dye used many years for identical applications—making it highly visible even in finest sizes. This helps operators feel more secure, results in higher quality work. Distinctive color simplifies its identification, too, from nonsolderable wires.

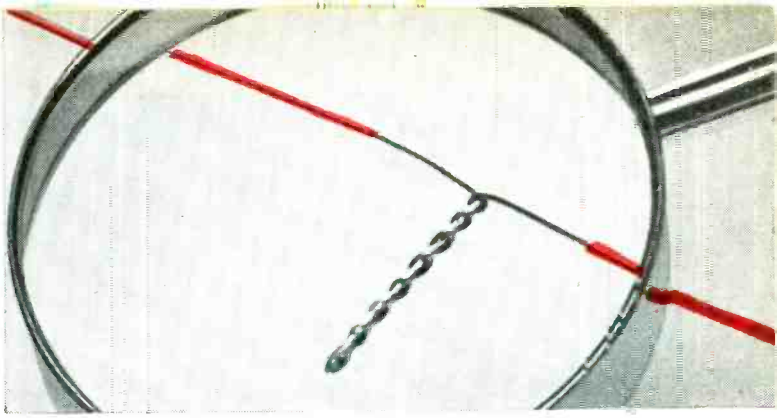
Analac is available in an exceptionally large range of sizes. The Man from Anaconda will be glad to give you more information and help with a production run in your plant. See "Anaconda" in your phone book—in most principal cities—or write: Anaconda Wire & Cable Company, Magnet Wire Headquarters, Muskegon, Michigan.

*Reg. U. S. Pat. Off. 57398

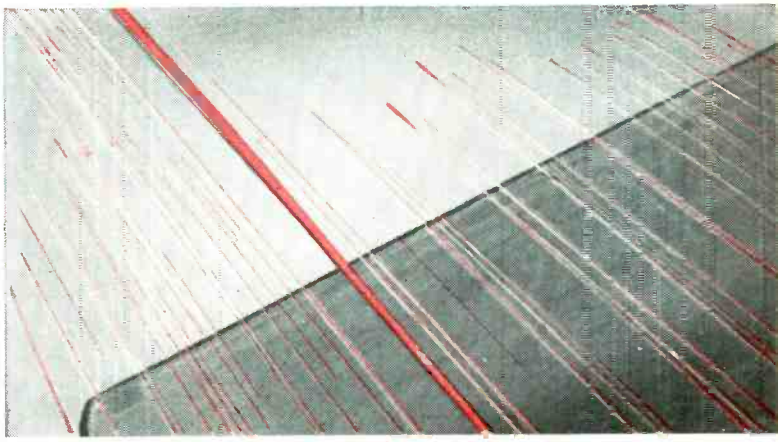


JOINT IS COMPLETED WITHOUT STRIPPING WIRE with Analac wire dipped in a 50-50 tin-lead solder at 360°C (680°F). The insulation is removed at the temperature of molten solder.

solderable magnet wire



1. **STRONG JOINTS**—as strong as the same joints made in bare copper wire—are produced. Here in laboratory test, joint holds under high stress.



2. **EXCELLENT ABRASION RESISTANCE** of Analac is shown in this test. It has the same high windability normally associated with Formvar, Plain Enamel.

3. **MOLDED-PLASTIC CASES** — designed and developed by Anaconda—protect spools of Analac from damage during shipping. Result: no breaks due to bent spools.

See the Man from

ANACONDA®

for ready-to-solder

Analac

magnet wire

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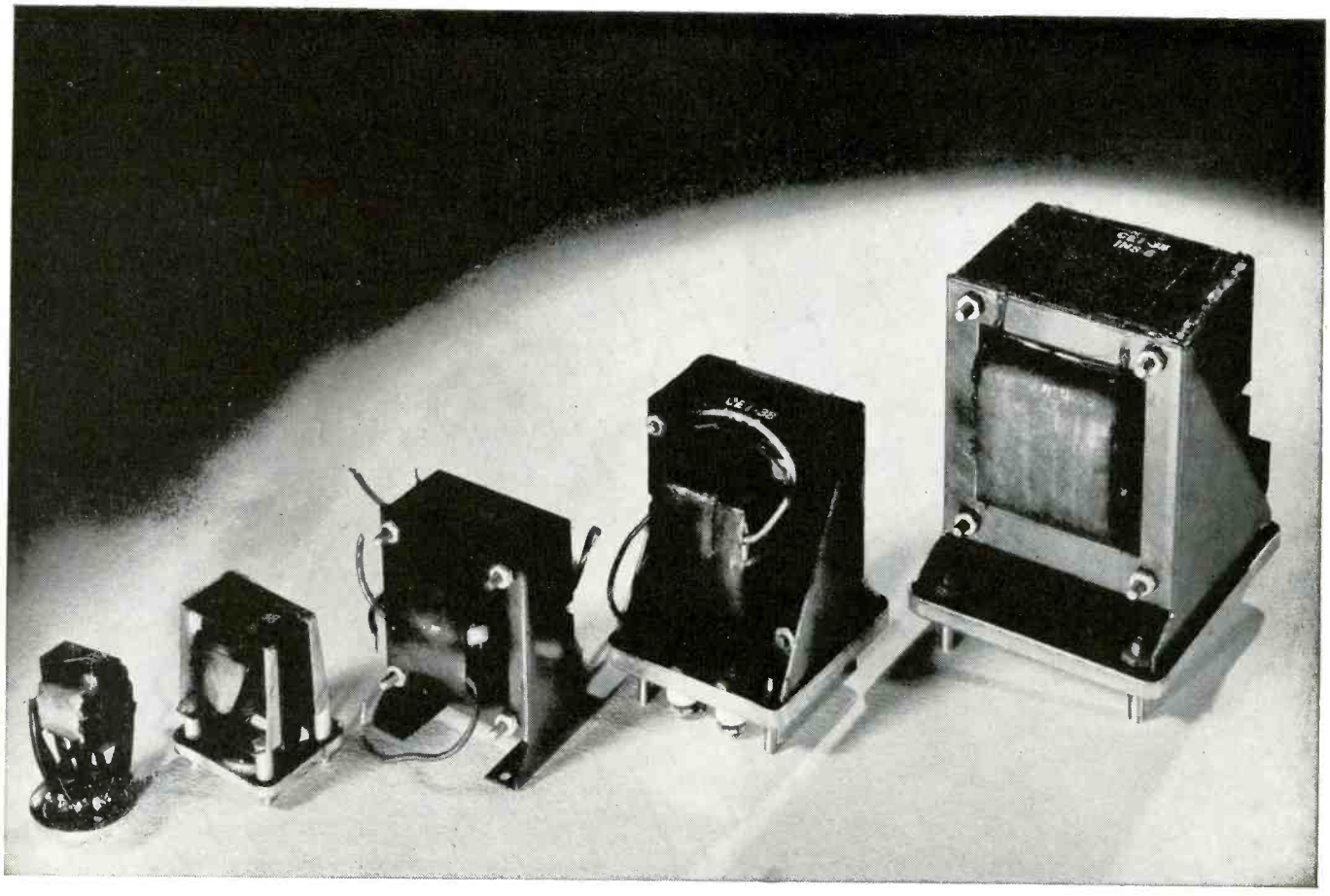

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★ **ALLEGHENY 4750**

★ **ALLEGHENY MUMETAL**

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In addition, our service on magnetic materials includes complete lamination fabrication and heat treatment facilities. What's more, this extensive experience in our own lamination stamping department is a bonus value for all users of A-L electrical sheets or strip. ● Let us supply *your* needs. ***Allegheny Ludlum Steel Corporation, Oliver Bldg., Pittsburgh 22, Pa.***

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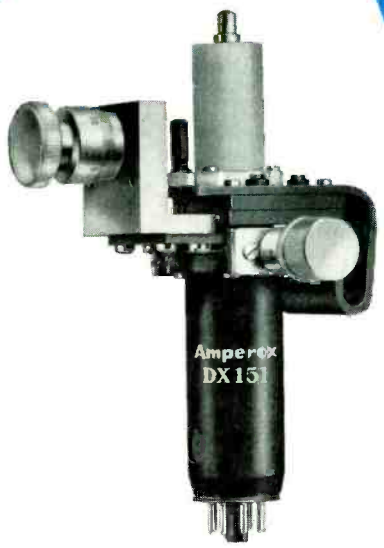
Circle 27 Readers Service Card →



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PAUL MAYEN

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"WAX-FREE"

TYPE V84 TUBULAR CAPACITOR!

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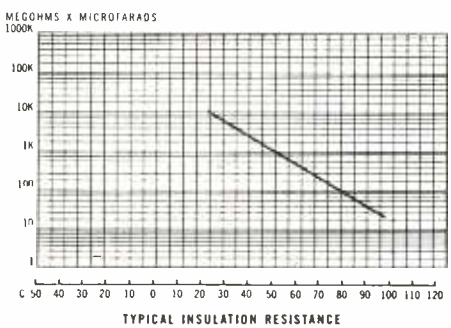
Aerovox "WHITECAP" capacitors offer a distinctive white case, completely free of wax. The absence of any wax facilitates handling and assembly procedures. No dripping and no gummed-up machines. Light in weight and clearly marked, these units will enhance the appearance of any assembly.

Aerovox "WHITECAP" capacitors are superior electrically over **ALL** other conventional paper tubulars including molded units. Outstanding humidity resistance . . . far greater than ever known before in units designed for radio-TV applications. Highest Insulation Resistance ever offered before in a paper tubular. Wide temperature range . . . low-power-factor. New standards of reliability backed by millions of hours of life and service tests.

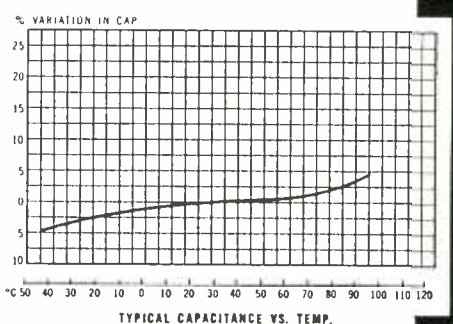
Operating Temperatures — −40°C to 85°C at full voltage rating and to 100°C with voltage rating of 75%

Power-Factor — at room temperature will not exceed 1%

Humidity — will withstand 95% relative humidity at 40°C in accordance with RETMA Specification RS164 except that exposure will be increased to **500** hours instead of 100.



TYPICAL INSULATION RESISTANCE



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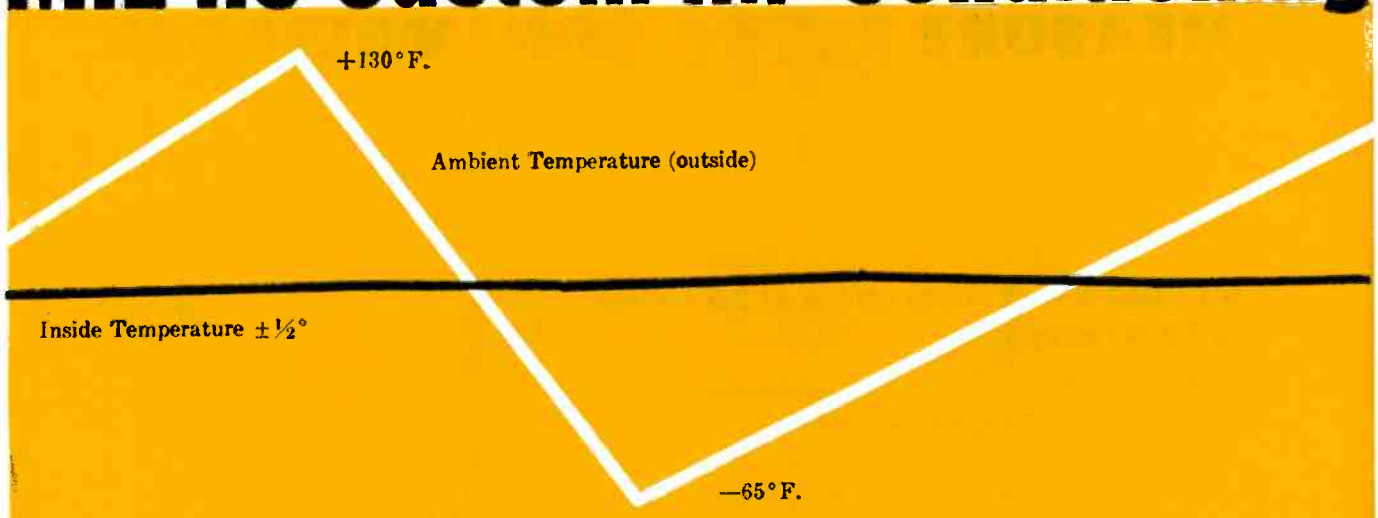

Condition: MIL-E-5272* Today, electronic systems can function under the most difficult environmental conditions (MIL-E-5272*), by using highly specialized air conditioning equipment.

Custom air conditioning is our business at Ellis and Watts. For example, we recently designed and built MIL-AC Units for Radome installations operating in ambient temperatures from −65°F. to +130°F. These air conditioning units maintain temperatures within ±½° F., with continuous dehumidification under varying internal load conditions. Because of operational limitations height of unit was restricted to 36".

MIL-AC Units are self-contained, compact, lightweight, readily air-transportable. They can be designed to cool, heat, humidify, dehumidify, filter, and can incorporate air-cooled or water-cooled condensers. Units are manually or automatically controlled. We are staffed with specialists who will analyze your requirements, submit a proposal, complete your installation promptly and to your complete satisfaction.

Write for helpful load calculating Nomograph and other technical data for use in making time-saving preliminary calculations.

*Military specification dealing with the following climatic and environmental conditions: Temperature, humidity, altitude, salt spray, vibration, fungus, sunshine, rain, sand and dust, explosive atmosphere, acceleration and shock.

Typical MIL-AC Unit. MIL-AC configurations, features and functions to suit your specific requirements.

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Ellis and Watts also design and build custom air conditioners, liquid coolers and heaters, dehumidifiers, wave guide dehumidifiers, laboratory temperature and humidity control units.

MEASURE *High* VOLTAGES

0 to 100 KV at Frequencies of 20 Cycles to 50 Megacycles

JENNINGS Model J1003 High Voltage Vacuum Tube Voltmeter is truly a versatile instrument with six direct reading linear voltage ranges to cover voltages of 0 to 100 kilovolts. It can accurately measure these voltages at frequencies from just above dc levels to 50 megacycles. There are two separate high voltage input circuits so that positive or negative peaks may either be read separately or added together vectorially.

Thus it can be used for single ended measurements of rf, audio and dc ripple voltages in radio or television transmitters, for measurements of high voltage pulses in radar and test equipment, and for measurements of magneto and ignition coil output. In these measurements one input circuit can be used to view a wave shape on an oscilloscope while the other indicates its peak value on the meter.

The instrument can also be used for the vector addition of multiphase line-to-line voltages in either balanced or unbalanced circuits, as well as for voltage readings on center-tapped transformers and push-pull tank circuits.

Jennings RADIO

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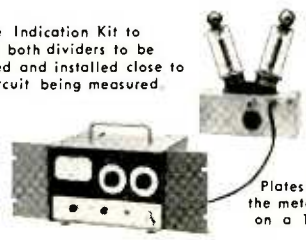
accessories

Type JP325 HV Probe for use with an oscilloscope where the meter indication is not required.

Type JCD5 Vacuum Capacitor to double the voltage range of the meter.

Remote Indication Kit to enable both dividers to be removed and installed close to the circuit being measured.



Panel Mounting Plates to mount the meter section on a 19" relay rack.

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Du Pont Hyperpure Silicon in new grades!

Whether you make or use silicon devices, investigate how new grades and broader commercialization of silicon can benefit you

Du Pont silicon used in rectifiers, transistors and photocells can now be closely matched to device needs, because of newly established, clear-cut differences in grades. Each grade has a rated maximum content of boron, the most critical impurity. Because of this new grading, more efficient use of Du Pont Hyperpure Silicon is now possible.

GRADE 1—This grade, with a maximum of 3 atoms of boron to every billion atoms of silicon, has the highest quality. It is a new grade developed for such devices as power rectifiers and power transistors, permitting lower reverse currents and hence higher-rated voltages.

GRADE 2—meets the needs of intermediate-voltage devices, such as those used in the field of radio and television. This grade contains no more than 6 parts of boron per billion. It is useful, too, for such applications as rectifiers for variable speed motors.

GRADE 3—is useful in making high-current, low-voltage devices such as diodes and low-voltage transistors. It has excellent potential for use in rectifiers for alternating-current generators in automobiles. This grade contains a maximum of 11 parts per billion of boron.

SOLAR-CELL GRADE—is the basic material used in solar batteries for powering telephone lines, radios and toys. Solar-grade silicon is a high-quality photoconductive material.

Quantities to meet today's needs

If you are a manufacturer of silicon devices or are planning to manufacture semiconductors, there is sufficient production capacity for Du Pont Hyperpure Silicon to meet anticipated requirements and assure you of an uninterrupted supply. Technical information on the growing of single crystals and the measurement of their properties is available to you. Get in touch with us about your silicon problems. We will be pleased to help you.

DU PONT HYPERPURE SILICON is available in three polycrystalline forms—needles, dense lumps and cut rods. At the Du Pont laboratories, a single-crystal ingot, such as those shown at left, is grown from each lot of polycrystalline Hyperpure Silicon.

The specifications are based on the values determined in our laboratory from resistivity measurements of such crystals and resistivity measurements of floating zone refined bars cut from those crystals. Boron concentrations refer to those in the melt from which the characterization crystals are grown.

Part of this characterization crystal is included with each shipment of a full lot of silicon. It may be used by the manufacturer as a seed to initiate the growth of single crystals and also as a resistivity reference to check the purity of single crystals grown from the lot.

Provision of these seed crystals is part of the service rendered to crystal growers by Du Pont, the pioneer producer of semiconductor-grade silicon in commercial quantities.

NEW BOOKLET ON DU PONT HYPERPURE SILICON

If you manufacture or use silicon devices, you'll want this new booklet which provides property data on Du Pont Hyperpure Silicon. It contains basic information on silicon and some of its many uses.

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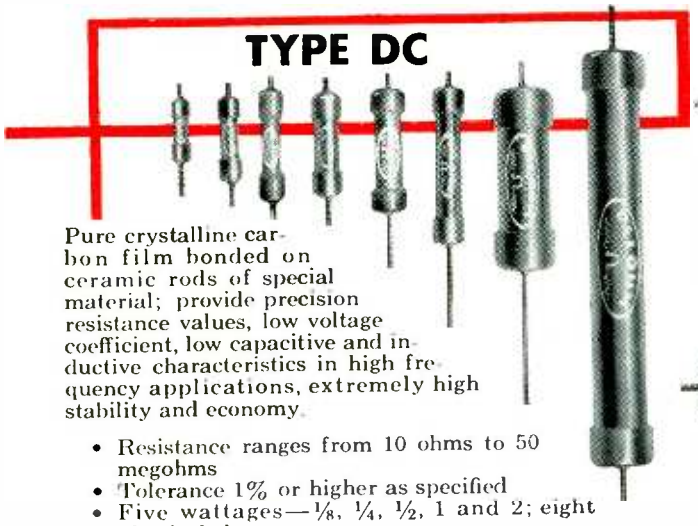

Pure crystalline carbon film bonded on ceramic rods of special material; provide precision resistance values, low voltage coefficient, low capacitive and inductive characteristics in high frequency applications, extremely high stability and economy.

- Resistance ranges from 10 ohms to 50 megohms
- Tolerance 1% or higher as specified
- Five wattages—⅛, ¼, ½, 1 and 2; eight physical sizes

Write for Bulletin R-24A

TYPE DCH

Essentially the same as type DC except hermetically sealed in a non-hydroscopic ceramic envelope to provide absolute protection against thermal shock, salt water immersion and humidity.

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For extremely high resistance where maximum stability is a prime factor in high voltage applications. Powered at 5 watts; high voltage up to 20,000 VDC; resistance range 1 megohm to 200 megohms; tolerance 1% or up to 10% on request.

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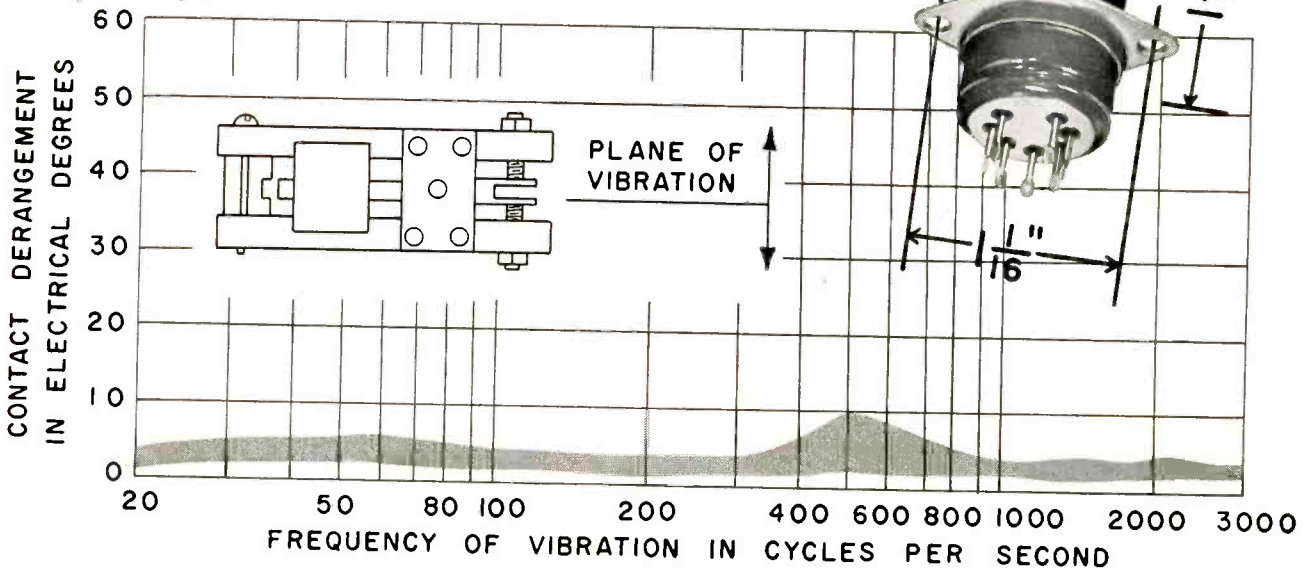

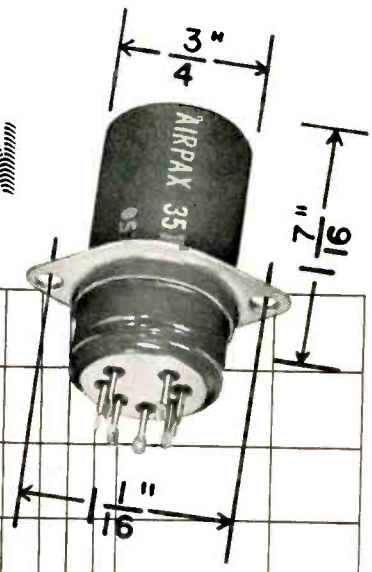

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Contacts of any chopper are deranged from normal operation by shock and vibration. In Airpax Series 350 choppers, this derangement is below 10 electrical degrees for vibrations up to 15 G. The choppers are undamaged by vibrations up to 100 G.

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Frequency ..... 400 ± 20 CPS
Voltage ..... 6.3 ± 0.6 RMS volts

Contacts

Dwell Time ... 130 electrical deg. min.
Balance ..... within 15 electrical deg.
Phase Angle ... 65 elect. deg. nominal
Voltage ..... up to 100 DC volts
Current ..... up to 2 milliamperes
Noise ..... 200 microvolts average

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Vibration .... 10 to 2500 CPS at 15 G
Shock ..... 50 G in any direction
Temperature ..... —65 C to +125 C

DESIGNERS AIRPAX ENGINEERS

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four 12-DIGIT print lines per second!

$850. for standard 6-digit model Additional digits - $50. each

Operates with most existing counting equipment

WITHOUT MODIFICATION! A reliable, accurate, compact instrument that fills an industry need for a truly high-speed, low cost digital printer. It may be connected directly to digital counting instruments and will print, on standard adding machine tape, the count measured during each counting sequence. Important features include: Parallel Entry, No Stepping Switches, Relays or Moving Contacts. Furnished standard with 6 digit print-out but up to 12 digits is optional. *Write today for complete specifications*

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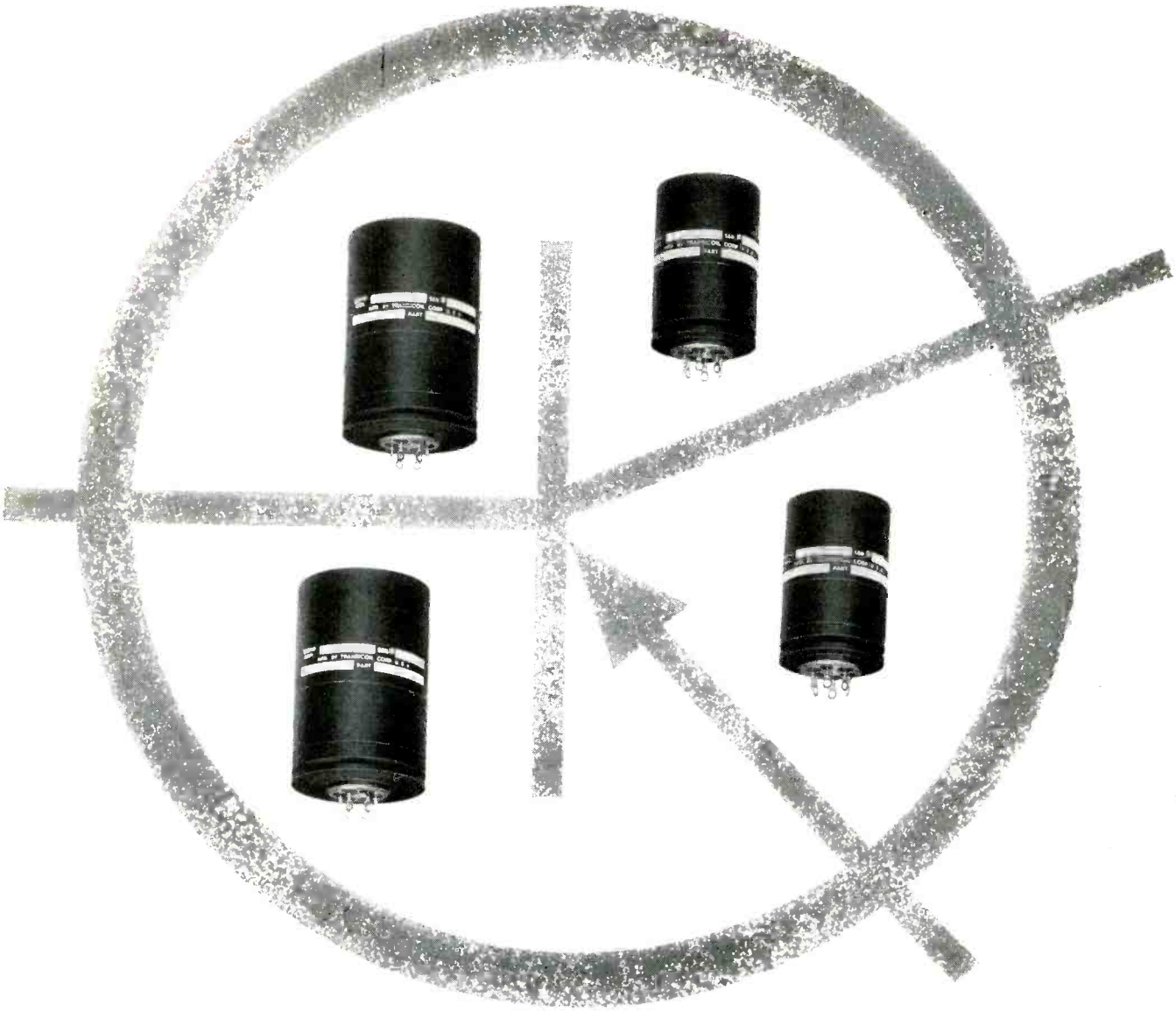

For greater miniaturization, higher performance . . .

new TRANSISTORIZED servo amplifiers

Transicoil introduces four new, completely transistorized Servo Amplifiers for use in applications requiring the highest order of precision, miniaturization, and dependability. Measuring a mere 3″ or less in length, these servo amplifiers help you keep assemblies within the severe space limitations of many types of military and industrial applications.

The new amplifiers produce voltage gains of 100:1, 200:1, 2000:1, and 4000:1. They are specifically engineered for use with Transicoil Motors and Motor Driven Induction Generators in sizes 8, 9, 11, 15, and 18. To insure maximum accuracy and dependability, Transicoil supplies these servo amplifiers only as part of its own miniaturized servo assemblies. All amplifier units are hermetically sealed and are made with the same care, materials, and precision that have made Transicoil a recognized leader in the manufacture of custom built servo components and assemblies.

For more complete information on Transicoil's new Transistorized Servo Amplifiers, write for Bulletin 101. And when you have control problems involving miniaturization or control complexity, be sure to get in touch with Transicoil. You profit most when you let Transicoil design and supply your complete servo package. You will be under no obligation—you pay only for results, on a fixed fee basis, for equipment delivered and operating properly.

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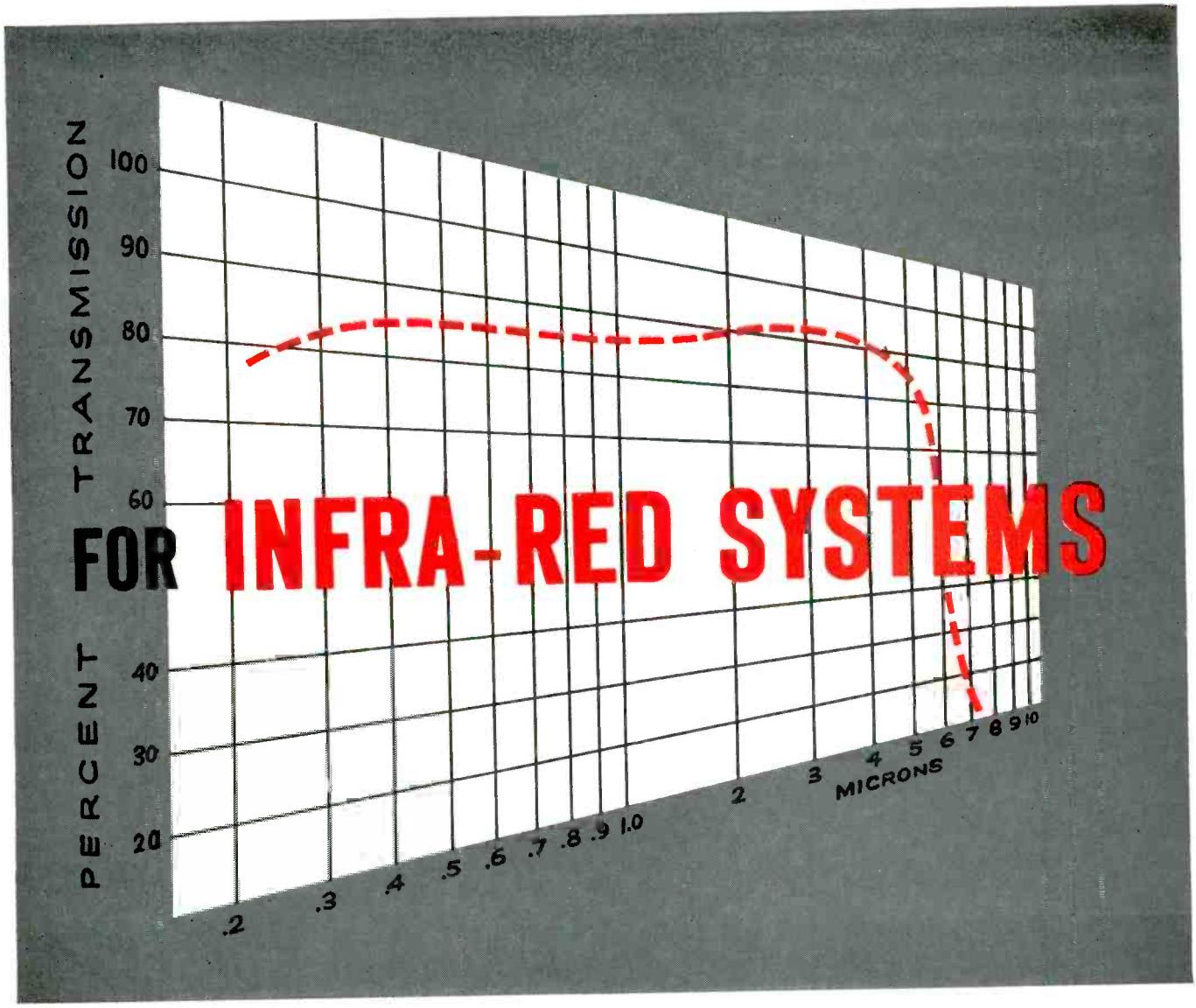

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- **Universal automatic triggering**

SPECIFICATIONS

130A

Input Amplifiers: (Similar Vert. and Horiz. Amps.). Sensitivity 1 mv/cm to 50 v/cm; 14 calibrated ranges, 1-2-5-10 sequence plus continuous vernier. Pass band dc to 300 KC; ac or dc coupling. Balanced input on 1, 2, 5, 10 and 20 mv/cm ranges.

Sweep Range: 1 μsec/cm to 12 sec/cm. 21 sweeps: 1-2-5-10 sequence, 5% accuracy.

Triggering: Internal, line voltage or external 0.5 v or more. Pos. or neg. slope, +30 to −30 v trigger range.

Preset Trigger: Optimum setting for automatic stable triggering.

Amplitude Calibration: 1 KC square wave, 5% accuracy.

Price: $650.00.

SPECIFICATIONS

150A, 150AR

Sweep Range: 0.02 μsec/cm to 15 sec/cm.

Calibration: 24 sweeps: 1-2-5-10 sequence, 0.1 μsec/cm to 5 sec/cm. 3% accuracy.

Triggering: Internal, line voltage or external 0.5 v or more. Pos. or neg. slope, +30 to −30 v trigger range.

Preset Trigger: Optimum setting for automatic stable triggering.

Horizontal Amplifier: Sweep magnification 5, 10, 50, 100 times. Vernier position control selects any 10 cm part of sweep. External input pass band dc to over 500 KC. Sensitivity 200 mv/cm to 15 v/cm.

Vertical Amplifier: Pass band dc to 10 MC. Optimum transient response and rise time less than 0.035 μsec. Signal delay of 0.25 μsec permits leading edge of triggering signal to be viewed.

Amplitude Calibration: 18 calib. voltages, 1-2-5-10 sequence, 0.2 mv to 100 v peak-to-peak. Accuracy 3%. Approx. 1 KC square wave, rise and decay approx. 1.0 μsec.

Prices: -*hp*- 150A High Frequency Oscilloscope, $1,100.00.

-*hp*- 150AR Rack Mount Oscilloscope, $1,200.

-*hp*- 151A High Gain Amplifier, $200.00.

-*hp*- 152A Dual Channel Amplifier, $250.00.

Low Frequency Cabinet Oscilloscope, Model 130A. Covers dc to 300 KC. Similar horizontal and vertical amplifiers. Input circuits balanced on 5 most sensitive ranges. Single ended input may be dc or ac coupled. Direct reading, linear sweep times. With most transducers, needs no preamplification to produce brilliant, high resolution trace. Universal automatic triggering; one preset condition provides optimum triggering for almost all inputs. $650.00.

Low Frequency Rack Mount Oscilloscope, Model 130BR. Similar to -*hp*- 130A except for rack mount and includes x5 magnifier usable on all ranges and expanding fastest sweep to 0.2 μsec/cm. Parallel input terminals front and rear. $650.00.

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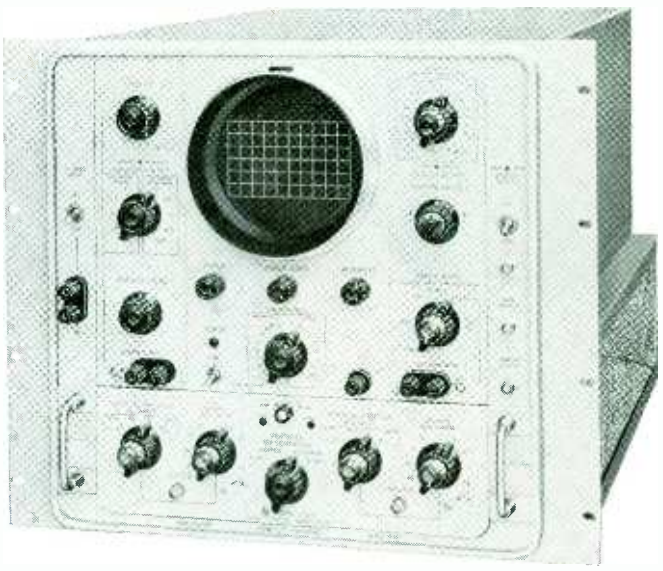
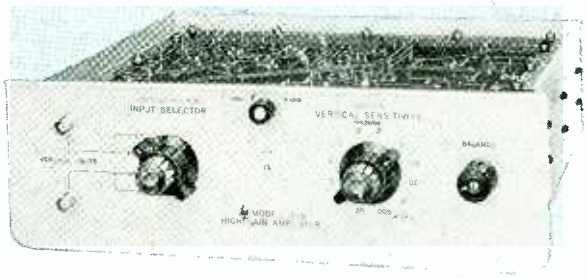
OSCILLOSCOPES

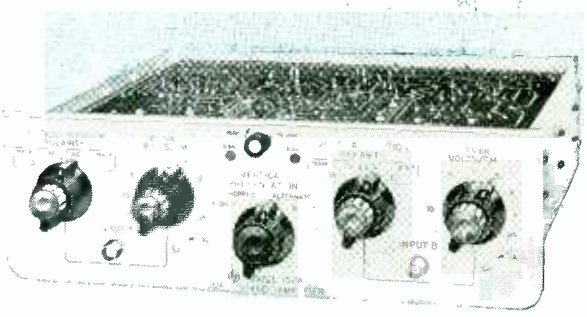
High Frequency Cabinet Oscilloscope, Model 150A. Covers dc to 10 MC with new reliability and convenience. Two plug-in preamplifiers for high gain or dual channel measurement (see below). 24 direct-reading sweep times; sweeps 0.02 μsec/cm to 15 sec/cm. Universal automatic triggering; one preset condition insures optimum triggering. $1,100.00.



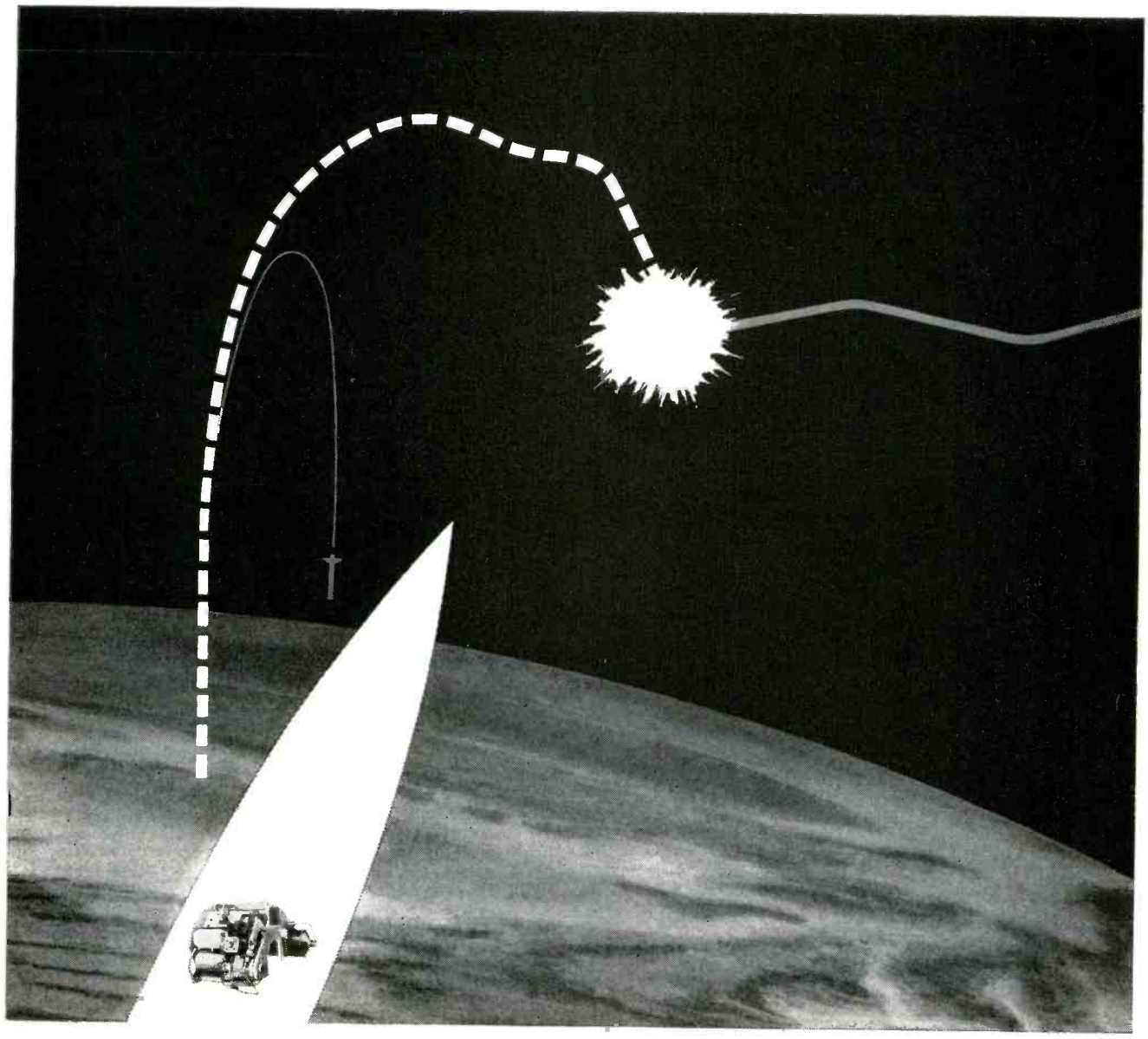
High Frequency Rack Mount Oscilloscope, Model 150AR. Same as *-hp-* 150A except for mounting in standard relay rack. Fitted with "pull-out" slides for maximum servicing accessibility. $1,200.00.



High Gain Amplifier, Model 151A. Designed for plug-in use with *-hp-* 150A or 150AR Oscilloscopes. High gain unit with 5.0 mv per cm sensitivity and frequency response dc to 10 MC. 12 calibrated ranges in 0.5, 1, 2, 5 sequence. 1 megohm input impedance with 25 μμf shunt. Pass band rise time 0.035 μsec. Equipped with two BNC input terminals. $200.00.



Dual Channel Amplifier, Model 152A. Designed for plug-in use with *-hp-* 150A or 150AR Oscilloscopes. Permits two phenomena to be presented on CRT simultaneously. Either amplifier usable separately. For dual presentation, electronic switch applies outputs to alternate traces, or switches outputs at a 100 KC rate. 50 mv/cm sensitivity, 9 ranges, 1, 2, 5, 10 sequence. $250.00.



For the "killing" demands of accessory power...

AMF has experience you can use

• No part of a missile is more important than the power supply that directs it to the "kill". And AMF has produced more gas turbine power units for guided missiles than any other source. • Typical AMF systems produce up to 50 hp.—with modifications, up to 200 hp.—at durations from 20 seconds to many hours. They are completely independent of the main power plant, insensitive to missile attitude or altitude, and to environment, acceleration, shock, or vibration. • Units offer multiple start-stop flexibility, precise frequency and voltage control, and can be packaged to fit practically any space arrangement, with little size and low weight. • See for yourself why, in accessory missile power as in a variety of other highly specialized fields, AMF has experience you can use.

- *Armament*
- *Ballistics*
- *Radar Antennas*
- *Guided Missile Support Equipment*
- *Auxiliary Power Supplies*
- *Control Systems*

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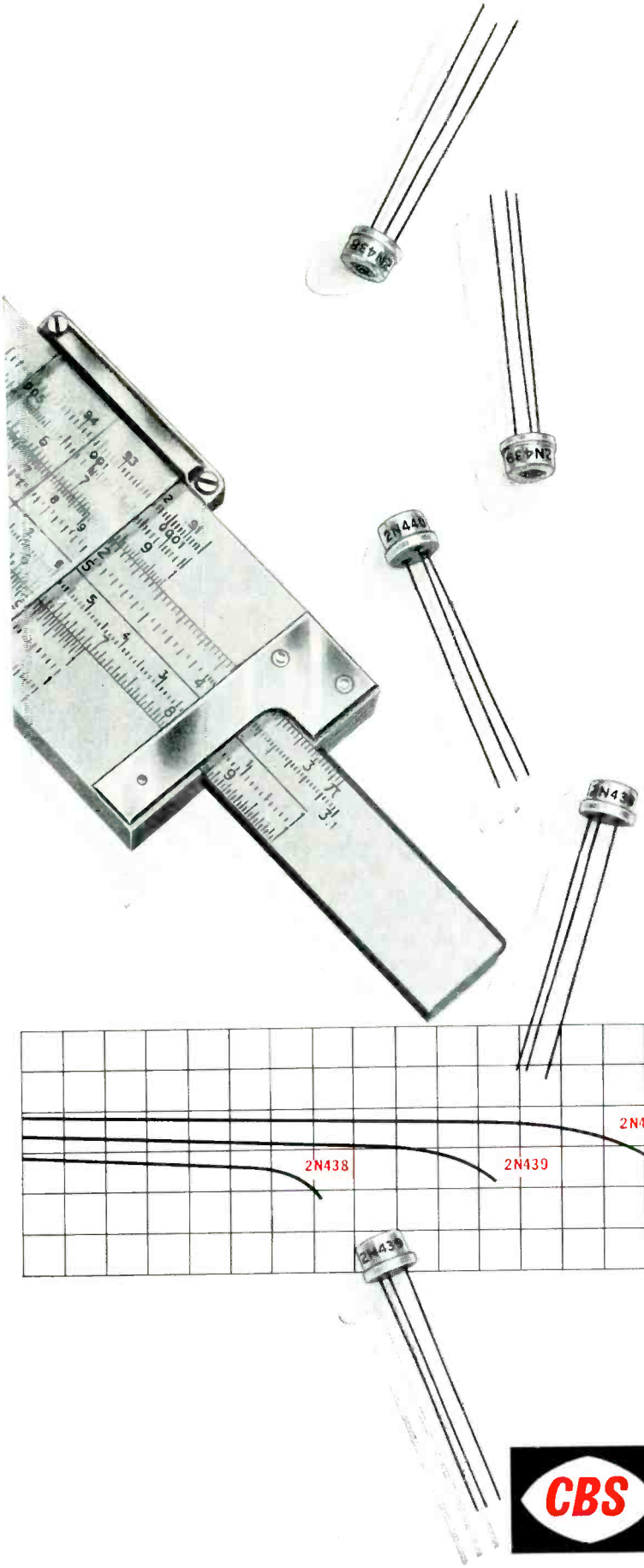


For high-speed switching

CBS HIGH-FREQUENCY TRANSISTORS

2N438
2N439
2N440

These transistors are designed for high-speed switching, control, analog and digital computer applications. All three are available in symmetrical versions, and they feature:

1. *JETEC Case* . . . employs a standard metal case (with .200 inch pin spacing) welded to achieve reliability never before approached with NPN transistors.
2. *Alloy-Junction* . . . for greater uniformity, higher voltage and current, flatter gain, and lower saturation resistance.

Note the many desirable features. Write for Bulletin E-268 giving complete data and helpful application notes.

CHECK THESE FEATURES

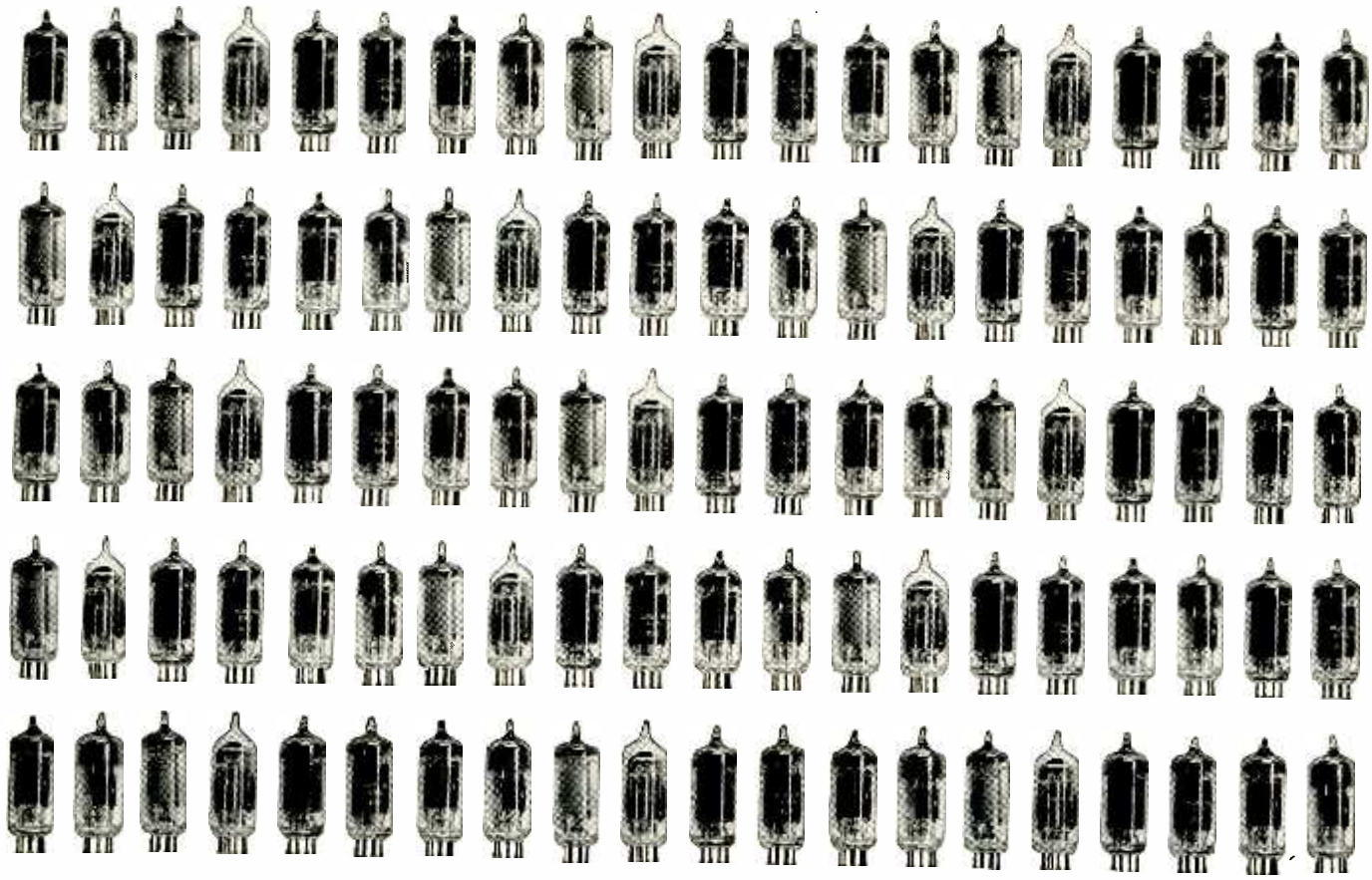
1. High frequency response:
   2N438 . . . . . 2.5 to 5 mc.
   2N439 . . . . . 5 to 10 mc.
   2N440 . . . . . 10 to 20 mc.
2. High operating voltage . . . . up to 30 volts.
3. High switching speed . . . . below 0.2 μsec.
4. High current amp. factor . . . . . up to 100.
5. High dissipation rating . . . . up to 100 mw.
6. Low leakage current . . . . . 3 μamps av.
7. Low base resistance . . . . . 150 ohms av.
8. Low collector capacitance . . . . . 10 μμf.

Reliable products through Advanced-Engineering.

CBS® **semiconductors**

CBS-HYTRON
Semiconductor Operations, Lowell, Mass.
A DIVISION OF COLUMBIA BROADCASTING SYSTEM, INC.

Circle 41 Readers Service Card



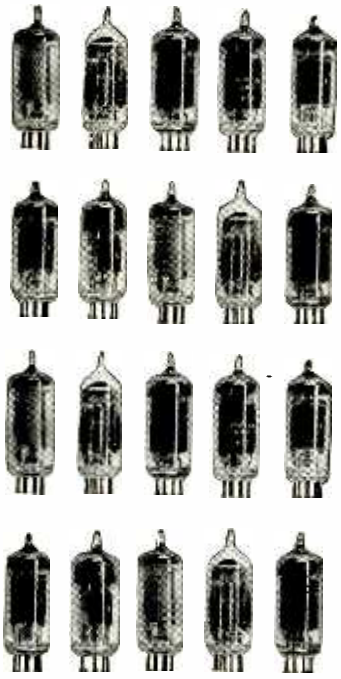
NOW—from a single stock Sola voltage regulator—±1% regulation of all these 6.3v tube filaments*

Now, you can supply *banks* of 6.3v electron tubes with ±1% regulated filament voltage from a single Sola Constant Voltage Filament Transformer. This static-magnetic stabilizer, designed for compact mounting as a manufacturer's component, is available in five stock ratings ranging from 5 to 25 amperes.

The Sola Constant Voltage Filament Transformer assures superior performance, reliability, and long life for the tubes it operates. The capacitor, an integral part of the Sola Constant Voltage principle, is supplied separately for external mounting, allowing greater flexibility in physical layout.

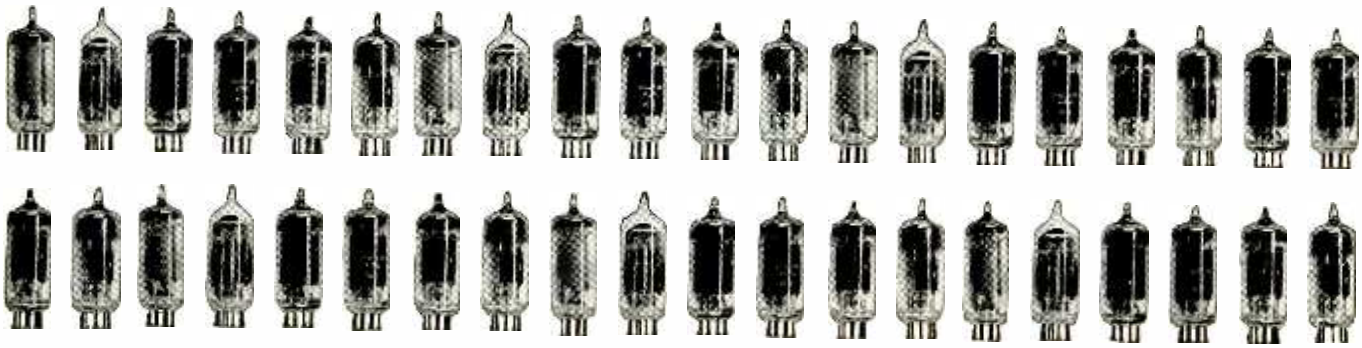
For further information on regulated 6.3v filament supply, contact your area representative or write for Circular CVF-269.

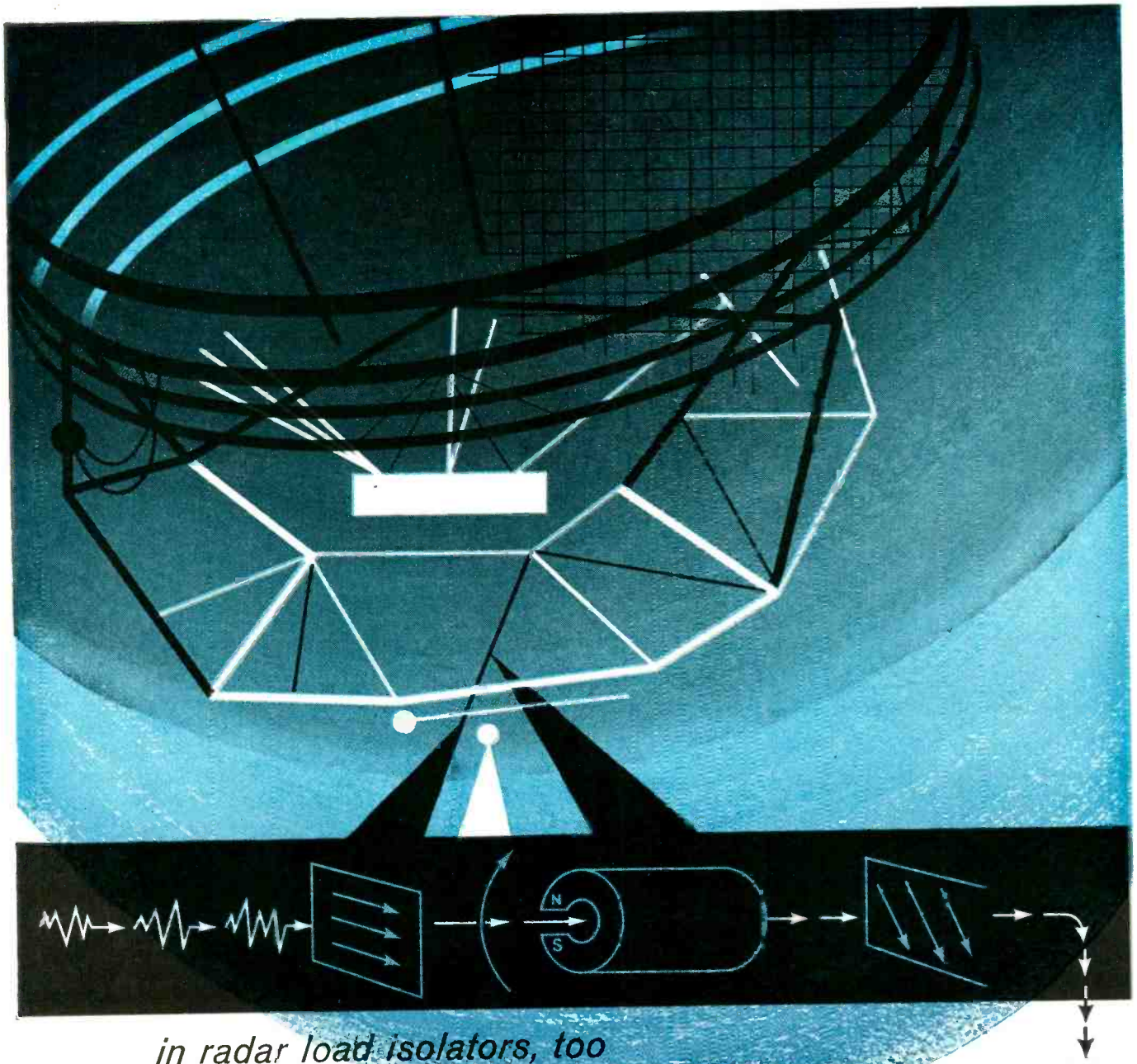
*Filament current drawn by 160 electron tubes with filament ratings of .15a each equals 24a— within the capacity of Sola's 25a Constant Voltage Filament Transformer.



SOLA *Constant Voltage* **TRANSFORMERS**

Sola Electric Co. • 4633 W. 16th Street • Chicago 50, Illinois





in radar load isolators, too

CRUCIBLE PERMANENT MAGNETS

give maximum energy. . . minimum size

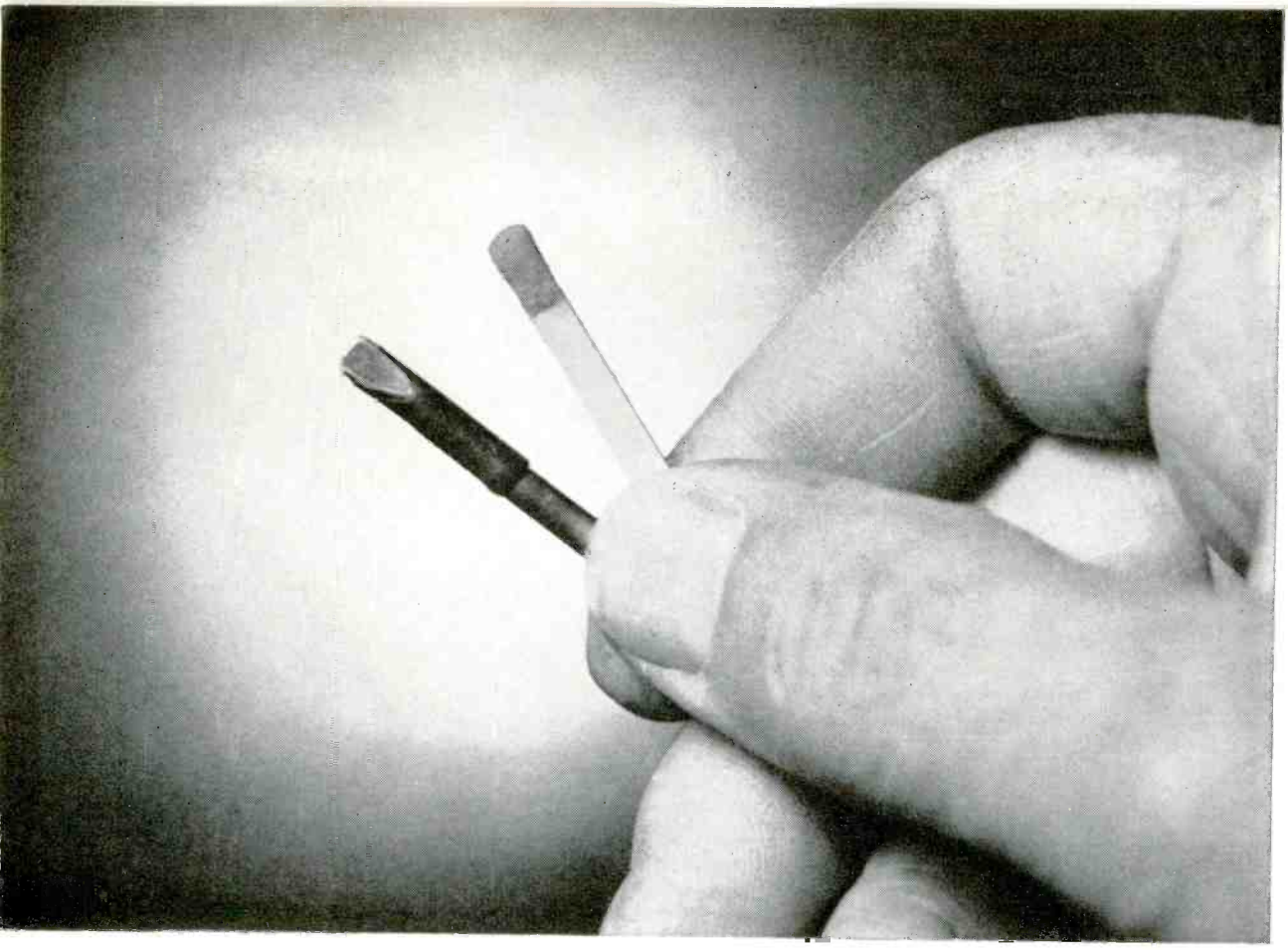
Special applications, such as radar load isolators, demand compact but powerful magnet assemblies. And this is but one of the many places where the *consistently* higher energy product provided in Crucible Alnico magnets pays off.

These Crucible Alnico permanent magnets can be sand cast, shell molded, or investment cast to exact size, shape or tolerance requirements . . . and in any size from a mere fraction of an ounce to hundreds of pounds.

The design and production of permanent magnets has been a Crucible specialty ever since Alnico alloys were discovered. It's one of the good reasons why so many people bring their magnet applications to Crucible. Why don't you? *Crucible Steel Company of America, The Oliver Building, Mellon Square, Pittsburgh 22, Pa.*

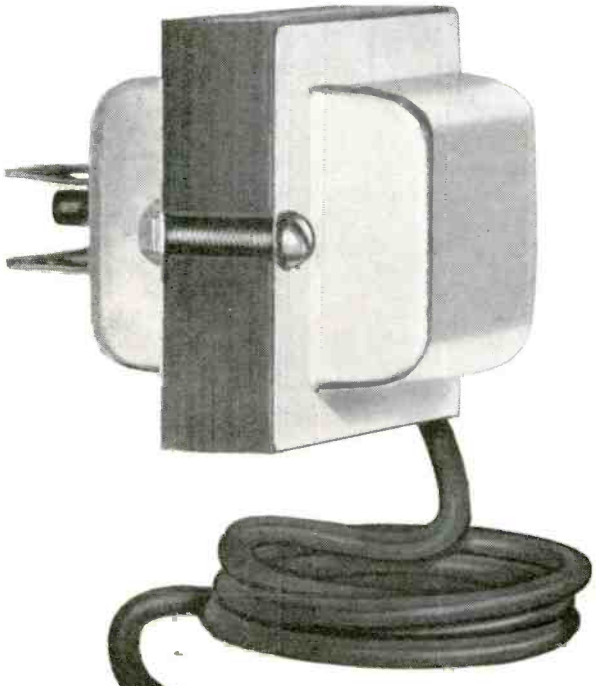
CRUCIBLE first name in special purpose steels

Crucible Steel Company of America



ACTUAL SIZE

Tip and Shank of New G-E Soldering Iron No Bigger Than a Paper Match: Gives Quick Heat Recovery for Production Use



General Electric's new Miniature soldering iron is designed especially for continuous production-line work on sub-miniature components. It can help increase your production by delivering fast, more dependable heat recovery from joint-to-joint. This is made possible by an efficient tubular heater built into its 1/8" diameter, long-life tip. As a result, heat is concentrated right at the work, minimizing heat loss.

What's more, the maneuverable Miniature iron gives you tip-touch control for rapid soldering of critical joints. Its tiny 1/8" shank reaches into almost inaccessible areas, with reduced risk of damage to adjacent parts.

Here are just a few of the other big reasons why the new Miniature is the answer to your needs for a small, efficient, production soldering iron:

EASY TO MAINTAIN—Tip and heater assembly can be replaced quickly and easily.

IMPROVES OPERATOR EFFICIENCY—Weighs less than 1¼ ounces, reduces fatigue.

TIP LASTS LONGER—Vacuum processed iron tip resists harmful effects of tin and high temperatures.

PORTABLE—Transformer plugs into any standard 115-volt outlet.

For more information contact your local G-E Apparatus Distributor, or write for Publication GEC-1318, Section 724-8, General Electric Company, Schenectady, N. Y.

GENERAL ELECTRIC

AMP's custom-designed and versatile line

FOR RADAR AND ELECTRONIC EQUIPMENT APPLICATIONS

Ampli-FILM® the all-purpose high voltage dielectric
- . . . is not affected by acids or organic solvents
- . . . undergoes no distortion under high temperatures and pressures
- . . . is readily bonded by adhesives
- . . . is easy to handle and fabricate

CAPITRON® WAFER CAPACITOR—Ampli-FILM® dielectric sheets and high conductivity copper electrodes are bonded together under high heat in hydraulic presses using a special non-polar thermo-plastic bonding resin to obtain a solid, void-free sealed capacitor for rugged requirements in high voltage circuits. Having indefinite shelf life, these capacitors are designed for use in oil filled assembly, but also they are well suited for many applications in potted or encapsulated assemblies. They can be supplied in various form factors including curved shapes.

CAPITRON® POWER SUPPLIES—Use of Capitron® Wafer Capacitors enables AMP to provide a wide variety of high voltage power supplies for radar indicators and radar modulators. The small size and light weight of these units dictates their use in many airborne applications. They are supplied either as oil filled metal cased units or as epoxy encapsulated units. AMP's LGH terminals solve high altitude application problems.

CAPITRON® ARMORED WAFER CAPACITOR—Factors of this Capacitor are as follows
- Armor type encapsulation to resist extreme thermal and mechanical shock.
- Eliminates high altitude flash-over, as metal terminals are not exposed . . . they are enclosed within the armor encasement.
- Multiple connections to capacitor leads can be made with little or no increase in over-all size of the capacitor.
- Versatility of design eliminates revamping assembly to accommodate the capacitor.

CAPITRON® PULSE SYSTEM PACKAGE—Charging choke, pulse forming network and pluse transformers are combined in a unit of minimum size and weight to work with a specific magnetron. All components are designed by and manufactured under the direct control of AMP's pulse specialists.

CAPITRON® PULSE FORMING NETWORKS—AMP pulse forming networks can be supplied to meet rigorous specifications with special emphasis on high reliability, small size and light weight for airborne radar applications.

CAPITRON® WAFER CAPACITOR

CAPITRON®
CURVED WAFER CAPACITOR

CAPITRON® POWER SUPPLY

CAPITRON® POWER PACK

CAPITRON®
ARMORED WAFER CAPACITOR

CAPITRON®
PULSE SYSTEM PACKAGE

CAPITRON®
PULSE FORMING NETWORKS

AMP INCORPORATED

CHEMICAL AND DIELECTRIC DIVISION
155 Park Street, Elizabethtown, Pennsylvania

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AMP®

4735

L&N's new Guarded Wheatstone Bridge

If you are checking resistors, making routine resistance measurements, or performing laboratory experiments, this new 4735 Guarded Wheatstone Bridge gives you faster, more accurate resistance measurements.

The most advanced general purpose bridge available today, this new 4735 has a host of new features including: high accuracy with a wide operating range . . . guarding of galvanometer circuit to prevent voltage errors due to humidity effects . . . three galvanometer keys interlocked with a battery key . . . thermals minimized by special features of construction . . . and bench-type or relay-rack mounting.

Complete information on this versatile bridge is presented in Data Sheet E-53(1). Write today for a copy from your nearest L&N Office or from Leeds & Northrup Company, 4979 Stenton Ave., Philadelphia 44, Pa.

Partial Specifications

List Number—*4735 Guarded Wheatstone Bridge.*
Range—*0.01 ohm to 1,111 megohms.*
Limit of Error—*±(0.05% + 0.001 ohm) up to 100 megohms; ±0.5% above 100 megohms.*
Rheostat Switches—*Five decades of enclosed switches in steps of 10 x (1000 + 100 + 10 + 1 + 0.1).*
Multiplier Dial—*Eleven-position enclosed switch; from 10^{-5} to 10^{+5}.*
Galvanometer Sensitivity Keys—*Three tap keys provide sensitivities of approximately 1, 1/100 and 1/1000. Battery reversal key is provided.*
Case—*Metal, gray enamel finish; 19" x 9" x 7", for relay-rack or bench use.*

Guarding against effects of humidity
High accuracy with wide operating range
Fast reading of resistance values

LEEDS NORTHRUP
Instruments Automatic Controls • Furnaces

Circle 46 Readers Service Card

Circle 47 Readers Service Card→

Transitron

MILITARY type silicon diodes

1N457
1N458
1N459
1N251

TRANSITRON'S Military type silicon diodes are designed to meet the requirements of MIL-E-1, and are characterized by reliability under the most severe operating conditions.

Their subminiature size and rigid specifications make them ideal for a wide range of applications. Types 1N457, 1N458, and 1N459 are intended for low and medium frequency uses, requiring voltage ratings up to 175 V. Type 1N251 is a high frequency diode especially designed for detector and high speed pulse units.

In addition to these four military types, silicon diodes meeting many other application requirements are also available. These include high conductance types, as well as fast switching-high voltage diodes.

Type	Minimum Forward Current at + 1 v (ma)	Inverse Current at Specified Voltage (μa)	Maximum Operating Inverse Voltage (volts)	MIL-E-1 TSS #
1N457	20	.025 @ −60 V	60	1026
1N458	7	.025 @ −125 V	125	1027
1N459	3	.025 @ −175 V	175	1028
1N251 *	2	.2 @ −10 V	30	1023

*Inverse recovery time under .15 microseconds

SEND FOR
BULLETIN TE 1350

Transitron
electronic corporation • wakefield, massachusetts

Germanium Diodes | Transistors | Silicon Diodes | Silicon Rectifiers

From one source...

SELENIUM • GERMANIUM

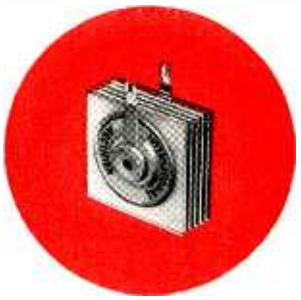
for all dc needs from microwatts to megawatts

SUB-MINIATURE SELENIUM DIODES

Developed for use in limited space at ambient temperatures ranging from −50°C to +100°C. Encapsulated to resist adverse environmental conditions. Output voltages from 20 to 160 volts; output currents of 100 microamperes to 11 MA **Bulletin SD-1B**

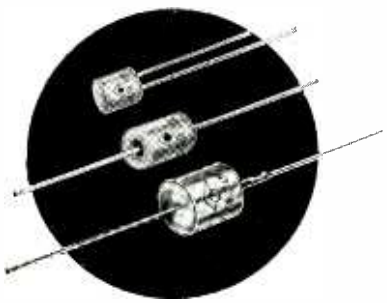
SELENIUM HIGH VOLTAGE CARTRIDGE RECTIFIERS

Designed for long life and reliability in Half-Wave, Voltage Doubler, Bridge, Center-Tap Circuits, and 3-Phase Circuit Types. Phenolic Cartridge and Hermetically Sealed types available. Operating temperature range: −65°C to +100°C. Specify **Bulletin H-2**



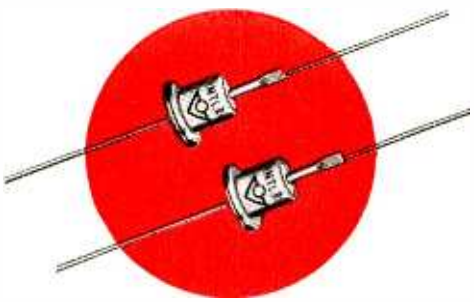
SELENIUM TV AND RADIO RECTIFIERS

The widest range in the industry! Designed for Radio, Television, TV booster, UHF converter and experimental applications. Input ratings from 25 to 156 volts AC and up. DC output current 50 to 1,200 MA. Write for application information. **Bulletin ER-178-A**



SELENIUM CONTACT PROTECTORS

Designed to eliminate arcing and erosion across the contacts of relays and switches. A complete series in each of three basic types: Diode type, Cartridge type and Hermetically sealed type for industrial application. For complete data: **Bulletin SR-150**



STYLE S SILICON POWER DIODES

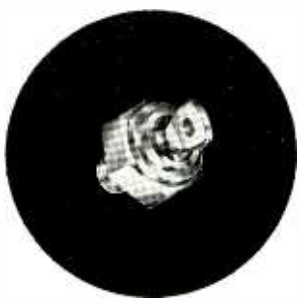
A complete series of hermetically sealed diodes for operating in temperatures from −55°C to +150°C. Power supply and magnetic amplifier types. PIV range: 50 to 600 v. For 100ma DC output request **Bulletin SR-136B** For 300ma DC output request **Bulletin SR-132E**

STYLE T SILICON POWER DIODES

Stud mounted-hermetically sealed types for power supply and magnetic amplifier applications. PIV ratings from 50 to 600 volts at 800 ma rectified DC output current. All welded construction. For operation at −55°C to +150°C. Ask for **Bulletin SR-135C**

SILICON MEDIUM POWER RECTIFIERS

Specifically engineered for industrial applications—the most conservatively rated silicon rectifiers in the industry! Rugged all-welded construction and hermetic sealing mean greater reliability—longer life. Types available in 3 series. Request **Bulletin SR-143B.**



10 AMP SILICON POWER DIODES

Conservatively rated to provide a substantial safety factor in industrial applications. Hermetically sealed, all-welded case construction provides reliability over a long life. Types available in a wide voltage range. Write for **Bulletin SR-151**

150 AMP GERMANIUM JUNCTIONS

Designed for high velocity, forced air cooling, the finned copper heat exchanger of these junctions feature 56 sq. inches of cooling area in 5.7. cubic inches of volume. Voltage input ratings from 20 to 85 volts rms. Lug or stud terminals. **Bulletin GPR-2**

For complete data on the products listed write on your letterhead to International Rectifier

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THE WORLD'S LARGEST SUPPLIER OF

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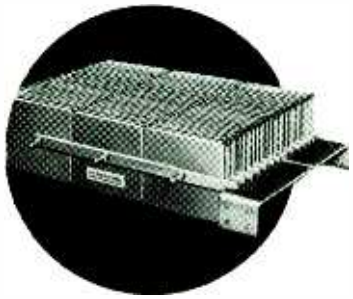
...the complete line of

SILICON RECTIFIERS

... the widest range in the industry!

SEE THEM ALL AT WESCON BOOTHS 1501-1502



SELENIUM INDUSTRIAL POWER RECTIFIERS

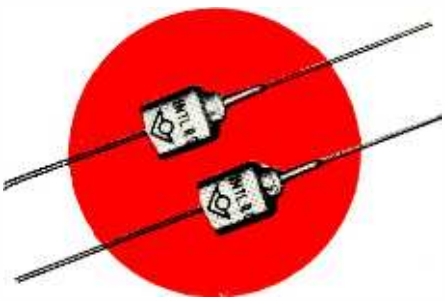
For all DC power needs from microwatts to kilowatts. Features: long life; compact, light weight and low initial cost. Ratings: to 250 KW, 50 ma to 2,300 amperes and up. 6 volts to 30,000 volts and up. Efficiency to 87%. Power factor to 95%. **Bulletin C-349**

HIGH CURRENT DENSITY SELENIUM RECTIFIERS

A complete line for natural convection cooling in industrial applications. Inverse voltage ratings up to 36 volts per cell. Rectified DC output approximately twice that of standard selenium stacks in approximately 50% less volume. Write for **Bulletin SR-152**

SELENIUM PHOTOCELLS—SUN BATTERIES

Self-generating photocells available in standard or custom sizes, mounted or unmounted. Optimum load resistance range: 10 to 10,000 ohms. Output from .2 MA to 60 MA in ave. sunlight. Ambient temperature range: −65°C to +100°C. **Bulletin PC649**



HIGH VOLTAGE SILICON POWER DIODES

Two styles available. Hermetically sealed, pigtail construction. Style J features PIV ratings from 600 to 1000 volts at 125 ma. DC output current. Ask for **Bulletin SR-138E** Style K: PIV from 600 to 1200 volts at 100 ma DC output current. **Bulletin SR-144A**

SILICON RECTIFIER STACKS

These units consist of hermetically sealed junction diodes mounted on copper cooling fins, stacked to include the interconnections required for specific circuits. Junction ratings: 1.25 amps. DC output; 70 to 350 AC input volts rms. Request **Bulletin SR-137A.**

SILICON CARTRIDGE RECTIFIERS

The answer to tough miniaturization problems! Ratings for high temperature applications: from 1000 volts PIV at 100ma half-wave DC output to 16,000 volts PIV at 45ma. Hermetically sealed, metallized ceramic housing. Request **Bulletin SR-139B**

330 AMP GERMANIUM JUNCTIONS

Low current density germanium junctions of high capacity for heavy duty applications. Corrosion resistant, cast aluminum cooling fins dissipate heat at high rate. Efficiency: 98.5. Six types. Input voltage ratings from 20 to 66 volts rms. Request **Bulletin GPR-2**

500 AMP GERMANIUM JUNCTIONS

Six high capacity junction types especially suited for extra-heavy duty such as electrochemical installations where air cooling is desirable. Cast aluminum airfoil housings. Input voltage ratings from 20 to 66 volts rms. Efficiency 98.5. **Bulletin GPR-2**

LIQUID COOLED GERMANIUM JUNCTIONS

Liquid cooled for maximum power in minimum space. Junction rating: 670 amps at 26 to 66 volts rms. Housed in high-conductivity copper cast around special steel coils. Water, oil or other accepted coolants may be used. For complete data. **Bulletin GPR-2.**

Corporation or contact the International Rectifier branch office or representative nearest you.

RECTIFIER CORP.

INDUSTRIAL METALLIC RECTIFIERS

CHICAGO AREA OFFICE: 205 W. WACKER DR., PHONE FRANKLIN 2-3888 • NEW ENGLAND AREA OFFICE: 17 DUNSTER ST., CAMBRIDGE, MASS., PHONE UNIVERSITY 4-6510

NEW General Electric M-2 Leak Detector Offers You

UNSURPASSED LEAK SENSITIVITY

Expensive rejects of sealed electronic products can be reduced by leak testing housings before assembly with the new General Electric mass spectrometer leak detector. It offers:

EXTREME SENSITIVITY—detects leaks of 1×10^{-10} standard cubic centimeters of air per second (9×10^{-6} micron cubic feet per hour).

FAST RESPONSE—as low as 2 seconds for small, hermetically sealed electronic components.

HIGH RESOLUTION which helps eliminate the possibility of response to elements other than the tracer gas.

THESE EASY MAINTENANCE FEATURES HELP REDUCE DOWN-TIME

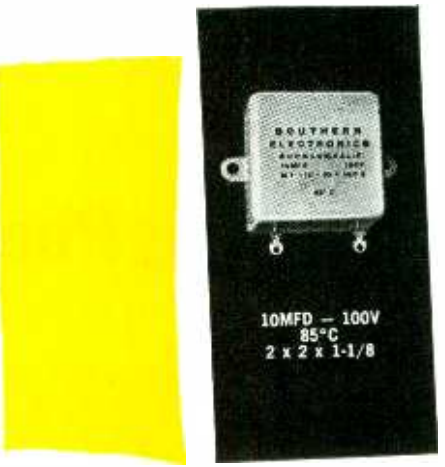
SIMPLIFIED DESIGN of the vacuum system and use of plug-in components gives excellent accessibility and saves maintenance time. The easily removed spectrometer tube greatly reduces down-time when the tube needs cleaning or filament replacement.

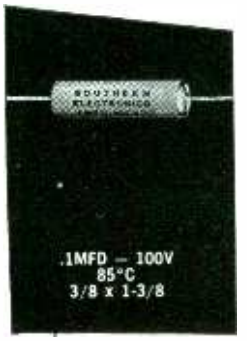
NO SPECIAL TRAINING is needed to operate the General Electric M-2 leak detector. After starting, the M-2 is operated simply by opening and closing one valve. The leak will show up on the leak rate indicator of the operator's panel. An audible alarm is also available.

FOR FURTHER INFORMATION, contact your nearest General Electric Apparatus Sales Office or write for descriptive bulletin, GEC-336, to Section 585-63, General Electric Co., Schenectady 5, N. Y.

DOWN-TIME IS REDUCED through easy access and removal of the spectrometer tube (right) and by a simplified vacuum system design.

GENERAL ELECTRIC





At last! Mycon Plastic Capacitors up to 150° C!

- *Reliability proved*
- *Rated for infinite long life*
- *Insulation resistance 1 x 10^{11} OHMS*

Derated at 125°C as follows:
100 volts — 50%
200 volts — 50%
300 volts — 33⅓%
400 volts — 33⅓%
500 volts — 20%
600 volts — 16%

Tested and proved! Only Southern Electronics Corporation has developed a test procedure which insures built-in reliability! For your most exacting requirements—be sure—always specify S.E.C.

SUPER MYCON CAPACITORS
Tolerance to 1%—lowest temperature coefficient. Superior insulation resistance at high ambient temp. Good stability compatible with material.

POLYCON SEC MYCON

Wire, write or phone for complete catalog today!

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Corporation

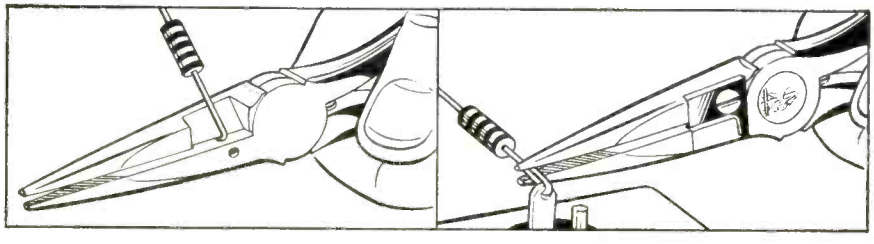
150 West Cypress Avenue, Burbank, California

PIONEERS IN CUSTOM CAPACITOR ENGINEERING

Faster Wiring with NEW Klein Shear Cutting Plier

PATENT PENDING

Two-step wiring of resistors:



1. Cut wire and bend in hook.

2. Close for soldering.

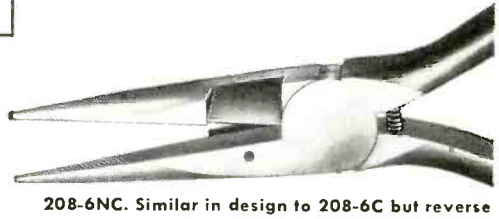
Here is a new Klein Plier based on an original principle which assures cleaner, faster cutting. The shear action makes it possible to cut hard wire or dead soft wire easily, quickly.

The reverse side of the plier has a milled section behind the knife so designed that when the wire is cut, it is held in position and a turn of the hand forms a 3/16-inch hook at the proper angle. Without changing pliers this hook may then be closed on the terminal for soldering.

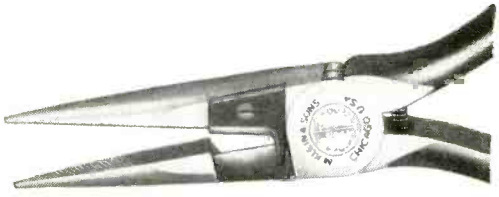
Shear blade is held in place with a countersunk setscrew and may be quickly replaced when knife becomes dull.

Also available as a straight side cutting plier with shear.

Furnished standard with self-opening coil spring and 1/16-inch point.



208-6NC. Similar in design to 208-6C but reverse side designed to put a positive 3/16-inch hook on the end of a resistor wire. Smooth one-motion operation saves production time on every television or radio set.



208-6C long nose shear cutting plier. A 6½-inch long nose plier with shear blades. Will cut dead soft or extremely hard wire. Blade replaceable. Plier never needs sharpening. Point of nose 1/16-inch diameter. Coil spring keeps jaws open ready for use.

ASK YOUR SUPPLIER

Foreign Distributor
International Standard Electric Corp.
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Mathias KLEIN & Sons
Established 1857 **Chicago, Ill., U.S.A.**
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Circle 52 Readers Service Card

Circle 53 Readers Service Card →

NEW encapsulated

SOLID HOT MOLDED VARIABLE RESISTORS

Now the famous Allen-Bradley Type J (2 watt) and the smaller Type G (½ watt) variable resistors are available encapsulated in epoxy resin . . . completely sealed. The operating shaft is provided with an "O" ring—to prevent moisture and detrimental vapors getting into the control. This new construction provides your critical circuits with the reliability and unequalled performance of Allen-Bradley's solid hot molded type resistor elements . . . plus the *extra protection* of epoxy encapsulation.

These famous Allen-Bradley variable resistors give you smooth control—without abrupt resistance changes. "Noise" characteristics are extremely low, and improve with long use. These controls can be supplied in single, dual, and triple units, with shaft variations and standard or special resistance tapers—as you may require. Please write today for complete information.

5-57-E

ALLEN-BRADLEY

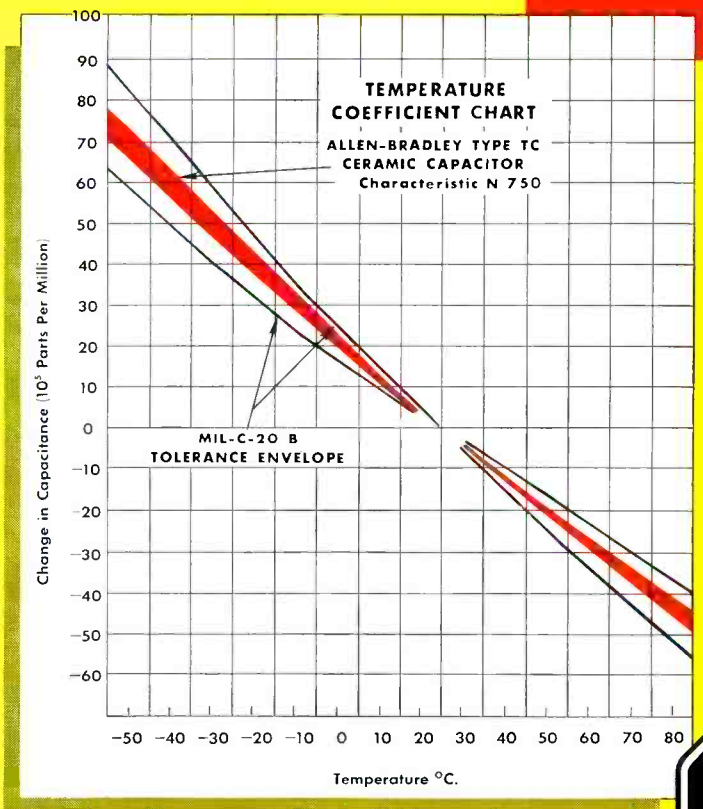
QUALITY

ELECTRONIC COMPONENTS

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

FOR SUPREME ACCURACY IN temperature compensating capacitors—

try ALLEN-BRADLEY



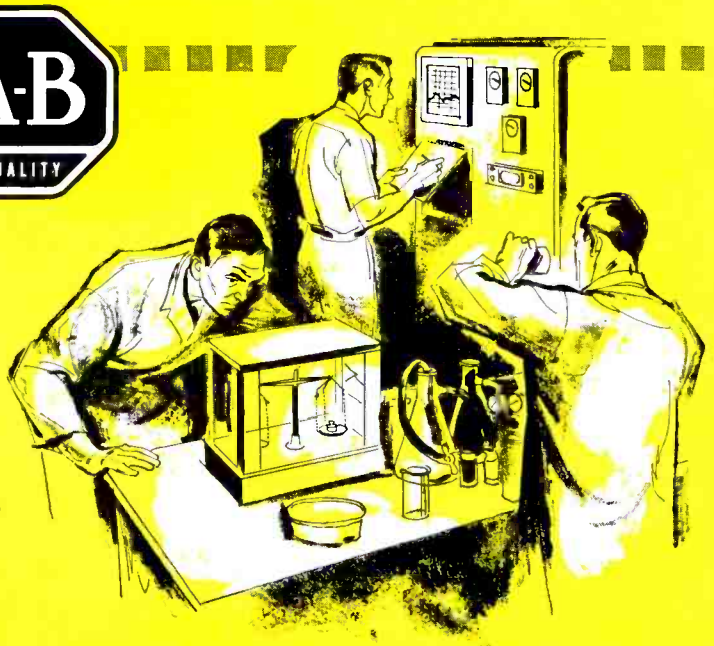
You can obtain greater precision with Allen-Bradley temperature compensating capacitors . . . much more accurate than conventional units . . . more accurate than the requirements of MIL or RETMA specifications.

Allen-Bradley is able to assure this accuracy by producing its own ceramic bodies. Years of experimentation, thousands of tests, and meticulous compounding enables Allen-Bradley to provide the exact characteristics you require. The accompanying temperature coefficient curve—typical of all Allen-Bradley temperature compensating capacitors—illustrates how precisely these characteristics are maintained.

Allen-Bradley temperature compensating capacitors are available from 2.0 to 510 mmf with eleven different temperature characteristics from P-100 to N-1500 in tolerances of ±5%, 10%, and 20%. Use these quality ceramic capacitors—they cost no more—and they will give you a more stable product.

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

A-B QUALITY

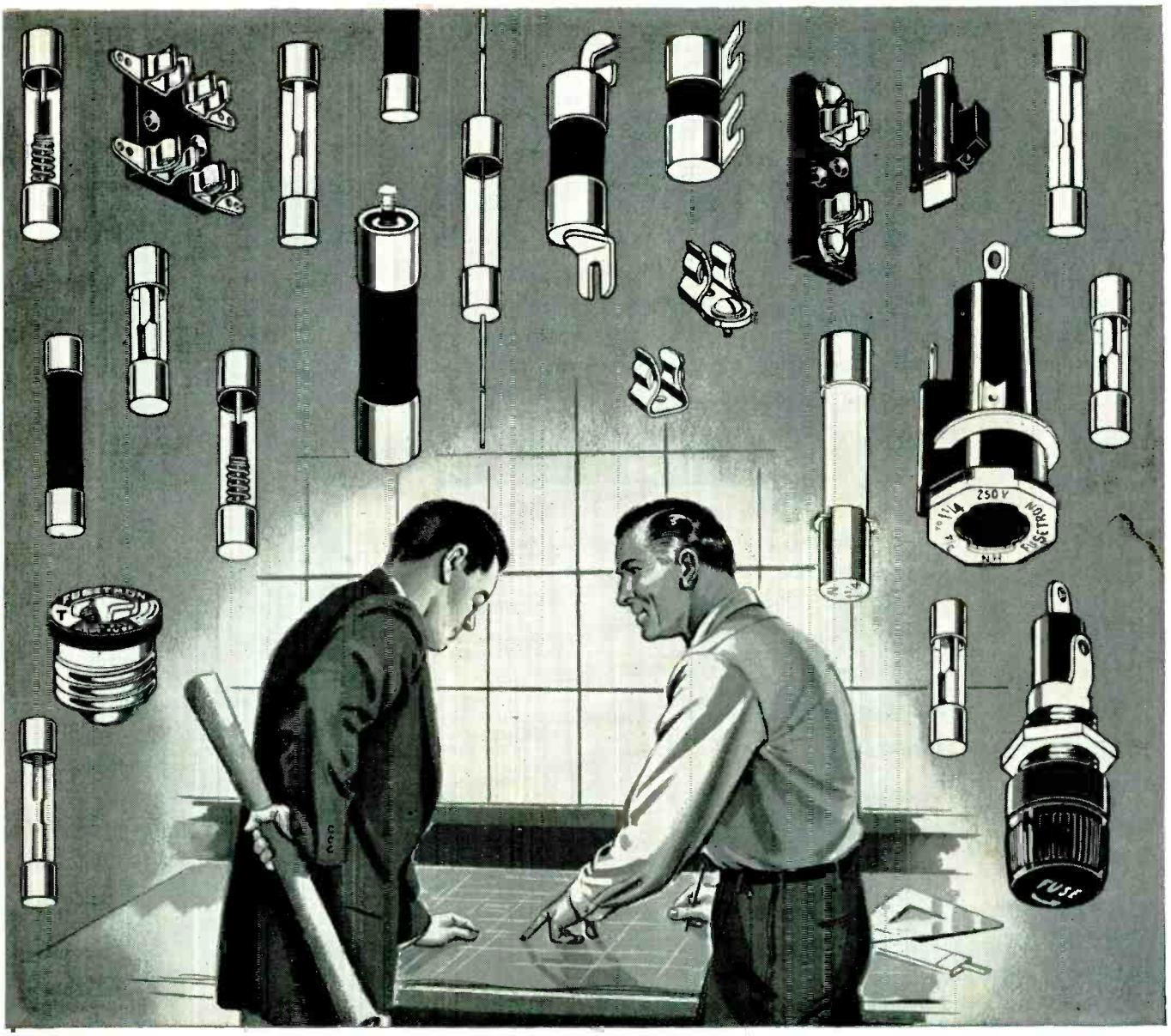


In modern laboratories, Allen-Bradley physicists conduct exacting tests on ceramic disc capacitors. The data accumulated from many thousands of tests—both electrical and physical—enables Allen-Bradley to produce ceramic disc bodies with *exact* temperature compensating characteristics.

ALLEN-BRADLEY

RADIO, ELECTRONIC, AND TELEVISION COMPONENTS

QUALITY



Whenever You Want Dependable Electrical Protection

. . . BUSS FUSES ARE YOUR ANSWER!

Here's why . . With BUSS fuses, dependable electrical protection isn't left to chance. Every BUSS fuse is tested in a sensitive electronic device that automatically rejects any fuse not correctly calibrated, properly constructed and right in all physical dimensions.

The result — when an electrical fault occurs, BUSS fuses quickly clear the circuit and the danger of damage to equipment is held to a minimum. Yet, BUSS fuses won't cause needless shutdowns by blowing when trouble does not exist.

By specifying BUSS fuses, you make sure your product received maximum electrical protection. And you are helping to safeguard the good name of your product for service and reliability.

If you have a troublesome fuseing problem . . . you can save engineering time by letting our research staff of fuse engineers work with you. If possible, a fuse will be selected that is available in local wholesalers' stocks, so that your device can easily be serviced.

For more information on BUSS and FUSETRON Small Dimension fuses and fuseholders . . . Write for bulletin SFB. Bussmann Mfg. Division (McGraw-Edison Co.) University at Jefferson, St. Louis 7, Mo.

"BUSS fuses are made to protect—not to blow, needlessly"

FUSETRON
TRUSTWORTHY NAMES IN ELECTRICAL PROTECTION
BUSS

Makers of a complete line of fuses for home, farm, commercial, electronic, automotive and industrial use.

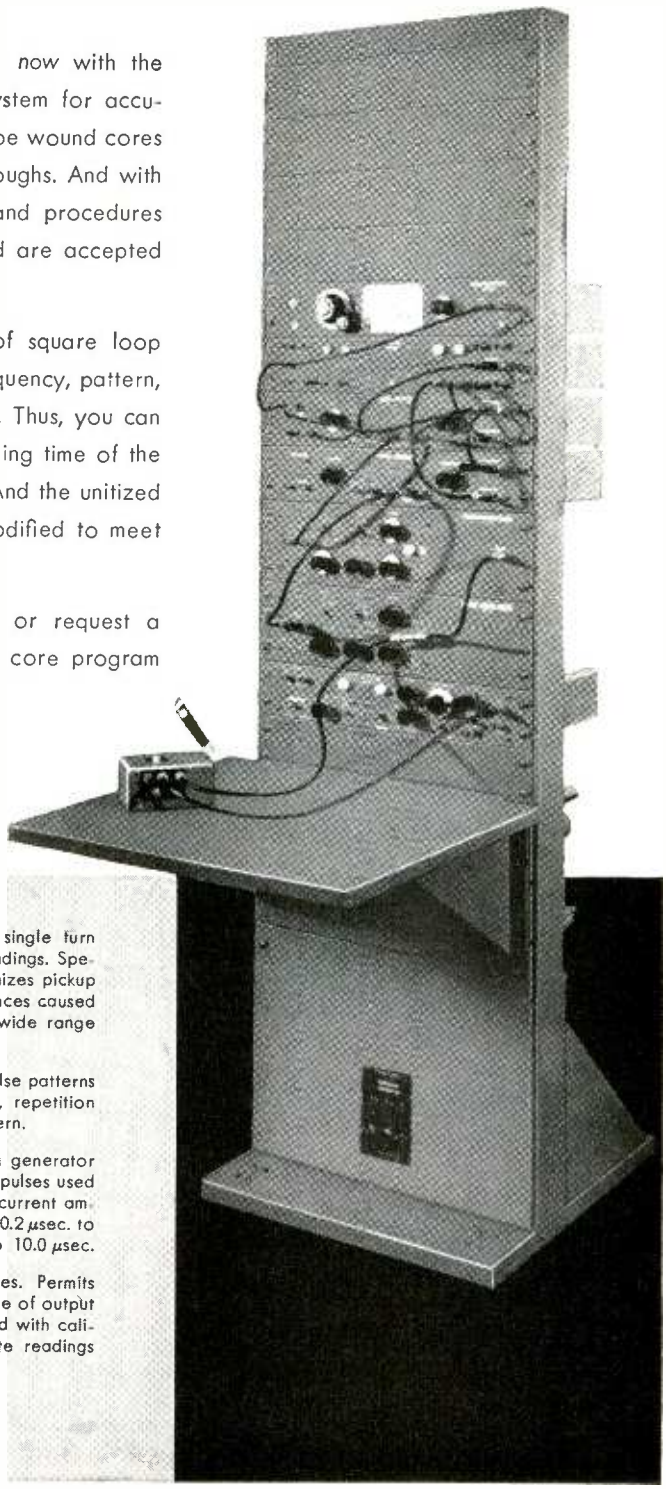
952

HOW TO TEST CORES

You can get your core program off the ground *now* with the Burroughs BCT-301. This complete and flexible system for accurately measuring the operating characteristics of tape wound cores is the result of six years of core research at Burroughs. And with it, you get the benefit of advanced techniques and procedures which are now in everyday use at Burroughs, and are accepted practice among major core manufacturers.

Designed expressly for the individual testing of square loop cores, the BCT-301 allows precise control over frequency, pattern, amplitude, and rise time of the core driving signal. Thus, you can get extremely accurate measurements of the switching time of the core as well as the amplitude of the output pulse. And the unitized sections of the BCT-301 can be expanded and modified to meet new testing requirements as they arise.

Write for additional details on the BCT-301, or request a demonstration of how this new tool can get your core program off the ground *now*.



tools for engineers

specifications

core mounting jig: Low-noise test mounting jig applies tight single turn loops around core for input and output windings. Special electrical and mechanical design minimizes pickup by the secondary as well as other disturbances caused by air flux. Adjustable pins accommodate wide range of bobbin sizes with equal precision.

pattern generator: Provides extreme flexibility in generating pulse patterns applied to core, controlling pulse spacing, repetition rate of cycle, and number of pulses in pattern.

current drivers: Two drivers convert voltages from pattern generator into positive and negative constant current pulses used for driving core. Front panel controls vary current amplitude from 0 to 1.0 ampere; rise time from 0.2 μsec. to 1.0 μsec.; pulse duration from 1.0 μsec. to 10.0 μsec.

calibrator: Accurately measures currents and voltages. Permits measurement of driving current and amplitude of output voltage with an error of less than 1%. Used with calibrated oscilloscope, permits highly accurate readings of switching time.

power supply: Provides seven regulated d-c voltages.

Burroughs

Burroughs Corporation • ELECTRONIC INSTRUMENTS DIVISION, DEPT. C, 1209 VINE STREET, PHILADELPHIA 7, PA.

Circle 56 Readers Service Card

Circle 57 Readers Service Card

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PRECISION CERAMICS

High Strength - Low Loss

Your best buy for uses requiring rugged strength, low dielectric loss, precision tolerances. Dependable performance. Produced by the source offering widest choice of specialized ceramic compositions in the field. Withstand high temperatures. Hard. Minimize chipping, breaking. Chemically inert. Permanently rigid. Cannot rust, corrode or deteriorate with time. Wide latitude of shapes and sizes. Pressed . . . extruded . . . machined. The right equipment for every operation, every size order . . . to improve quality, decrease cost. Rapid delivery of uniform parts. Prototypes available . . . small lots for test purposes without special tooling.

VERSATILE *AlSiMag 196* STARS IN SUCH APPLICATIONS AS THESE:

- Atomic Applications
- Appliance Parts
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- Grommets
- High Frequency Insulators
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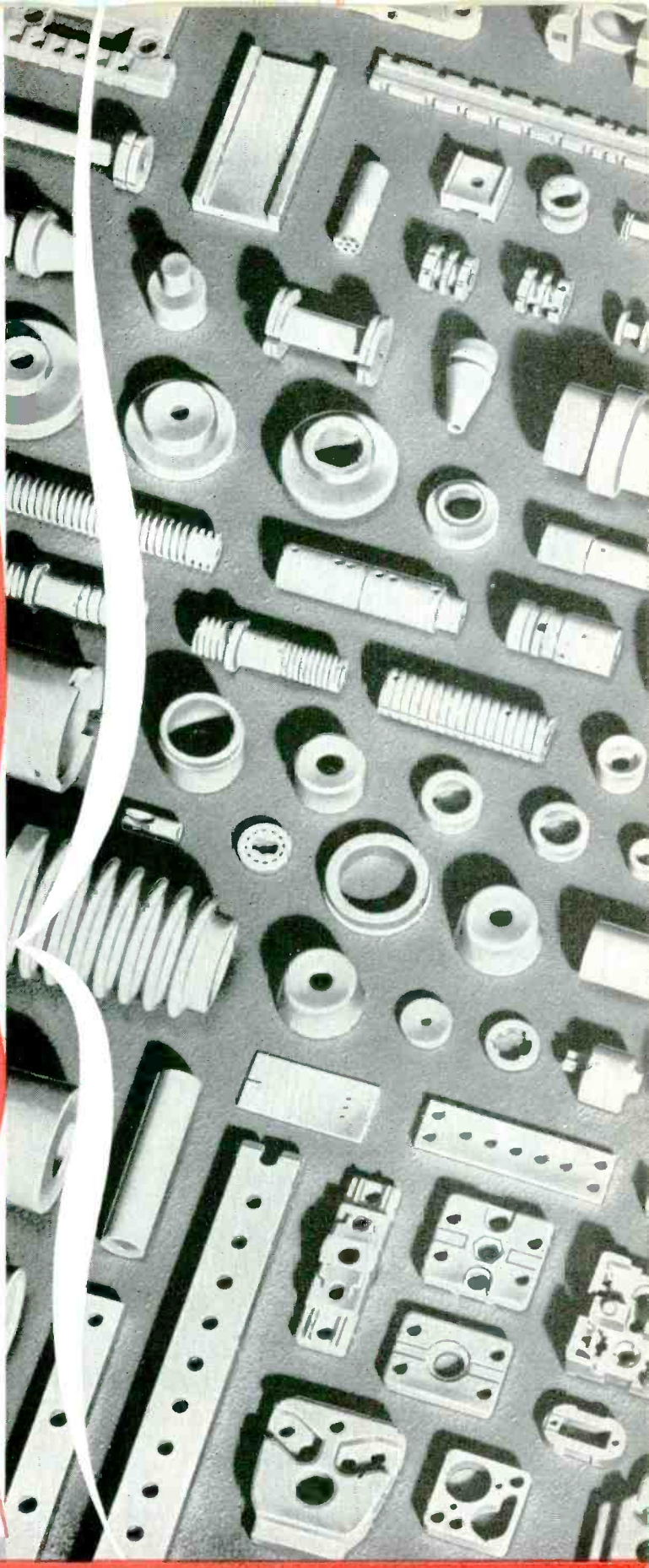
- Spacers
- Standoffs
- Supports
- Switchbacks
- Terminal Boards
- Transformer Bushings
- Trimmers
- Tube Parts

Why not investigate the many advantages of AlSiMag 196 for your application? Sketch or blueprint, together with details of operation, will bring you complete information.



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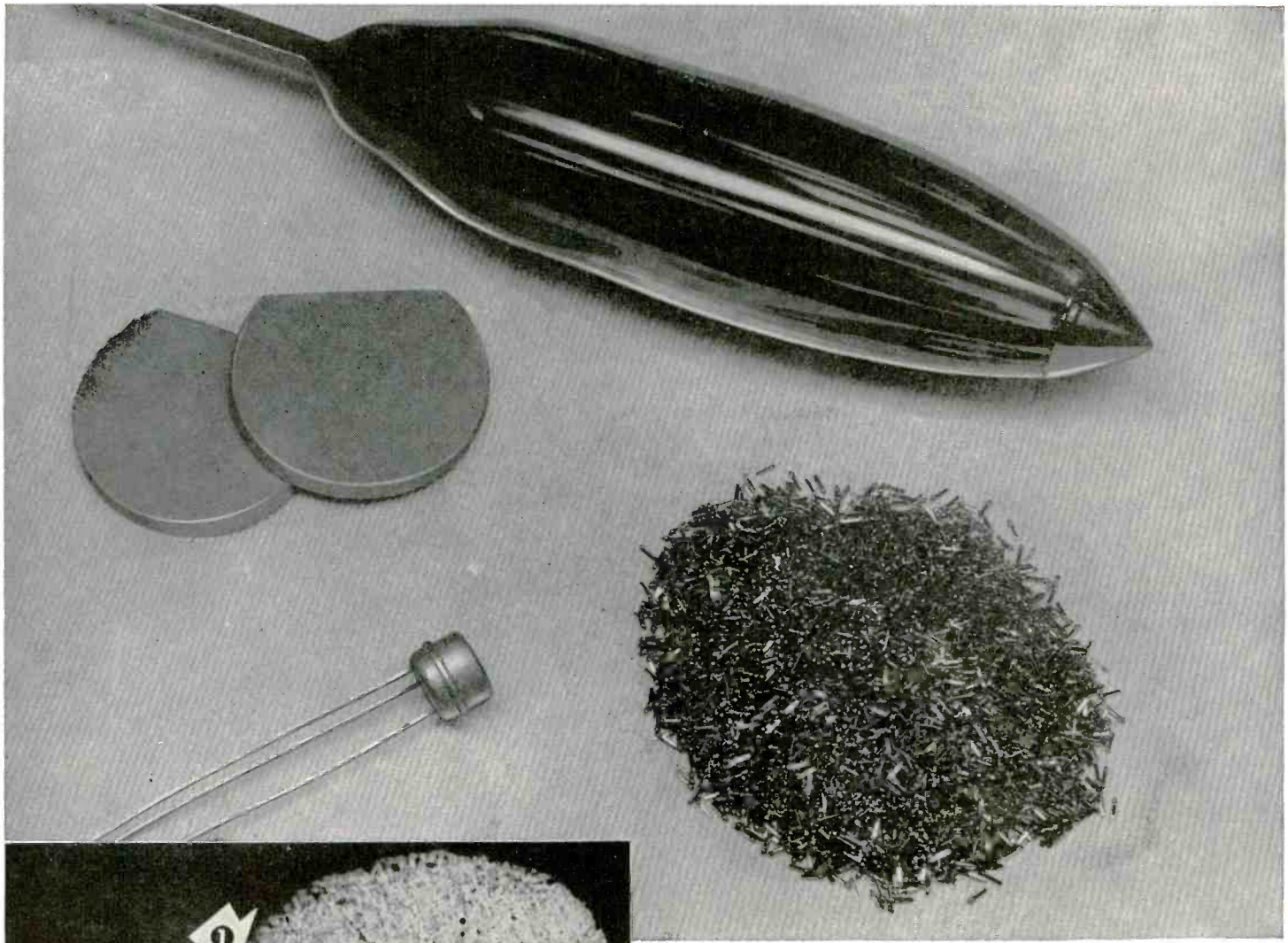
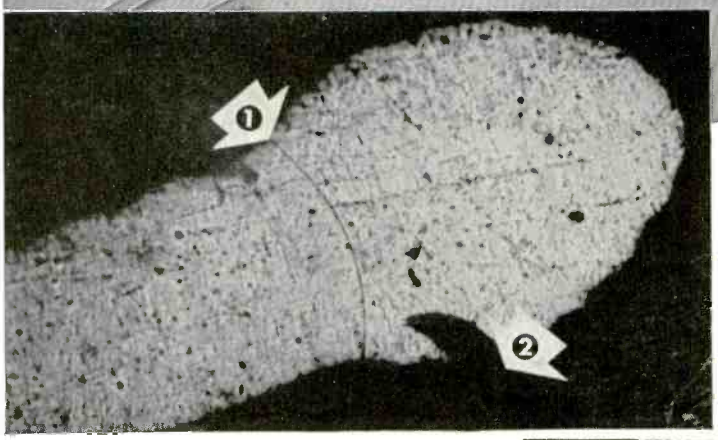
Using the diffused-meltback process

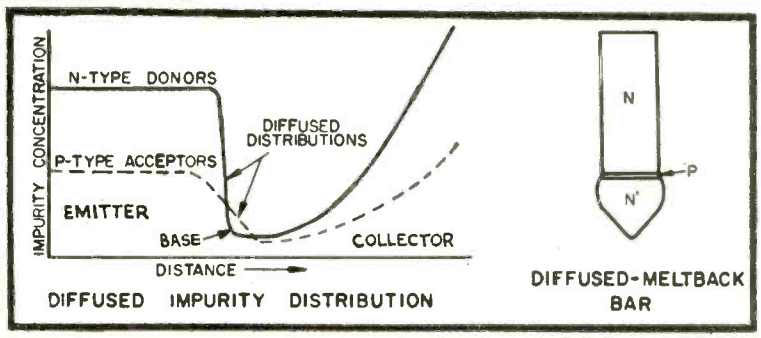
G.E. gets the most from silicon...





Before going through the diffused-meltback operation, a crystal of silicon is sawed into wafer-form: wafers are then diced to produce 4000 to 5000 individual silicon bars. Photomicrograph at left shows size-comparison of a silicon NPN bar, or pellet, with human hair (Arrow 2). "Tear drop" at end of bar is formed during meltback process. Micro-thin base, or "P", region (Arrow 1) is created through G-E diffusion technique. Base regions of 2-micron size are made with relative ease.

Curves illustrating impurity distribution after diffusion. P-type impurities in the high concentration side of the meltback junction diffuse, within solid semiconductor, into "plateau" region of low impurity concentration. High resistivity "plateau" contributes to elimination of punch-thru effects.



to put the most into transistors

High degree of uniformity and control in junction formation. General Electric's diffused-meltback process was developed by Dr. I. A. Lesk of the G-E Advanced Semiconductor Laboratory. The development came about as the result of Dr. Lesk's efforts to create a transistor manufacturing process that would yield high-quality results at reasonable cost.

Not only does the G-E diffused-meltback process result in a maximum number of transistors from a single crystal (4000 to 5000 NPN transistors), *but it offers an extremely high degree of uniformity and control in transistor junction formation.*

Opens the door to high frequency performance. Diffusion of a melted-back silicon bar, or pellet, is the final step in the diffused-meltback process. It's the stage in which the micro-thin base, or "P" region is formed, establishing the final NPN transistor structure. Because the actual diffusion is accomplished over a high temperature heating cycle lasting several hours, the need for split-second accuracy is eliminated. The result is a high degree of process control.

By proper choice of the initial impurity concentrations and the time and temperature of the diffusion cycle, heavily-doped base regions as thin as 2 microns are easily obtained. *These micro-thin, uniform base regions are the "open-sesame" to extremely reliable high frequency transistor performance.*

Ordering Data—G-E Silicon NPN Transistors

High Frequency Amplifier Type
ask for: **2N429** (formerly 4JD4A2)

Computer DCTL Type
ask for: **2N430** (formerly 4JD4A3)

General-Purpose Amplifier Types
ask for:

		Beta
2N431	(formerly 4JD4A4)	9 to 30
2N432	(formerly 4JD4A5)	20 to 55
2N433	(formerly 4JD4A6)	45 to 100

High current gain. Silicon NPN transistors feature inherent high current gains and high frequency cut-offs. The diffused meltback process permits mass production, since it combines the principles of impurity segregation and solid-state diffusion.

G-E silicon NPN transistors are nominally rated for 25 megacycles, but with useful gain to 50 megacycles—the highest frequencies offered by any mass-produced silicon NPN triode on the market today. All production units are aged at extremely high temperatures for over 150 hours. This is to provide maximum stability of I_{co} and current gain (beta).

The header assemblies of G-E silicon NPN transistors are constructed of high-purity materials. A gold-silicon alloy is used for end connections: the base lead is pure aluminum. There are no solders or fluxes, eliminating any danger of transistor "sleeping sickness" caused by corrosion at soldered junction points.

Outstanding For Switching Applications and Linear Amplifier Use. The gold-alloy mountings, with a melting temperature of over 350°C represent the lowest melting point of the entire transistor assembly structure. The G-E Series 4JD4A silicon transistors provide reliable operation to 150°C, with storage temperatures to 200°C.

With well-controlled high frequency characteristics and a low saturation resistance of 20 ohms, G-E silicon NPN transistors are "naturals" for switching applications and linear amplifier use.

Would you like complete specification information? Please contact your nearest G-E Semiconductor Products district office, or write to General Electric Company, Semiconductor Products, Section S2597, Electronics Park, Syracuse, N. Y.

View of uncapped G-E silicon NPN diffused-meltback transistor, showing mounted silicon bar with aluminum base lead connected. Bar ends attached using a gold-alloy mounting technique. No solders or fluxes are used.

Diffusion furnace. Operator places quartz vials, with large quantity of silicon bars, in furnace. Diffusion occurs through high-temperature heating cycle lasting several hours.

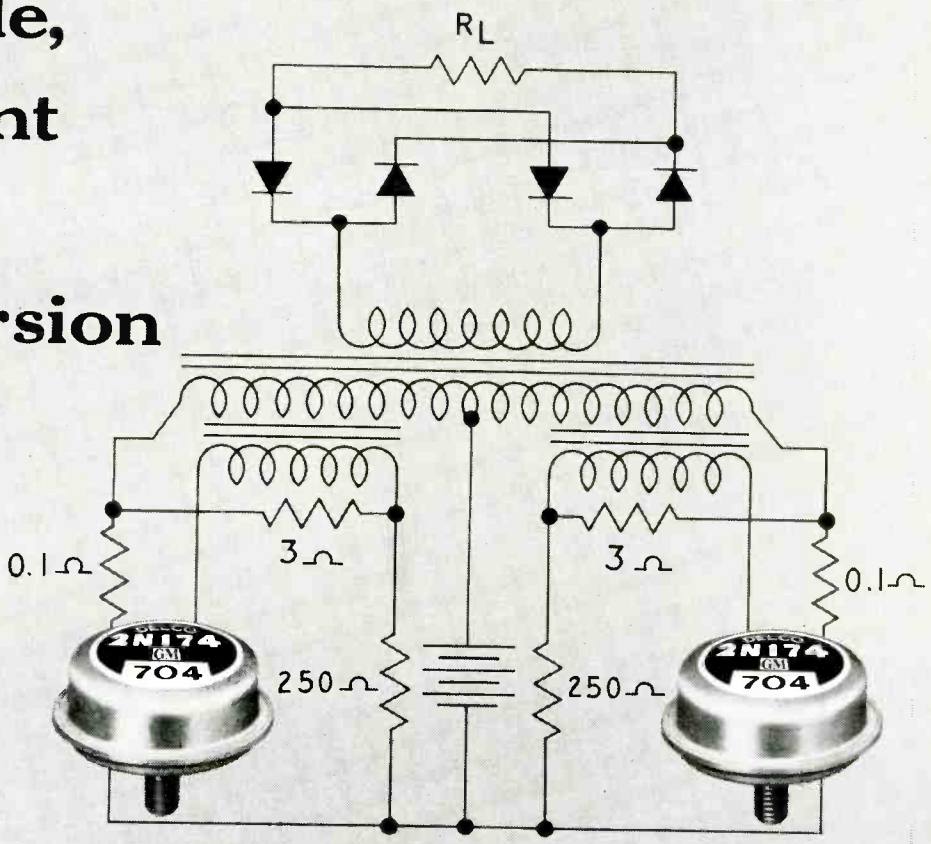
An aging oven in which G-E silicon NPN transistors are aged at extremely high temperatures for over 150 hours. Provides maximum stability of I_{co} and current gain (beta).

CUSTOMER CONFIDENCE 10th ANNIVERSARY SEMICONDUCTOR PROGRESS

Progress Is Our Most Important Product

GENERAL ELECTRIC

Reliable, Efficient DC Conversion



Industry's Highest Power Transistors

Low saturation voltage of Delco Radio 2N173 and 2N174 opens new opportunities for converter economy, efficiency and reliability

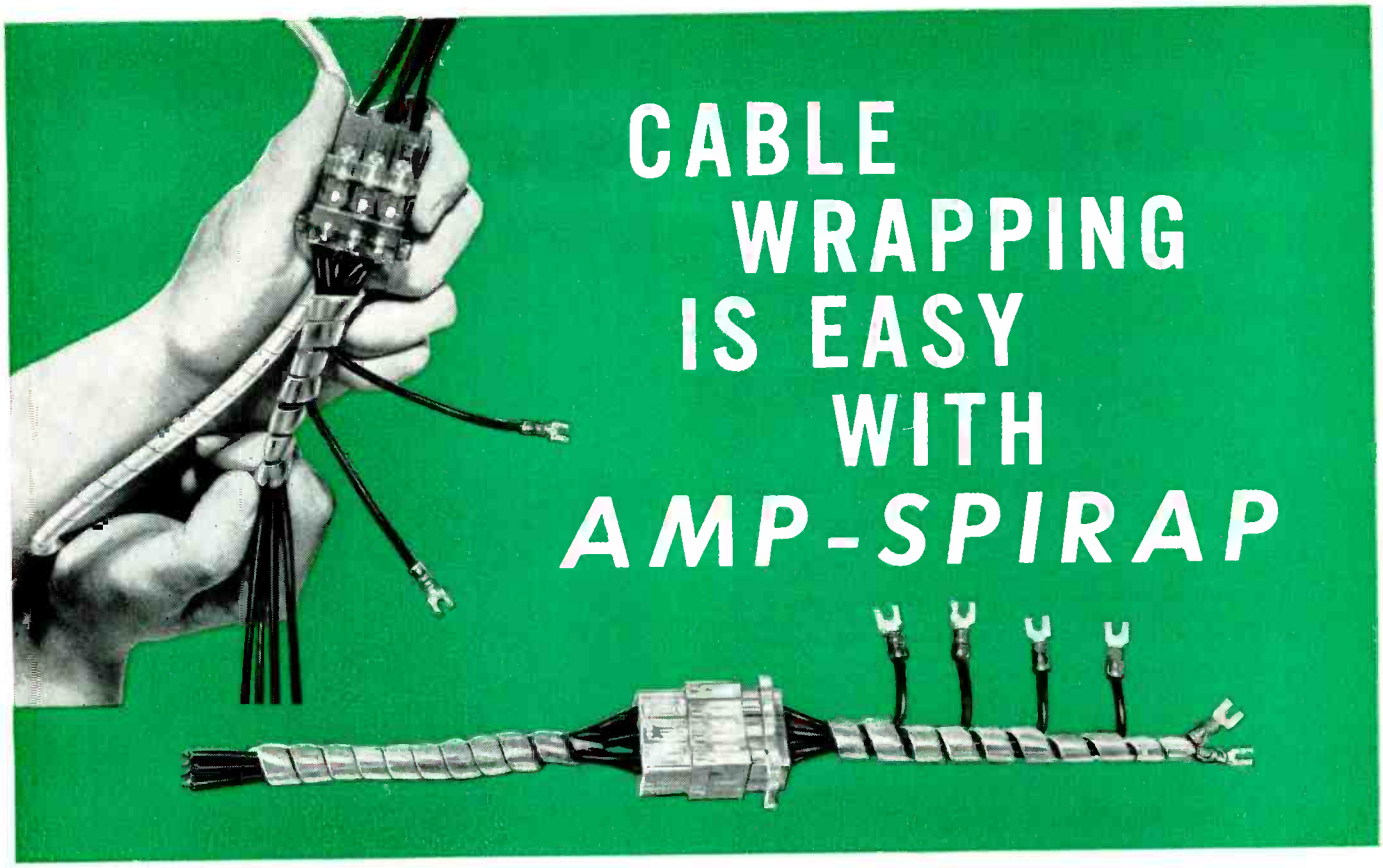
The excellent electrical characteristics of Delco High Power transistors permit the conversion of *low* DC voltage to *higher* DC voltage—with a high degree of efficiency—in a wide range of applications. This proved performance offers greater reliability than will be found in corresponding vibrator circuits.

The low saturation voltage of Delco 2N173 and 2N174 transistors also reduces their internal power dissipation in conversion applications to an insignificant degree so that little self-heating is apparent. The result is an overall economy which permits converters of smaller size . . . important in many applications.

TYPICAL CHARACTERISTICS

	2N173	2N174
Properties (25°C)	12 Volts	28 Volts
Maximum current	12	12
Maximum collector voltage	60	80
Saturation voltage (12 amp.)	0.7	0.7
Power gain (Class A, 10 watts)	38	38
Alpho cutoff frequency	0.4	0.4
Power dissipation	55	55
Thermal gradient from junction to mounting base	1.2°	1.2°
Distortion (Class A, 10 watts)	5%	5%

DELCO RADIO DIVISION OF GENERAL MOTORS
KOKOMO, INDIANA



The development and production of the finest quality solderless terminals for your electrical circuitry requirements is AMP's primary objective. We also constantly search for allied products and application techniques that will speed, simplify, and obsolete present time-consuming sub-assembly operations. *AMP-SPIRAP* and its application technique stems from such constant searching activity.

AMP-SPIRAP is a unique, spirally-cut plastic wrapping that . . .

- eliminates tedious cable lacing, insulation damage, and pulling of wires through spaghetti tubing
- is quickly applied to wire bundles of any size up to 3½ inches diameter
- permits individual wires to be entered or led out at any point
- is quickly unwound to allow wires to be added, removed, or relocated—thereby eliminating the necessity for cutting into the cable bundle after assembly
- holds wires together tightly, but permits flexibility for forming cable
- provides mechanical protection over entire length of cable

When required for your maintenance and repair needs, *AMP-SPIRAP* is available in the U.S.A. through American Pamcor Inc.

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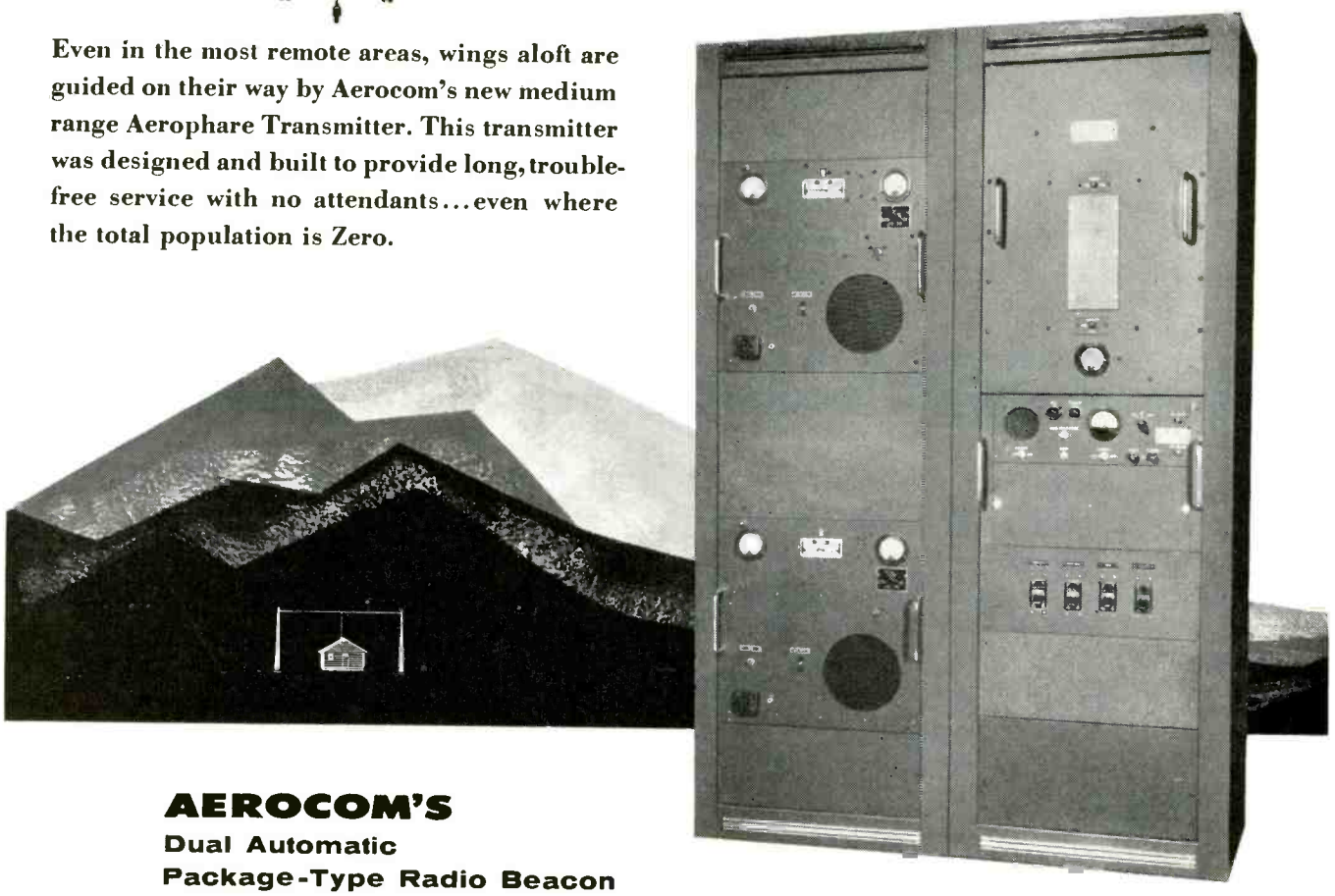
Circle 61 Readers Service Card

population - O

Even in the most remote areas, wings aloft are guided on their way by Aerocom's new medium range Aerophare Transmitter. This transmitter was designed and built to provide long, trouble-free service with no attendants... even where the total population is Zero.



AEROCOM'S
Dual Automatic Package-Type Radio Beacon

for completely unattended service. This aerophare (illustrated) consists of two 100 watt (or 50 watt) transmitters with keyer, automatic transfer and antenna tuner. (Power needed 110 or 220 volts 50/60 cycles, 520 V.A. for 50 watt, 630 V.A. for 100 watt.)

Frequency range 200 - 415 kcs.: available with either crystal or self excited oscillator coil. High level plate modulation of final amplifier is used, giving 40% tone modulation in 100 watt transmitter and 60% in 50 watt model. Microphone P-T switch interrupts tone, permitting voice operation.

The "stand-by" transmitter is selected when main transmitter suffers loss (or low level) of carrier power or modulation. Audible indication in monitoring receiver tells which transmitter is in operation.

Unit is ruggedly constructed and conservatively rated, providing low operating and maintenance costs.

Also available in 1 K.W. and 4 K.W. Models

AER-O-COM

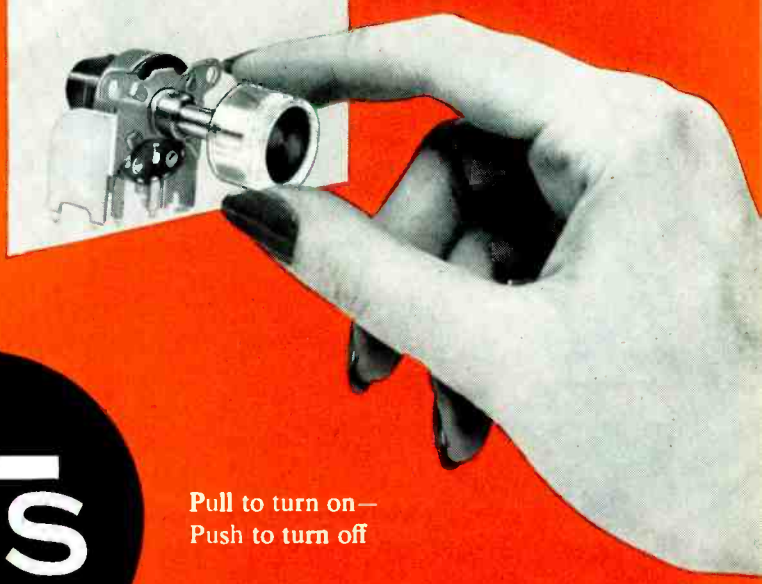
A-134

3090 S. W. 37th AVENUE • MIAMI 33, FLORIDA

PUSH-PUSH

One push on—
One push off

PULL-PUSH



Pull to turn on—
Push to turn off

CTS

Two new switch-controls

Volume setting unaltered by ON-OFF operation

Just switch on and walk away. No coming back or waiting for further adjustment after warm-up.

Volume can be changed instantly as desired by rotating shaft . . . or can remain indefinitely at any selected setting regardless of on-off switch operations.

Push-push switch available with either 3 amp 125V rating (Type J) or 6 amp 125V rating (Type TJ). Pull-push switch available with 3 amp 125V rating (Type K). Both switches available in many special terminal and control combinations.

Write today for Data Sheets containing dimensional drawings and complete technical details.

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WEST COAST MANUFACTURERS:
Many types of variable resistors now in production at our South Pasadena plant. Your coil, transformer and compression molding business also invited. Prompt delivery. Modern versatile equipment. L. A. phone CLinton 5-7186.

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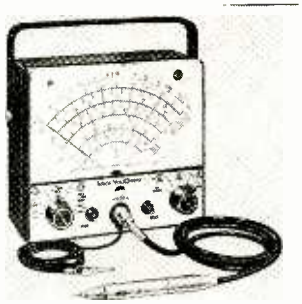
ELKHART • INDIANA

The Exclusive Specialists in Precision Mass Production of Variable Resistors

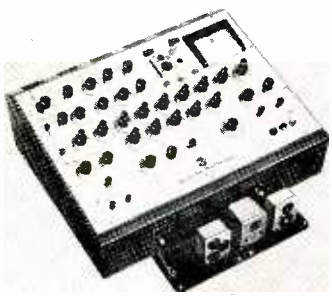
JUNIOR VoltOhmyst® WV-77C—Biggest value in vacuum-tube volt-ohmmeters! Factory tested and calibrated to lab standards. Measures dc from 100 millivolts to 1200 volts; ac from 100 millivolts to 1200 volts rms; resistance from 0.2 ohm to 1,000 megohms. User Price **$59.50***



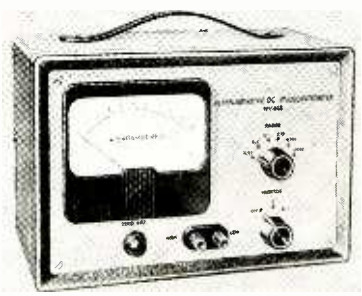
SENIOR VoltOhmyst® WV-98A—Improved circuit provides greater accuracy, 3% on *BOTH* ac and dc measurements. Measures directly the peak-to-peak values of complex wave forms and rms values of sine waves. *LARGE* full-vision meter, with less than 1% tracking error, provides one of the easiest reading VTVM scales. User Price **$79.50***

MASTER VoltOhmyst® WV-87B—Ideal for TV, radar and other types of pulse work. Has accuracy and stability necessary for laboratory applications. Features ±1% multiplier and shunt resistors; a ±2% meter movement; DC polarity reversing switch; zero-center scale adjustment for discriminator alignment; ±3% accuracy on AC and DC voltages, many other features. User Price **$137.50***

FOR YOUR LAB OR LINE



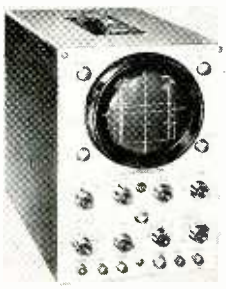
ELECTRON-TUBE MicroMhoMeter WT-100A—Accuracy suited for electronic equipment manufacturers, research and development, maintenance groups. Precision tube testing under *actual* circuit conditions. Built-in "shorts" test; burnout protected meter; regulated power supplies for dc voltages; measures gm up to 100,000 micromhos in 6 ranges. User Price **$785.00***



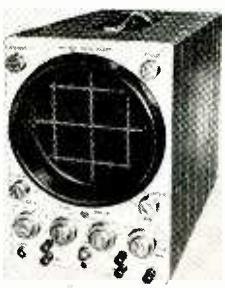
ULTRA-SENSITIVE DC MICROAMMETER WV-84B—Popular choice in industrial, chemical, general lab applications. Designed to measure extremely "feeble" currents, extremely high resistances. Self-contained batteries permit use almost anywhere. Low-drain tubes extend battery life, meter protected from accidental overloads. User Price **$110.00*** (less batteries)

5" OSCILLOSCOPE WO-88A—An all-purpose scope for general lab use, production-line alignment and testing. Built-in voltage calibrating facilities permit simultaneous waveshape display and peak-to-peak voltage measurements. Sync polarity instantly reversible with front panel switch. Directly coupled, push-pull amplifiers in vertical circuit provide flat response down to dc. User Price **$179.50***

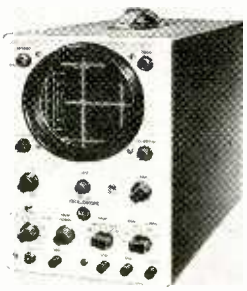
CHOOSE AN RCA DESIGN!



5" OSCILLOSCOPE WO-91A—Dual Band 4.5 Mc scope, for waveshape observation and measurement, signal tracing and alignment of chrominance circuits and wide-band amplifiers—voltage-calibrated input step-attenuators and calibrated graph screen make possible direct voltage readings as easily as with a VTVM. User Price **$239.50***



7" OSCILLOSCOPE WO-56A—For phase measurements or vector display—7-inch screen plus trace expansion of 3 times screen diameter provide unusually large waveshape display for distant or close examination of minute portions of waveshapes. Frequency-compensated voltage-calibrated attenuators in both "V" and "H" amplifiers. User Price **$289.50***



5" OSCILLOSCOPE WO-78B—Famous "engineer's choice" dual-band scope for use when extra sensitivity and extended frequency response are required. Uses flat-faced cathode-ray tube with post-ultor potential of 3000 volts; automatic sync limiting; push-button for calibration checking; excellent phase characteristics; full screen deflection over entire rated frequency range. User Price **$475.00***

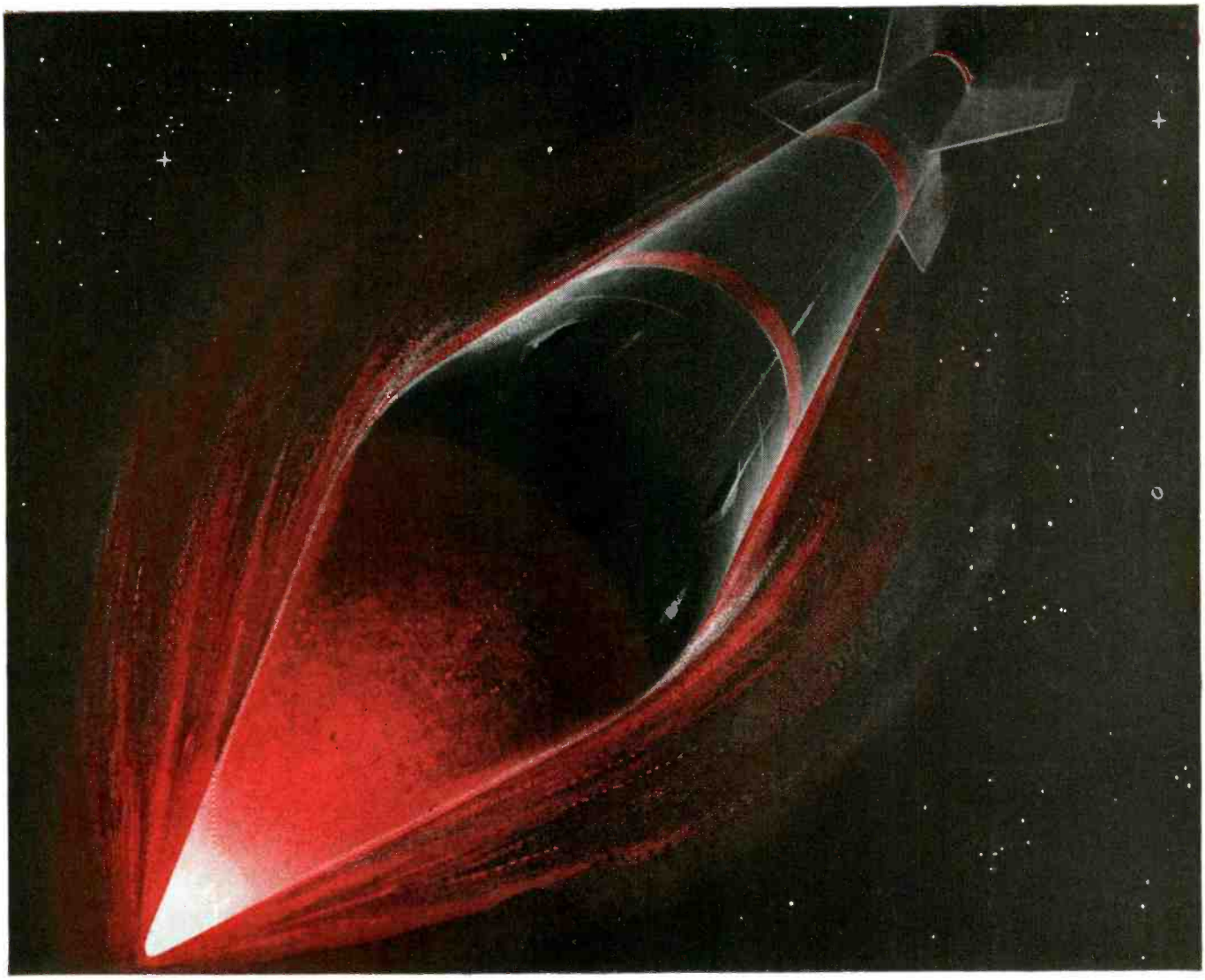
**User Price (Optional)*

For fast delivery of the best in test instruments for lab, line or shop . . . call your RCA Distributor!

RADIO CORPORATION of AMERICA

COMPONENTS DIVISION

CAMDEN, N. J.



Sustained operating temperatures up to 400° F, as in guided missiles, are death to inferior electrical insulations and laminates. CDF glass-base laminates of Teflon*—the only laminates of their kind approved by the military—can take this punishment steadily.

LATEST HIGH-HEAT INSULATION SYSTEMS NEED CDF GLASS-BASE LAMINATES AND TAPES

Widest available range offers Teflon, epoxy, silicone, mica products for dimensional stability under continuous heat

As components and equipment grow smaller, and heat becomes more difficult to dissipate, CDF high-heat electrical insulations become increasingly important to electronic design. For nowhere else can such a wide range of quality insulations be found under one roof as at CDF.

FOR HIGH-HEAT PRINTED CIRCUITRY, CDF glass-base metal-clad laminates of Teflon* and epoxy exhibit best dimensional stability and current-carrying capacity. Constant operating temperatures of 300°F — soldering temperatures to 500°F — are readily met by these specialized CDF Dilecto® laminates.

HIGH-HEAT FLEXIBLE INSULATIONS. CDF offers a wide choice of insulating tapes made of Teflon, silicone varnish, silicone rubber, and Micabond®, with glass-cloth support. CDF tapes may be used either by hand wrapping or on automatic winding machines. Unsupported Teflon in colors available to meet MIL-STD 104.

TEFLON SPAGHETTI TUBING AND OTHER SPECIALTIES. Part of CDF's vast fabrication facilities is devoted to the production of custom parts from Teflon — spaghetti tubing, rods, sheets, and machined parts to rigid specifications.

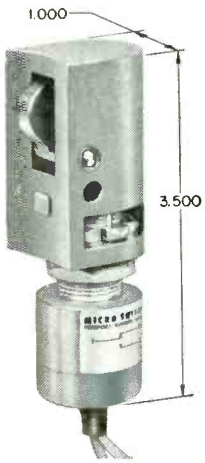
NEW — *cementable* Teflon, bondable to itself and to other materials with commercial adhesives.

SEE SWEET'S Product Design File, Electronics Buyers' Guide, and other directories for the name and phone number of your CDF sales engineer. Then send your print or your problem, and we'll return specific technical data and test samples.

*trademark of DuPont tetrafluoroethylene resin

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

Switches have uses unlimited



NEW!

MICRO SWITCH "Rocket Switch"— a rugged, sealed small switch for indicating and lockout devices

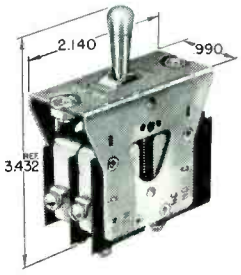
Developed for use on rocket launchers, this MICRO SWITCH 21AS2 assembly fits the needs of many industrial designs.

The assembly consists of one SPDT Type-EN switch attached to a rugged cam-type actuator. The assembly is environment-proof and withstands the highly-corrosive effects of rocket propulsion gases. The assembly will withstand heavy impact hammer blows on the actuator. *(Send for Data Sheet 120)*

SWITCH CHARACTERISTICS

Operating force—6 to 12 lbs. Full overtravel force—10 lbs. min.; Release force—4 lbs. min.

Electrical Data: 28 vdc rating: inductive, 3 amps. at sea level and 2 amps. at 50,000 feet; resistive, 4 amps. at sea level and 50,000 feet; inrush, 24 amps. at sea level and 50,000 feet. Motor, 4 amps. at sea level and 50,000 feet; inrush, 24 amps. at sea level and 50,000 feet. (Altitude ratings established with seal deliberately broken.)



NEW!

MICRO SWITCH three-position toggle switch—4 SPDT circuits with a single lever

MICRO SWITCH 115AT Series of toggle switches uses four SPDT switching units. Two units are actuated in each extreme toggle lever position. None are actuated when lever is in center position.

Many different combinations, however, may be obtained, including the make and break of circuits in all three lever positions.

Outstanding features of this series include the compact design, positively-driven switch actuators and sturdy construction. A safety catch guards against accidental movement of toggle lever. *(Send for Data Sheet 132)*

SWITCH CHARACTERISTICS

Electrical rating at 30 vdc: inductive—10 amps. at sea level, 6 amps. at 50,000 ft.; resistive—10 amps.; motor—6 amps. Basic units listed by Underwriters' Laboratories for: 10 amps. 125 or 250 vac; ½ amp. 125 vdc; ¼ amp. 250 vdc.

NEW!

MICRO SWITCH completely sealed magnetic hold-in toggle switch

The MICRO SWITCH 5ET Series is a completely sealed momentary action toggle switch which also functions as a maintained contact switch. When the toggle lever is operated and a solenoid is energized, the magnetic force holds the lever operated. This hold-in feature permits remote electrical release of the lever.

Both switch and solenoid are sealed within the cylindrically shaped enclosure. This insures constant operating characteristics. An elastomer seal at the base of the toggle lever prevents entrance of dust or moisture. *(Send for Data Sheet 121)*

SWITCH CHARACTERISTICS

Total travel 30°; Contact arrangement SPDT, may be wired either N. O. or N. C. Electrical rating at 28 vdc: inductive, 3 amps. at sea level and 2.5 amps. at 50,000 feet; resistive, 4 amps. at sea level and 50,000 feet; motor, 4 amps. at sea level and 50,000 feet; inrush, 24 amps. at sea level and 50,000 feet; Hold-in rating of solenoid is 18-30 volts dc.

NEW!

MICRO SWITCH "typewriter" pushbutton switch for manual keyboard control

MICRO SWITCH 1PB81-T2 switch is ideal for one-finger rapid-repeat operation such as is required for the type of keyboard control found in electric typewriters, adding machines, etc. The repeat action is as rapid as the fastest operator can push the button.

This switch uses a SPDT MICRO SWITCH subminiature switch for snap-action reliability. The contoured button and unique overtravel spring combine to reduce operator fatigue. Operating "feel," however, is sufficient to avoid mistakes and false actuations.

Removable ½ in. dia. plastic button is available in red, green, off-white or black. It is keyed to prevent rotation. *(Send for Data Sheet 125)*

SWITCH CHARACTERISTICS

Electrical rating at 30 vdc: inductive—3 amps. at sea level and 50,000 ft.; maximum inrush—15 amps. Basic subminiature switch is listed by Underwriters' Laboratories at 5 amps. 125 or 250 vac.

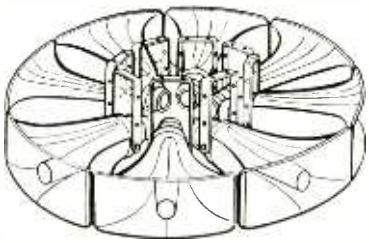
MICRO SWITCH

A DIVISION OF MINNEAPOLIS-HONEYWELL REGULATOR COMPANY

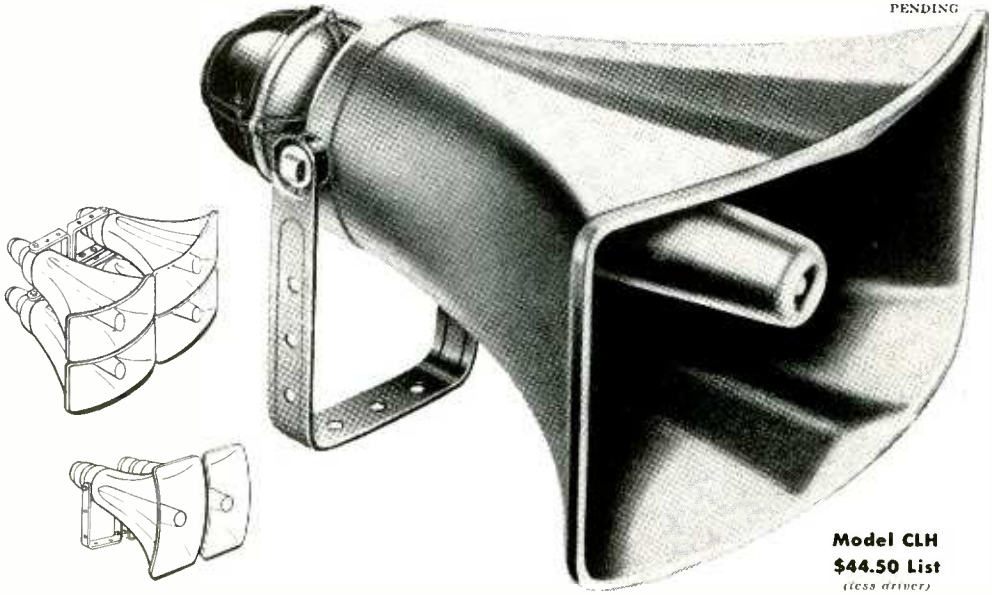
In Canada, Leaside, Toronto 17, Ontario • FREEPORT, ILLINOIS

UNIVERSITY ANNOUNCES THE VERSATILE MODEL

CLH WIDE-ANGLE PROJECTOR

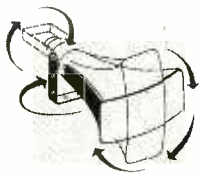


PATENTS PENDING



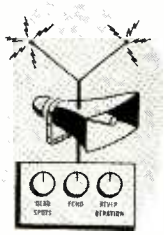
Model CLH
$44.50 List
(less driver)

EXCLUSIVE OMNI-DIRECTIONAL MOUNTING



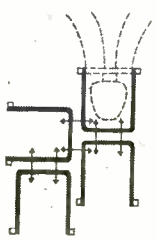
Horn *bell* rotates full 360° on its axis, while the 'U' mtg. bracket provides better than 180° vertical and 360° horizontal adjustment of *projector* positioning. Thus, sound can be distributed in *any* direction regardless of projector location.

"TUNE OUT" ECHO & REVERBERATION



The unique *pin-point adjustment* possible with the CLH at last provides the long-awaited answer to coverage of "dead spots" and control over troublesome echo and reverberation—regardless of structural or physical placement limitations!

USE SINGLY OR STACKED



The 'U' mounting bracket of the Model CLH is specially designed to link two or more projectors into *any* configuration, achieving *exactly* the sound distribution pattern required. Even diagonal or alternating projections are just as easy to achieve as "standard" patterns.

VERSATILITY & ADAPTABILITY UNLIMITED

Meets every soundcasting requirement. Use the CLH wide-angle projector with *any* University driver to get exactly the frequency response, efficiency and power handling capacity you need. Here is dependable performance and *real* economy—for actual dollar savings you can count on year after year.

SPECIFICATIONS: Air Column, 4½ ft.; Horn Cut-off, 120 cps; Dispersion, 120° x 60°; Bell Mouth, 21½" x 11½"; Depth (less driver), 20"; **$44.50 List.**

LISTEN *University sounds better*®

COMMERCIAL-INDUSTRIAL

UNIVERSITY LOUDSPEAKERS, INC., 80 SOUTH KENSICO AVENUE, WHITE PLAINS, N. Y.

THE MOST COMPLETE SELECTION OF DRIVERS IN THE INDUSTRY NOW AVAILABLE FOR USE WITH THE CLH

Model PA-50. Features extended high and low frequency range, highest continuous duty power capacity, greatest conversion efficiency, husky *built-in* multi-match transformer with terminals conveniently located at base of unit. The answer to the toughest sound problem. Nothing finer!

Response: 70 to 10,000 cps. Power Capacity: Full Range 50 watts; Adjusted Range* 100 watts; List Price: $57.50.

Model PA-HF. For applications requiring the greatest power handling capacity, maximum sensitivity, widest range frequency response, *plus* rugged lifetime construction. *Completely die-cast* aluminum housing. Increased sound output cuts amplifier requirements in half!

Response: 70 to 10,000 cps. Power Capacity: Full Range 50 watts; Adjusted Range* 100 watts; List Price: $47.50.

Model SA-30. "Battleship" construction for maximum durability against abuse or in hazardous environments. *Completely die-cast* aluminum housing and *built-in* matching transformer for connection to high impedance lines or "constant voltage" systems.

Response: 80 to 10,000 cps; Power Capacity: Full Range 30 watts; Adjusted Range* 60 watts; List Price: $47.50.

Model SA-HF. Will deliver that extra punch needed to cut through heavy noise. Use for speech or high quality music.

Response: 80 to 10,000 cps.; Power Capacity: Full Range 30 watts; Adjusted Range* 60 watts; List Price: $36.00.

Model MA-25. Low in cost, high in quality, featuring high efficiency magnet, tropicalized 2" voice coil, "rim-centered" breakdown-proof bakelite diaphragm.

Response: 85 to 6500 cps.; Power Capacity: Full Range 25 watts; Adjusted Range* 50 watts; List Price: $27.50.

**Program response adjusted to horn cut-off.*

ACCESSORIES

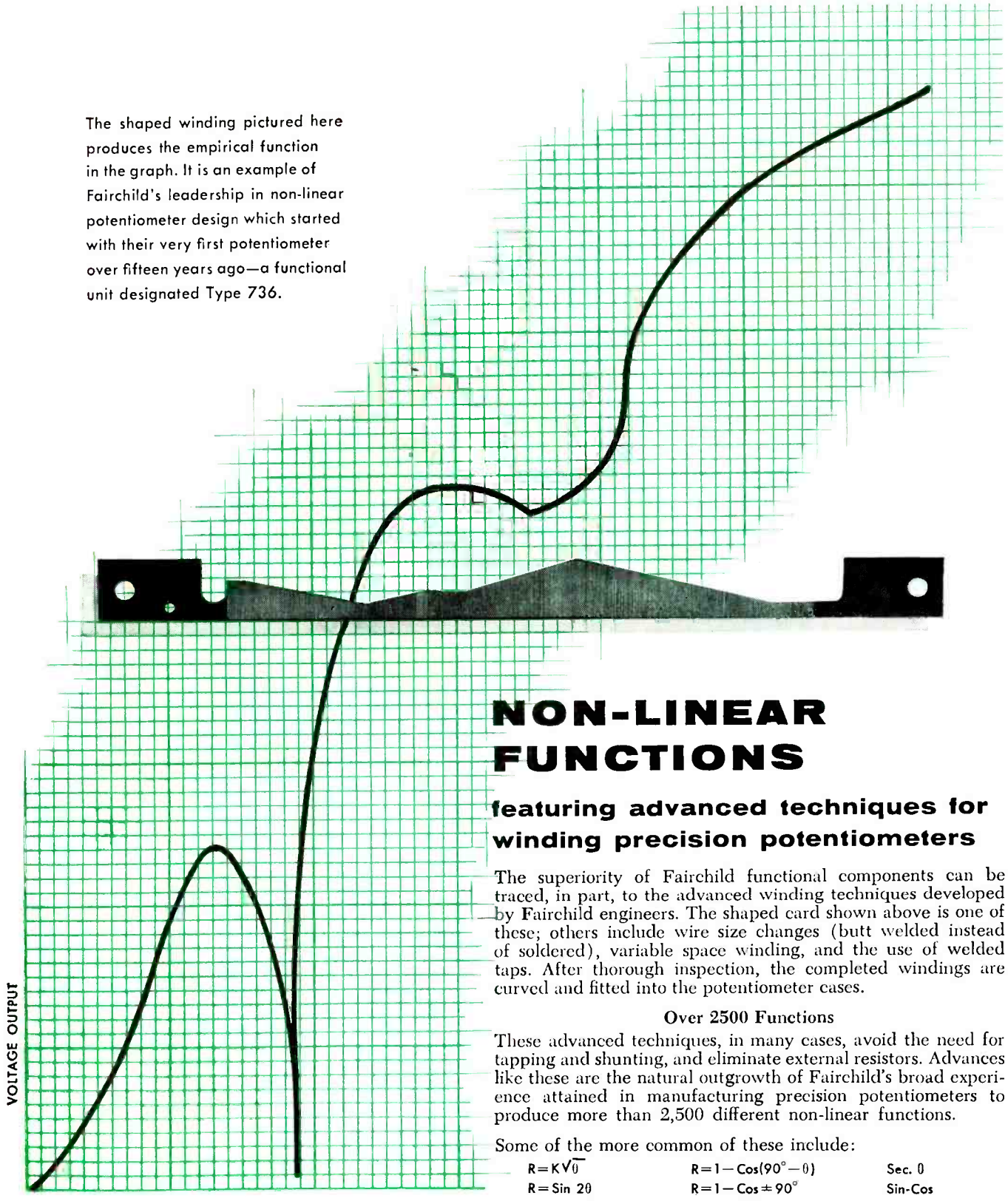
2YC CONNECTOR

PMA ADAPTER

2YC Connector enables two driver units to be used with one CLH trumpet for up to 200 watts output. Now you can get the Super-Power you want...when you want it, using standard stock drivers.

PMA Adapter fits standard ½" dia. threaded pipe to the CLH 'U' mounting bracket. Takes the headache out of mounting on pipe!

The shaped winding pictured here produces the empirical function in the graph. It is an example of Fairchild's leadership in non-linear potentiometer design which started with their very first potentiometer over fifteen years ago—a functional unit designated Type 736.



NON-LINEAR FUNCTIONS

featuring advanced techniques for winding precision potentiometers

The superiority of Fairchild functional components can be traced, in part, to the advanced winding techniques developed by Fairchild engineers. The shaped card shown above is one of these; others include wire size changes (butt welded instead of soldered), variable space winding, and the use of welded taps. After thorough inspection, the completed windings are curved and fitted into the potentiometer cases.

Over 2500 Functions

These advanced techniques, in many cases, avoid the need for tapping and shunting, and eliminate external resistors. Advances like these are the natural outgrowth of Fairchild's broad experience attained in manufacturing precision potentiometers to produce more than 2,500 different non-linear functions.

Some of the more common of these include:

$R = K\sqrt{\theta}$	$R = 1 - \text{Cos}(90^\circ - \theta)$	Sec. θ
$R = \text{Sin } 2\theta$	$R = 1 - \text{Cos} \pm 90^\circ$	Sin-Cos
$R = K \frac{\text{Sin}^2\theta}{2}$	$\%R = \%\theta^2$	1.875 log
		2 cycle log

These functions can be provided in many standard types ranging from ⅞" to 3", as well as an infinite variety of specials. Call on this vast experience the next time you have a problem involving non-linear functions—or *any* precision potentiometer problem. Write to Dept. 140-89A, Fairchild Controls Corporation, Components Division:

EAST COAST
225 Park Avenue
Hicksville, L. I., N. Y.

WEST COAST
6111 E. Washington Blvd.
Los Angeles, Calif.

FAIRCHILD
PRECISION POTENTIOMETERS and COMPONENTS

Circle 69 Readers Service Card

MODULIZED

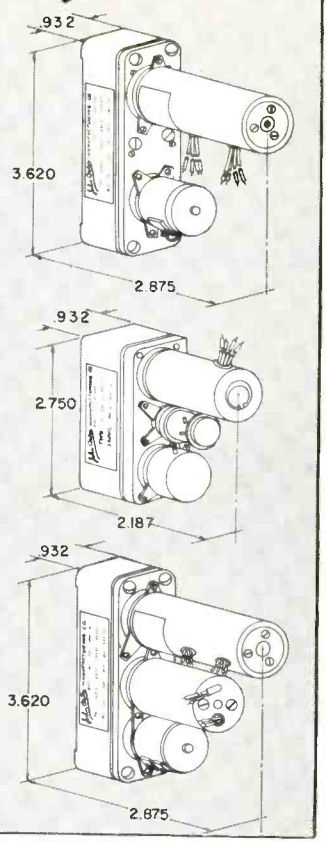
SERVO SYSTEMS

QUICKLY INTERCHANGEABLE . . . EASILY SERVICED

- Miniaturized
- Lightweight
- Simple, fast installation
- Meets MIL-E-5272
- Can be hermetically sealed with dimensional changes

OSTER TYPE	SB-9805-01	SB-9805-02	SB-9805-03	SB-9805-11
Motor				
Fixed Phase Voltage	26v	115v	115v	26v
Control Phase Voltage	26v	115v	115v	26v
Frequency	400	400	400	400
Max. Power @ Stall	6	5	5	6
No Load Speed	10,500	10,000	10,000	10,500
Generator				
Excitation Voltage Phase 1	26v			26v
Output Phase 2	0.3v/1000 RPM 100,000 ohm load			0.3v/1000 RPM 100,000 ohm load
Null	.012v			.012v
Wobble Voltage	.007v			.007v
(Power Excitation)	3.5 watts Max.			3.5 watts Max.
Linearity	0.5% to 4000 RPM			0.5% to 4000 RPM
Potentiometer				
Mechanical Rotation	360°	360°	360°	360°
Resistance	1000 ohms	50,000 ohms	50,000 ohms	1000 ohms
Accuracy of Total Resistance	±5%	±5%	±5%	±5%
Electrical Angle	350°	350°	350°	350°
Servo Block Unit				
Ambient Temperature	−55°C to 72°C	−55°C to 72°C	−55°C to 72°C	−55°C to 72°C
Altitude	−1000 feet to 55,000 feet	−1000 feet to 55,000 feet	−1000 feet to 55,000 feet	−1000 feet to 55,000 feet
Life	3000 hours excluding pot.	3000 hours excluding pot.	3000 hours excluding pot.	3000 hours excluding pot.
Gear Train				
Ratio	1000 : 1	336 : 1	167 : 1	10,000 : 1
Dust Enclosed per	Section 4.11 MIL-E-5272A	Section 4.11 MIL-E-5272A	Section 4.11 MIL-E-5272A	Section 4.11 MIL-E-5272A
Backlash	Anti-Backlash gear on pot.	1°	1°	Anti-Backlash gear on pot.
Synchro				
Input Voltage—Stator	11.8v			
Output Voltage—Rotor	10.6v			
Clutch Brake				
Input Voltage		100v dc	100v dc	
Input Power		2.0 watts Max.	2.0 watts Max.	
Operate Time—Energize		5 milliseconds	5 milliseconds	
Operate Time—De-energize		20 milliseconds	20 milliseconds	

Oster®



Offered as illustrated with identical or different combinations of:

gear ratios	servo
clutch	synchro
brake	motor-tach
clutch-brake	potentiometer

Write for further information TODAY, enclosing details of your requirement.

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

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Your Rotating Equipment Specialist
Avionic Division
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Engineers For Advanced Projects:

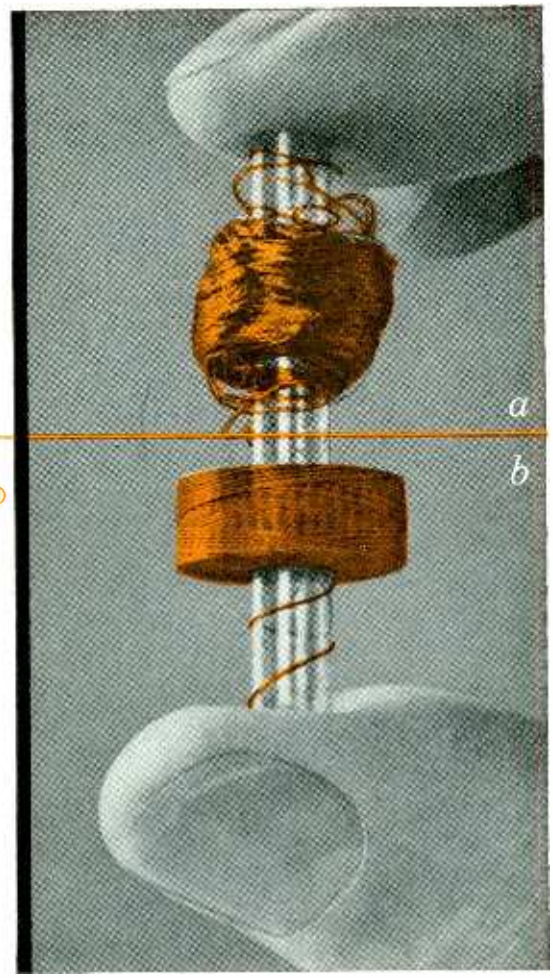
Interesting, varied work on designing transistor circuits and servo mechanisms. Contact Mr. Zelazo, Director of Research, in confidence.

BURTON BROWNE ADVERTISING

If you have this problem, investigate

GRIP-EZE®

—an example of Phelps Dodge's realistic approach to Magnet Wire research



THE PROBLEM: To develop a solderable film-coated wire without fabric for winding universal lattice-wound coils without adhesive application.

THE SOLUTION: Phelps Dodge Grip-eze—a solderable film wire with controlled surface friction for lattice-wound coils that provides mechanical gripping between turns and keeps wire in place.

EXAMPLE: Coils wound with (a) conventional film wire; (b) Grip-eze. Note clean pattern of Grip-eze as compared to fall-down of conventional film wire.

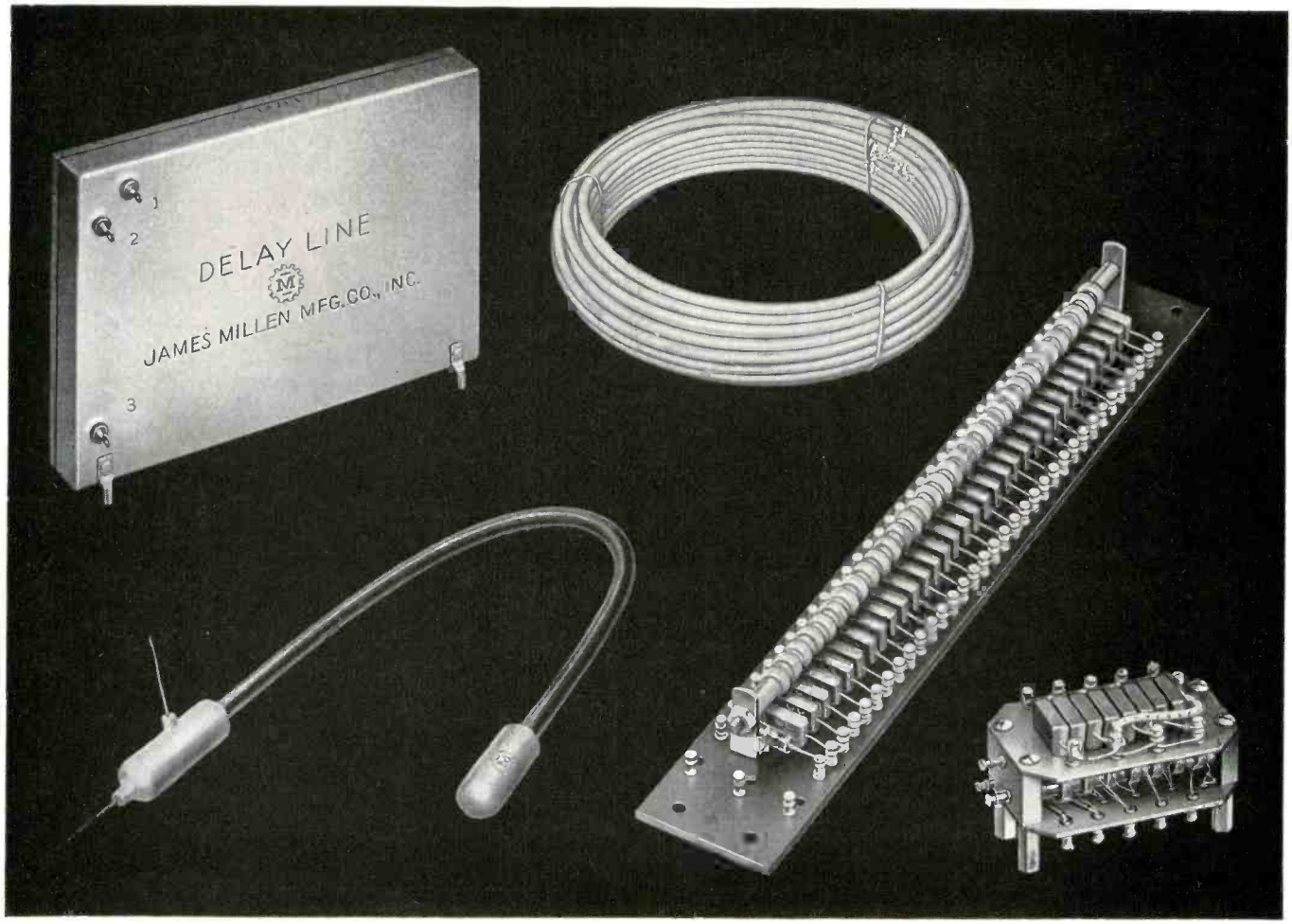
Any time magnet wire is your problem, consult Phelps Dodge for the quickest, easiest answer!

FIRST FOR LASTING QUALITY —FROM MINE TO MARKET!

PHELPS DODGE COPPER PRODUCTS CORPORATION

INCA MANUFACTURING DIVISION

FORT WAYNE, INDIANA



"Designed for Application"

Delay Lines and Networks

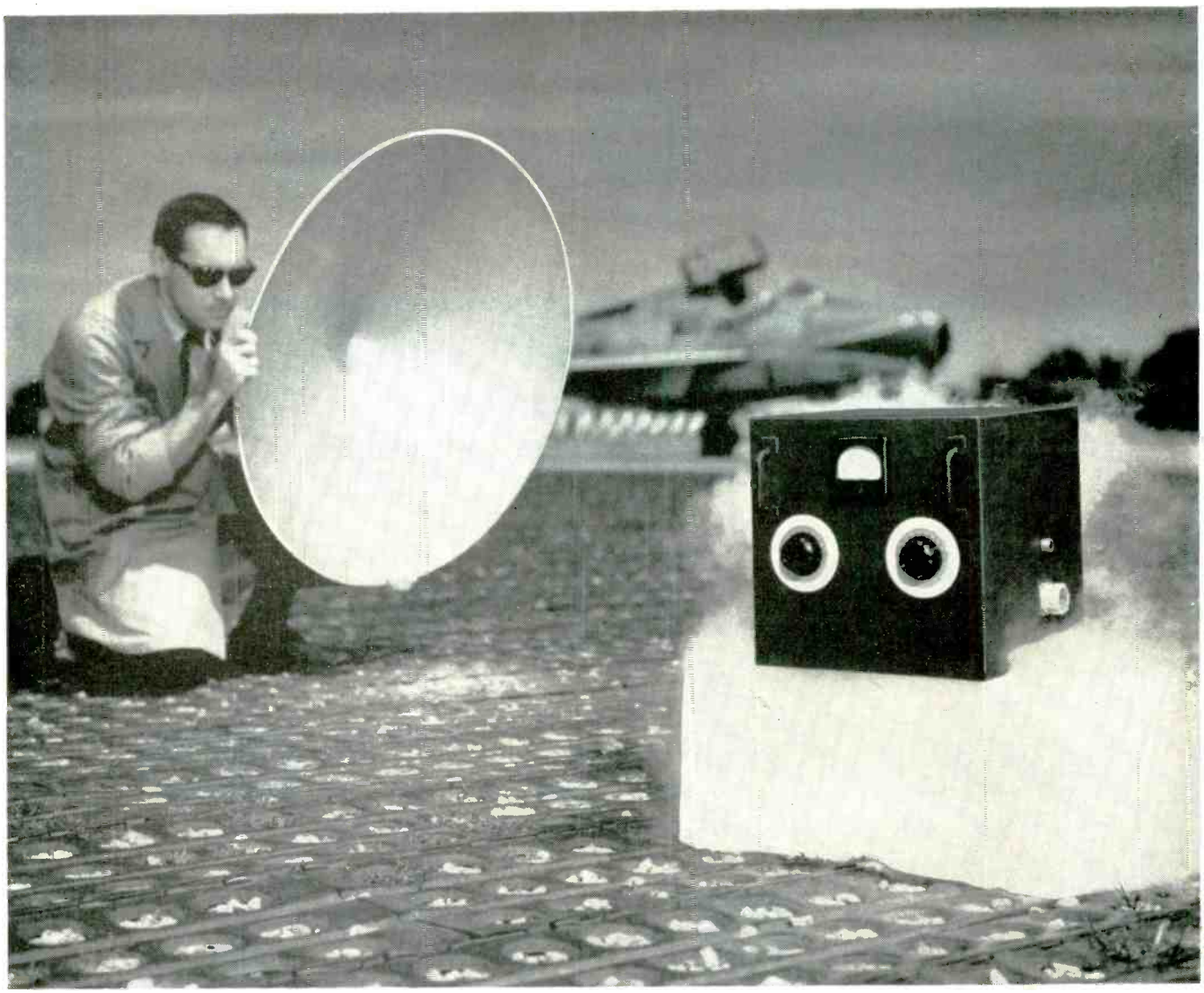
The James Millen Mfg. Co., Inc. has been producing continuous delay lines and lump constant delay networks since the origination of the demand for these components in pulse formation and other circuits requiring time delay. The most modern of these is the distributed constant delay line designed to comply with the most stringent electrical and mechanical requirements for military, commercial and laboratory equipment.

Millen distributed constant line is available as bulk line for laboratory use and in either flexible or metallic hermetically sealed units adjusted to exact time delay for use in production equipment. Lump constant delay networks may be preferred for some specialized applications and can be furnished in open or hermetically sealed construction. The above illustrates several typical lines of both types. Our engineers are available to assist you in your delay line problems.

JAMES MILLEN MFG. CO., INC.

MAIN OFFICE AND FACTORY

MALDEN, MASSACHUSETTS, U.S.A.



Dry ice and a sun reflector—these symbolize the ever-widening range of temperatures that now challenge air-borne electronic equipment.

Monsanto's OS-45 keeps this "black boxed" equipment functioning. It is tailored to be an efficient coolant/dielectric from –65°F to 400°F.

OS-45 Coolant/Dielectric keeps black-boxed equipment functioning from –65°F to 400°F

You know the problems all too well: How to keep black-boxed electronic equipment operating in sub-zero arctic temperatures; how to dissipate the heat black boxes generate at extremely high altitudes when air-cooling is impractical.

Monsanto's OS-45 coolant/dielectric is the answer. It is usable from -65°F to 400°F. In addition, OS-45 is an excellent heat-transfer medium, with suprisingly good dielectric properties for today's air-borne electronic equipment.

NO HANDLING PROBLEMS . . . A silicate ester, Monsanto's OS-45 is safe to use and does not affect most materials used in electronic construction.

OS-45 may well be the coolant/dielectric you need in miniaturizing air-borne electronic equipment. You can make a realistic appraisal by reading Technical Bulletin O-123. We'll be glad to send it to you. Just wire, write or send the coupon below.

MONSANTO PIONEERS NEW FLUIDS FOR THE MISSILE AGE

OS-45: Reg. U. S. Pat. Off.

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Aviation Fluids Dept. OS-2
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Please send me Technical Bulletin O-123 which describes OS-45 completely.

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.....

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21 YEARS

14 YEARS

21 YEARS

Over 200 years experience

by 14 leading companies

demonstrates KOVAR® Alloy dependability

21 YEARS

Western Electric

19 YEARS

VARIAN associates

8 YEARS

MACHLETT

18 YEARS

10 YEARS

RAYTHEON

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9 YEARS

AMPEREX

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16 YEARS

SPERRY

16 YEARS

Outstanding application results . . . year-after-year!

These leading companies have learned to depend on Kovar alloy for long-term, uniform, quality performance.

Here are the advantages that make Kovar the ideal alloy for glass sealing: *it matches* thermal expansion characteristics of hard glass over the entire working temperature range . . . *it fuses* into the glass in a permanent, chemically-bonded, vacuum-tight seal . . . *it provides* superior service because of Stupakoff's precision manufacturing controls.

Kovar alloy is available as rod, wire, tube, sheet, strip, and foil . . . in fabricated shapes such as cups, eyelets, leads . . . and, it can be welded, soldered and brazed to other metals readily. What's more, technical service available from Stupakoff Engineers insures the most suitable design to achieve best application results.

Write us about your specific requirements.

STUPAKOFF DIVISION OF

The CARBORUNDUM Company

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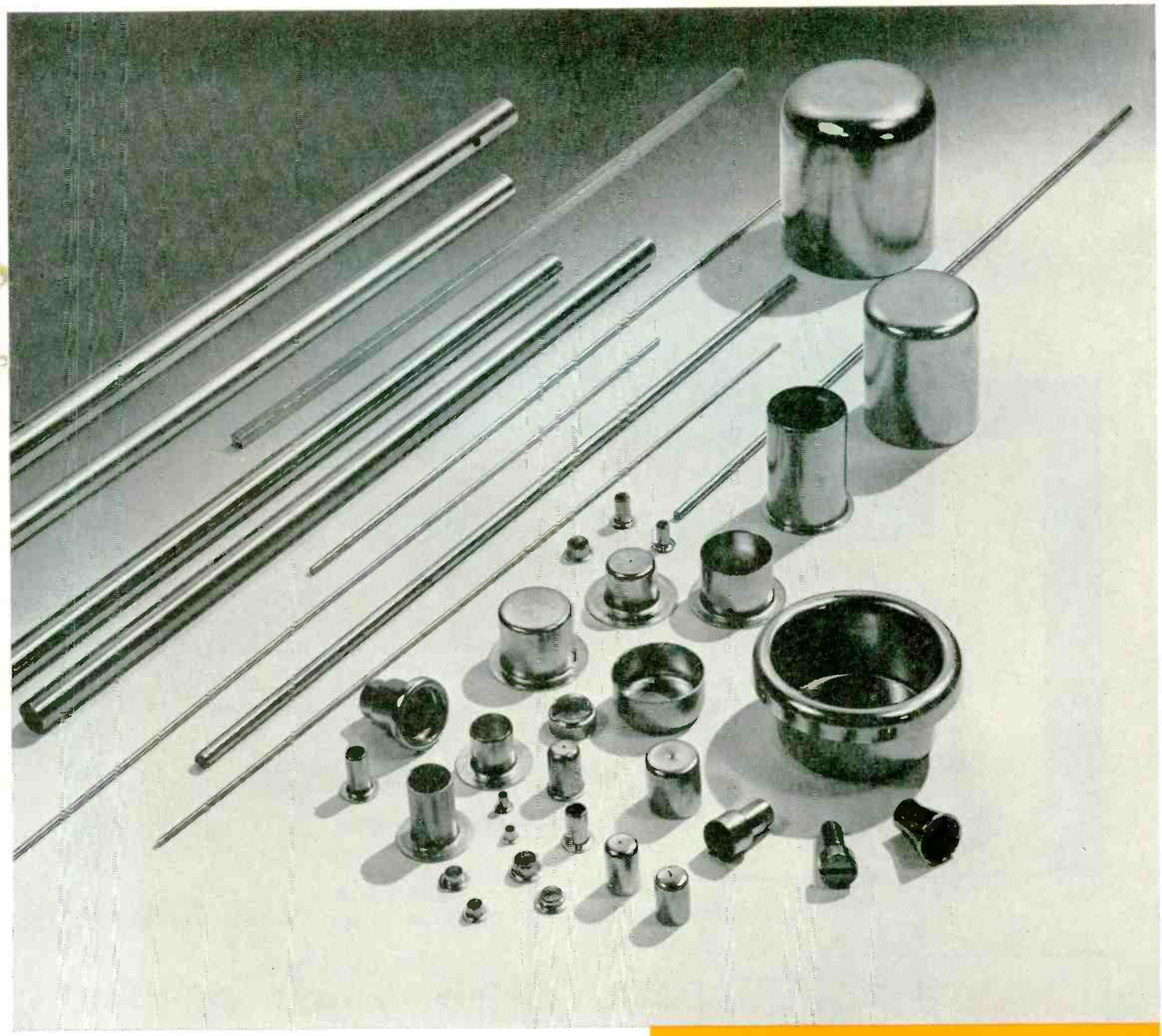

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KOVAR
glass-sealing alloy

for:
perfect matching
permanent bonding
long-term reliability

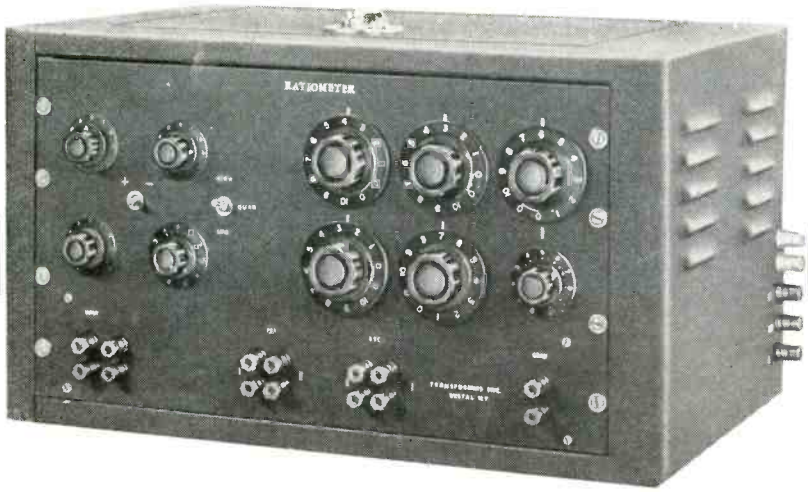
Circle 75 Readers Service Card

TRANSFORMERS Inc.

Ratiometer

...accurate to five parts per million!

REFERENCED TO UNITY RATIO

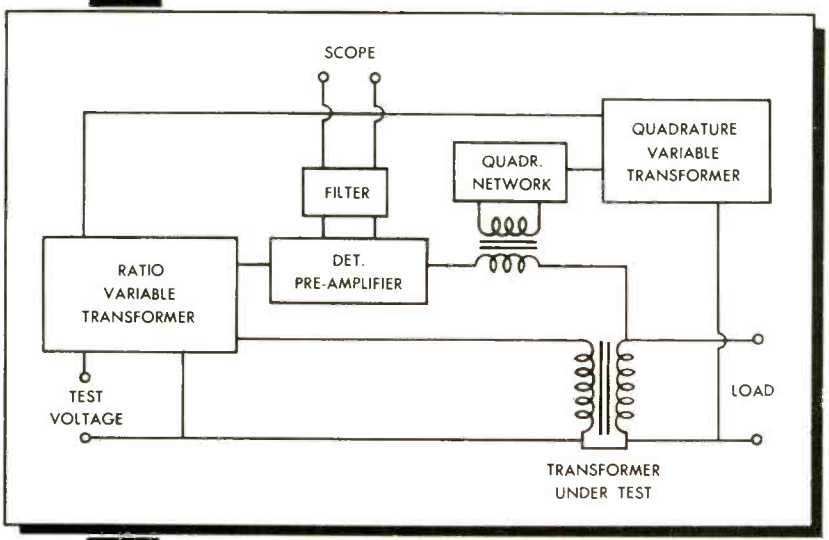


The Transformers, Inc. Ratiometer is a precision instrument to measure any voltage ratio from 0.000001 to 1.111111. Transformer ratios can be accurately measured at "no load" and under full load. Two models are available:

MODEL 204 is designed for use between 200 cps and 2,000 cps. It is supplied with plug-in units for 400 cps operation.

MODEL 206 is designed for use between 40 cps and 1,000 cps. It is supplied with plug-in units for 60 cps operation.

Plug-in units for any other frequency are supplied to order.



The Ratiometer consists of two precision variable transformers, a calibrated quadrature injector, a filter, and a pre-amplifier. Block diagram indicates connections of the various components within the instrument.

ACCURACY

Five parts per million referenced to unity ratio.

MAXIMUM VOLTAGE

Model 204	120 V	200 cps
	180 V	300 cps
	240 V	400 cps and over
Model 206	120 V	40 cps
	160 V	60 cps
	240 V	100 cps and over

PRICE

Model 204 Ratiometer, complete with 400 cps plug-in filter and quadrature units **$865**

Model 206 Ratiometer, complete with 60 cps plug-in filter and quadrature units **$1235**

For additional information, ask for Bulletin #204

TRANSFORMERS, INCORPORATED

200 Stage Road, Vestal, N.Y.

Circle 76 Readers Service Card

PYLE *star-line*® CONNECTORS

Assure long-lasting protection of vital connections under a wide range of extreme environmental conditions

Currently establishing itself as a performance leader in the missile systems field, Pyle-Star-Line connectors offer engineers an entirely new line of electrical connectors for universal military and industrial use.

With characteristics of construction and performance never before combined in compact, rugged, lightweight standardized connectors, they exceed NEC requirements and classes A, B, C and E of military specifications MIL C-5015C.

FEATURES

Tough, lightweight shell: Strength comparable to mild steel, yet weighs only ⅓ as much.
Anodic coating: Gives shell toughness of case-hardened steel. Takes up to 1800 volts to penetrate coating.
"Sandwich" insulation: Silicone laminate floats between two rigid discs. Silicone disc absorbs shock, lets contacts align themselves freely; rigid discs impart just the right amount of restraint. Gives all advantages of both flexible and rigid mountings.
Chamber sealing: Silicone insulation disc positively and completely prevents water, gas, moisture or dust from passing into shell.
Wide range of pin and socket configurations: Configurations from 2 to 100 poles available. Within each form size all inserts are interchangeable and reversible.

Environmental Limits of Pyle-Star-Line connectors	
Temperature	—80 F. to 225 F.
Pressure	300 PSI External, 200 PSI Internal
Chemical Resistance	Most acids, most alkalis, oil
Corrosion Resistance	Salt Spray: 300 days without failure
Dust Resistance	Exceed requirements of MIL C-5015C
Shock Resistance	50G Minimum
Vibration	Exceed 20G to Method II of Mil C-5015C
Humidity & Moisture Resistance	Exceed Class E. Spec. of Mil C-5015C
Air Leakage	Meet Class E Spec. of Mil C-5015C

Write today for complete specifications.

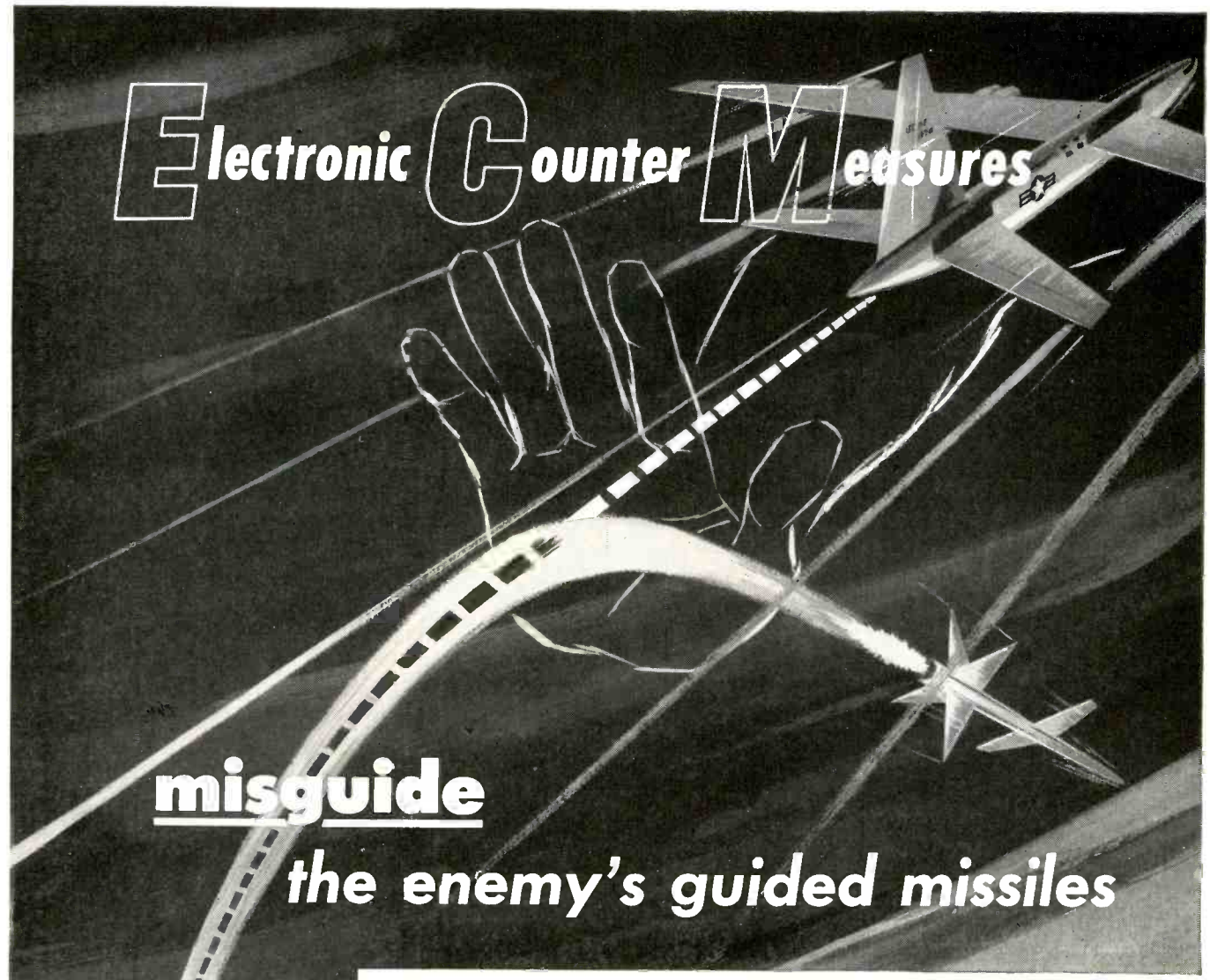
the PYLE-NATIONAL company

Where Quality is Traditional

1330 North Kostner Avenue, Chicago 51, Illinois

District Offices and Representatives in Principal Cities of the United States

CONDUIT FITTINGS • CIRCUIT CONTROLS • LIGHTING EQUIPMENT



Admiral® develops airborne *ECM*

You can't count on shooting down a guided missile. The only effective defense against it is some form of Electronic Counter Measures...devices that deceive or destroy enemy missiles short of their targets.

Admiral has taken the lead in furthering the high priority program to develop ECM. Advanced ECM developments now in progress at Admiral will serve many defense purposes. Resulting equipments will be carried by aircraft for protection in hostile territory. At ground installations, ECM will confuse enemy missiles.

Inquiries are invited regarding Admiral's capabilities in ECM and other forms of military electronics.

LOOK TO *Admiral* FOR
- **RESEARCH**
- **DEVELOPMENT**
- **PRODUCTION**

IN THE FIELDS OF:
MILITARY TELEVISION
COMMUNICATIONS UHF AND VHF
ELECTRONIC COUNTER MEASURES
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DISTANCE MEASURING
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ENGINEERS. The wide scope of work in progress at Admiral creates challenging opportunities in the field of your choice. Write Director of Engineering and Research, Admiral Corporation, Chicago 47, Illinois.

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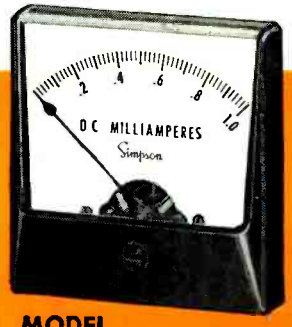
GOVERNMENT LABORATORIES DIVISION

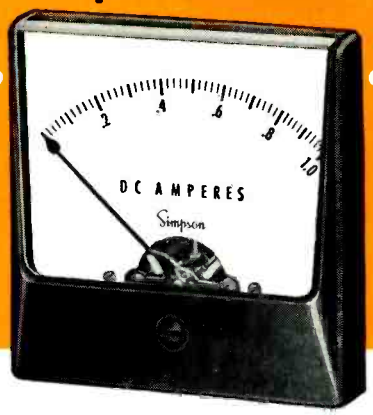
new!

MODEL 1329



MODEL 1227

Simpson WIDE-VUE panel instruments



MODEL 1327

a new concept in styling and visibility

available in stock and custom-built units!

The clean, graceful lines of "Wide-Vue" panel instruments add two plus values to your equipment designs. First, style—*ultra-modern beauty* that blends with today's streamlined panels. Second, functionalism—longer scales with *wide-angle readability*. The 2½" size, for example, has the same scale length as a conventional 3½" meter. Wide-Vue's durable cover is formed in one piece from clear plastic, and can be supplied with black or color (custom-built units only) finishes. DC, AC, and AC rectifier types in 2½", 3½", and 4½" sizes.

SELF SHIELDED MOVEMENT ELIMINATES CALIBRATION PROBLEMS...

All stock DC Wide-Vue meters use the Simpson *self shielded* Core Magnet Meter Movement, except the 0-25 and 0-50 DC Microammeters and V. U. meters.

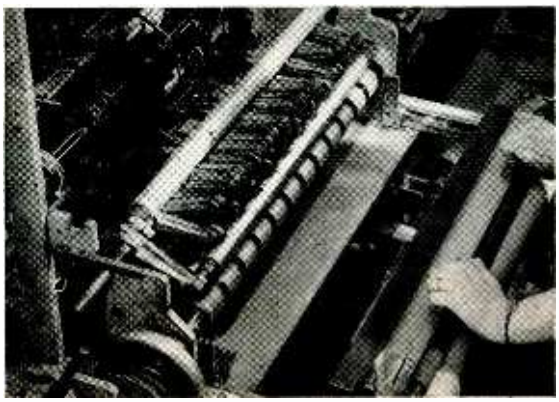
See your Electronic Distributor for IMMEDIATE DELIVERY on *stock* Wide-Vue meters... over 130 ranges and types to choose from!

SIMPSON ELECTRIC COMPANY
5200 W. Kinzie St., Chicago 44, Illinois
Phone: EStebrook 9-1121
In Canada: Bach-Simpson Ltd., London, Ontario

INSTRUMENTS THAT STAY ACCURATE

Circle 79 Readers Service Card

for applications demanding **ABSOLUTE UNIFORMITY**



Specify...

ESSEX

EXTRA TEST MAGNET WIRE

Maximum dielectric strength
Dependable insulation qualities
Superior windability

High speed winding subjects magnet wire to a most severe test—demands tough, pliable insulating film . . . spool-to-spool uniformity . . . copper with proper degree of anneal. These are qualities you find in every spool of Essex Extra Test Magnet Wire. Essex engineers maintain close control from raw material through finished product to assure you consistent, trouble-free performance. Essex delivers one quality of Magnet Wire to all customers—"Extra Test"—and this wire is produced to the industry's most severe specifications. You pay no more for these "extra tests" so be sure to specify SX.

TESTING...

Essex Extra Test Magnet Wire has earned its reputation for excellence through continous testing of every important quality. Here the Dielectric test is being made. Results in each case must exceed accepted standards.

PACKAGING...

Essex Extra Test Magnet Wire is available in Metal or Fiber container (MAGNA-PAK®). Distinctive labeling assures fast, accurate identification. MAGNA-PAK® containers are palatized for shipment; simplyfing storage.

SX WIRE PRODUCTS

Extra Test®

ESSEX MAGNET WIRE

DIVISION ESSEX WIRE CORPORATION, Fort Wayne 6, Indiana

MANUFACTURING PLANTS — Birmingham, Alabama; Anaheim, California; Fort Wayne, Indiana; Detroit, Michigan.

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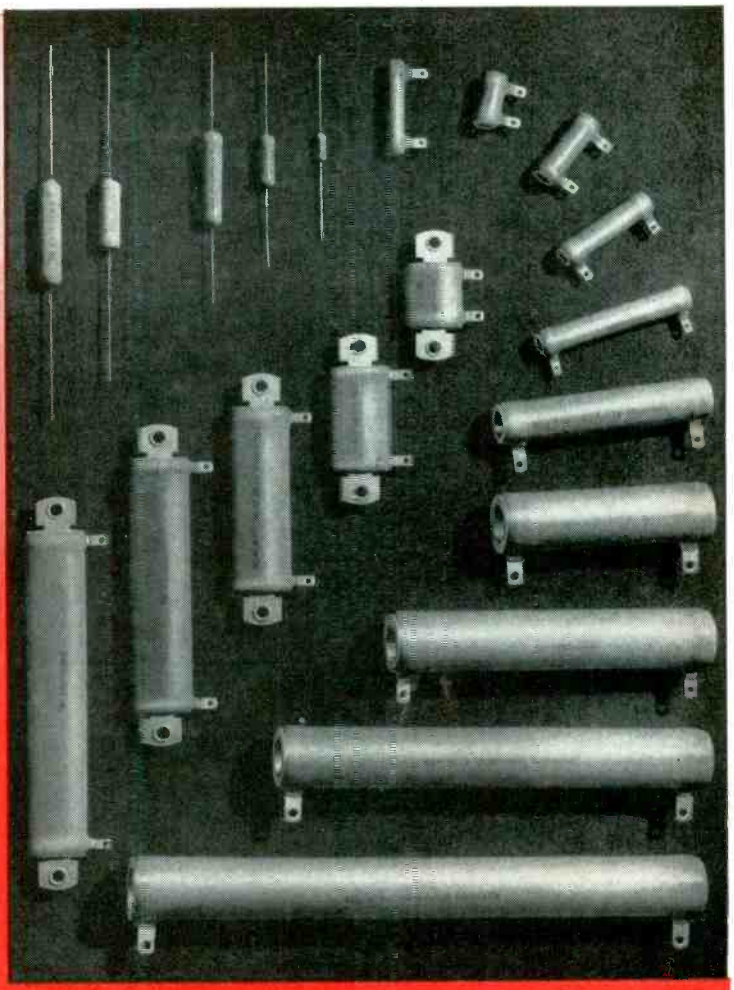
Distributed nationally to the repair and maintenance industry through Insulation and Wires, Incorporated

Now!

Vitrohm MIL-R-26C Resistors in all styles!



Famous Ward Leonard Vitrohm® vitreous-enameled resistors are now available in every style to meet all requirements of Military Specification MIL-R-26C including the severe bogeys on moisture resistance, thermal shock, insulation resistance and many other properties.

What's more, this line offers you *all* characteristics—G, V, and the exacting Y—and *all* specification sizes and resistance values—even the highest values using the finest wire (0.00175" dia.) permitted by the spec.

Tab-terminal, axial-lead and stack-mounting types are available in styles and characteristics shown in table.

For complete data on these MIL-R-26C resistors, write us for Bulletin 12. (And incidentally, for Vitrohm resistors to *highest commercial and industrial standards*, get W/L Catalog 15.) Ward Leonard Electric Co., 30 South Street, Mount Vernon, N.Y. In Canada: Ward Leonard of Canada Ltd., Toronto.

ENGINEERING DATA

TYPE	STYLE	AVAILABLE IN CHARACTERISTICS	RESISTANCE RANGE
Stack Mtg.—Tab	RW20 thru 24	V and G	All values in Spec.
Tab terminal	RW29 thru 47	V, Y* and G	All values in Spec.
Axial lead	RW55 thru 59	V and G	All values in Spec.†

*Characteristic Y applies to styles RW30, 33, 37 and 47 only. Characteristic Y is similar to V but requires high insulation resistance at end of moisture-resistance tests.

†Maximum values for single-layer-wound resistors with 0.00175" diameter wire.

7.7 A

LIVE BETTER...*Electrically*

WARD LEONARD ELECTRIC COMPANY
MOUNT VERNON, NEW YORK

RESISTORS · RHEOSTATS · SWITCHES · CONTROLS · DIMMERS

Result Engineered Controls Since 1892

COMPUTER THERMOSTATS NOW CIGARETTE SIZE

Some Fenwal Units Smaller Still Take Little More Room Than Sugar Lump

ASHLAND, MASS. — If you want to control temperatures in tight spots, you should see Fenwal. Fenwal has cut the size of thermostats way down.

You can fit one of their Midget THERMOSWITCH units anywhere a cigarette will fit. And, if you're working with even less space, one of their Miniature THERMOSWITCH units is what you're looking for. The Miniatures are little bigger than a lump of sugar, and some are even smaller.

The Midgets and Miniatures use the same unique principle used in Fenwal's bigger THERMOSWITCH controls. They use it with the same high degree of success.

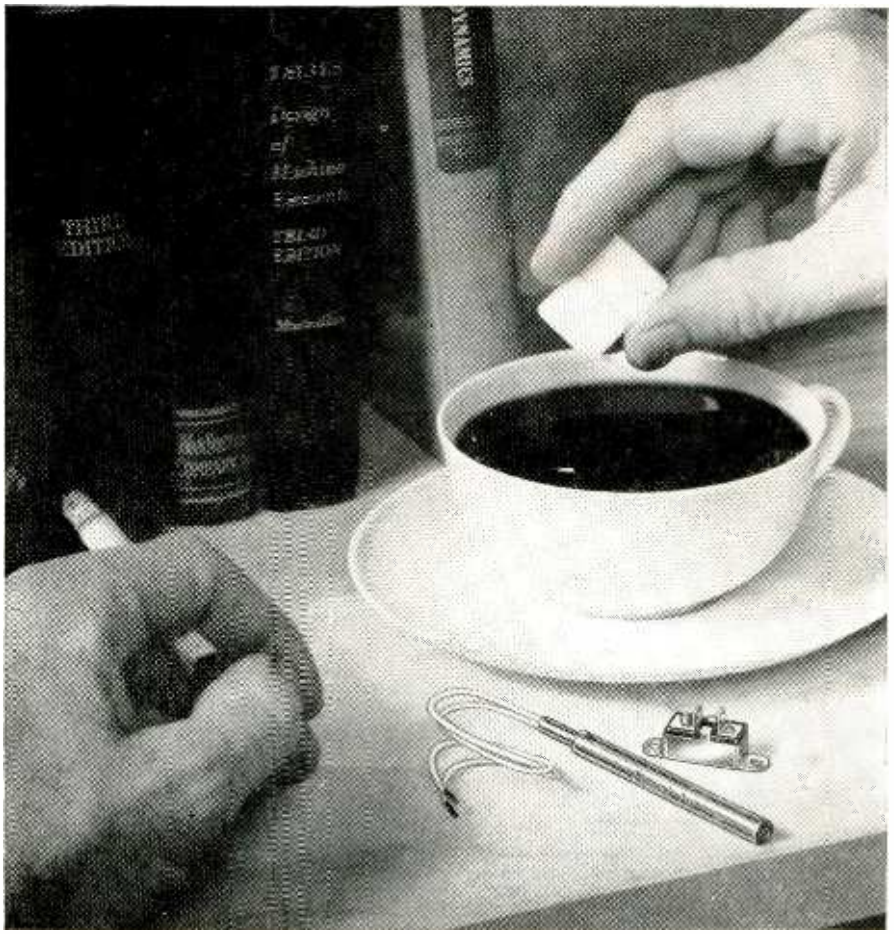
The principle of all Differential Expansion THERMOSWITCH units, large or small, is this: a single metal shell expands or contracts with temperature changes, making or breaking totally enclosed electrical contacts.

The smallness of the Midget and Miniature units does not deprive them of any of the performance characteristics that have made larger THERMOSWITCH units famous. They have THERMOSWITCH ruggedness, THERMOSWITCH accuracy, and reasonable THERMOSWITCH prices.

Temperature range of the Midget series: −50°F to 500°F. Range of the still smaller Miniature series: −20°F to 275°F.

Midgets and Miniatures, all in stainless steel, come in a variety of mountings. Hermetic sealing is also available.

These Fenwal THERMOSWITCH units are precision-engineered to give optimum temperature control with minimum-sized devices. They remain accurate under the most severe operating conditions.



THERMOSTATS FOR TIGHT SPOTS — A Fenwal Midget THERMOSWITCH® unit and a Fenwal Miniature THERMOSWITCH unit — two good answers to the question, "How can you install an accurate, reliable thermostat where there's almost no room?" Actual sizes of these particular models — ¼" x 2 25/32" for the Midget; 1" x ½" for the Miniature.

You should have details on this advance in temperature control at your fingertips. Write for information to **Fenwal Incorporated, 209 Pleasant Street, Ashland, Massachusetts.**

Fenwal

CONTROLS TEMPERATURE ...PRECISELY

Fast, convenient, dependable

precision wave analyzers frequency-selective voltmeters

Sierra 121A Wave Analyzer

Sierra now offers exactly the instruments you need for wave analysis, wire carrier and microwave subcarrier applications.

Sierra 121A Wave Analyzer is a highly selective, double superheterodyne receiver covering frequencies from 15 KC to 500 KC and providing wave analysis data directly in voltage and dbm at 600 ohms. The instrument offers the selectivity required for use with new single sideband carrier systems.

Sierra 158A Wave Analyzer is similar but covers frequencies from 500 KC to 10 MC.

Both analyzers have high selectivity, accuracy of ± 2 db, spurious response at least 50 db down, and a signal-measurement range of 77.5 μv to 97.5 volts. The instruments are supplied in cabinet mountings which are readily adaptable to relay rack mounting.

SPECIFICATIONS — SIERRA VOLTMETERS

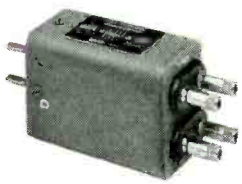
Model	Frequency Range—kc	Selectivity		Accuracy		Direct Reading in dbm	
		Down 3db	Down 45db	Frequency	Measuring	Balanced	Unbalanced
101C	20-500	± 550 cps	± 2900 cps	Note A	± 3 db	Note D	600 ohms
103B†	3- 40	± 400 cps	± 3000 cps	± 0.5 kc	± 3 db	Note D	600 ohms
104A	5-150	± 300 cps	± 1500 cps	± 1 kc	± 3 db	Note D	600 ohms
108B	15-500	± 550 cps	± 2900 cps	± 3 kc Note B	± 2 db Note C	135 ohms Note D	600 ohms
114A	100-800	± 550 cps	± 2900 cps	Note A	± 3 db	Note D	600 ohms

All Sierra Carrier Frequency Voltmeters feature built-in calibration oscillators and circuits for level calibration, have aural monitoring jacks, and (except 103B) are furnished with Sierra Model 149A Precision Spiral Scale Dials.

† Contains carrier re-insertion oscillator for monitoring suppressed carrier systems. Furnished with planetary drive dial. Note A. Ranges from ± 2 KC at low end of dial to ± 3 KC at upper end. Note B. ± 1 KC in the 48 KC to 256 KC region. Note C. ± 1 db for + 30 db to — 40 db attenuator steps on 135 ohm balanced measurements. Note D. All models may be converted for 135 and 600 ohm balanced line measurements by convenient plug-in bridging transformer, Model 130D.

Sierra 101C Carrier Frequency Voltmeter

For carrier system and other field or laboratory work between 3 kc and 800 kc, Sierra offers 5 accurate, stable, tuned vacuum tube voltmeters. All are direct reading in voltage and dbm at 600 ohms from —80 dbm to +42 dbm.



Line Bridging Transformer

Model 130D Dual Impedance Line Bridging Transformer converts VTVM and wave analyzer inputs from single-ended to balanced operation. Covers 3 kc to 500 kc, bridges both 135 and 600 ohm balanced lines.

Impedance Meter, Line Fault Analyzer

Sierra 166 Impedance Meter (at left) measures impedance on high noise circuits, 30 kc to 300 kc; measures on "hot" lines through coupling capacitor.
Sierra 124 Line Fault Analyzer pinpoints shorts, opens or grounds on open wire lines. Direct reading, range ½ to 200 miles, accuracy ¼ mile.

Data subject to change without notice.

sierra

4084

Sierra Electronic Corporation

A Subsidiary of Philco Corporation

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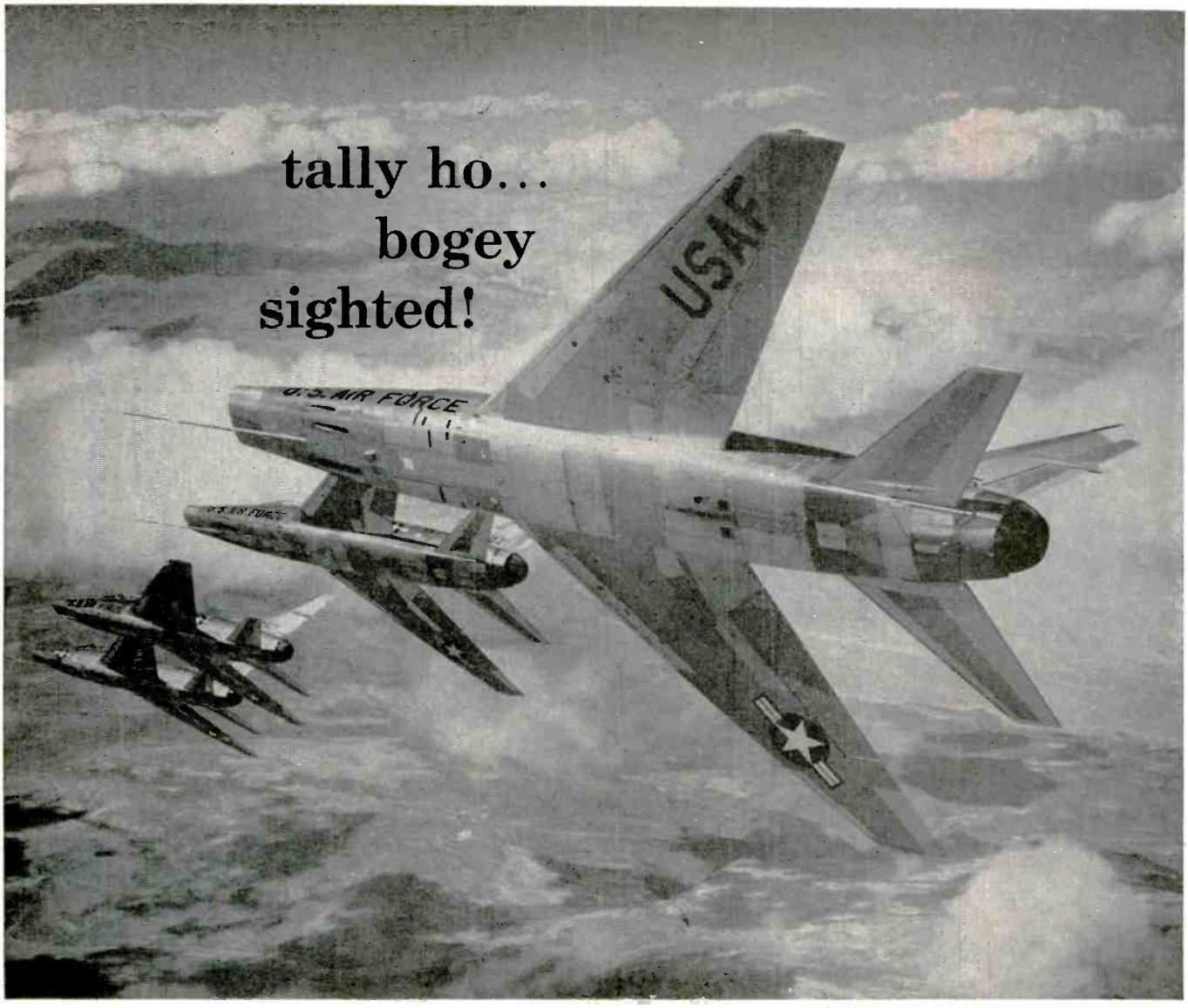

PHOTO COURTESY: NORTH AMERICAN AVIATION INC.

Three Genisco Accelerometers help the Super Sabre close in

If enemy air infiltration happens, you can be sure that modern knights of the sky powering the swift *Super Sabre* at speeds faster than sound will spearhead America's defense.

Typical of today's supersonic aeronautics, the USAF's *Super Sabre* reflects the finest contemporary engineering skill and scientific creative imagination. But this swept-wing assassin is more than just another jet-powered plane. It is a proven, integrated electro-mechanical system, combining a multitude of precision sub-systems, assemblies, and individual parts.

The automatic flight control system, for example, consists of numerous components, each one vital to the performance of the system. Naturally, component reliability is imperative if the plane is to carry out its mission. The flight control system of the F100D incorporates three Genisco Model DDL Accelerometers.

The Model DDL is only one of many Genisco Accelerometers now in use on America's air guardians, including our most important operational guided missiles. Like other models, the DDL was designed for a particular application—to function perfectly in the severe vibrational and shock environment of supersonic flight.

Genisco's ability to design for the most stringent applications and to produce precision instruments in large quantities has made the company an important link in our nation's defense chain.

Descriptive technical data on the Model DDL and other Genisco accelerometers will be sent upon request.

Genisco
INCORPORATED

2233 Federal Avenue, Los Angeles 64, California

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Circle 85 Readers Service Card→

DU PONT
Better Things for Better Living
. . . through Chemistry

ELECTRONIC DESIGN NEWS
LATEST PROPERTY AND APPLICATION DATA ON
TEFLON® tetrafluoroethylene resins

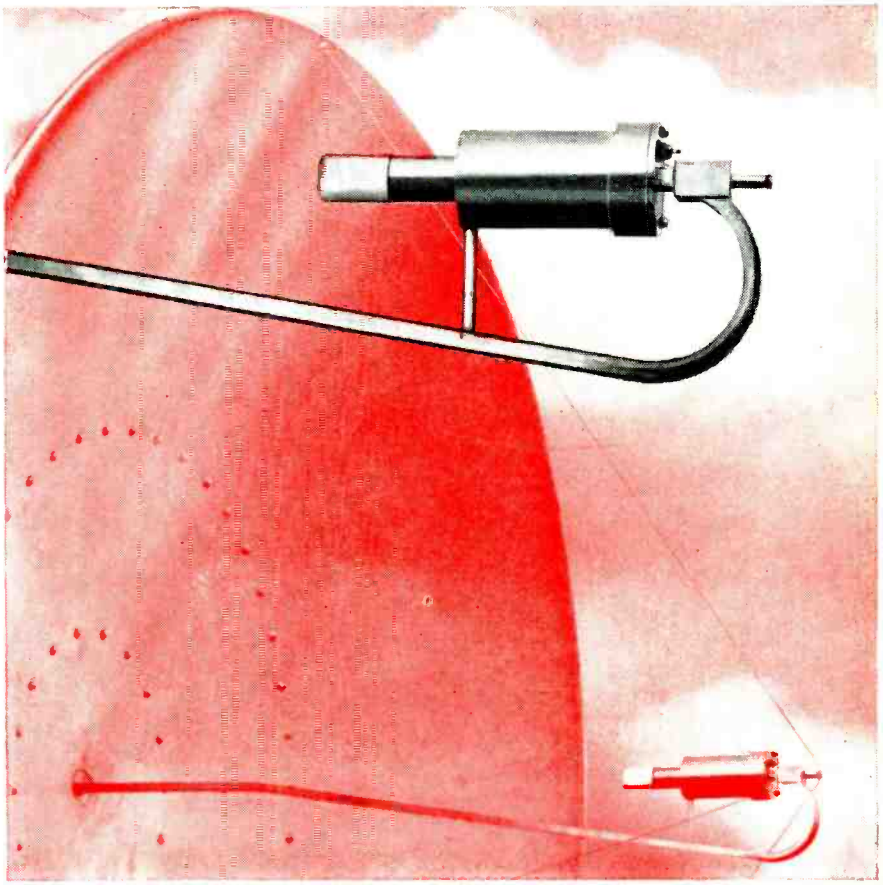
Impedance-matching weather protection of Du Pont TEFLON® tetrafluoroethylene resins featured in new variable-polarization K-band antenna

Du Pont TEFLON tetrafluoroethylene resins are uniquely qualified as materials for making the matching devices and radome used in the feed system of the new Diamond K-brand antenna. The 16,000 mc radar signal passes through an impedance-matching and weatherizing system based on components of a TEFLON resin, and is reflected from the accurate parabolic dish. The .027" wall of the radome matches the horn to space.

No other material could compare with TEFLON resins for this highly critical electronic application. They are unaffected by outdoor weathering and have so little moisture absorption that their dielectric constant remains unchanged under all humidity conditions. The very low dielectric constant of TEFLON resins gives the material its excellent matching characteristics. They are rated at 2.1 from 60 cycles through the super-high frequency range and have a power factor of under 0.0003 from 60 cycles to over 10,000 mc, so that the loss figure in transmission is very low. Dirt has no tendency to stick to the naturally "slick" surface. TEFLON is unaffected by heating to 260° C.

With this system, the plane of polarization can be varied a full 90° by Faraday rotation. Use of a TEFLON resin overcomes the impedance-matching problem. Moreover, no orienting effects are produced by radomes of this resin. VSWR of the antenna is less than 1.2: 1 over the required ±1% frequency band.

For your own designs, you are invited to take a closer look at the many outstanding advantages of Du Pont TEFLON tetrafluoroethylene resins in electronic applications. The coupon will bring you details.



RADOME of a TEFLON resin matches impedance of feed horn to space and provides protection against weather. Wave-guide impedances at input and output of ferromagnetic rotator in the feed are matched with minimum insertion loss by internal cones of a TEFLON resin. (Made by Diamond Antenna and Microwave Corp., Wakefield, Mass.)

Tapes made of TEFLON® tetrafluoroethylene resins provide high dielectric strength

Tapes made of TEFLON resins are strong, smooth and easy to handle. They have a dielectric strength of 500 to 4,000 volts, depending on thickness. Arc resistance is high, too; no carbonized path is formed by a surface arc. Tapes of TEFLON resins make high-grade electrical insulation which "snugs down" easily, conforms to sharp corners and odd shapes, and becomes tighter as temperature rises.

SEND FOR INFORMATION

For additional property and application data on Du Pont TEFLON tetrafluoroethylene resins, mail this coupon.

E. I. du Pont de Nemours & Co. (Inc.), Polychemicals Dept.
Room 179, Du Pont Building, Wilmington 98, Delaware

Please send me more information on Du Pont TEFLON tetrafluoroethylene resin. I am interested in evaluating this material for_____

*Name*_____

*Company*_____ *Position*_____

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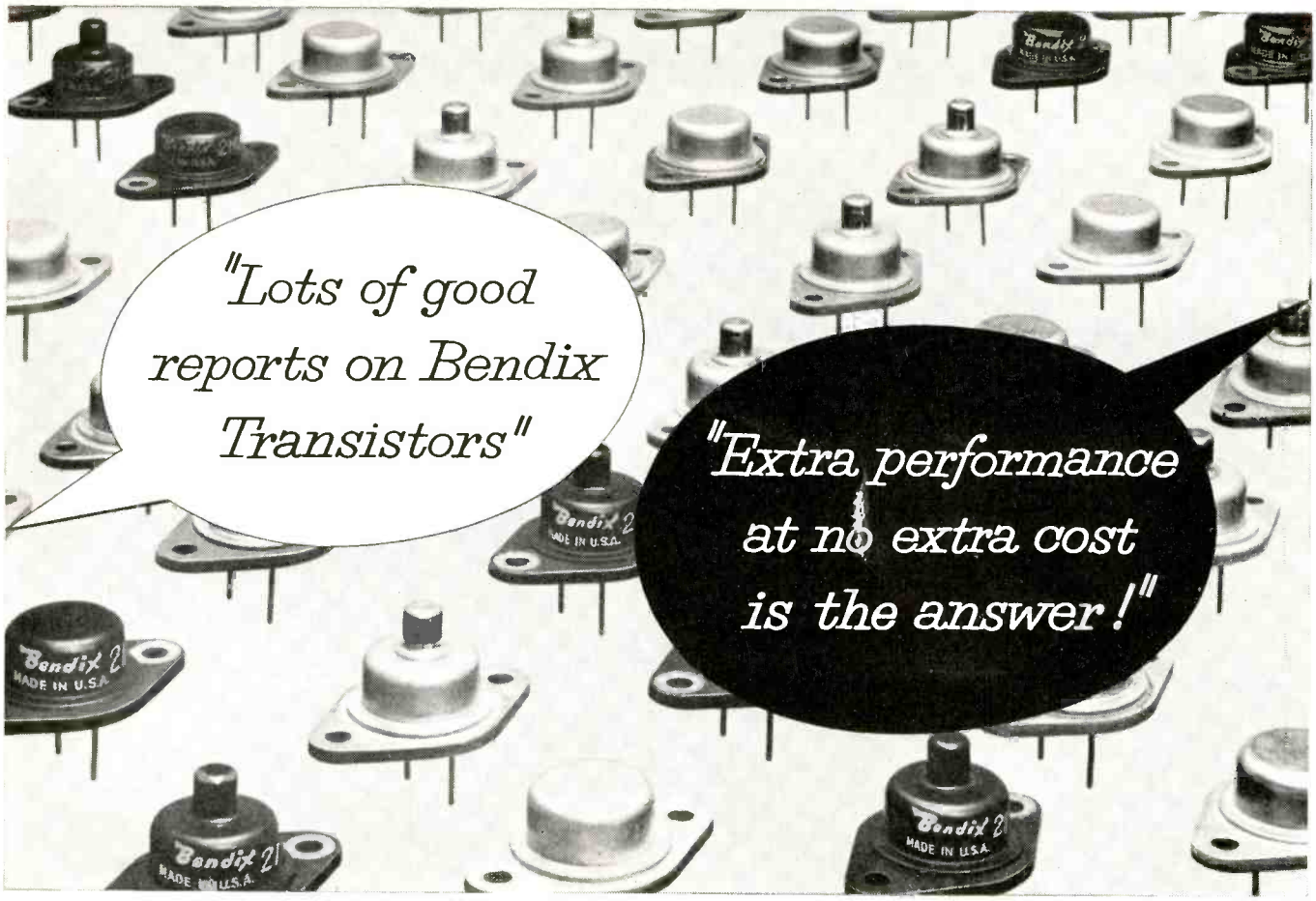
In Canada: Du Pont Company of Canada (1956) Limited, P. O. Box 660, Montreal, Quebec



If you're after extra quality at no extra cost . . .

TRY BENDIX HIGH GAIN POWER TRANSISTORS

More impressive than anything we can say about Bendix High Gain Power Transistors is the enthusiastic endorsement they are receiving from engineers who have tried them. These design, project, and research and development people report they like Bendix transistors because of their HIGH POWER AND CURRENT GAIN • LOW LEAKAGE • LIFE STABILITY • HIGH BREAKDOWN VOLTAGE • LOW THERMAL RESISTANCE • LINEAR TEMPERATURE VARIATION.

Why this universal acceptance? Because our transistor program is based on the following:

1 *Simplified design* that keeps initial cost down and operating dependability up.

2 *Extra performance capability* through use of component parts and materials that exceed specification requirements by a sizeable margin.

3 Improved manufacturing techniques that help contribute to *better transistors at low cost.*

4 *Uniformly dependable quality* . . . through close quality control that includes comprehensive inspection procedure utilizing Bendix-developed test methods and instruments.

We believe that our many years' experience in designing and producing precision, special-purpose electron tubes has a great deal to do with this extra-high quality and dependability.

We make a wide variety of power transistors. And, because we are in volume production, we can offer immediate delivery on most models. We'll be glad to help you in working out troublesome circuitry problems, too, if you wish.

It will pay you to get complete details about Bendix transistors. Write SEMICONDUCTOR PRODUCTS, BENDIX AVIATION CORPORATION, LONG BRANCH, NEW JERSEY.

BENDIX TRANSISTORS EXCEL AS—

Power Amplifiers	High-Current Switches
Inverters	Power Oscillators
Power Supplies	Motor Controls
Audio Amplifiers	Hi Fi Amplifiers
Voltage Regulators	

West Coast Office: 117 E. Providencia Ave., Burbank, Calif.
Export Sales & Service: Bendix International Division, 205 E. 42nd Street, New York 17, N. Y.
Canadian Affiliate: Aviation Electric Ltd., P. O. Box 6102, Montreal, Quebec.

Red Bank Division

Bendix
AVIATION CORPORATION

Circle 86 Readers Service Card

Circle 87 Readers Service Card→

One Pallet of Quality -Coming Up!

Whatever packaging you choose for the Roebling Magnet Wire you buy, you are certain the wire is of *unsurpassed quality!*

Modern manufacturing methods... quality ingredients . . . wire-making skill based on decades of experience . . . exacting testing and inspection—all these factors combine to assure this one high standard. Yet *quality* Roebling Magnet Wire costs no more than others!

Roebling Magnet Wire comes in types and sizes exactly suited to your applications . . . and packaged to give you utmost flexibility, efficiency, economy. Write Electrical Wire Division, John A. Roebling's Sons Corporation, Trenton 2, New Jersey, for all the facts.

ROEBLING

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Laminated Plastics
Vulcanized Fibre

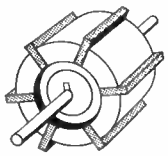
Shop Talk

TAYLOR FIBRE CO.
Plants in Norristown, Pa. and La Verne, Calif.

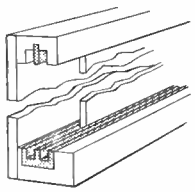
PHENOLIC—MELAMINE—SILICONE—EPOXY LAMINATES • COMBINATION LAMINATES • COPPER-CLAD LAMINATES • VULCANIZED FIBRE

Tips for designers

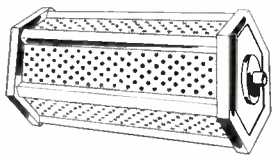
Terminal board for a complex circuit in an electronic spectrophotometer is made of Taylor Grade LE laminate . . . selected for its insulating and mechanical properties.



Gas pump impeller unit is fabricated of Taylor Grade LE-6 phenolic laminate . . . economical, light-weight, wear-resistant . . . chosen because of strength, stability.



Guides for sliding doors, made from Taylor vulcanized fibre, last longer because of high strength and resistance to abrasion.



Metal plating barrels of Taylor Grade C-5 melamine withstand corrosion and erosion successfully in alkaline solutions. Downtime and maintenance costs are substantially reduced.

TAYLOR SUPERIOR COPPER-CLAD LAMINATES

Taylor GEC (glass epoxy) Copper-Clad and Taylor XXXP-242 cold punching (paper-phenolic) Copper-Clad. Taylor uses high purity rolled copper on base materials with outstanding electrical properties.

This coil form for radio frequency transformers is fabricated by Taylor of Grade XX laminate plastic tubing for Collins Radio Co. The O.D. of the center section is held to a tolerance of .230″ ± .0005″. Material was chosen for its good electrical properties, dimensional stability and machineability.

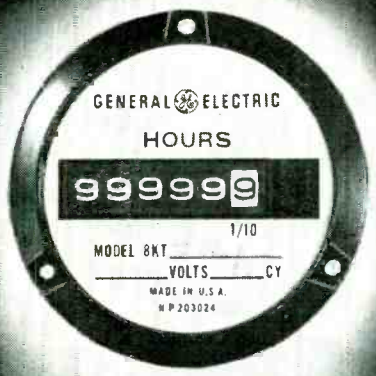
Precise electrical insulation parts? Taylor can produce them.

This coil form for radio frequency transformers was produced by Taylor's Fabricating Division, holding the tolerance of the outside diameter of the center section to ± .0005″.

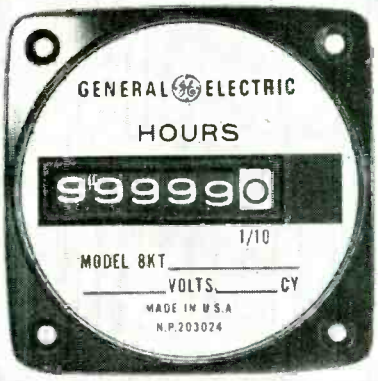
Taylor has special techniques and facilities capable of providing parts—such as this coil form—to your own specifications, promptly and economically. You can shorten your production steps by putting Taylor to work for you . . . simplifying production . . . safeguarding schedules . . . reducing overall costs.

Precision fabrication of laminates and vulcanized fibre is difficult . . . but Taylor can and is doing it, in a great variety of Taylor grades, and to extremely close tolerances. In your present products or in those that are now on your drafting boards are opportunities for you to take advantage of Taylor's equipment and experience. Design to closer tolerances—Taylor can handle the job. Taylor is equipped to handle any type of fabrication—punching, drilling, grinding, forming, milling or turning—simple or complex.

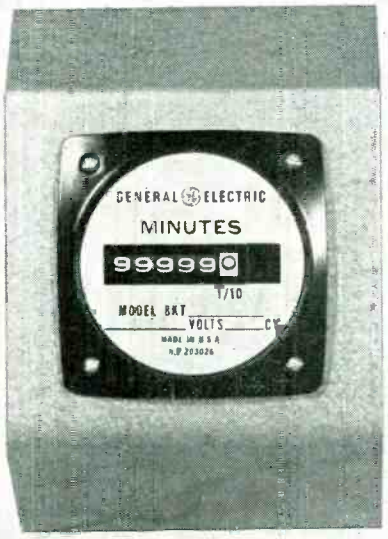
Chances are that Taylor's staff of specialists can help you with design, material selection and fabrication. Call or write your nearest Taylor sales office for a talk about your needs.



Round model for panel mounting.



Square model for panel mounting.



Portable model for laboratories.

Conduit case for easy installation.

NEW General Electric Time Meters cost less, read easier, give wider range of measurement

ALL DIGITS 2½ TIMES LARGER—NEW, EXTRA DIGIT GIVES WIDER RANGE FROM 0 TO 99999.9 HOURS OR MINUTES

OLD
(Life Size)

NEW
(Life Size)

At a new, low cost, General Electric now offers you a complete line of time meters for measuring operating time of every type of electrical equipment.

Available in 2½ and 3½ inch sizes these new General Electric Time Meters offer you these important benefits:

- **DUST-PROOF PROTECTION** . . . due to totally enclosed construction. Sealed models also available to military specifications.
- **RESET MODEL** . . . conveniently located reset knob available (optional) on all General Electric Time Meters except sealed models.
- **INCREASED OPERATING TEMPERATURE RANGE FROM** —67F to 150F . . . means more flexible application and longer meter life.

3 WAYS YOU BENEFIT WITH GENERAL ELECTRIC TIME METERS:

LOWER COST, BETTER PLANNED MAINTENANCE . . . because you can measure the operating time of your equipment, thus allowing you to apply pre-planned productive maintenance.

LESS DOWNTIME, FEWER PRODUCTION LOSSES . . . because you can measure the total operating life of your equipment, and thus replace it on a scheduled basis before it breaks down unexpectedly.

BETTER UTILIZATION OF MANPOWER AND MACHINES . . . because General Electric Time Meters measure the shutdown time of your equipment, allowing efficient scheduling of employee and machine work assignments.

FOR AN ACTUAL DEMONSTRATION of how these new General Electric Time Meters can help you save money and improve operating performance, call your nearest General Electric Apparatus Sales Office. And write today for descriptive bulletin GEA-6710, General Electric Company, Section 584-12, Schenectady, N. Y.

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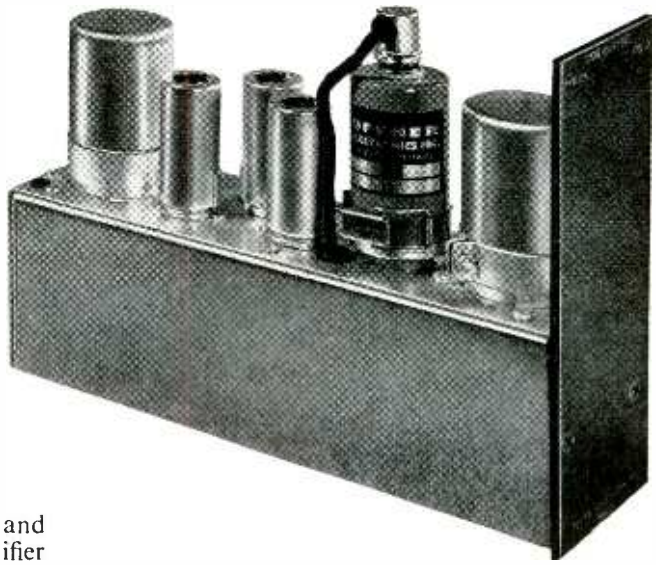
Circle 89 Readers Service Card

THE OFFNER TYPE 190

differential DATA AMPLIFIER



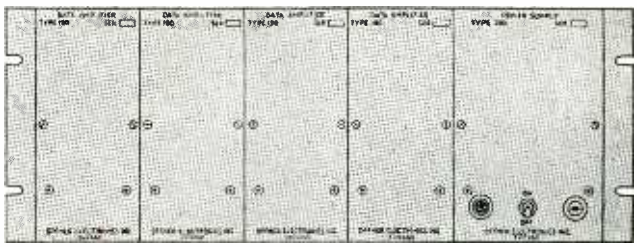
d-c Amplifier with zero drift and 1/100th percent gain stability

For amplification of thermocouple, strain gage, and similar low level signals the Type 190 Data Amplifier provides a combination of features available in no other amplifier:

- ☆ **Infinite rejection of common-mode d-c signals**
- ☆ **One microvolt input resolution**
- ☆ **Gain stability of 0.01%**
- ☆ **Rapid step input response**
- ☆ **Linearity of 0.05%**

The true differential response of the Type 190 provides increased accuracy and simplified installation for data reduction, control, and similar applications. With infinite rejection of common d-c signals, and a rejection ratio at 60 cps of the order of a half million, errors due to ground currents are completely eliminated, and pickup problems greatly diminished.

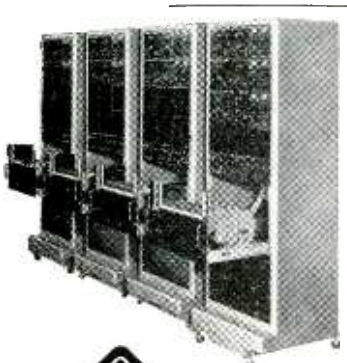
The Type 190 is designed for fixed-gain operation from low impedance sources, into high impedance load. Gain may be set at values ranging from 160 to 1200. Amplifier characteristics are unchanged at ambients from −67°F to +170°F.



Four Type 190 Amplifiers mounted in BM190 modular rack unit with Type 390 power supply.

Price of Type 190 Amplifier.....$325
Type 390 Power Supply, for up to four Type 190 Amplifiers.....$250
Type BM190 Rack Unit for four Type 190 Amplifiers and Type 390 Power Supply.....$140

Ask for bulletin No. 572 giving full technical information



OFFNER DYNOGRAPH Direct-Writing Oscillograph

Zero-drift d-c recorder with microvolt sensitivity. One amplifier type covers all requirements.

Models for one to 19 channels.

Rectilinear or curvilinear recording.

Ask for bulletin No. L-861

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OFFNER ELECTRONICS INC.

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measure and supply DC voltages to 0.02%

with the new KIN TEL DC voltage standard and null voltmeter

LABORATORY ACCURACY. The Model 301 is an extremely compact and accurate variable DC power supply and calibrated null voltmeter. It employs KIN TEL's proved chopper circuit to constantly compare the output voltage against an internal standard cell. As a DC voltage standard, it combines the stability and accuracy of the standard cell with the current capabilities and excellent dynamic characteristics of the finest electronically regulated power supplies. The self-contained null voltmeter indicates the voltage difference between the supply in the 301 and the DC source being measured, affording simple and rapid measurement of DC voltages to an accuracy of 0.02%.

PRODUCTION LINE SPEED. DC voltage measurements can be made as fast as changing ranges on a VTVM. Merely set the direct reading calibrated dials on the 301 to exactly null out the unknown DC input voltage. The reading on the dials then indicates the value of the unknown input voltage to within 0.02%. As a variable DC standard or power supply, the calibrated dials provide instant voltage selection to an accuracy normally attained only with standard cells.

VERSATILITY. The KIN TEL Model 301 is ideal for rapid and accurate production calibration of precision measuring instruments and DC power supplies . . . design of DC amplifiers and complex electronic circuitry . . . computer reference . . . versatile precision reference for calibration and measurement laboratories.

0.01% stability

0.02% accuracy

1 to 501 volts at 20 ma

4 accurate null ranges

0.002% regulation

Less than 100 μv ripple

IMPORTANT SPECIFICATIONS

Output Voltage & Current 1 to 501 volts at up to 20 ma
Full Scale Meter Ranges (Zero Center)
DC Output Range . . . . . ±500, 50 volts
DC Input Range . . . . . ±500, 50 volts
DC Null Meter Range . . ±50, 5, 0.5, 0.05 volts
Long Time Stability . . . . . ±100 parts per million
Output Voltage Calibration . . . . . ±0.02% or 2 mv
Output Hum and Noise . . . . . Less than 100 μv RMS
Line and Load Regulation 0.002%
DC Output Impedance . . . . . Less than 0.01 ohm
Response Time . . . . . 0.2 millisecond
Model 301 Price $625.

Representatives in all major cities. Write today for demonstration or descriptive literature.
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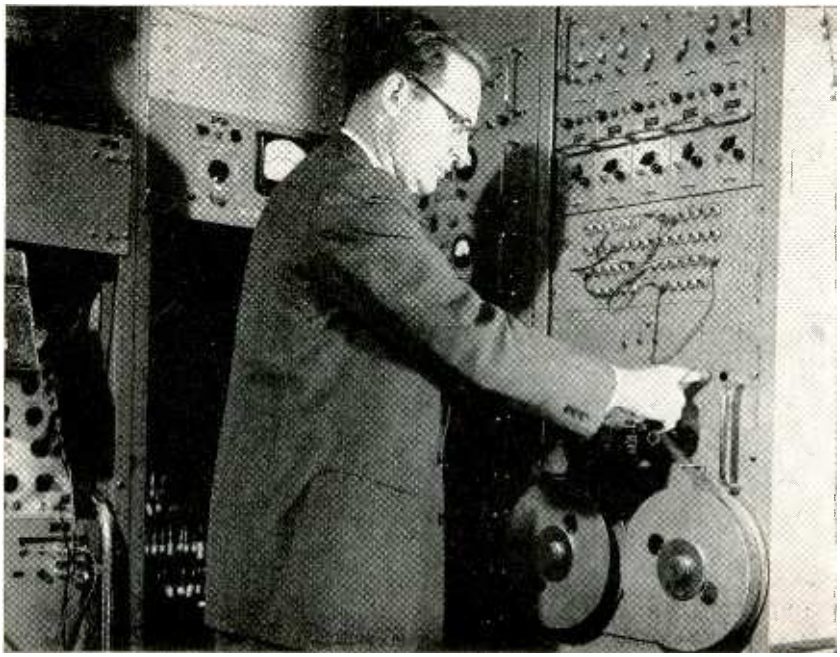
KIN TEL
(KAY LAB)

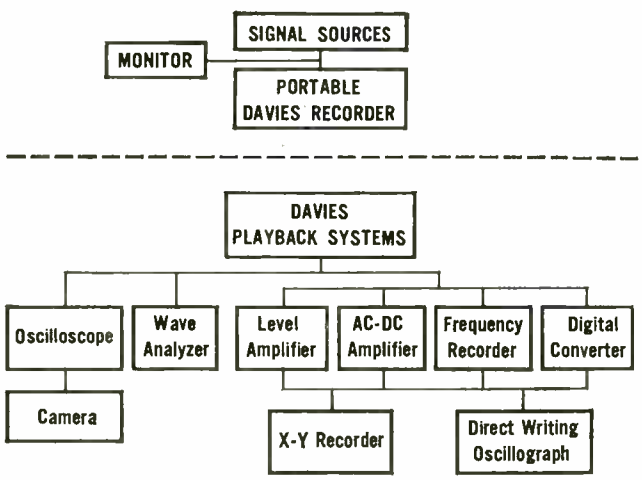


General Electric Company's Charles A. Woodcock begins analysis of aircraft gas turbine operating dynamics by pressing "Start" button on one of two Davies Division magnetic tape systems at the Flight Propulsion Laboratory Dept. Data Reduction Center, Evendale, Ohio.

how G.E. data center analyzes dynamic jet engine operation

G.E. wants to know a lot of things about an aircraft gas turbine before it leaves the ground. Not just thrust, pressure, temperature . . . but vibration and stress characteristics too. While suitable equipment has long been available for recording and measuring the "static" operating characteristics, only the last five years have seen reliable techniques introduced for measuring, recording, and reducing significant information from dynamic signal sources.

A pioneer in the application of these techniques, General Electric's own dynamic data handling installation at the Flight Propulsion Laboratory Department, Aircraft Gas Turbine Division, Evendale, stands as one of the most complete in the country. Originally conceived by the Laboratory, the facility has contributed substantially to the outstanding progress of aircraft gas turbine design at G.E. Data recorded at the test site can be played back through two tape systems at the Laboratory into electronic data analysis equipment and analog and digital displays for a fast, detailed picture of gas turbine performance.



The substantial part played by magnetic tape in the system reflects its growing importance as the common denominator of dynamic data handling. Dynamic range and frequency range are several times greater than characterize other recording media, and the data is stored "live". The original electrical transducer signal can be accurately re-created whenever desired for observation and processing.

Five portable magnetic tape data recording systems are used by G.E. to collect data at the engine test cells. Signals ranging in frequency from DC to 30 kc, are recorded by Direct or FM carrier techniques. Wide 1¾" tape carries 28 tracks of data, plus reference frequencies, timing signals, and voice, as desired. Monitoring oscilloscopes permit visual observation of the recorded signals. It is interesting to note that the five *portable* recording systems were originally designed by the Davies Laboratories Division for the limited space and severe environments of aircraft flight testing. The strength built into them has proved invaluable to G.E. despite the fact that they have never been operated in the air.

With the completion of a test, the reel of tape is transferred to the data reduction center. Two complete Davies Division laboratory record-reproduce systems permit utmost flexibility in feeding tracks of data serially or simultaneously into reduction and display equipment. Oscilloscopes permit a quick look at results through rapid visual inspection; wave analyzers provide a record of frequency components; level recorders measure amplitude; direct-writing recorders and oscilloscope cameras permit a complete record of wave shapes and phase relationships.

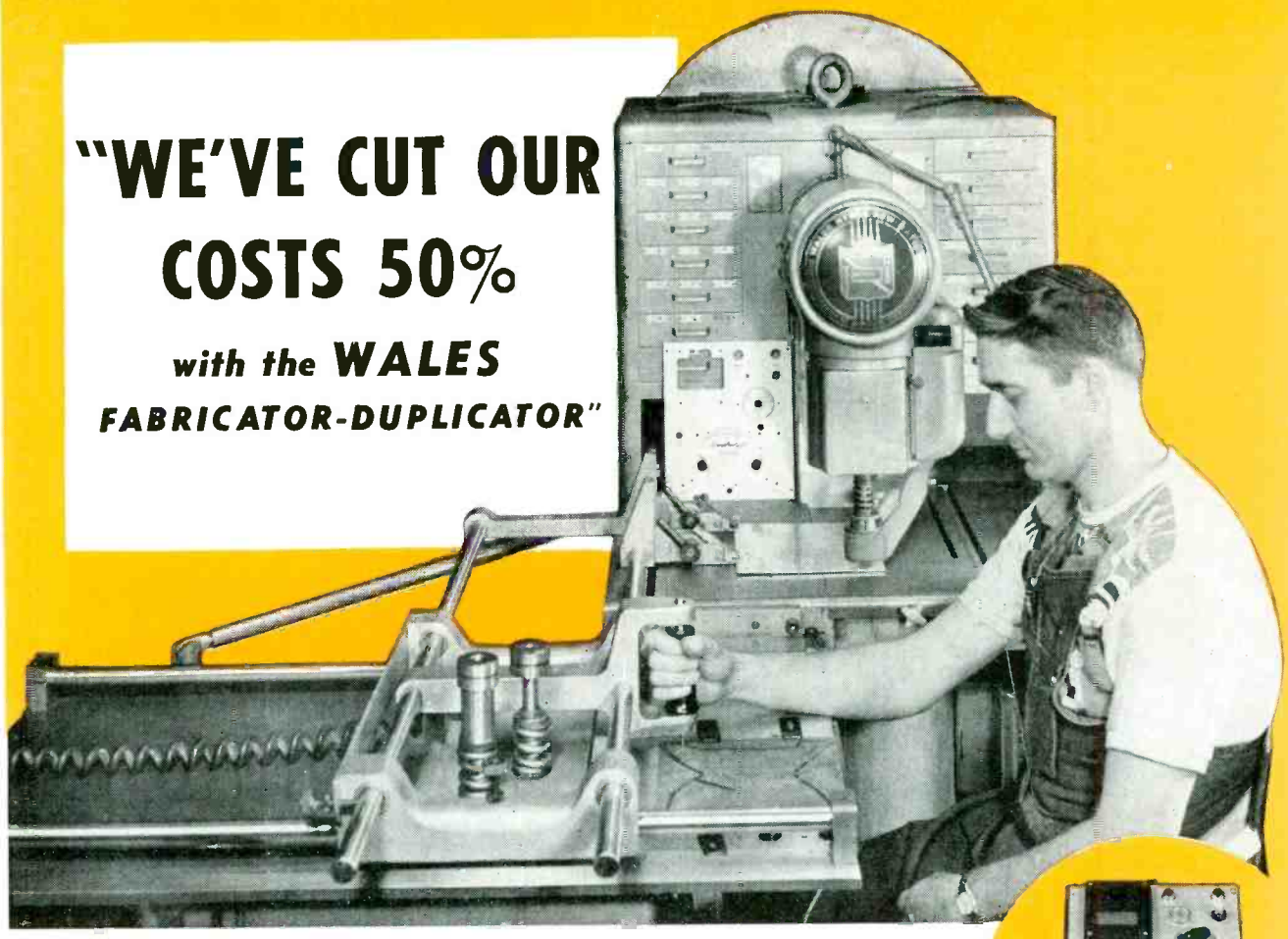
Davies Division magnetic tape data recording installations as large and complex as this one at General Electric Company can rarely be outfitted with standard package equipment. But for the smaller installations, recently announced Davies Universal Magnetic Tape Systems are an ideal choice. You can get a good background in magnetic tape data recording techniques in general by requesting our Bulletin 1001. Universal Systems are covered in Bulletin 2701. Minneapolis-Honeywell Regulator Company, Davies Laboratories Division, 10721 Hanna Street, Beltsville, Maryland. Or call WEbster 5-2700.

MINNEAPOLIS **Honeywell**

DAVIES LABORATORIES DIVISION

"WE'VE CUT OUR COSTS 50%

with the WALES FABRICATOR-DUPLICATOR"



Mr. Richard H. Aufderheide, President and Production Manager of Rex Metal-Craft Inc., Indianapolis, Indiana reports: "We have been able to cut our costs 50% by using the Wales Fabricator and Duplicator for the manufacture of the Breathalyzer. This punching equipment has proven highly efficient for fast set-up, close tolerance, short to medium production work."

The Breathalyzer is an instrument for determining immediately the degree of alcoholic intoxication. This instrument is used widely by law enforcement agencies and Laboratories.

The WALES Fabricator combined with WALES positive Duplicator is the modern, low cost answer to hole punching. You get holes with sharp definition, clean walls and minimum bell mouth. This equipment is perfect for short to medium runs, from one piece to thousands. Change dies for hole sizes in seconds with a range up to 3½" dia. Accuracy is automatic and positive. Make your own templates, too, on the Fabricator. Eliminate layout, drilling machines or jig-borers. The WALES Fabricator-Duplicator is a complete punching shop in itself.

WALES Strippit COMPANY

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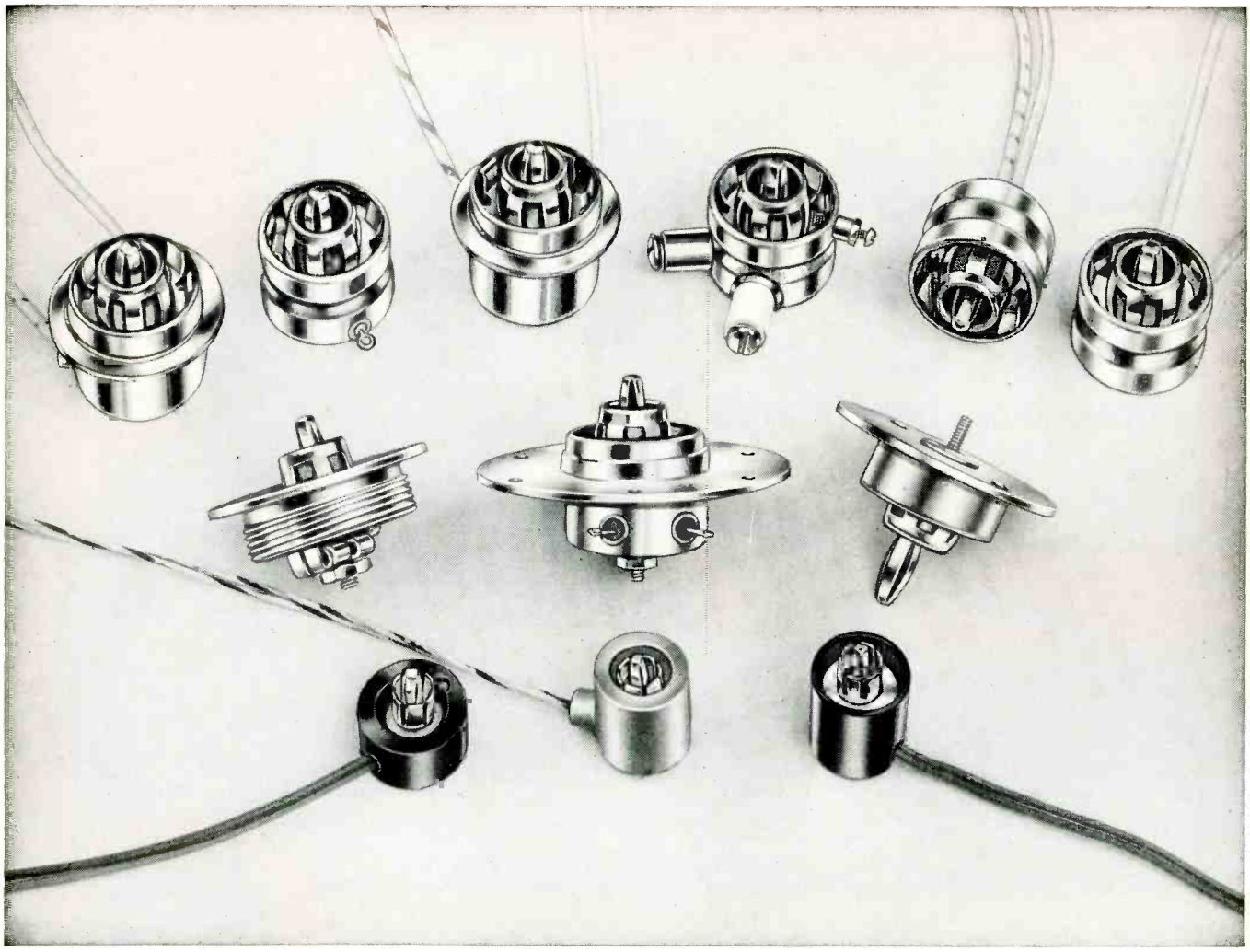
Time studies, specifications, illustrations etc., are all yours for the asking.

WALES MOBILE FIELD UNITS

We'll bring the Fabricator Duplicator right to your door for a demonstration. *Ask for details.*



Ucinite Magnetron Connectors

Ucinite manufactures a variety of special connectors for the heater and heater-cathode terminals of magnetrons. Many of these have been adapted for special applications as to size and function to meet the sealing and mounting requirements of high temperature and high altitude operation and other special conditions.

Connectors are coaxial in construction and can be supplied with built-in capacitors for added protection. Connecting leads of any length can be furnished to customer's specifications.

With an experienced staff of design engineers, plus complete facilities for volume production, Ucinite is capable of supplying practically any need for metal or metal-and-plastics assemblies. Call your nearest Ucinite or United-Carr representative for full information or write directly to us.

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Newtonville 60, Mass.
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Specialists in
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Quick Recovery

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Diodes

FASTER THAN GERMANIUM COMPUTER DEVICES

...and able to withstand high voltages at high temperatures, these quick recovery silicons are particularly useful in circuits where germanium once provided the only possibility. Unlike germanium, breakdown voltages for the silicons *increase* with temperature, thereby removing the danger of failure should temperatures rise to unexpected levels. This kind of ruggedness together with increased speed identify the diodes as ideal when the demand for reliability is greatest.

Perhaps one of the IN620 series will be just right for your particular application; if not, there will undoubtedly be a Hughes germanium or silicon diode that is. For a call from one of our field sales engineers or for additional information about our quick recovery silicon diodes, please write:

SPECIFICATIONS

WIV @ 0.1mA	up to 200V
Forward Voltage @ 4mA	less than 1.5V
Recovery (modified IBM "Y" test)	400K ohms (min.) in one μsec. when switched from 30mA forward to −35V reverse.
Reverse Current @ 25°C	as low as 1μA @ −175V
Reverse Current @ 100°C	as low as 100μA @ −175V
Operating Temperature Range	−80°C to +150°C

PHYSICAL CONFIGURATION. All types are packaged in the famous glass body, created at Hughes to provide absolute protection from moisture penetration and contamination. Body length: 0.265 inch maximum. Body diameter: 0.105 inch maximum.

Types now available IN625 through IN629

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RCA DATA FOR

RCA Traveling-Wave Tubes for Improved Microwave Designs

Lightweight, Compact Power Types—Need No Solenoid Power

Featuring integral *periodic-permanent-magnet* focusing systems, RCA's new power traveling-wave tubes eliminate the need for external solenoid power—make possible dramatic advances in physical compactness and weight reduction.

RCA Dev. No. A-1101...only 2½ inches in diameter and short enough to mount in a standard aircraft ATR-box, this remarkable tube weighs only 12 pounds including the permanent-magnet focusing system! Designed to operate at altitudes up to 70,000 feet, the A-1101 delivers about 100 watts at 10% duty factor over the range from 2000 to 4000 Mc.

RCA Dev. No. A-1063...approaching the ultimate in compactness, the A-1063 complete with permanent-magnet focusing system weighs only 3½ pounds...is less than 1½ inches in diameter! "Plug-in" construction simplifies field maintenance. Minimum power output is 10 watts from 2250 to 3750 Mc.

Low-Noise Types Increase Receiver Sensitivity —Eliminate Crystal "Burnout"

RCA low-noise traveling-wave tubes enable the practical design of rf-amplifier and if-amplifier stages for microwave receivers featuring high signal-to-noise ratio and increased sensitivity. Crystal "burnouts" caused by TR-tube leakage are eliminated by the isolation afforded by the rf stage. RCA low-noise traveling-wave tubes can be made in a variety of designs to meet specific requirements.

Here are some typical types:

	Frequency Range	Noise Figure	Gain
RCA Dev. No. A-1056	1215 to 1365 Mc	7.0 db	25 db
RCA Dev. No. A-1105	2000 to 2500 Mc	7.0 db	25 db
RCA-6861	2700 to 3500 Mc	6.5 db	25 db
RCA Dev. No. A-1079	2500 to 4000 Mc	7.0 db	20 db
RCA Dev. No. A-1088	3500 to 4300 Mc	6.5 db	20 db
RCA Dev. No. A-1106	5900 to 7400 Mc	7.0 db	25 db

For details on RCA Traveling-Wave Tubes, call your RCA Field Representative.

RADIO CORPORATION of AMERICA

Electron Tube Division, Harrison, N. J.
Semiconductor Division, Somerville, N. J.

DESIGNERS

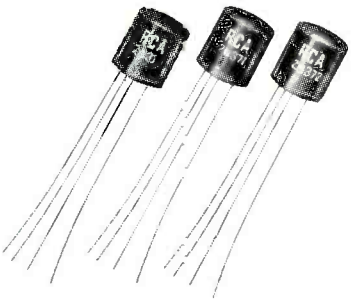
New Beam Power 9-Pin Miniature Adds a New Measure of Performance to Compact High-Fidelity Amplifier Designs

RCA-6973...delivers up to 20 watts in push-pull class AB_1 operation in audio amplifier service. Distortion at maximum rated power output is 1.5%. The compact construction, relatively low heater-power requirement of 6.3 volts at 450/ma and linear operation over a wide range of power make RCA-6973 an excellent designers' choice for compact Hi-Fi amplifiers.

New Front-End Tubes for Medium-Priced FM Sets

RCA-6DT8, RCA-12DT8...designed for rf amplifier and oscillator-mixer service—inter-unit shielding of RCA-6DT8 and -12DT8 permits FM-tuner designs with high voltage-gain capability and substantial reduction in antenna radiation.

3 New RCA "Drift" Transistors Now Make Practical the Mass-Production of All-Transistor Short-Wave Receivers



RCA-2N370 for rf-amplifier, **RCA-2N371** for oscillator, **RCA-2N372** for mixer service...first transistors specifically designed and controlled for operation in short-wave receivers at frequencies up to 23 Mc. These three new "drift" transistors are controlled for input and output values and for power gain characteristics to give good unit-to-unit interchangeability. The new units offer advantages of high frequency stability and economies in space, weight, and battery life.

New Photoconductive Cell Permits Direct Relay Operation — *without the use of an amplifier*

RCA-6957...is intended for use in street-lighting control and industrial light-operated relay applications. Sensitivity and current-handling capabilities permit relays to be directly operated in many applications — simplify circuitry—minimize power-supply requirements. Spectral response covers the approximate range from 3300 to 7400 angstroms. Maximum response occurs at about 5800 angstroms.

750 Kilowatts—Peak Power Output—with power gain of at least 100 offered by new RCA Super-Power Tube in plate-pulsed modulator service at 225 MC

RCA-6952...beam power tube, featuring ceramic-metal construction—intended for use at frequencies up to at least 600 Mc as plate-pulsed amplifier in applications involving Government end use, such as long-range search radar and pulsed communications service. For details on this and other RCA Super-Power Tubes, contact your RCA Field Representative.

For sales or applications information on the products shown, please contact your RCA Field Representative at the RCA Field Office nearest you:

Equipment Sales:

- 744 Broad Street, Newark 2, N. J., HUmboldt 5-3900
- Suite 1181, Merchandise Mart Plaza, Chicago 54, Ill., WHitehall 4-2900
- 6355 E. Washington Boulevard, Los Angeles 22, Calif., RAymond 3-8361

Government Sales:

- 415 South Fifth St., Harrison, N. J., HUmboldt 5-3900
- 224 N. Wilkinson Street, Dayton, Ohio, HEmlock 5585
- 1625 "K" St., N.W., Washington, D.C., DIstrict 7-1260

Technical bulletins on the following types are available from RCA, Commercial Engineering, Section I-19-R, Harrison, N. J. Please use this coupon.

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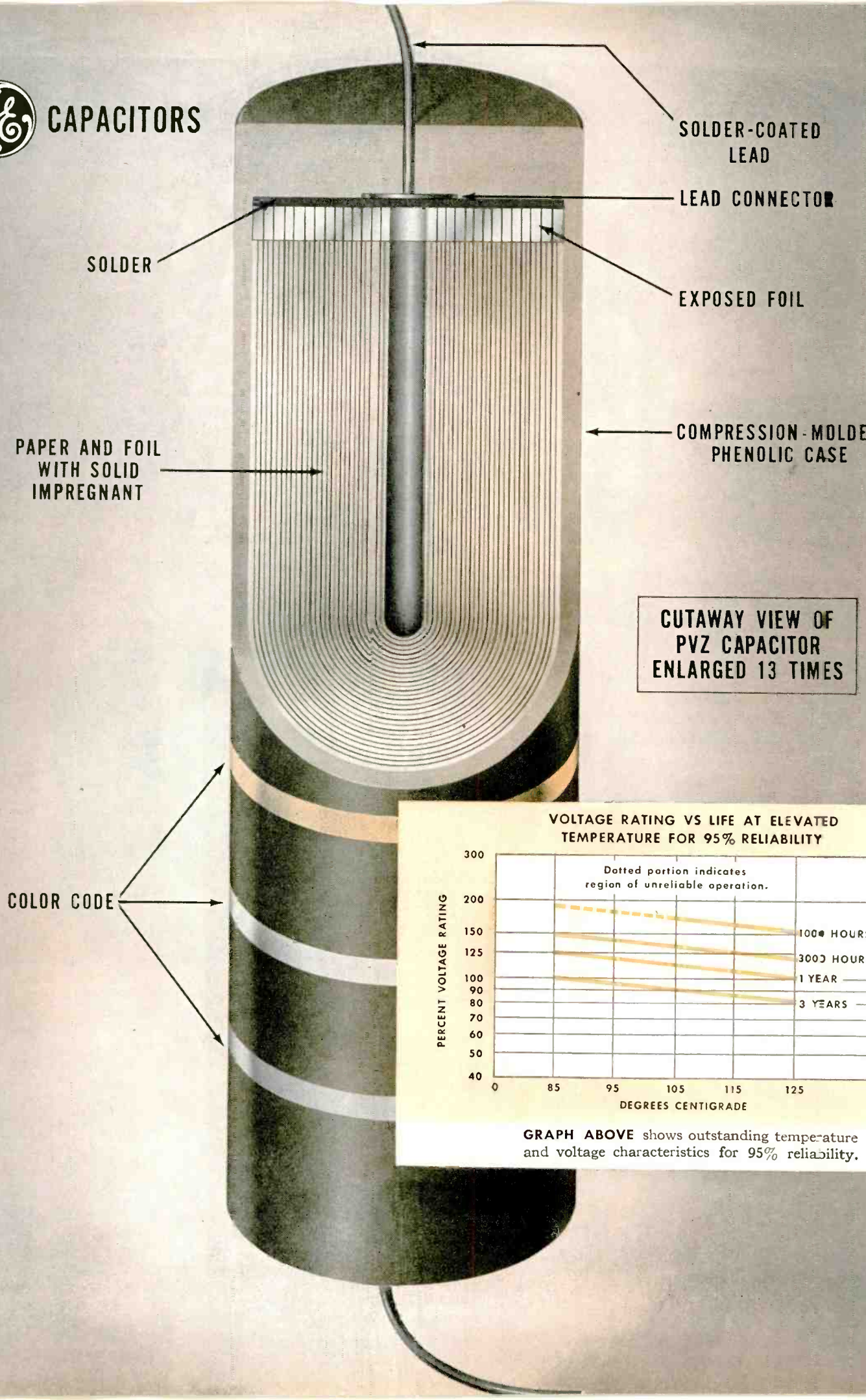
Circle 99 Readers Service Card

CAPACITORS



CUTAWAY VIEW OF PVZ CAPACITOR ENLARGED 13 TIMES

GRAPH ABOVE shows outstanding temperature and voltage characteristics for 95% reliability.

Solve critical space and temperature problems with subminiature PVZ* capacitors

Low-cost molded units operate from —55 C to +125 C

Now immediately available for exacting applications in commercial and military electronic equipment, these molded paper capacitors meet performance requirements of Characteristic "E" for MIL-C-91A. General Electric's PVZ capacitors are priced substantially lower than comparable metal-clad tubulars. They are designed to operate for a minimum of one year at +125 C with no voltage derating.

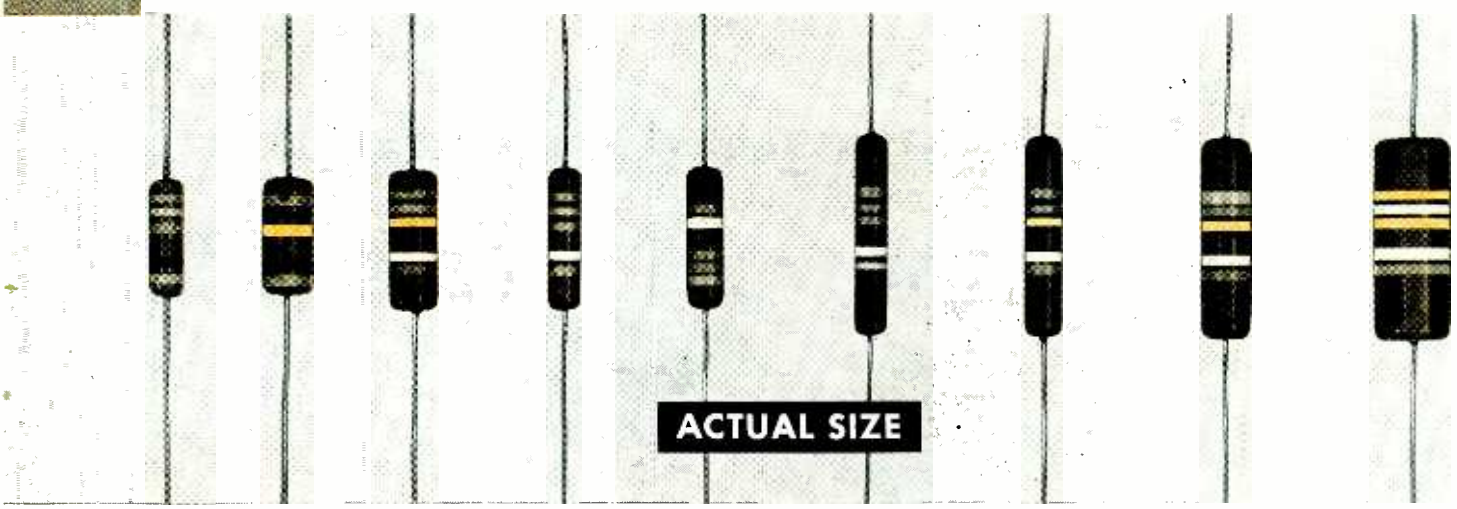
Completely solid after molding, PVZ capacitors feature the following advantages:

- small size
- excellent humidity resistance
- high lead-strength
- insulated body—solid impregnant
- high shock and vibration resistance
- color code for easy identification

General Electric PVZ capacitors are available at 100, 200, 300, and 400 volts. Microfarad ratings range from .00047 to .15.

If you need a capacitor with the characteristics described above, ask your General Electric Apparatus Sales Engineer about PVZ tubulars. He can give you expert application information. He can also arrange for immediate delivery of PVZ capacitors from factory stock in most ratings. For descriptive data write for bulletin GEC-1452 to General Electric, Section 447-2, Schenectady 5, N. Y.

*Trademark of the General Electric Co.



PVZ CAPACITORS range in size from .175″ diameter by .625″ length to .375″ diameter by 1.0625″ length. Capacitance ratings are available with ±20%, ±10%, and ±5% tolerances. The color code indicates microfarads, volts, and capacitance tolerance.

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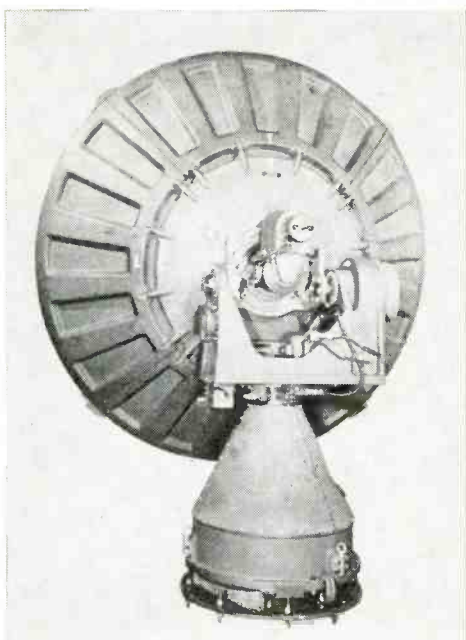
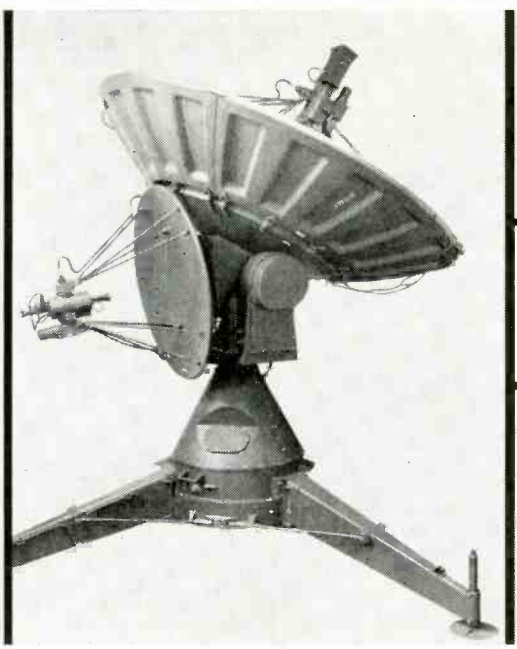
When you order from Eclipse-Pioneer, you'll enjoy the advantages of experienced engineering coupled with favorable delivery and prices that result from mass production techniques.

District Offices: Burbank and San Francisco, Calif., Dayton, Ohio, and Seattle, Wash.—Export Sales and Service: Bendix International Division, 205 E. 42nd St., New York 17, N. Y.

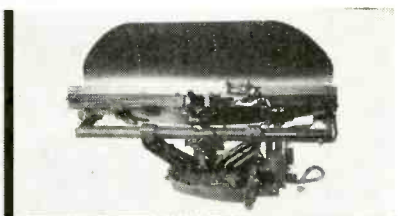
TYPICAL EXAMPLES OF BENDIX RADAR ANTENNA DEVICES



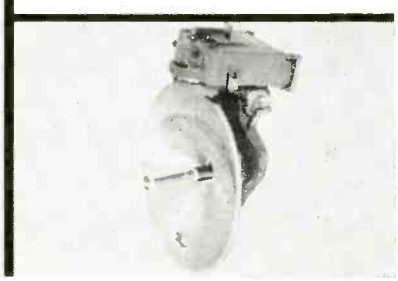
Lightweight, ground-based, air-transportable tracking antenna pedestal for mounting 8-ft. diameter, s-band segmented parabolic reflector and nutating scanner; highly accurate 2-speed data systems in elevation and azimuth.



Lightweight, ground-based, air-transportable, dual reflector, multi-band, high gain search antenna and control system; 2-speed data systems and magnetic clutch drives in azimuth and elevation.



Airborne reflector mounting and drive unit for x-band antenna; 2-speed, continuous rotation in azimuth, either direction; 40° and 60° sector scans; remote manual tilt; line of sight stabilization.



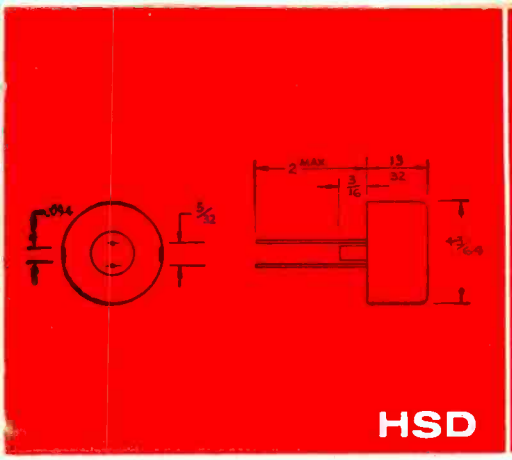
Airborne weather radar antenna with line of sight stabilization for x- or c-band; switchable wide fan (cosecant squared) beam pattern for mapping or pencil beam for storm detection.

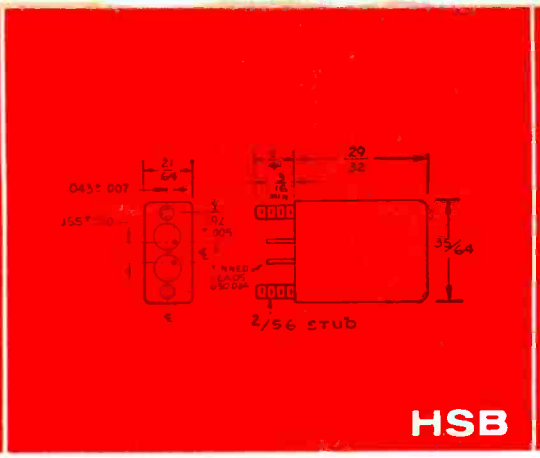
Eclipse-Pioneer Division
TETERBORO, N. J.

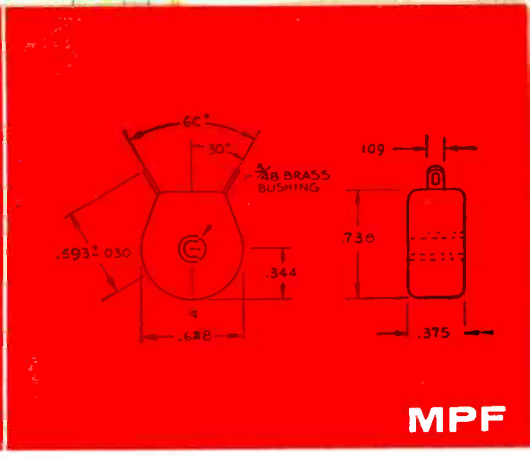
Bendix
AVIATION CORPORATION

Circle 102 Readers Service Card

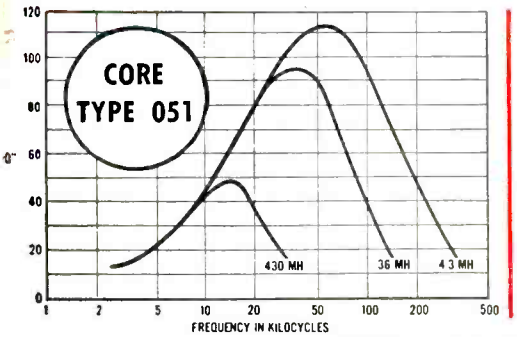
Circle 103 Readers Service Card→

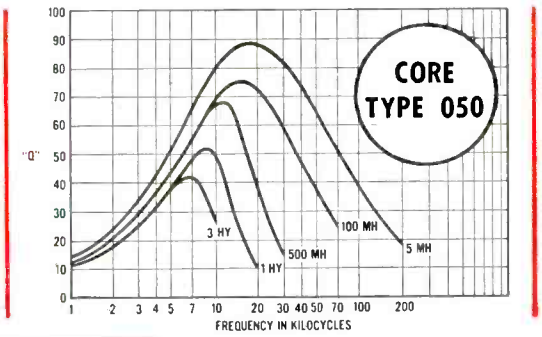


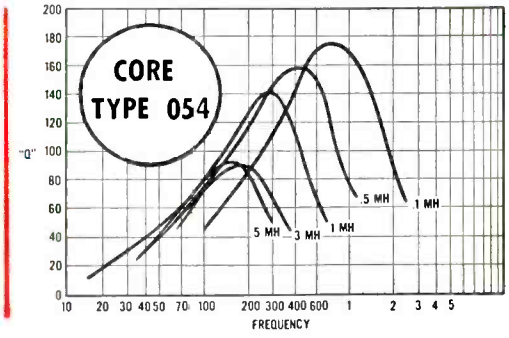




THREE STANDARD PACKAGES AVAILABLE IN THREE CORE TYPES







MOLDED and CASED TOROIDS

	STANDARD INDUCTANCE VALUES:		
Dash No.	050	051	054
–1	5.0 MH	1.0 MH	.05 MH
–2	6.0	1.2	.06
–3	7.2	1.5	.072
–4	8.6	1.75	.086
–5	10.0	2.0	.100
–6	12.0	2.4	.120
–7	15.0	3.0	.150
–8	17.5	3.6	.175
–9	20.0	4.3	.200
–10	24.0	5.0	.240
–11	30.	6.0	.300
–12	36	7.2	.360
–13	43	8.6	.430
–14	50	10.0	.500
–15	60	12.0	.600
–16	72	15.0	.720
–17	86	17.5	.860
–18	100	20.0	1.0
–19	120	24.0	1.2
–20	150	30.0	1.5
–21	175	36.0	1.75
–22	200	43.0	2.0
–23	240	50.0	2.4
–24	300	60.0	3.0
–25	360	72.0	3.6
–26	430	86.0	4.3
–27	500	100	5.0
–28	600	120	6.0
–29	720	150	7.20
–30	860	175	8.6
–31	1.0 HY	200	10.0
–32	1.2	240	
–33	1.5	300	
–34	1.75	360	
–35	2.0	430	
–36	2.4	500	
–37	3.0		

IN ORDERING: Please designate type, core, dash number, and inductance value. For example: "MPF 050 –10 24 MH."

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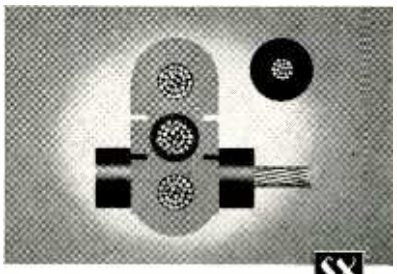

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Circle 104 Readers Service Card

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SERIES 145-58
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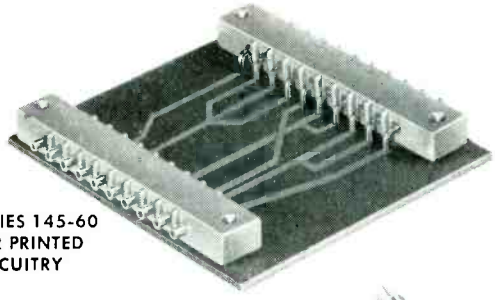
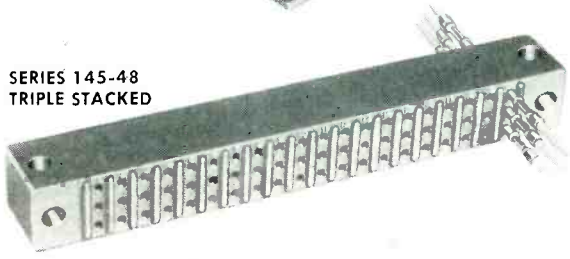


SERIES 145-48
TRIPLE STACKED



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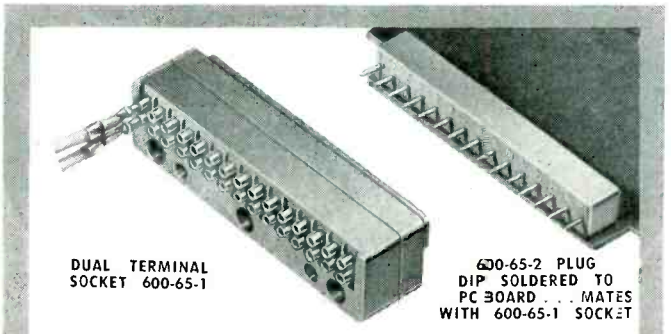
Here is an improved terminal block design with permanently molded-in and precision reamed taper pin receptacles for maximum durability. These receptacles maintain secure electrical and physical contact with AMP Series "53" solderless taper pin. The body is molded of high impact, glass reinforced Alkyd 446 (MIL-P-14E, Type MA160). Other molding materials on request. Taper receptacles are brass, gold plated over silver for low contact resistance.

Continental Connector can supply all types of taper pin blocks and connectors for conventional wiring and printed circuitry in any combination of feed-through shorting or non-shorting terminals. Our engineering department is prepared to cooperate in solving your connector application problems. Write today for technical information.



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from **Beckman®** / *Berkeley*

MODEL 4904

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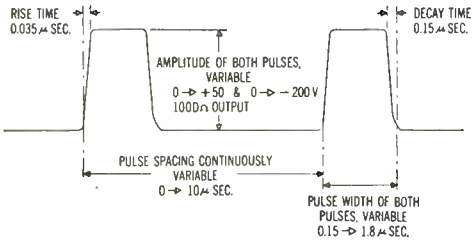
For seven years Beckman/Berkeley double pulse generators have played an important part in the designing and testing of pulse circuitry wherever pulse techniques are studied. Basically, these are general purpose laboratory instruments that provide a source of "clean" paired or single pulses. Both instruments feature independent adjustment of pulse width, pulse amplitude, pulse to pulse spacing, pulse polarity and repetition rate. Unusually low interaction between control functions is achieved by careful design and by operating all circuitry from precision-regulated supply voltages.



PULSE DIMENSIONS FOR MODEL 903 (POSITIVE OR NEGATIVE) as shown.

MODEL 903

APPLICATIONS: Measurement of paired pulse resolution time of counting circuits. Measurement of rise time, decay time and transient response of pulse forming circuits, electronic switches, gates and wide band amplifiers. Calibration of input sensitivity of counting instruments. Frequency calibration of counting rate meters. Measurements of overload characteristics and dynamic range of pulse amplifiers. Delayed coincidence work.

SPECIFICATIONS	MODEL 903	MODEL 4904
PULSE WIDTH	0.15 to 1.8 μ sec.	0.3 to 10 μ sec.
MAXIMUM PULSE AMPLITUDE	200 volts negative, 50 volts positive across 1000 ohm load. 10 volts negative and 2.5 volts positive across a 50 ohm load	160 volts negative and 75 volts positive across a 1000 ohm load. 5 volts negative and 2 volts positive across a 50 ohm load
RISE TIME	0.035 μ sec.	0.08 μ sec.
DECAY TIME	0.15 μ sec.	0.26 μ sec.
PULSE POLARITY	positive or negative	positive or negative
PULSE SPACING	0 to 10 μ sec. Single control	0 to 100 μ sec. Coarse and fine adjustments (accuracy ±2%)
INTERNAL DRIVE	1 to 1000 cps.	1 to 10,000 cps.
EXTERNAL DRIVE	1 to 1000 cps by negative 100 volt pulse with 0.5 μ sec. rise time and 2 μ sec. duration	1 to 10,000 cps by sine wave 3 volts rms, or positive pulse 7.5 volts and 1 μ sec. duration
OSCILLOSCOPE SYNC.	30 volt positive pulse 1 μ sec. before first pulse	30 volt negative pulse 5 μ sec. before first pulse
PRICE (f.o.b. factory)	$498.00	$645.00

Write for complete specifications on the Models 903 and 4904 Double Pulse Generators. Please Address Dep't. G-9

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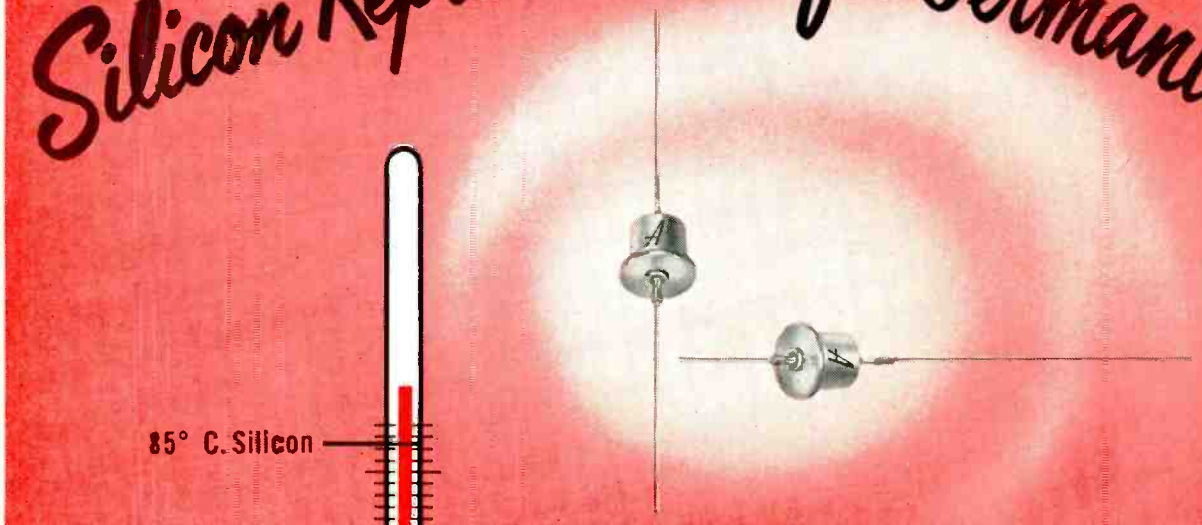
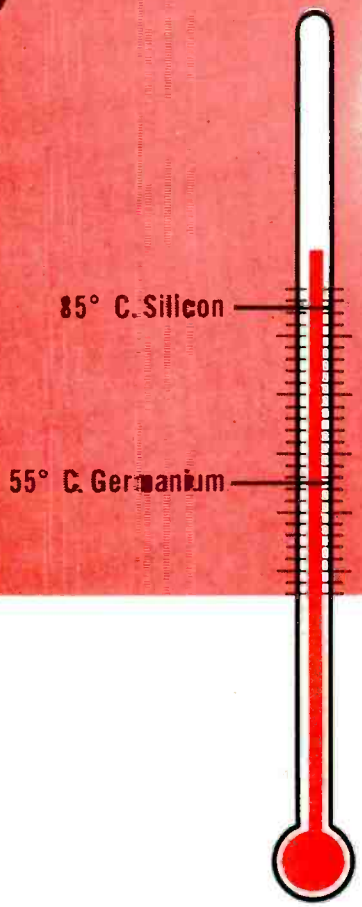
Silicon Replacements for Germanium





AUTOMATIC "S" LINE SILICON REPLACEMENTS		Silicon Replacements For Germanium Type 1N91		Silicon Replacements For Germanium Type 1N92		Silicon Replacements For Germanium Type 1N93	
Absolute Maximum Ratings (For 85° C. Ambients)		S91	S91H	S92	S92H	S93	S93H
Peak Inverse Voltage	Volts	100	100	200	200	300	300
Continuous D.C. Reverse Working Voltage	Volts	50	80	100	160	150	240
D.C. Output Current	MA	200	250	200	250	200	250
Half-Cycle Surge Current @ 60 c.p.s.	Amps	5.0	5.0	5.0	5.0	5.0	5.0
Full Load Voltage Drop	Volts	1.5	1.5	1.5	1.5	1.5	1.5
Leakage Current @ Rated P.I.V.	MA	1.0	0.5	1.0	0.5	1.0	0.5
Maximum Operating Frequency	KC	100	100	100	100	100	100
Storage Temperature	°C.	100	150	100	150	100	150

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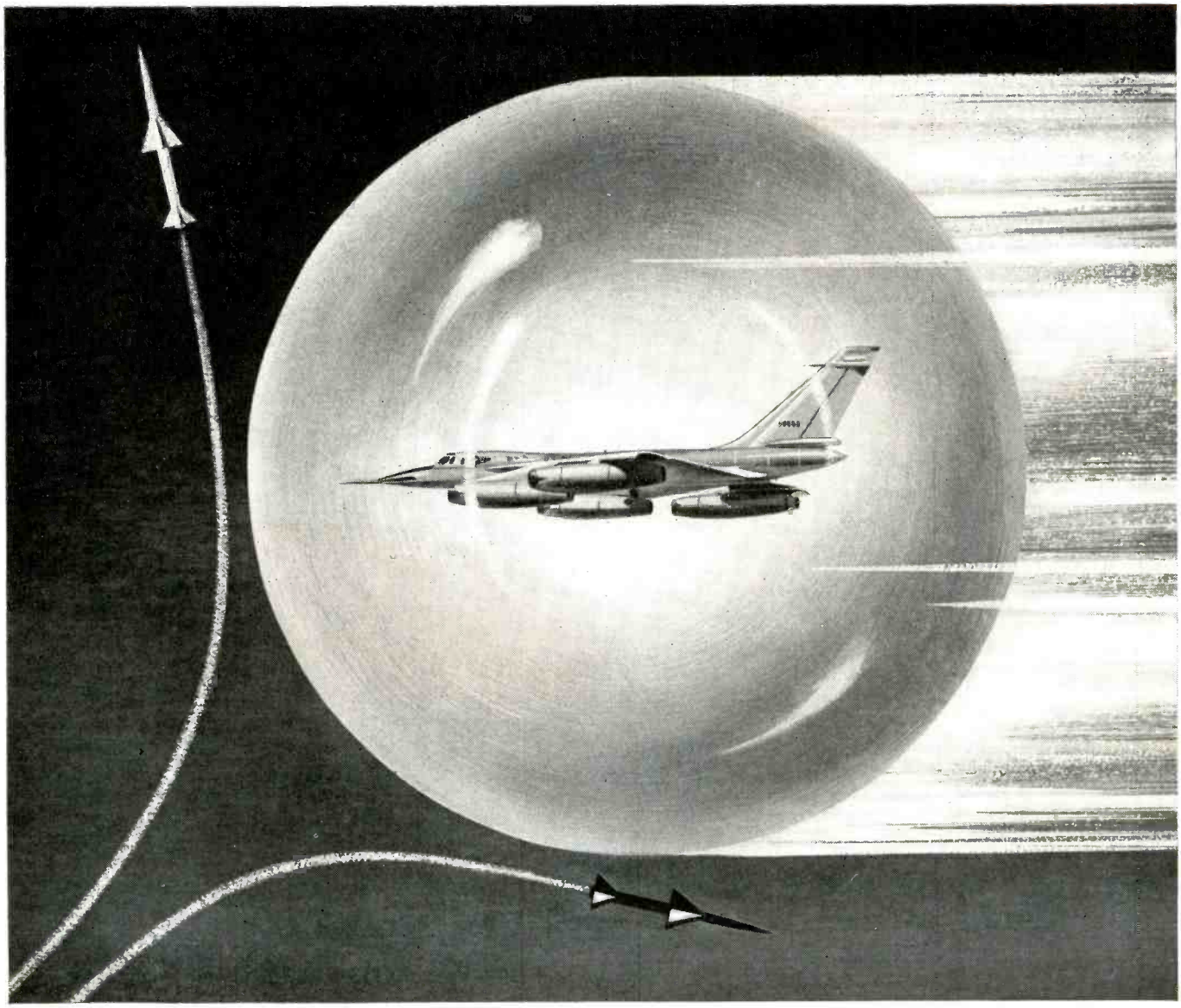

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Data sheets B-211, B-214 and B-216 provide all the facts on Clevite Power Transistors. Write for your copies.

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Instantaneous Collector-to-base Voltage (absolute Maximum)	−60	−40	−40	−80	−20	−80	Volts
Junction Temperature (absolute Max.)	85	85	85	85	85	85	°C
Average Total Power Dissipation (with inf. heat sink @ 25°C)	25	30	25	25	25	25	Watts
Average Total Power Dissipation (with 36 sq. in. heat sink @ 25°C)	15	18	15	15	15	15	Watts
Typical Power Gain	a	33[b]	33[c]	31[c]	30[d]	26[c]	db
Frequency Cutoff	5	6	7	6	6	4	Kc/s

a Large Signal D.C. Current Gain = 12 to 40 at Ic = 2.0 amps.
b Vcc = −14V; Ic = 750ma; R_L = 17Ω (choke coupled); R_s = 10Ω
c Vcc = −14V; Ic = 420ma; R_L = 30Ω (choke coupled); R_s = 10Ω
d Vcc = −7V; Ic = 420ma; R_L = 15Ω (choke coupled); R_s = 10Ω

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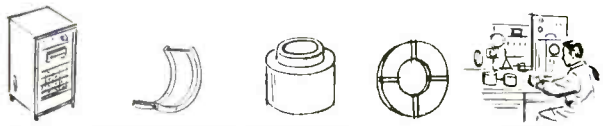

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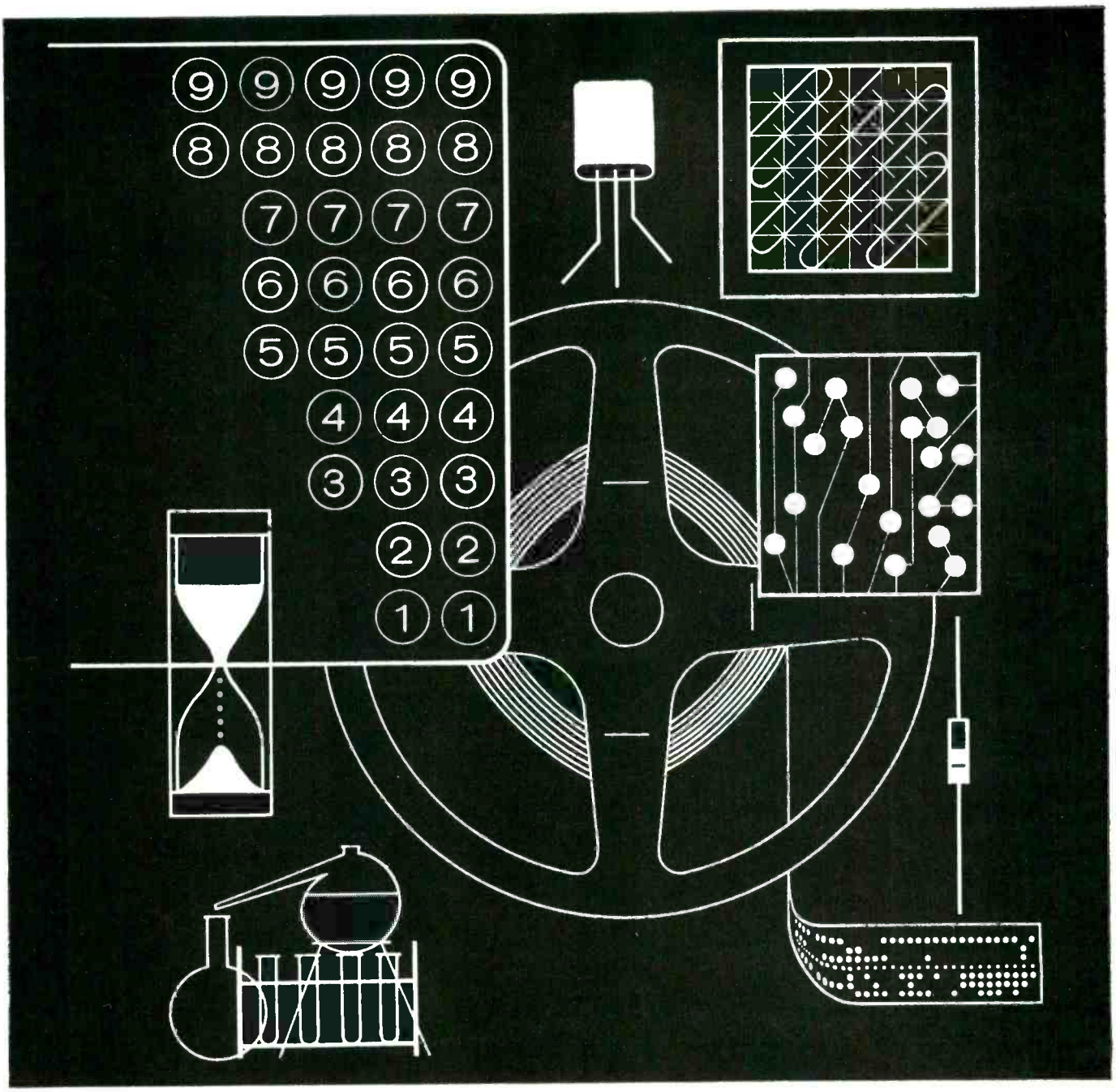

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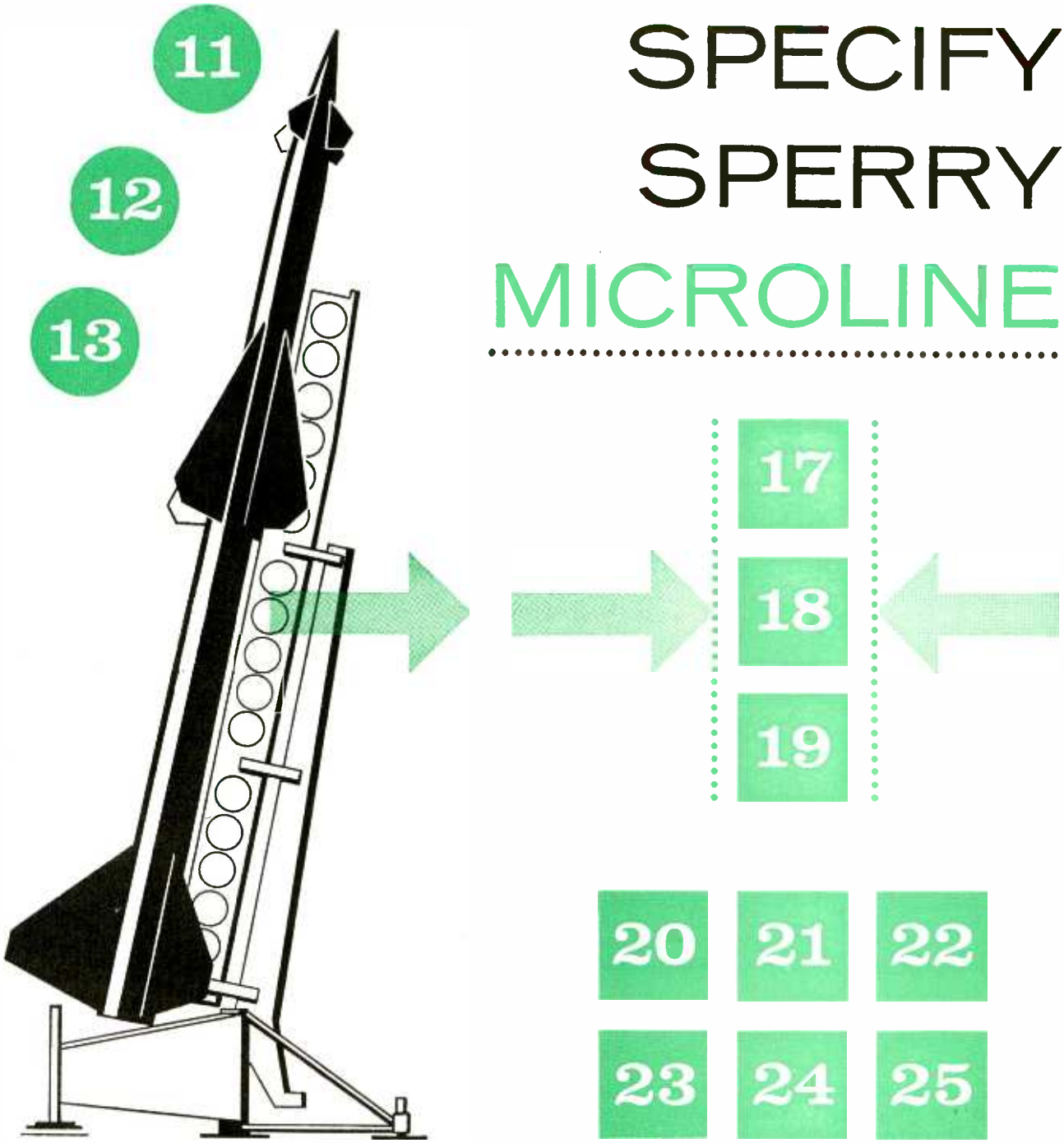

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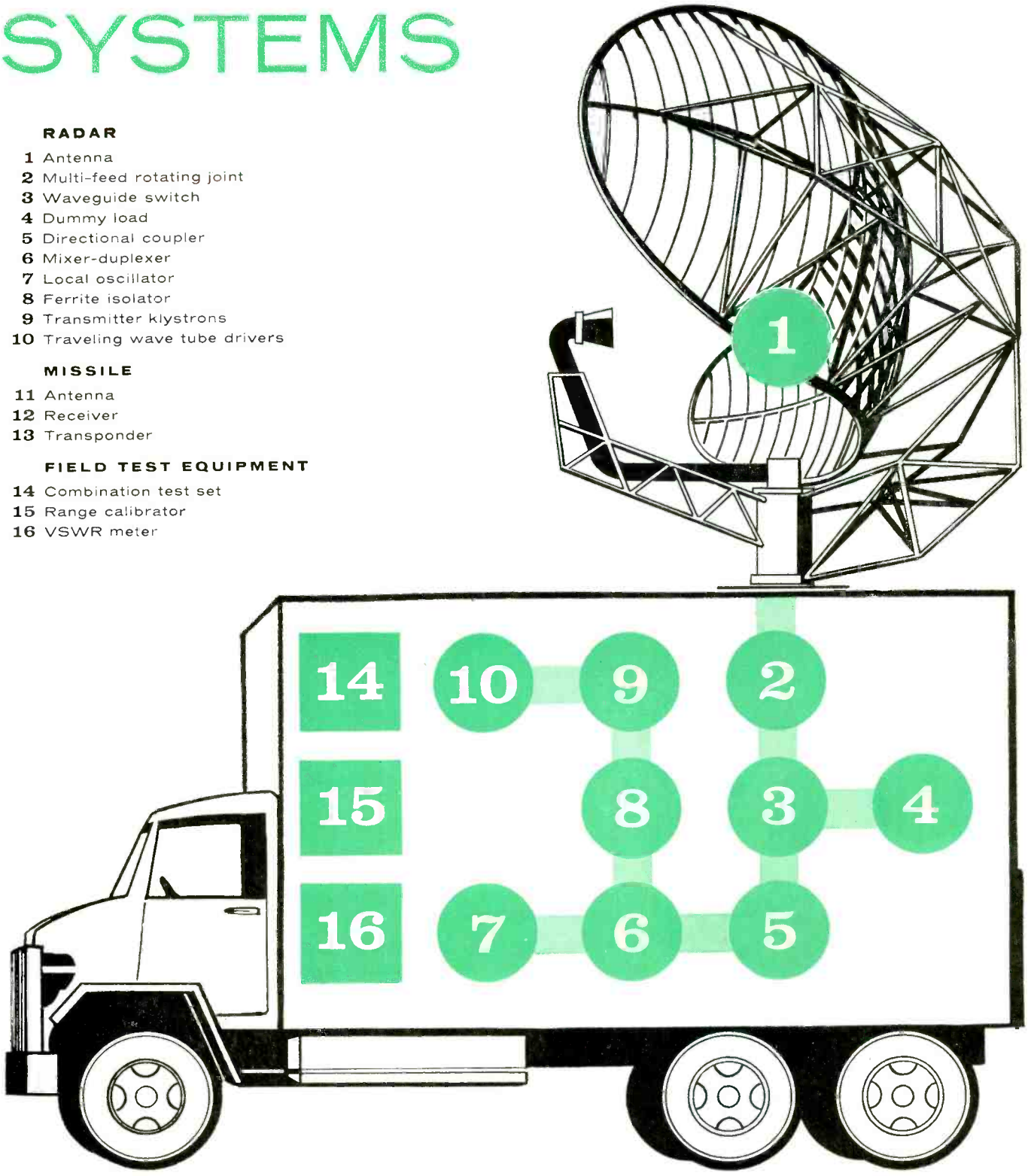
3 Waveguide switch
4 Dummy load
5 Directional coupler
6 Mixer-duplexer
7 Local oscillator
8 Ferrite isolator
9 Transmitter klystrons
10 Traveling wave tube drivers

MISSILE

11 Antenna
12 Receiver
13 Transponder

FIELD TEST EQUIPMENT

14 Combination test set
15 Range calibrator
16 VSWR meter



SUPPORT EQUIPMENT

17 RACE (Rapid Automatic Checkout Equipment)
18 System evaluators
19 System performance monitors

DEPOT SUPPORT EQUIPMENT

20 Peak power meter
21 Multi-pulse generator
22 Directional couplers
23 Ferrite isolators
24 Ferrite attenuators
25 Barretter mounts

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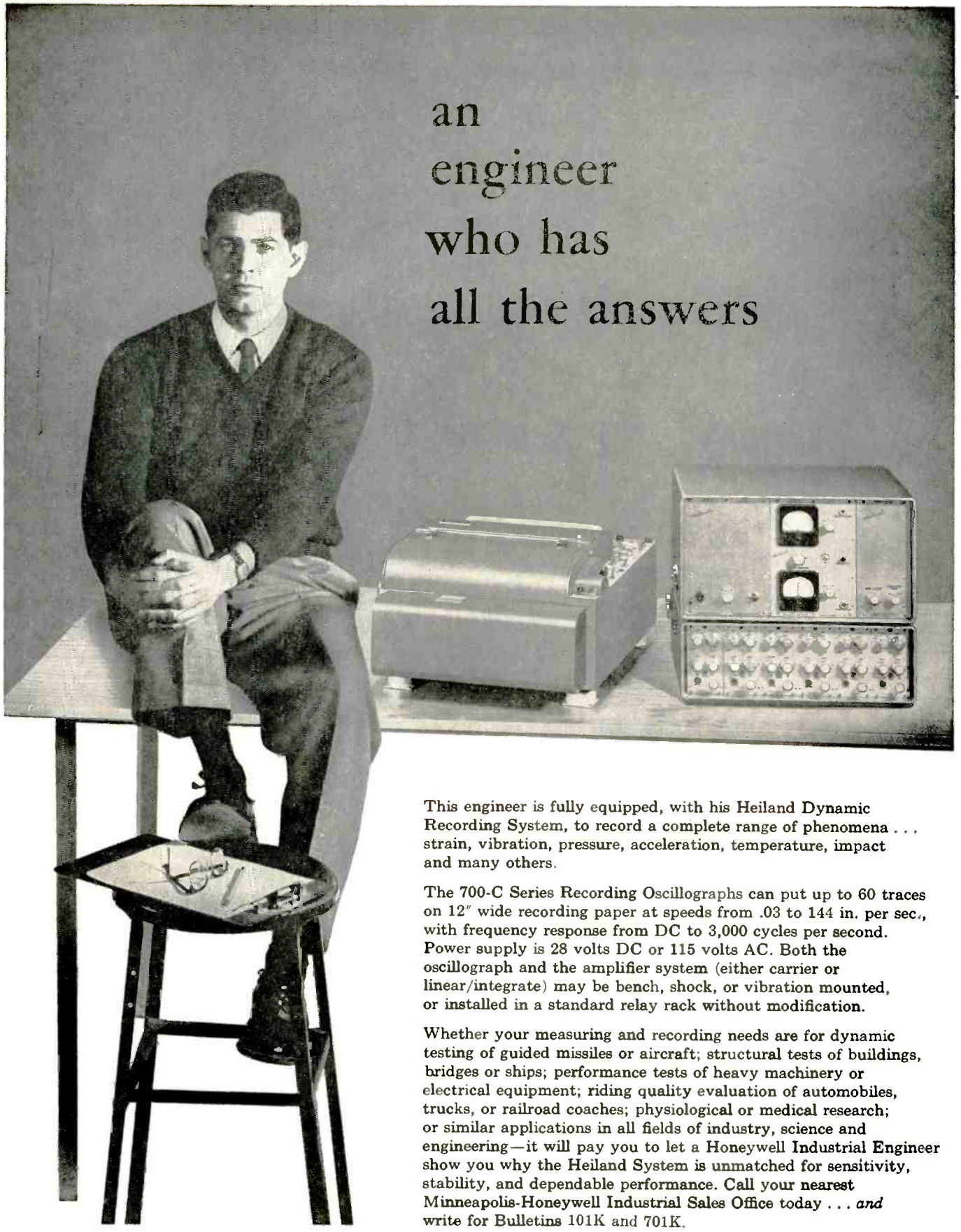

This engineer is fully equipped, with his Heiland Dynamic Recording System, to record a complete range of phenomena . . . strain, vibration, pressure, acceleration, temperature, impact and many others.

The 700-C Series Recording Oscillographs can put up to 60 traces on 12″ wide recording paper at speeds from .03 to 144 in. per sec., with frequency response from DC to 3,000 cycles per second. Power supply is 28 volts DC or 115 volts AC. Both the oscillograph and the amplifier system (either carrier or linear/integrate) may be bench, shock, or vibration mounted, or installed in a standard relay rack without modification.

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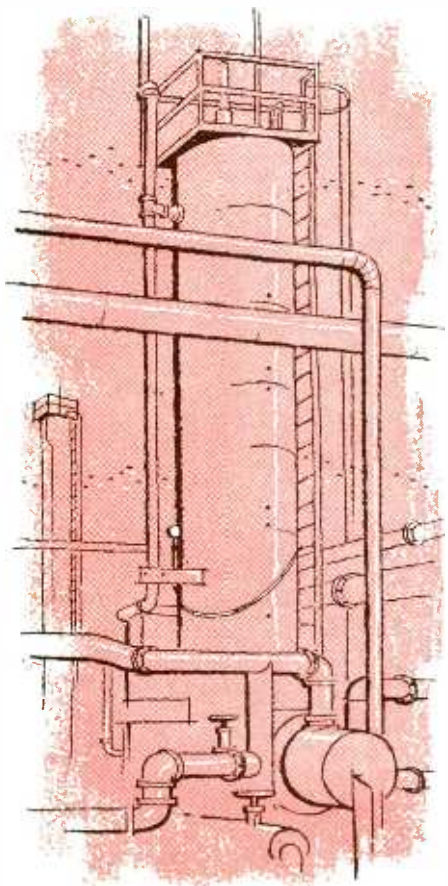

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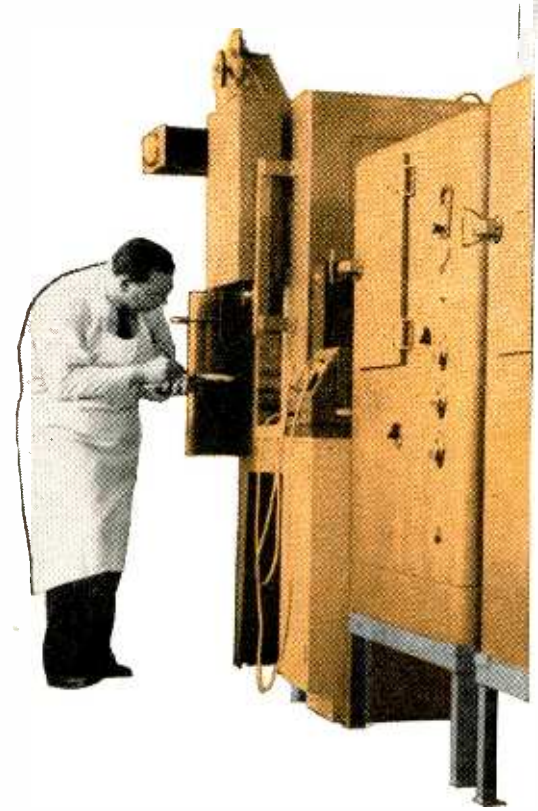

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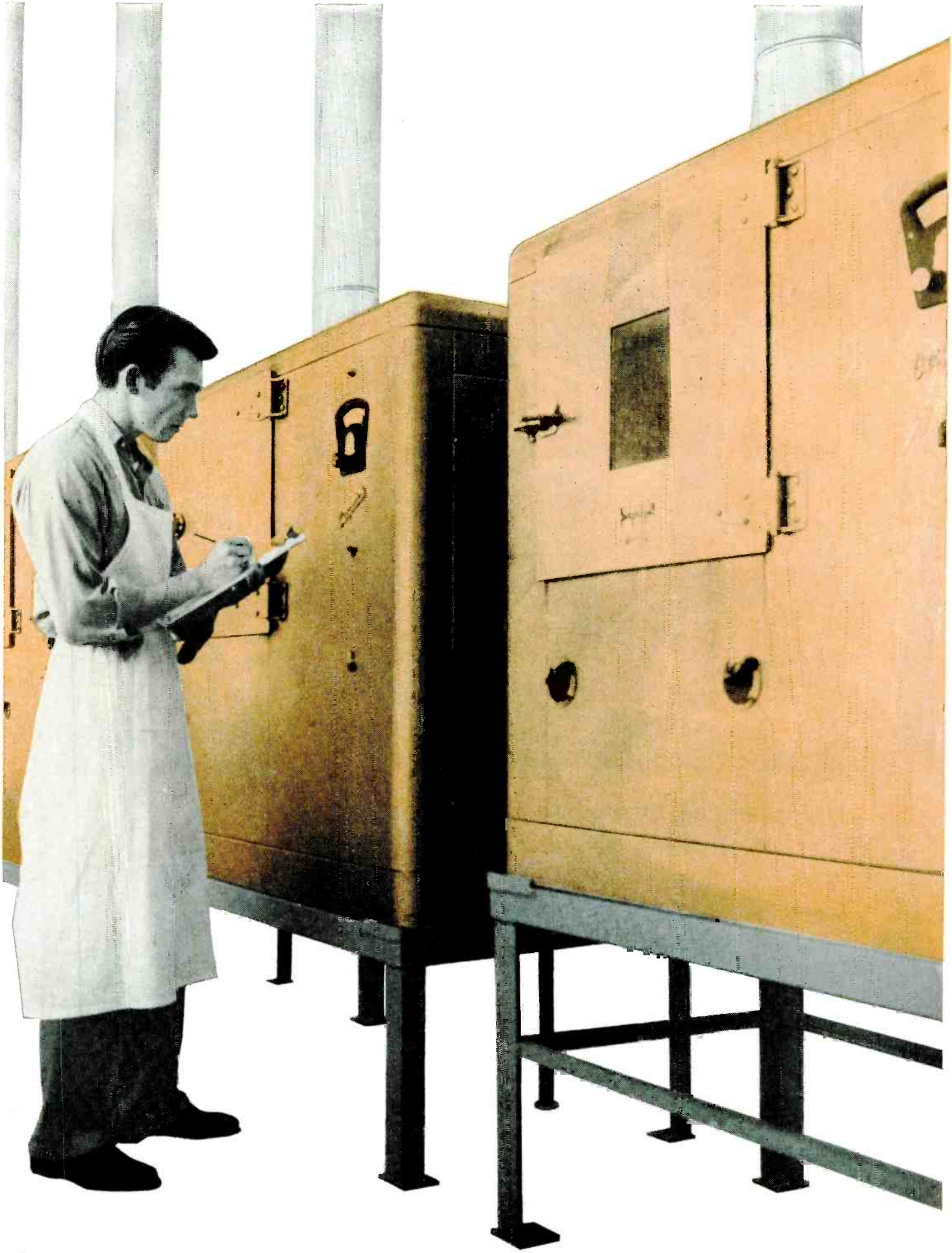

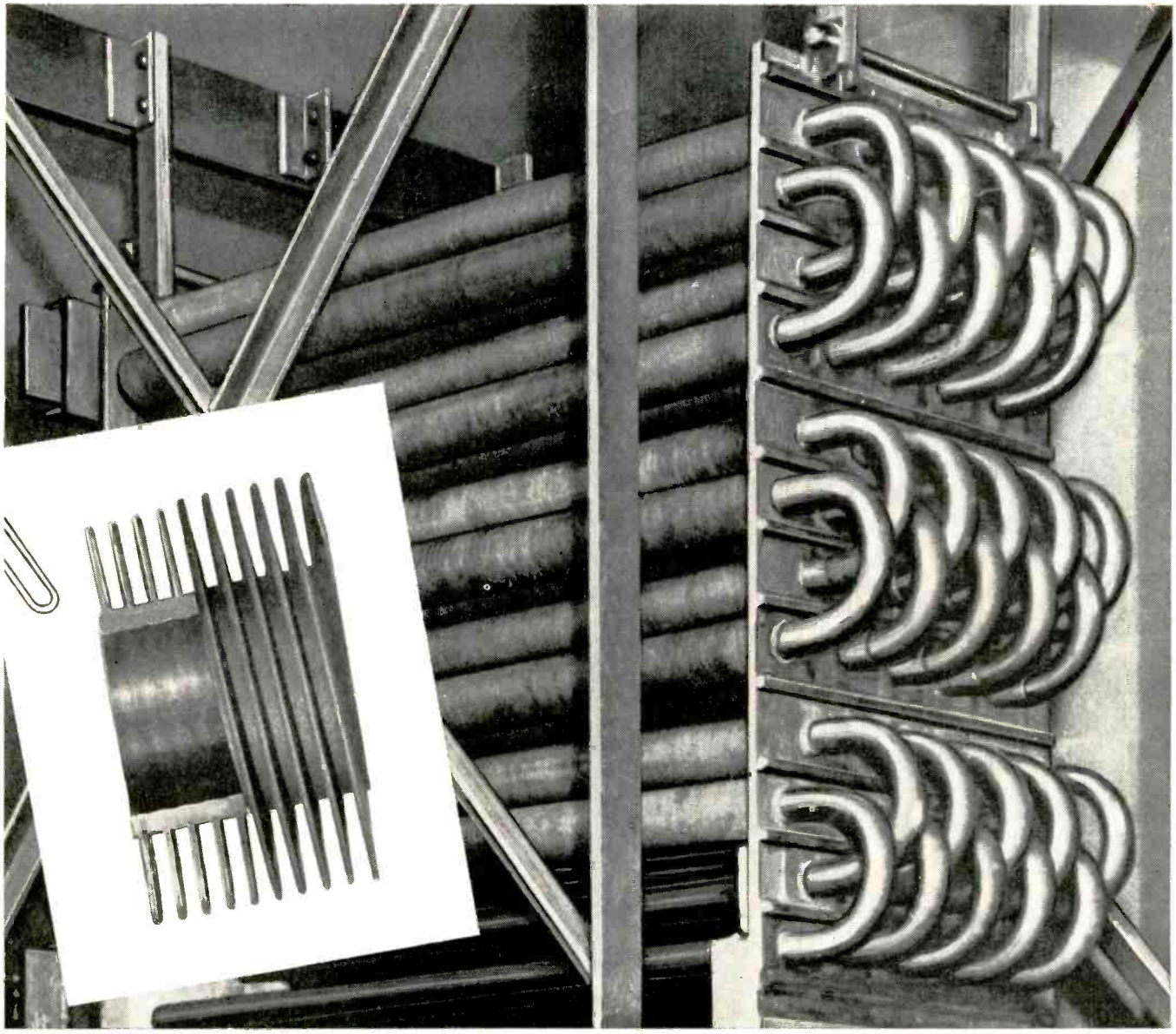

General Plate Stainless Clad Copper Enables Griscom-Russell K-Fins

To Meet 2600°F Operating Conditions

Two metals are often better than one, and here's a case in point...

In Griscom-Russell's K-Fin tubing for high temperature gas to liquid heat exchangers, General Plate Stainless Clad Copper reduces fin tip temperatures 29% (2090°F to 1475°F) with nearly twice the heat transfer rate of unclad stainless.

Benefits? Fin tip temperatures in G. R. K-Fin run well below the oxidation point — fin life is greatly extended — heat exchanger performance is improved substantially — with worth while economies in design.

G. P. Stainless Clad Copper is available in widths up to 13″ and thicknesses up to 1/16″, single or double clad, in long lengths. It can be blanked, drawn, spun, formed, brazed, and spot or seam welded.

Let us send complete information on G. P. Stainless Clad Copper — it may be just what you have been looking for. Write today for Catalog Sheet 727C.

You can profit by using General Plate Clad Metals.

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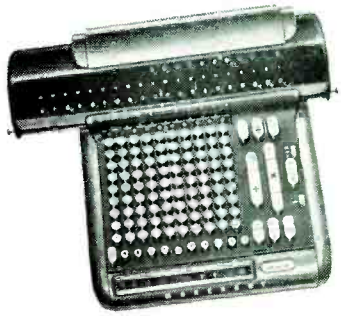
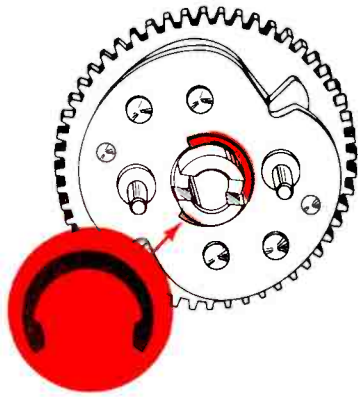
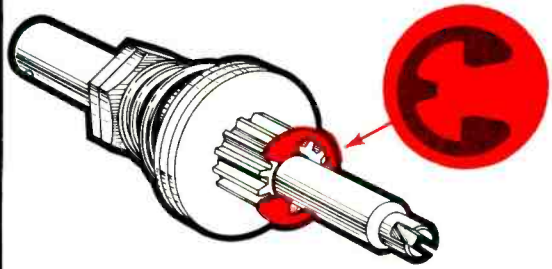
Waldes Truarc Rings speed assembly, facilitate maintenance, improve performance of new automatic calculator



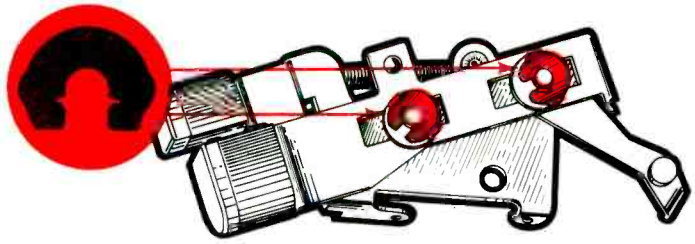
THE NEW MARCHANT DECI•MAGIC
automatic-decimals calculator mode by Marchant Calculators, Inc., Oakland, California.



CRESCENT RING SPEEDS ASSEMBLY, DISASSEMBLY
Main clutch utilizes radially-installed series 5103 crescent ring for rapid assembly and disassembly. Ring's low protruding shoulder provides necessary clearance between ring and the two studs. The main clutch operates each time a Deci-Magic control key is depressed.



E-RING SECURES PARTS AGAINST SPRING THRUST. Slip clutch assembly uses Truarc series 5133 E-ring to hold parts on shaft. Functioning of the assembly is dependent upon the ring's ability to withstand thrust exerted by the heavy barrel spring.



LOCKING PRONG RINGS PERMIT SIMPLE DESIGN. Shift slide assembly uses two Truarc series 5139 bowed locking prong rings to lock the parts together in a sliding fit. Precise amount of spring tension prevents objectionable wobble and noise, permits the key to slide smoothly in operation. Easy radial assembly and disassembly of rings facilitates field maintenance and repair. Alternative construction would have required cut washer, spring washer and hairpin-type spring clip on each stud.

Whatever you make, there's a Waldes Truarc Ring designed to save you material, machining and labor costs, and to improve the functioning of your product.

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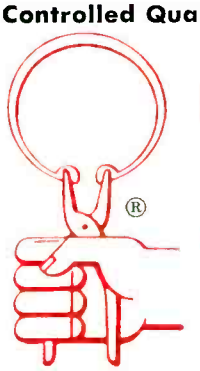

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These test instruments are an example of Cubic's progress in transistorization. This progress enables us to develop special-purpose instruments and equipment for your specific requirements in both military and civilian electronics.

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INSIDE FRONT COVER INSIDE BACK COVER BACK COVER

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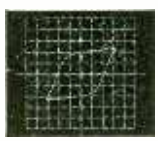
The Type 536 is also an excellent general-purpose laboratory oscilloscope. A new plug-in time-base generator, Type 53/54T, provides the horizontal deflection system with a wide range of sweep rates and extremely versatile triggering facilities.

Ferrite bead characteristics at two different temperatures. These B-H curves were plotted on the Type 536 Oscilloscope with wide band differential plug-in units. Driving frequency was *1 megacycle!* This is but one of the many unique uses for this instrument.



A. At 25° C.

B. Hot (equilibrium temperature due to self-heating).

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VERTICAL and HORIZONTAL DEFLECTION SYSTEMS, with Type 53/54G Units plugged in —

Passbands — dc to 10 mc.
Risetimes — 0.035 μsec.

Deflection factors — 0.05 v/div maximum, 9 calibrated steps from 0.05 v/div to 20 v/div; continuously-variable adjustment between steps.

Relative phase shift — less than 1 degree to 15 mc, less than 2 degrees to 17 mc, less than 5 degrees to 23 mc — provided amplifiers are not overdriven by the input signals.

Amplifier phasing control — phase balance can be obtained at any one frequency to above 25 mc provided amplifiers are not overdriven by the input signals.

Linear deflection — 10 by 10 divisions (3⅛" x 3⅛").

Differential Input

HORIZONTAL DEFLECTION SYSTEM, with a Type 53/54T Time-Base Unit plugged in —

Sweep range — 0.2 μsec/div to 2 sec/div in 22 calibrated steps, with variable control for continuous adjustment from 0.2 μsec/div to 6 sec/div.

Magnifier — 5 x, accurate at all sweep rates.

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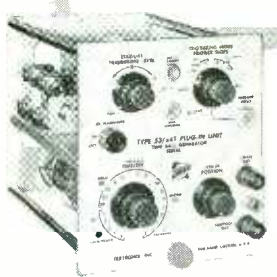

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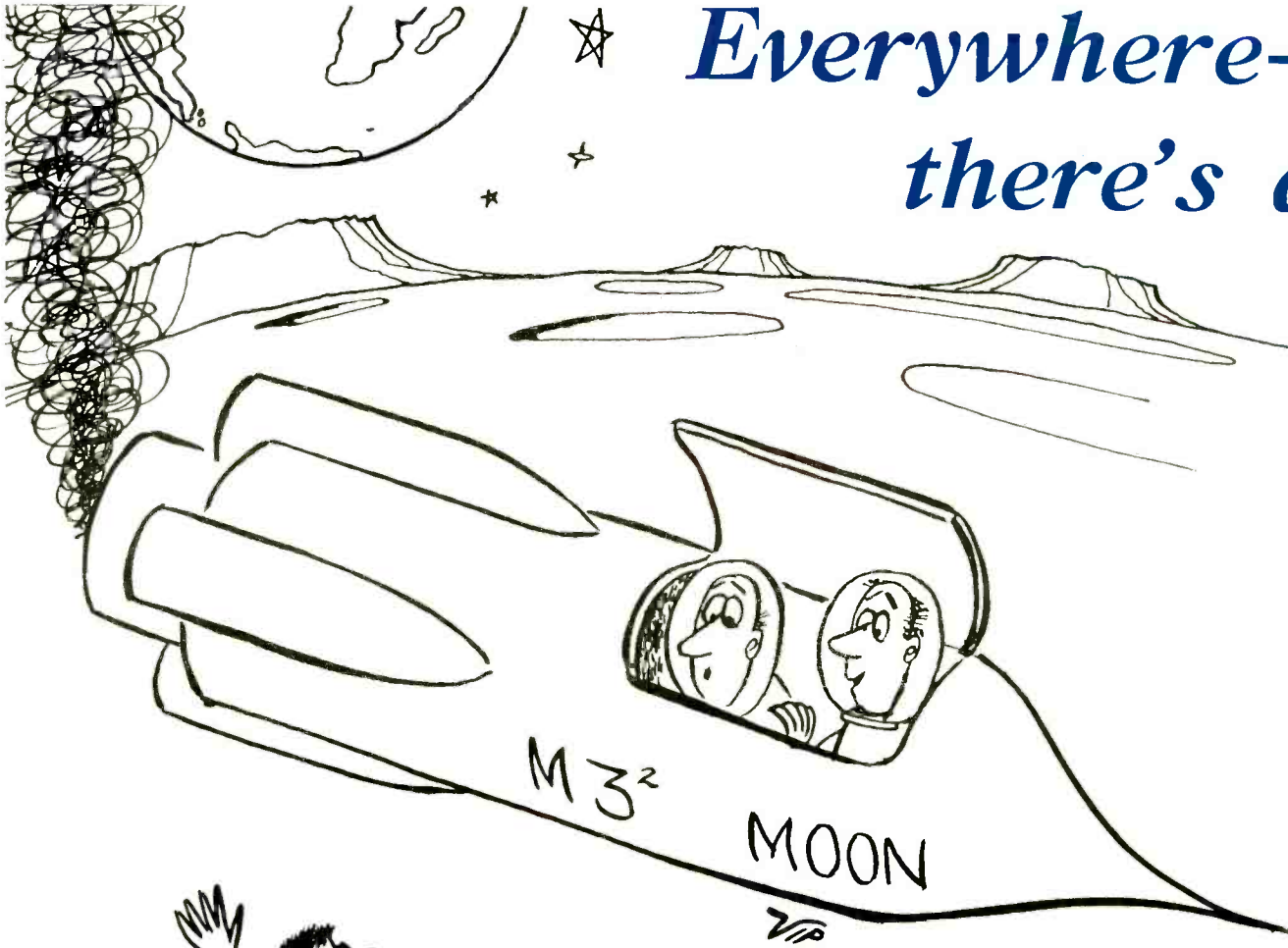

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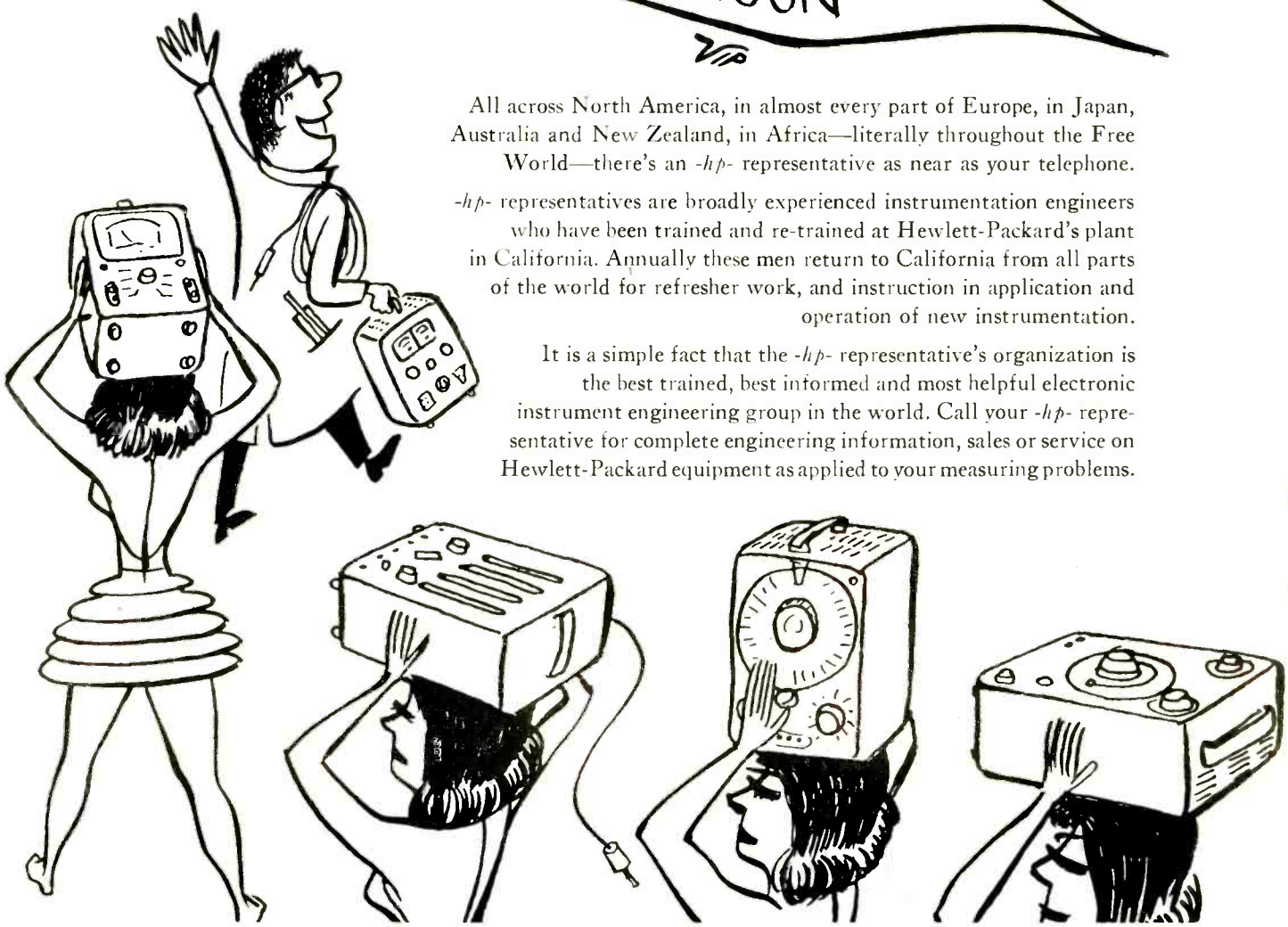

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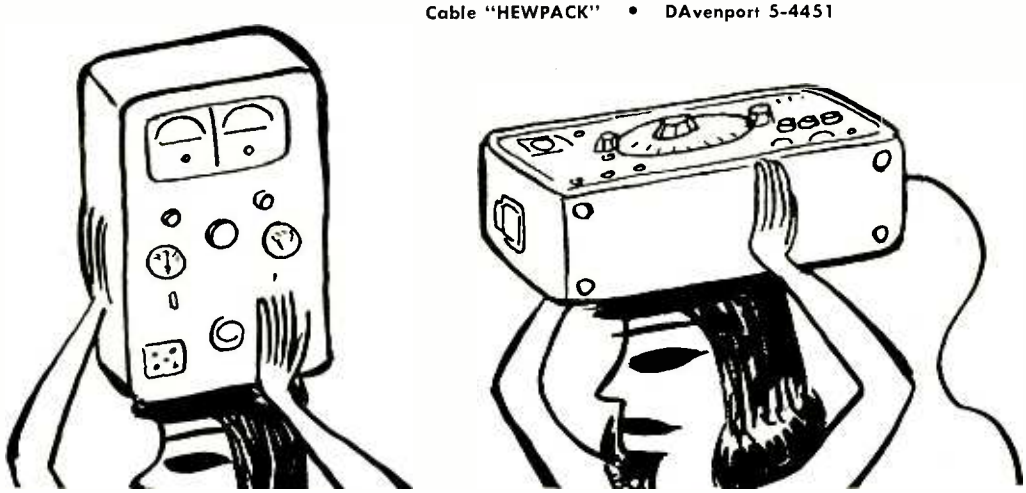

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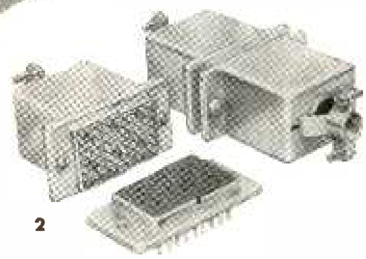

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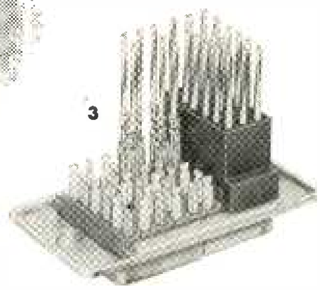

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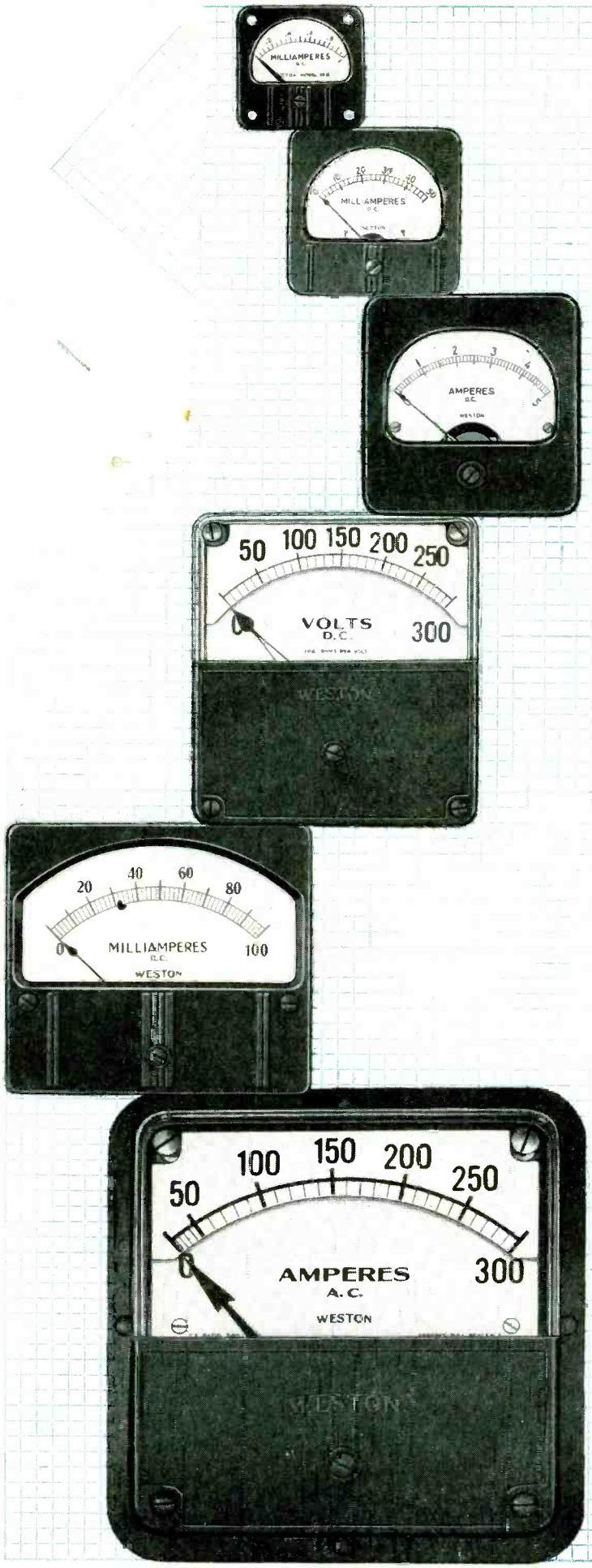

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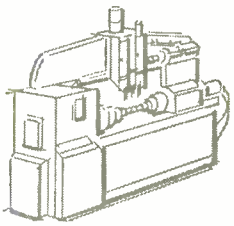

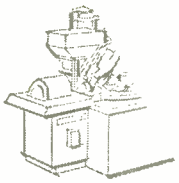

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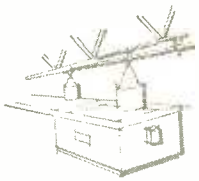

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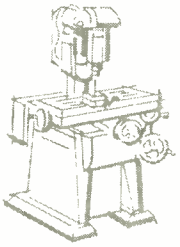

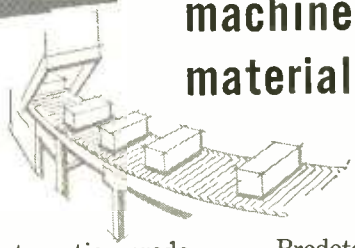

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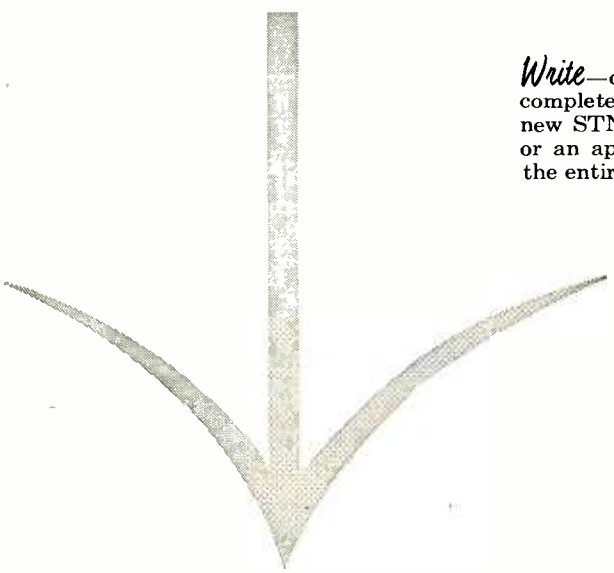

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W. W. MacDONALD, Editor

SEPTEMBER 1 • 1957

CROSS TALK

►**WHO MINDS STORE?** . . . Vacations are wonderful and we certainly have enjoyed the time so far squeezed in between routine publishing emergencies. And it may be that we are prejudiced by the fact that several of our favorite restaurants were closed for weeks following our return to the office. But it does seem to us that this business of shutting down a plant for long stretches works a certain amount of hardship on the customer and must result in some shift of trade.

►**NEW BREED** . . . Evidence is beginning to build up around our best educational institutions that there will soon be a numerically important group of men out in industry programming computers. A cross between a mathematician and a technician and perhaps other things too, such men need a name. "Computer progammer" leaves much to be desired. Who's got the answer?

►**MANPOWER EASING?** . . . Can't measure it, certainly have no statistical proof, don't think it will develop very fast, but we do feel there may be some slight easing of the engineering manpower shortage. If this is so it could be caused by a combination of factors, such as cutback of some military projects, tightening of government allowances for recruiting and research and even some long overdue steadying down on the part of manufacturers in their employment practices.

►**OPPORTUNITY** . . . Fact that manufacturing plants are still loaded with machine tools purchased during the war, and economic considerations that slow modernization, are having two effects. It is becoming increasingly difficult to effect man-hour productivity increases, and the military services are becoming concerned about our standby production capacity.

As this logjam slowly breaks under the impact of competitive pressures there will be increased opportunity for the sale of automatic controls in general and electronic controls in particular; tool programming devices appear to be a particularly good bet.

►**WHISTLE IN DARK** . . . Far be it from us to guess what the general public will or will not go for. But it does seem to us that while shorter television picture tubes are indeed a worthwhile technological advance this and this alone is unlikely to give the fall sales season the sales fillip it needs. We think the boys in the back room, if not those in the front, know it.

LOOKING AHEAD . . .

Sale of prerecorded magnetic tape is moving steadily though inconspicuously upward. Much of it is stereophonic, which may give hi-fi business a needed hypodermic

Competitive struggle between tubes and transistors on basis of size alone is by no means over; ceramic envelopes are one of the keys to smaller tube size

Microwave communications equipment is probably in for a new spurt but time required for studies of spectrum utilization in Washington could delay it until late next year

Watch Japanese technological as well as commercial progress in our field. Both are coming up fast

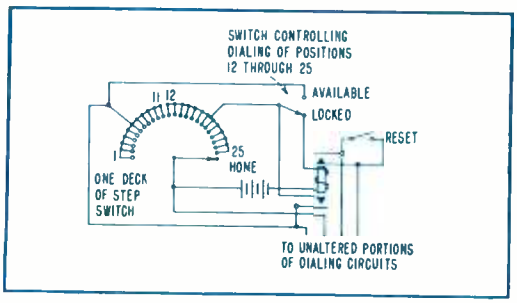


FIG. 1—Modification of step-switch control circuit at remote control point. With switch in locked position as shown, dialing above 11 makes switch return to home position

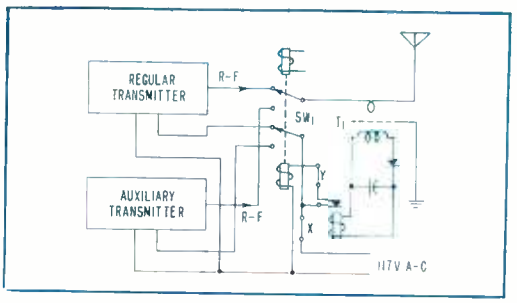


FIG. 2—Simplified automatic antenna shift circuit. Loss of antenna current makes relay drop out, thereby energizing switch solenoid for transferring antenna and power to auxiliary transmitter

SUMMARY —— Completely automatic shift to emergency broadcast transmitter is achieved in less than 24 seconds after loss of regular transmitter carrier, making lost air time much less than is possible with ordinary remote manual control. Complete remote monitoring and remote control facilities are also provided at studio, with fail-safe provisions for both automatic and manual-remote modes of operation

By JAMES H. GREENWOOD
Chief Engineer
WCAE, Inc., Pittsburgh, Pa.

Automatic Changeover

ONE APPROACH to the conversion of existing transmitter plant facilities for unattended operation involves performing manually, at some remote control point, all operations previously performed by an operator on duty at the transmitter location. The other approach involves making the transmitter plant completely self-operating.

With an automatized plant, the lost air time in the event of trouble is much less than would be possible with simple remote operation. Usually it is also less than would occur with an operator on duty using normal manual controls. An automatized plant requires no human attention other than for starting and stopping. The legal requirement of log-keeping must still be performed by an operator, however.

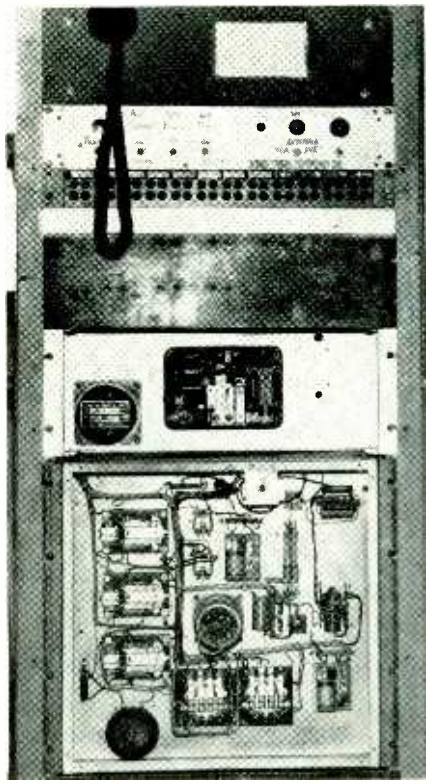
Remote manual control requires less complex equipment and is therefore cheaper to purchase and install. However, more capable human supervision is required continuously at the remote control point.

The WCAE conversion provides both manual-remote and automatic operation, chosen by a selector switch. For normal operation, the automatic mode is used. In case of trouble the manual-remote mode is activated. It then becomes possible to override the automatic operations where desired.

Basic Control System

Commercially available remote control equipment was modified as in Fig. 1 for performing the manual-remote and remote metering operations at WCAE. The manual-remote metering and control positions (12 through 25) are made inaccessible until required, to avoid unintentional operations which would interfere with the automatic operation.

The most important automatic operation needed is the shift from the regular to the auxiliary upon failure of the regular transmitter. The basic circuit for accomplishing this is shown in Fig. 2. A sample of the current going to the antenna is fed through current transformer T_1 and a rectifier-filter system to the relay, holding its contacts open. Loss of power to the antenna permits the contacts to close, feeding power to one of the solenoids operating antenna switch SW_1. This connects the antenna to the auxiliary transmitter and at the same time feeds power to the auxiliary



New automatic changeover controls are in lower half of rack, with modified remote control unit at top. Carrier loss for 8 seconds initiates shift

Antenna transfer switch and associated relays, with dummy antenna and its ammeter on shelf above and carrier-detecting transformer in shielded box at right

Tower insulator, showing how one electrode of original ball-gap was replaced with point and gap reduced to ⅛th inch for minimizing effects of lightning

# of Radio Transmitters

and removes power from the regular transmitter.

A common power switch, connected at X, is used for both transmitters and for the automatic switching equipment to prevent a shift to the auxiliary when the equipment is shutdown at the end of the broadcast day. When the transmitter is turned on, there is a delay of nearly 2 minutes before the regular transmitter will supply power to the antenna. To avoid a shift to the auxiliary during this period, a time-delay relay is used, energized by the same common power switch X, with its contacts connected at Y. This disables the automatic transfer function for the first 5 minutes after application of power. If the regular transmitter has not come on during this time, the antenna shift circuit operates and turns on the auxiliary.

The complete automatic shift circuit is given in Fig. 3. When 5-minute time-delay relay K_8 is closed, current is fed through contacts on relays K_6, K_7 and K_{11} to 8-second time-delay relay K_5. This relay prevents operation of the antenna transfer switch by momentary interruptions such as occur during lightning storms. The 8 seconds covers both the momentary carrier interruption and the following 5 seconds of reduced-power operation provided by the regular control circuit of the transmitter.

Contacts on relay K_{11} are normally closed since this relay is in the fail-safe control circuit for the transmitters, shown in Fig. 4. Relay K_3 is provided to permit intentional carrier interruptions for transmission of Conelrad alerts. It is operated manually from the remote control position and when operated disables the automatic transmitter shift equipment. Another relay, with its coil connected in parallel with K_8, simultaneously cuts the plate voltage and thus stops the carrier.

Auxiliary Operations

The auxiliary transmitter is adjusted to start in 12 seconds. This is made possible by operating continuously the few tubes having indirectly heated cathodes and by having motor-generator plate supply. The total time from loss of the regular transmitter to operation on the auxiliary is thus approximately 20 seconds.

Automatic operation of the antenna transfer switch is provided in one direction only—from the

regular to the auxiliary transmitter. After each such operation the regular must be checked, repaired if necessary and manually returned to the air. Switch SW_2 permits manual operation of the antenna transfer switch in either direction by an operator at the transmitter. This switch is paralleled by circuits to the remote control position, as are all the circuits necessary for checking the operation of either transmitter on the dummy antenna. These circuits are accessible at the remote control position only after unlocking the manual-remote mode of operation.

Relays K_3 and K_4 are necessary only to handle the high currents required by solenoid-operated antenna transfer switch SW_1. These relays are interlocked with the limit switches on SW_1 so they and the SW_1 solenoids are deenergized when the switch has reached the end of its travel even though the activating switch may remain closed. They are also electrically interlocked to avoid the possibility of energizing both simultaneously during maintenance or testing.

Remote Monitoring

Facilities are provided for monitoring the demodulated output of each transmitter at the remote control point and at the transmitter station, whether on the air or on the dummy antenna, as a check on noise, distortion or possible failure of only the audio portion. For simplification, these circuits are omitted from the diagrams.

An indicating lamp is lighted at the transmitter when the antenna is connected to the auxiliary transmitter. At the remote control point, when the control position for operating SW_1 is dialed, the associated metering circuit indicates the position of SW_1. A high meter reading indicates that the regular transmitter is connected to the antenna, and a midscale reading that the auxiliary is connected. If the switch sticks in an intermediate position, a low meter reading is obtained. A zero reading indicates failure of the indicating circuit.

Going on the Air

Figure 4 shows the circuits for turning the transmitters on, in both the automatic and the manual-remote modes of operation. Each mode includes the fail-safe features required by the FCC as well as by logical considerations of safety. Relay K_9 is operated by the master power circuit on the remote control equipment. Failure of the remote lines opens this circuit. A local switch is connected in parallel with the remote master power circuit so an operator on duty can take advantage of the automatic features. An indicator lamp across the coil of K_9 shows when the transmitter control circuits have been energized, either locally or by remote control.

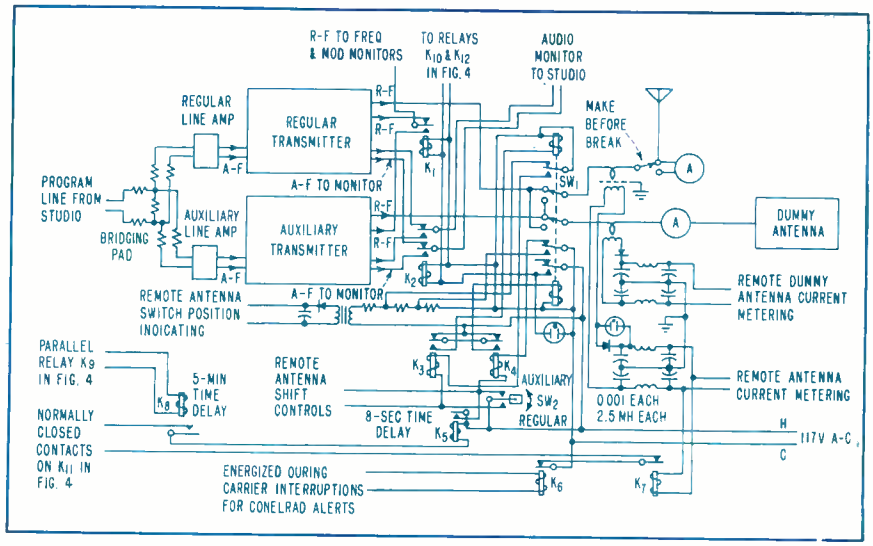


FIG. 3—Complete automatic antenna shift circuit. Audio is fed simultaneously to both transmitters through bridging pad and additional line amplifier

Relay K_{10} is normally not operated, but is energized by contacts on SW_1 of Fig. 3 whenever the antenna is switched to the auxiliary transmitter, Normally open contacts on relay K_9, in series with normally closed contacts on relay K_{10}, connect to the regular transmitter start switch. When relay K_9 is operated, the regular transmitter comes on and stays on until relay K_{10} operates. Loss of r-f to the antenna shifts the antenna to the auxiliary transmitter and operates relay K_{10}, thus removing power from the regular transmitter. In a similar manner, power is supplied to the auxiliary transmitter by normally open contacts on relay K_9 in series with normally open contacts on relay K_{10}.

Power may be reapplied to the regular transmitter for checking its operation on the dummy antenna by operating latching relay K_{11}. This relay may be operated both from the remote control position and at the transmitter plant. When operated, an additional pair of contacts disables the automatic antenna shift equipment. This permits manual return of the antenna to the regular transmitter, which deenergizes relay K_{10}. Power is then supplied to the regular transmitter

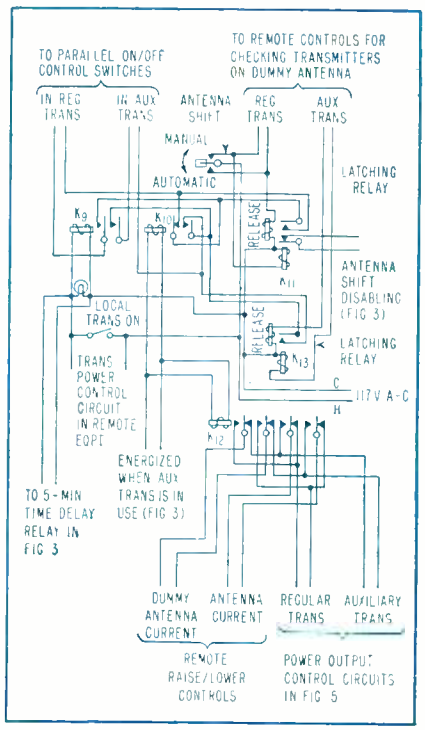


FIG. 4—Fail-safe controls for regular and auxiliary transmitters, with provisions for overriding automatic control when required

by relays K_9 and K_{10}. Relay K_{11} is manually released, reactivating the automatic antenna transfer facilities.

Latching relay K_{13} performs similar functions for the auxiliary transmitter, except that in this case there is no need to disable the automatic antenna transfer equipment. After any such check of either the regular or the auxiliary transmitter latching relays K_{11} and K_{13} must be returned to their normal positions. Since these relays can be operated from the remote control position only with the equipment in the manual-remote mode, all return-to-normal controls are operated as the last step in any use of the manual-remote mode.

Means are provided at the remote control point for manually raising and lowering the power outputs from each transmitter. The increase and decrease operations associated with metering of antenna current control the output power of whichever transmitter is feeding the antenna. This is accomplished by relay K_{12} in Fig. 4. Its coil is connected in parallel with relay K_{10}, which is operated when the auxiliary transmitter is connected to the antenna. Thus, in the operated position of relay K_{12} the antenna current increase and decrease control circuits are connected to operate the power output increase and decrease motor relays on the auxiliary transmitter. Likewise, when relay K_{12} is unoperated and the regular transmitter is feeding the antenna, the antenna current increase and decrease control circuits are connected to control power output of the regular transmitter. Remote control circuits for raising and lowering dummy antenna current are similarly routed to the correct transmitter by relay K_{12}.

Metering and Controls

Antenna current metering and the associated increase and decrease controls are available in the automatic mode of operation, since antenna current is required to be logged. Metering and controls for dummy antenna current are accessible only in the manual-remote mode. A servo loop for maintaining antenna current within tolerance was not found necessary. The regular transmitter is already equipped with an automatic line-voltage regulator which effectively accomplishes this after initial warmup. Since it is necessary in any case for the remote operator to read and log antenna current, the additional burden of adjusting it during the first half hour of operation is negligible.

Upon shutting down the transmitter, the power output is automatically reduced to a preset value. The value is chosen to give an antenna current slightly below normal when the transmitter is cold. This avoids overloading the transmitter at sign-on the next morning.

Alarm Circuits

With automatic equipment for placing the auxiliary transmitter in operation, the remote operator must know that this has been performed. Circuits for providing this alarm are shown in Fig. 5, together with the power output controls for the auxiliary transmitter. When it is not operating, relay K_{14} is deenergized. It remains so when the transmitter is first turned on, whether automatically or manually. In this condition, a-c is fed through the 0.25-μf capacitor to one side of the audio monitor circuit in the transmitter, producing a hum in the monitored signal at both local and remote monitors. Upon hearing this alarm signal, the operator checks all his circuits and thus confirms that the auxiliary is in use. One of the circuits which he checks is the antenna current, which will be slightly low. Operating the increase antenna current control operates increase relay K_{15} in Fig 5 and also operates relay K_{14}. Once operated, a second coil holds it closed, removing the hum from the audio monitor circuit. When the transmitter is shut down, relay K_{14} is deenergized, operating decrease relay K_{16}. This runs the power output control motor until the low-limit switch is opened.

Since the two coils of relay K_{14} are fed from separate a-c sources, it is necessary that they be in phase at the relay to secure stable operation. It is likewise necessary to maintain the same phase for the a-c power to all portions of the control equipment. In the various circuits shown, the a-c polarity is indicated by *C* for common and *H* for hot.

Both transmitters are equipped with overload protection. After the first operation of the overload relay, half of normal plate voltage is immediately reapplied, and after 5 seconds is raised to full value. After a second overload, the same sequence occurs. However, if not manually reset in the meantime, a third overload will permanently remove all plate voltage. An indicator lamp lights upon the first overload and remains lighted until the relay has been reset.

The remote operator is provided

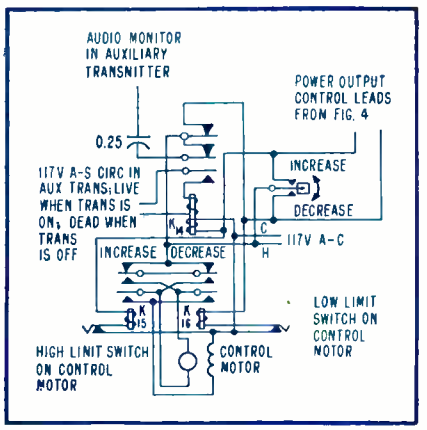


FIG. 5—Power output control and in-use alarm for auxiliary transmitter. Controls for regular transmitter are same except for omission of alarm

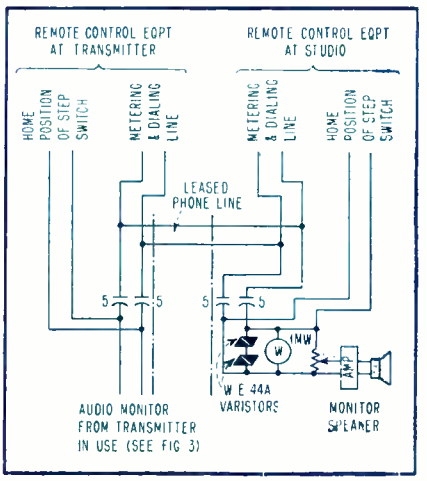


FIG. 6—Audio monitor is fed from transmitter to studio continuously over line used also for metering and dialing in remote control equipment. Varistors suppress dialing clicks from audio

with an overload alarm, a manual reset and an automatic reset. The alarm is a hum superimposed on the audio monitor which is fed from the transmitter output by a phone line to the control point and continuously monitored there. This hum is obtained from the overload indicator lamp and is fed by a transformer and pad of suitable value to the monitor circuit.

Overload Reset

The automatic overload reset waits 15 seconds after the first overload, then resets the overload relay. However, it is so connected with the transmitter control circuits that it functions only after one or two overloads. If the overload relay is tripped three times within 15 seconds, the plate voltage stays off until manually reapplied.

The hum which indicates an overload does not differ appreciably from that which indicates use of the auxiliary transmitter, though it does differ in other respects. With the automatic overload reset functioning, this sum is removed in 15 seconds. Should the operator prefer to reset the overload relay manually before the 15 seconds has elapsed, this operation will remove the hum. If the hum remains after manual reset or continues for more than 15 seconds, he reads the metering circuits provided and thus determines the exact status of the equipment.

Failure of the regular transmitter is normally accompanied by an overload and its indicating hum. In this case, after 8 seconds the auxiliary transmitter is substituted for the regular, and at the same time the overload-indicating hum is replaced by the auxiliary-in-use indicating hum, which then remains until appropriately acknowledged by the operator.

Power Failure

Protection against power line failure is important at any transmitter plant. Two separate feeders bring in the a-c power, with automatic power-distribution type switchgear for selecting between them. This switchgear incorporates a 7-second delay so that momentary power dropouts do not actuate it. Except in very unusual situations any power interruptions will thus be 7 seconds or less. However, even a momentary interruption could result in a much longer period of lost air time, since all the time-delay relays in the transmitter would drop out. When power is restored again the normal transmitter start cycle takes about 2 minutes. The auxiliary does not come on in this case, despite loss of carrier, since the 5-minute time-delay relay disables the automatic shift just as it does at sign-on.

The time-delay relays in the regular transmitter prevent application of plate voltage until the mercury-vapor rectifiers and other tubes are up to operating temperature. When there is a momentary interruption of power, a different type of time delay is advisable. The tubes being protected cool off at approximately the same rate at which they warm up. Thus if power is removed for only 7 seconds, an additional 7-second delay before reapplying plate voltage is all that is required. Special relays of this type were unobtainable, and therefore available pneumatic time-delay relays were altered to provide this type of operation.

The automatic power-line-selecting switchgear also required modification. The two power lines are each three-phase. Occasionally only two phases fail. The sensing element for initiating the power-line shift, as originally installed, was single-phase. Thus the auxiliary power line would be placed in service only if the particular phase of the regular line to which the sensing equipment was connected should fail. This unacceptable characteristic was corrected by adding a relay across the second phase. In some 4-wire systems it may be necessary to provide two relays with contacts in series, with the coil of the second relay connected across the third phase.

Conventional compression and limiting amplifiers automatically maintain correct modulation level. Frequency stability is achieved by crystal control, where the performance has been so satisfactory that no servo loop is justified.

The manual-remote mode of operation employs a modified commercial remote control unit. Two metallic pairs are used between the control point and the transmitter. One pair is used for metering, operation of the step switches and (by capacitance coupling) audio monitoring of the transmitter output. The second line operates the controls selected by the step switches, and (by capacitance coupling) feeds a phone circuit. Figure 6 shows how the equipment was modified to permit a single line to be used for audio monitoring and for dialing and metering without mutual interference.

Achieving Reliability

Automatized operation can be successful only if all equipment is highly reliable. In a broadcast plant there is one unpredictable element—lightning—which complicates any evaluation of reliability. The specific points at which lightning has in the past caused trouble should all be studied and changes made to minimize a recurrence of the trouble. A good starting point is at the antenna. The lightning gap across the base insulator should be just large enough to prevent a sustained arc by the transmitter. With a point electrode this distance can be much smaller than with ball electrodes.

In Fig. 3, a neon lamp is shown connected across the diode in the antenna current metering circuit. This provides over-voltage protection for the diode during lightning surges.

All indicating lamps in 117-volt a-c circuits are neon since they have an almost unlimited lifetime. The absence of an indication can be as misleading as a false indication.

Any points of repeated trouble should be studied and the cause of the trouble eliminated if possible. All rectifier tubes in low-voltage power supplies were replaced with selenium or silicon units. Tests are now being conducted with the object of replacing the high-voltage rectifiers also with silicon units.

Automatization of the WCAE transmitter plant has been highly successful. This could not have been the case except for the extensive and whole-hearted assistance of the complete operating staff during the planning, installation and subsequent operation.

Magnetic Tape Controls Projector Synchronism

By JAMES N. WHITAKER

Senior Member Technical Staff
Systems Development Labs
Hughes Aircraft Company
Culver City, California

SUMMARY —— Power-frequency control signal and movie sound share dual-track tape to synchronize picture to audio. Sync signal from projector supply line modulates tape through filament transformer and auxiliary record head without erase or bias. During projection, amplified control signal is fed to synchronous motor coupled to projector power train. Auxiliary motor acts as synchronous brake on projector which is adjusted slightly above frame rate

EXAMINATION of the many systems devised for synchronizing sound to narrow-gage motion-picture film indicates that most of them are complicated for amateur use, expensive, low in audio quality or not fully automatic. These shortcomings are avoided by a system of coincident sound comprising a tape recorder modified by adding a head to record and reproduce a synchronizing tone, an amplifier producing 10 watts of power from the output of the auxiliary head, and a projector arranged for speed control from the synchronizing amplifier. The modifications to both the tape recorder and the projector are relatively simple.

Tape Control Signal

Figure 1 shows the recording system with signals from a microphone and a phono pickup mixed and half-track recorded on magnetic tape, while a 60-cps tone from the projector power line is recorded on the adjacent track.

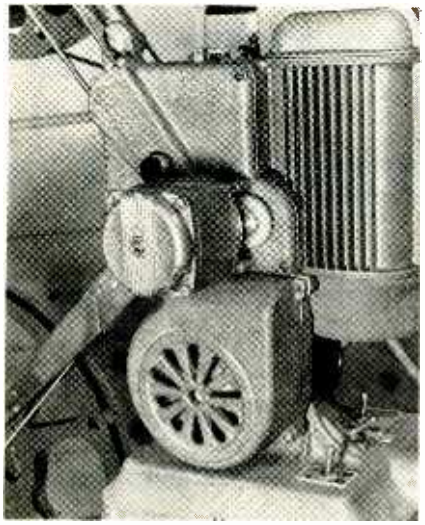
Figure 2 shows the reproducing system with the audio track going to the sound channel, and the 60-cps signal fed through the synchronizing amplifier to control the speed of the synchronous motor on the projector.

Hence the power line frequency which controls the projector speed during recording is simultaneously recorded on tape for subsequent control during playback. The reproduced sound and the image projected on the screen will therefore remain coincident during playback to the same degree that they were during recording.

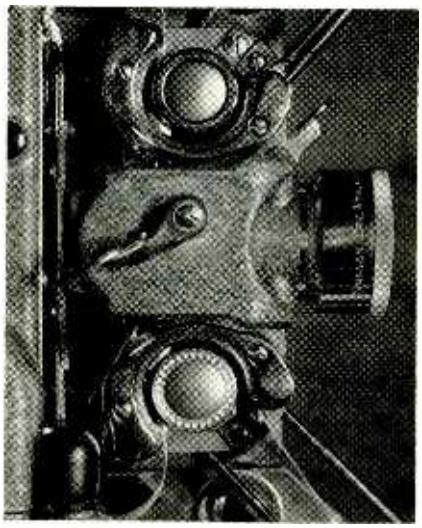
Threading and Cueing

To assure the starting of the tape at the proper time with respect to the film, cue points are

Simplicity of operation assures successful results in hands of novice. Auxiliary head is integral part of tape recorder shown



Control motor coupled to projector drive



Lower sprocket hub forms stroboscope

established on both media. A convenient method is to affix narrow strips of pressure-sensitive tape to the film leader and to the back of the recording tape. When the tape machine is threaded up, the cue marker is positioned at some definite point. The projector is then started, and as the cue marker on the film leader passes a pre-determined point, the recorder is started and the tape assumes control of the projector speed.

The system can also produce "lip sync" by recording the sound simultaneously with photography, with the camera driven or controlled by a synchronous motor. The tape is later edited into the final sound track just as the filmed sequences are cut into the completed picture. System details will depend upon the equipment used, but most standard tape recorders and motion-picture projectors may be modified to a coincident sound system.

Mechanical Assembly

Projectors are usually equipped with a hand knob for checking film threading, which is connected directly to the shutter shaft. It then operates at one revolution per frame, or 16 rps when the projector speed is 16 fps. This knob may be removed and replaced with a gear, providing a convenient coupling to the synchronous motor.

The motor shaft usually rotates at 30 rps and the gear ratio between motor and projector should therefore be 30:16. A 48-pitch 32-tooth gear with a 1/8-in. face on the motor and a mating 60-tooth gear on the projector are an ideal standard combination. Although gear noise is not serious, the use of a fiber or nylon gear with one of metal will result in noise reduction. The loss of the testing knob presents no problem, as the projector motor switch can be snapped on and off quickly for a threading test.

When mounting the synchronous motor to the projector it is supported on studs attached to the gear housing. These studs have one end tapped in the center and the other end tapped off center. The resulting eccentricity permits a slight adjustment of the motor position for optimum meshing of the gears. The motor may also be mounted on a separate metal plate which in turn is secured by the gear cover plate mounting screws. This is recommended for projectors where the hand knob is in front and the gear cover plate is too small for the synchronous motor.

The motor found most satisfactory for this application is Bodine type KYC26. This is an instrument chart drive motor, requiring only 10 watts of power at 1,800 rpm.

Speed Indication

Since this system provides for speed control rather than for positive drive, a projector speed indicator is desirable. A small neon lamp operated from the synchronous motor power line will provide a stroboscopic light source. This illuminates the end of the lower film sprocket around the periphery of which 30 equally-spaced holes have been drilled and filled with white paint.

The sproket contains eight teeth, and rotates twice per second when the projector speed is 16 fps. When the sprocket is illuminated by a 60-cps light source, the circle of white dots appears stationary. If the control fails, the dots will appear to rotate forward or backward, depending upon whether the projector is running fast or slow. For any other sprocket speed, frame rate, or number of sprocket teeth T, the number of strobe seg-

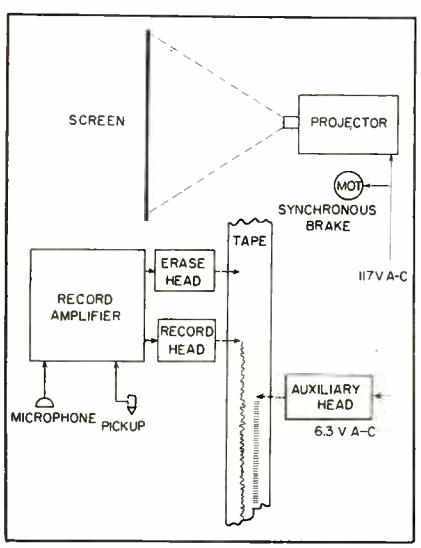


FIG. 1—Stepped-down projector voltage supplies sync signal during recording

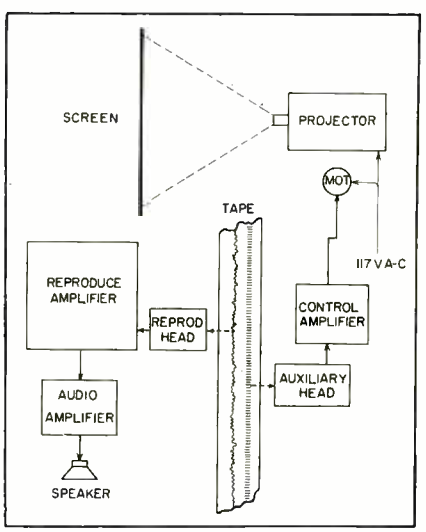


FIG. 2—Amplified control signal holds picture to sound speed during screening

ments may be calculated from $(2 \times cps \times T)/(rps \times fps)$.

The recorder modification involves mounting an auxiliary record-reproduce head at a convenient point where the signal track on the tape will pass over the head gap. Recorders equipped for binaural recording and playback require no modification. The 60-cps signal is applied to the second channel for recording through a bridging circuit, and its output is fed to the synchronizing amplifier on playback. On other recorders the Brush BK1090 head works well and is easy to install, since it requires only a single mounting hole.

Recording Sync Signal

Where an auxiliary head is installed on a standard half-track machine, the synchronizing tone is recorded without bias. Six volts from the cathode heater supply is applied directly to the winding of the head. This produces complete saturation of the tape and results in a series of "blocks" of oxide which are of alternating polarity. It also automatically erases any previous recording. The waveform is shown in Fig. 3A. When the head is resonated at 60 cps a reasonably good waveform may be reproduced from the pulses as shown in Fig. 3B.

The synchronizing amplifier may be any one capable of delivering 10 watts at 60 cps from the output of the auxiliary head, and having an output impedance of 500 ohms. Although this does not exactly match the impedance of the motor, it is quite satisfactory.

Voltage Regulation

Stray magnetic fields are often present in the vicinity of the motors and transformers of popular-priced recorders. These fields may induce a low-level 60-cps voltage in the auxiliary head, resulting in a slow beat with the signal from the tape. If this causes the output of the synchronizing amplifier to vary more than 10 volts, it will be desirable to arrange for some limiting action.

Any standard limiter circuit may be used, or it may be introduced into the power amplifier stage itself. A resistor of moderately high value inserted in series with the grid of each tube will provide all of the limiting necessary.

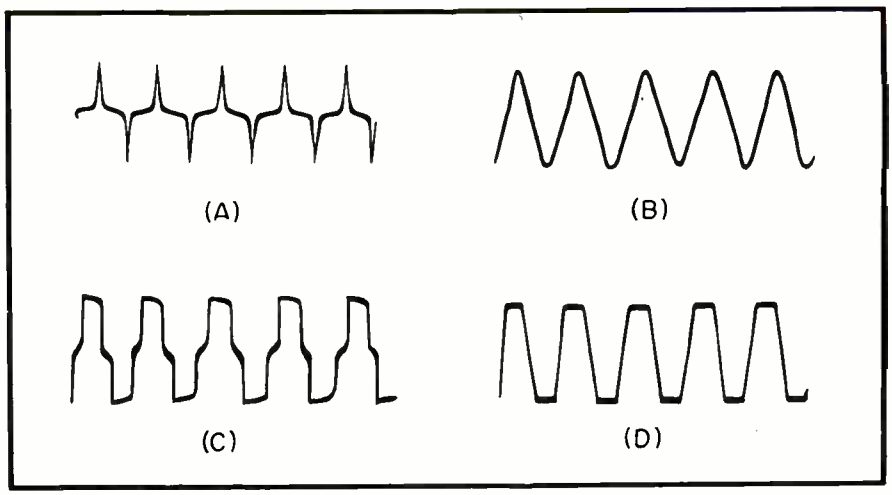


FIG. 3—Control-signal waveforms at output of auxiliary head (A), input to sync amplifier (B), output of amplifier after limiting (C) and input to motor (D)

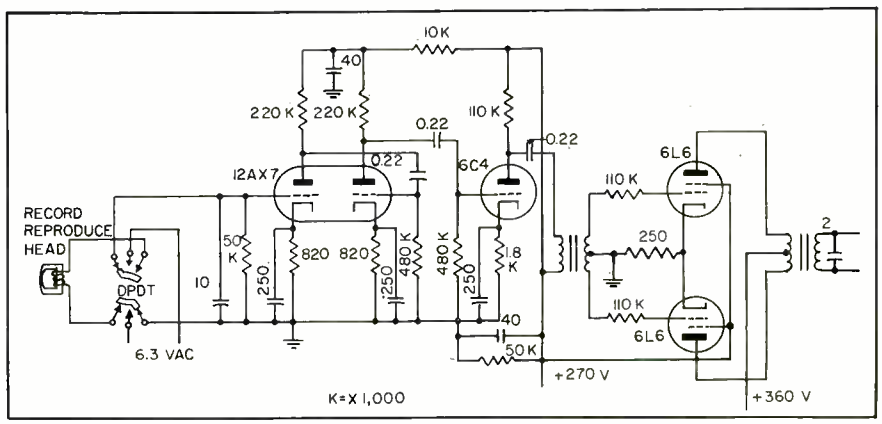


FIG. 4—Circuit of synchronizing amplifier. Resistors in push-pull grids provide voltage limiting, and capacitors across input and output resonate head and motor

Limiting will introduce distortion, but it is of little consequence in this application since the synchronous motor is insensitive to it. Since the motor represents an inductive load, a power factor correction capacitor will improve the overall performance and output waveform.

A suitable synchronizing amplifier is shown schematically in Fig. 4. A switching arrangement either feeds 6.3 v to the head or applies the output of the head to the amplifier. The circuit is conventional except that the input includes a 10μf capacitor for resonating the recommended head at 60 cps, the output stage includes limiting resistors, and a power factor correcting capacitor is shunted across the output transformer.

The amplifier should be adjusted to produce an output of 110-130 v when connected to the motor load.

Some adjustment is obtainable by changing taps on the output transformer or by varying the screen grid voltage on the output stage. Since limiting is involved, the adjustment must be accomplished in the final stage.

Signal Waveforms

The limited output waveform is shown in *C* of Fig. 3 and the waveform as modified by the power factor capacitor is shown at *D*. While this departs appreciably from a sine wave it is quite satisfactory for driving the synchronous motor.

The control motor is operated as a synchronous brake rather than as a motor. The best performance results from overdriving the projector with its own motor while using the synchronous motor to hold the mechanism down to speed.

Video Recorder Trains

By RALPH M. HEINTZ

Senior Research Engineer
Television Laboratory
Stanford Research Institute
Menlo Park, California

SUMMARY — Airborne unit, designed around conventional ppi radar indicator, records video output of the operating radar directly on 35-mm film. Intensity-modulated crt with stationary sweep is continuously photographed by moving film, synchronized with rotation of radar antenna. Ground-based playback consoles, with range and azimuth-mark generators, permit trainees to measure or interpret target situation

REALISTIC and reliable presentations of airborne radar observations can be obtained if the video output of an operating radar is stored permanently for later reproduction. Storage of the video information eliminates the need for complex scale models, or more complex electronic generators and provides as much latitude in the reproduced picture as with the original radar. In addition, the video recording can be replayed indefinitely for either training or operational briefing or meteorological use.

Conventional 35 mm movie film was favored as a recording medium because of ease of synchronization, high storage capability and very low rate of travel. In addition, reproductions of the master recordings are made easily and are not subject to accidental erasure as may be the case with magnetic recordings.

Recorder and Playback

The complete trainer consists of two basic pieces of equipment, an airborne recorder and a playback system.

The airborne recording unit stores video and synchronization information on 35-mm film directly from radar output signals. The playback unit recovers the recorded information and supplies it, together with all the necessary synchronizing and operating voltages to one or more ground based radar indicators.

Figures 1 and 2 show simplified block diagrams of the recording and playback systems, respectively.

For recording, a cathode-ray tube trace is intensity-modulated with the radar video signal and is swept in synchronism with the range sweep of the radar. The trace is maintained in a fixed position with respect to an optical system which produces a reduced image of the trace on continuously moving 35-mm photographic film. The image appears at right angles to the direction of film travel. Image magnification of the full trace occupies approximately eighty percent of the available film width.

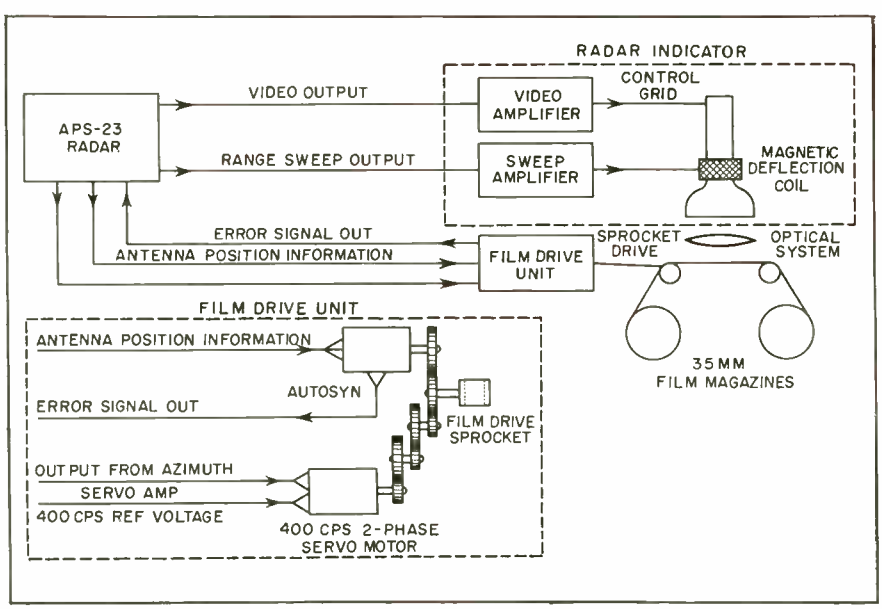


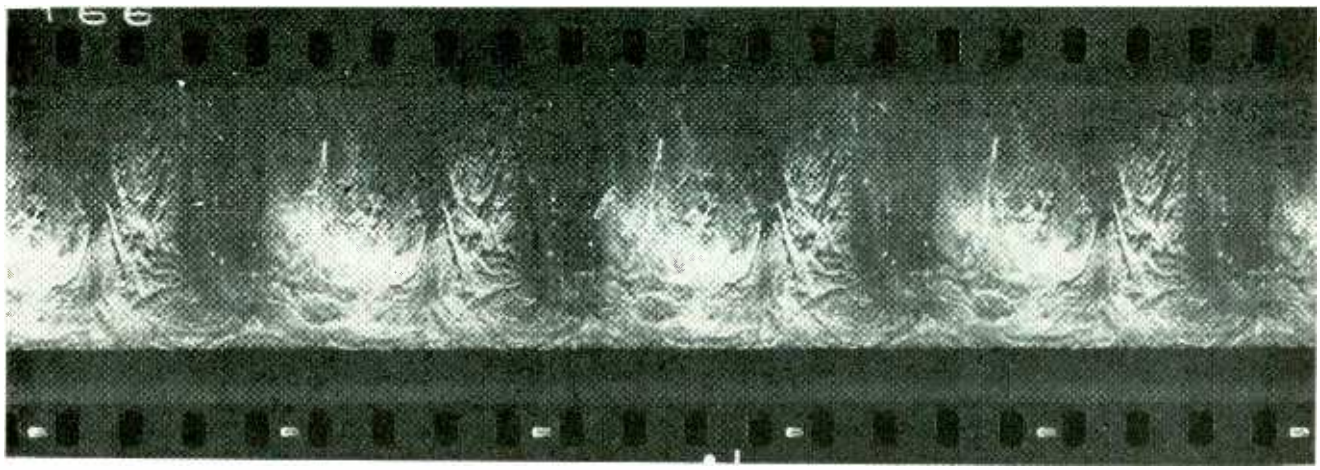
FIG. 1—Block diagram of the recording system. A cathode-ray tube trace is intensity-modulated with the radar video signal and is swept in synchronism with the range sweep of the radar

Synchronizing

Film travel is determined by rotation of the radar antenna. A servo link, similar to that used to rotate the deflection yoke of a radar indicator, is coupled to the drive sprocket of the recording camera. As the antenna rotates, positional information is continuously fed to the recording camera and the film is driven accordingly. Consequently, a given length of film will always correspond to a specific angular displacement of the antenna.

Since commercial film maintains

RADAR OBSERVERS



Film recording of airborne radar observations stores video and synchronization information on conventional 35-mm film. For film playback, the original negative is printed on clear-base positive stock to remove attenuation effects of grey-base film and prefogging

extremely close tolerances on sprocket hole size and position, this drive system provides a highly accurate method of assuring azimuth synchronization. In effect the synchronizing signal is locked into the sprocket holes.

Because of the large amount of redundant information in successive radar sweeps it is possible to permit some overlap of the exposure from adjacent sweeps. Instead of recording a series of discrete lines, with each line containing a larger amount of information in common with its immediate neighbors, the system records an integrated picture which has the appearance of a distorted view of the radar scope.

A flying-spot scanner and camera arrangement, similar to that used in the recording process, recovers the recorded information. A constant-intensity cathode-ray spot is swept linearly across the face of the scanner tube and an image of the trace is focused on the exposed area of the film. The magnified image covers the full width of the exposed area. A phototube, located behind the focal plane, receives the light transmitted through the film and converts the light-intensity levels into video voltages. Phosphor persistence on the scanner tube is very short compared with the sweep rate and the total light reaching the phototube at any instant may be considered as illumination entirely from the spot, the residual light from phosphoresence being negligible.

Video output of the phototube is amplified and applied to a radar indicator whose sweep is synchronized with that of the flying-spot scanner. Thus, target information appears at the proper radial distance on the indicator. Range relationships from the original radar presentation are preserved in the reproduction.

Film travel in the playback system is controlled by a synchronous motor driving a servo generator, which supplies signals to operate the film drive unit shown in Fig. 1, and the yoke rotation systems of one or more radar indicators. A synchronous drive motor provides an accurate time base for repeating runs simulating the same air speed.

The airborne recording unit is

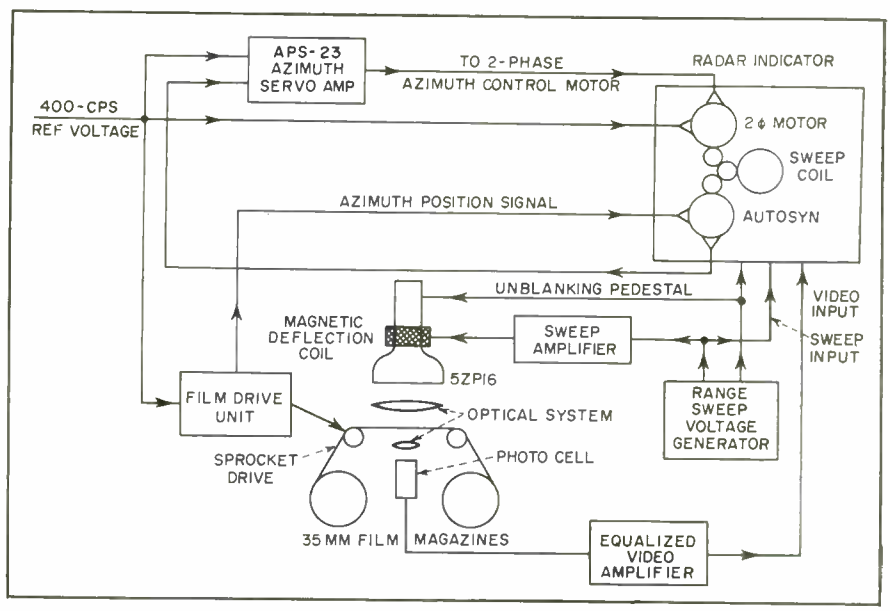


FIG. 2—Block diagram of the playback system. A phototube, located behind the focal plane, receives the light transmitted through the film and converts the light intensities into video voltage variations

designed around a conventional ppi radar indicator. Two major changes in the indicator were required to adapt it to video recording. The long persistence, P-14, crt was replaced with a short persistence P-5 tube having the same electrical and mechanical characteristics; the deflection yoke gearcase was removed completely and the yoke was clamped in a position to produce only a horizontal trace. The complete gearcase was then built into a Fairchild Oscillo-record camera in place of the normal drive system.

Camera and indicator are mounted on a rigid base at the proper focal distance since fixed focus operation is used at all times. A light-tight housing including a bellows in the breadboard model couples the face of the indicator to the camera lens. Within the housing, but out of the camera field, a phototube monitors the light output from the crt for photometric purposes. Video output from the phototube, corresponding to the video information being recorded, is presented as a type A display on a small calibrated oscilloscope. Proper video and brightness levels, set at the beginning of each run, are checked periodically during the run.

Since the actual exposure depends on integrated light reaching the film while the monitoring oscilloscope displays only instantaneous values, it is necessary to compensate for changes in pulse repetition frequency and radar range, that is, sweep speed of the cathode ray spot. A modified agc circuit samples the duty cycle of the sweep voltage and adjusts the gain of the monitor scope amplifier accordingly.

Gearcase for the recording camera

The recording unit receives all necessary signals and most of the required operating power from the radar with which it is used. Exceptions include power supplied to the monitoring and agc circuits. Power for these circuits is obtained from regulated supplies operating from the aircraft 400-cycle lines. Conventional 60-cycle supplies were used in the breadboard model shown. For exclusive airborne use, an integrated 400-cycle supply would cut the size and weight by about 60 per cent.

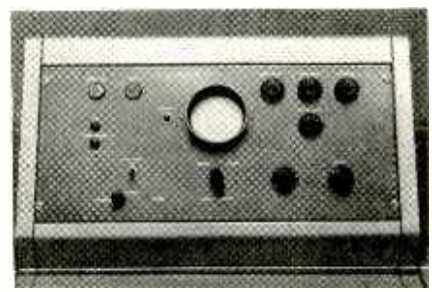
The playback unit, a completely self-contained console requiring only 115-volt 60-cycle primary power, is designed primarily as a master station from which a number of remote indicators can be controlled. However, since it has a complete operating indicator, it may also be used as a training station.

Special optical and mechanical requirements for the scanning and film transport equipment made it more practical to design and build a special unit rather than use a commercially available camera. A photomultiplier and condensing system was mounted behind the focal plane. A servo drive for normal playback operation was designed with rapid traverse—approximately 250-times normal speed, in either direction for quick film positioning or rewind. In addition, the use of a 25-kv crt requires special precautions to prevent operating personnel from exposure hazards.

Range and Azimuth

Although the playback unit reproduces the original radar picture with fairly high fidelity, its usefulness as a training aid is enhanced by the addition of electronic range and azimuth-mark generators which permit each trainee to measure or indicate target location independently. Signals from the generators are mixed with the video output from the scanner to

Self-contained console of playback unit, designed primarily as a master station from which a number of remote indicators can be controlled, is used as a training station, since it is provided with a complete operating indicator



All adjustments for normal operation of the playback console are made from the control panel

produce a composite picture on the indicator.

Range indication on the scope is a bright spot which describes a circle about the origin as the ppi trace rotates. Azimuth indication is given by a bright radial line occurring when the ppi trace coincides with the predetermined direction. The intersection of the azimuth line with the range circle describes the coordinates of the selected point. Azimuth and range marks may be positioned either by the instructor to point out a particular target, or by a student, at a remote station, to indicate his interpretation of the target situation. In either case the marks appear identically on both indicators.

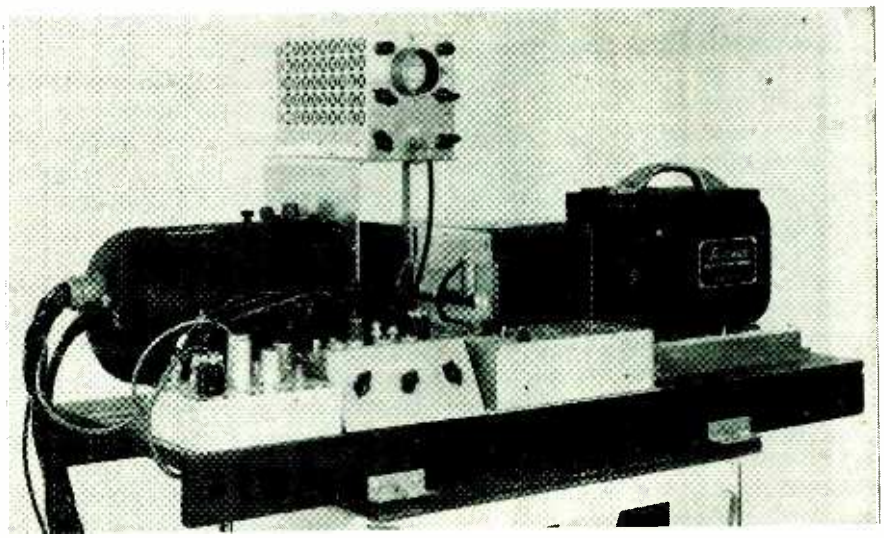
Playback Controls

The number of operating controls on the playback console has been kept to a minimum. Two controls deal with the mechanics of recovering the information. The centering control positions the scanner trace so that its image coincides with the recorded area of the film, while the orientation control adjusts the phasing in the servo system to provide the proper (north or ship's heading) orientation of the reproduced picture on the indicator.

The video gain and brightness controls, respectively, adjust photomultiplier gain and cathode-ray tube bias. These two quantities. jointly determine the amplitude of the video signal applied to the indicators. The two parameters are made variable because they can be used to alter the picture quality while maintaining constant video output level. With high video gain and low brightness level, the photomultiplier noise becomes an appreciable influence in the total video output and the resulting picture simulates low gain output of the radar. Conversely, high gain operation may be simulated by increasing the scanner trace brightness and reducing the video gain accordingly. A monitor scope providing a type-A presentation of the video signal permits accurate maintenance of the proper video output level.

Other controls involve positioning of the electronic cursors, advancing or rewinding the film, and calibrating the monitor scope. A system of limiting and protective circuits prevents damage to the equipment due to a faulty adjustment of the main panel controls.

The video recording unit employs conventional 35-mm film developed to a gamma of approximately 0.7. The factor limiting resolution in the recorded image is the size of the cathode-ray spot rather than the resolving capability of the film; therefore, the fastest film available minimizes the recording spot intensity and size. Because of its general availability, Tri-X film has been adopted as the recording standard.



Breadboard model of the airborne recording unit employs an indicator from the AN/APS-23 radar unit

Film travel is set at approximately one inch per revolution of the antenna, which, for the AN/APS-23 radar in normal operation, corresponds to about 0.4 inch per second. At this rate the standard 100 foot roll of film gives approximately 50 minutes of continuous recording.

The film is effectively pre-fogged during recording by establishing a minimum-brightness level corresponding to the zero-signal level of video input. The minimum brightness is set to a level which, with no video superimposed, will expose the film sufficiently to bring all subsequent exposure above the toe of the film characteristic. Thus even weak video signals are recorded. Overexposure on large signals can be avoided by proper adjustment of the video gain.

The original recording is not used directly for playback, but is printed on standard positive stock. There are several advantages to the use of positive prints in addition to the fact that they provide for unlimited duplication with a minimum of extra photographic processes. In trying to recover the video signal from the original negative, the areas in which photomultiplier noise is highest are those in which the video signals are very weak and masking of these signals by noise can occur. With a positive, however, the reverse is true. Areas in which the photomultiplier noise is high have correspondingly high signal levels, while the low signal areas are relatively noise-free. In addition, the use of clear-base positive stock removes the attenuation effects of the gray base film and pre-fogging. It also permits use of a lower intensity on the flying-spot scanner with a resulting decrease in spot size and improvement in playback resolution.

The work described in this article was conducted by Stanford Research Institute under Air Force Contract AF 18-(600)-500. A complete technical report of the development of the video recorder has been published by the Air Force Personnel and Training Research Center, Air Research and Development Command.

Transistorized Multiplex

By PHILLIP G. WRAY

Teletype Corp.
Chicago, Ill.

SUMMARY — Up to four channels of teletypewriter signals are combined by time-division multiplex for transmission over a single radio communication circuit. Use of 572 transistors and 739 germanium diodes cuts weight of complete set to 275 lb, compared to 1,450 lb for older model using 357 vacuum tubes. Simplified ring counter and digital synchronizer contribute to high operating speed of 100 words per minute

A SMALL, LIGHTWEIGHT multiplex telegraph set is under development for the Navy Bureau of Ships, to provide additional radio-teletypewriter channels for mobile and shipboard service. Use of transistor circuitry will allow an 80-percent reduction in volume and weight and a 95-percent reduction in power consumption over its electron-tube equivalent, which was developed earlier for fixed-station installations. Time-division multiplex equipment is used to combine two, three or four channels of teletypewriter information for transmission over a single radio communication circuit.

Although some of the circuits used in the transistorized version were derived from the rapidly growing field of transistor pulse techniques, several unique circuits were developed. This article describes two of these, a simplified ring counter and a digital synchronizer.

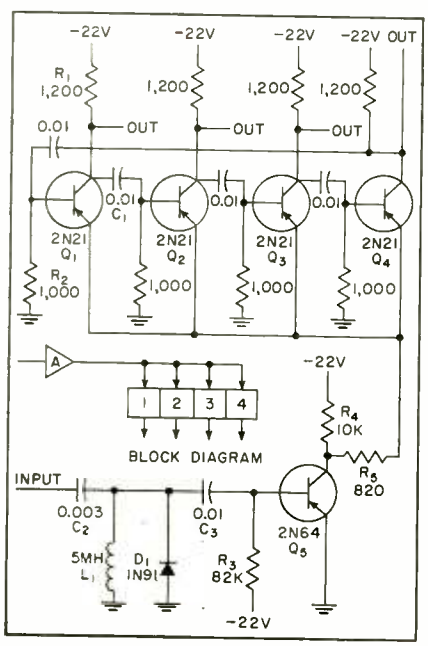


FIG. 1—Ring counter and drive amplifier

Simplified Ring Counter

A ring counter circuit was needed to perform the basic function of distribution (conversion between serial and parallel forms of information). Since the complete multiplex set requires twelve of these ring counter distributors, it is important for the counter to be of simple design, requiring a minimum of components.

The new ring counter achieves its simplicity through use of the inherent negative resistance characteristic of the point contact transistor. Only three components per stage, in addition to the transistors, are required.

The circuit of the simplified ring counter is given in Fig. 1. While only four stages are shown, the ring may be constructed of any number ranging from two upward. Rings of this type have been reliably operated with as many as 26 stages.

When power is applied, transistor Q_5 will conduct into saturation because of the negative bias supplied to its base through R_3. As a result, the collector of Q_5 will be essentially at ground potential. Simultaneously, the counter element with the highest combination

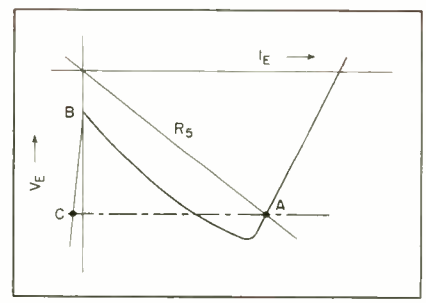


FIG. 2—Characteristic curve for typical ring counter element

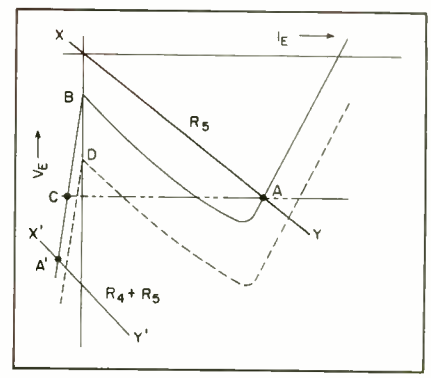
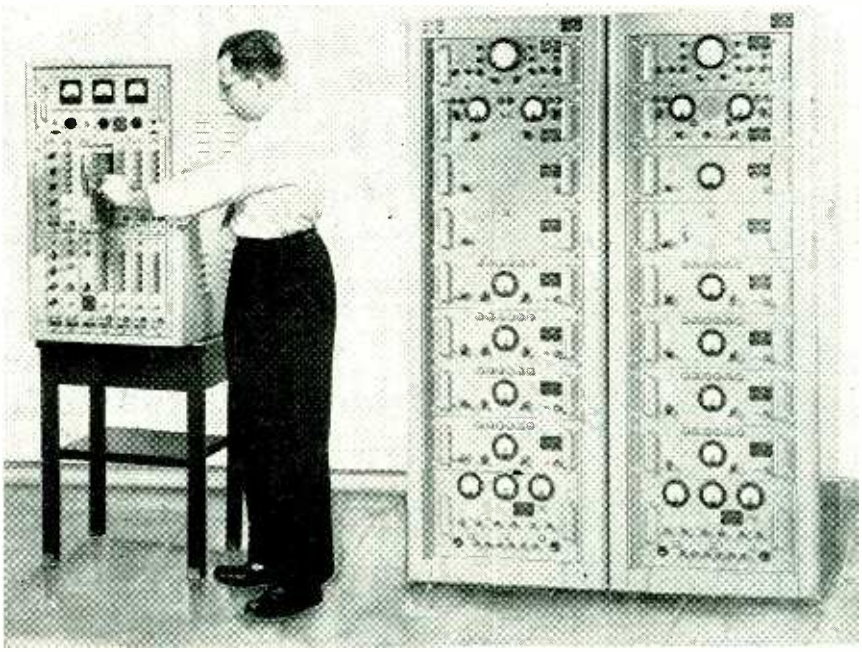


FIG. 3—Stepping action of counter

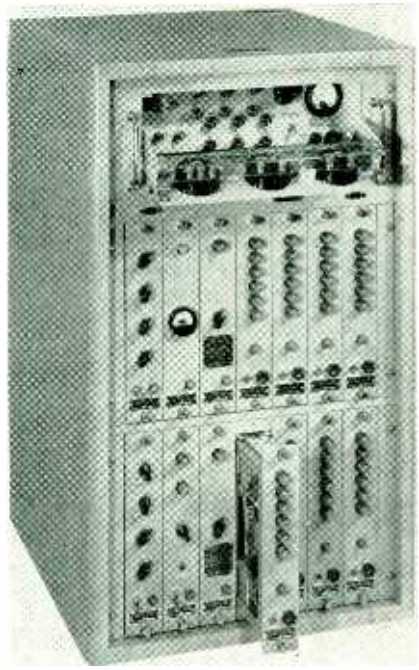
of reverse collector to base leakage current (I_{co}) and emitter current amplification (alpha) will conduct into saturation. Current flowing through the common emitter resistor R_5 develops a bias voltage which, when applied to the emitters of the remaining off elements, holds them sufficiently in the reverse direction to prevent their conduction.

Figure 2 shows the input negative resistance characteristic curve of emitter voltage and emitter current for a typical ring stage. With the element nonconducting, the voltage at point B is mainly the re-

Radio-Teletypewriter



New transistorized multiplex AN/UGC-1 on table has volume of only 10.9 cu ft. compared to 55 cu ft for older two-rack electron-tube version on floor at right



New set, in 15-drawer aluminum cabinet, makes extensive use of etched wiring

sult of I_{co} flowing through base resistor R_2. When conducting, the element will be stable at point A. Because the common emitter resistor produces a voltage which is common to both on and off elements, the emitters of the off elements must be located at point C. The off counter elements are held at this point, which corresponds to a slightly negative emitter current, by a bias voltage equal to BC.

Stepping Action

The counter is stepped from one conducting element to the next by means of negative stepping pulses. Each pulse applied to the common emitter connection causes the conducting element to switch to the nonconducting state.

When the collector voltage of the on element switches from slightly negative to highly negative, a differentiated negative waveform is passed through coupling capacitor C_1 and impressed on the base resistor of the following element, thus priming that element. When the stepping or triggering pulse is removed, the primed element conducts into saturation.

Referring to Fig. 3, the switching of the on element to the nonconducting state is shown as the displacement of load line XY to $X'Y'$, with the resulting change in operating point from A to A'. As described, when the collector voltage of the on element switches from slightly negative to highly negative, a differentiated negative waveform is generated and applied to the base of the following element. This priming effect is shown as a displacement of the characteristic curve for the primed element to the position indicated by the dotted curve. The emitter of the primed element is now more positive with respect to its base by a voltage equal to BD than any of the other elements in the distributor ring.

The time constant of the distributor coupling circuit has been designed to hold the element in this primed condition for a period longer than the duration of the trigger pulse. Therefore, when the trigger pulse is removed, indicated by a shift in the load line from $X'Y'$ back to XY, the primed element will be the one that is switched into conduction.

Each ring counter requires a drive amplifier (Q_5 in Fig. 1) to produce negative triggering pulses of the required width and magnitude to step the counter. To control Q_5, a square-wave input signal is applied to series-resonant ringing circuit C_2-L_1. The ringing circuit has a resonant frequency of approximately 50 kc. The positive-going leading edge of the square wave shock-excites the resonant circuit into damped oscillation.

Clamp diode D_1 prevents the oscillation from continuing past the first half-cycle by dissipating the energy in the resonant circuit when the voltage swings negative. The result is a single positive output pulse approximately 10 microseconds in width. This positive pulse is coupled by C_3 to the base of normally conducting transistor Q_5, driving the transistor out of saturation and into cutoff for the duration of the pulse. The collector output of Q_5 is thus a 10-microsecond trigger pulse swinging from ground potential to approximately -20 volts.

Ring Counter Waveforms

A group of typical waveforms of the ring counter and its drive am-

plifier is shown in Fig. 4. Waveform *B* shows the positive output pulse that is obtained from the ringing circuit and applied to Q_5. The resulting 10-microsecond trigger pulse is shown in waveform *C*.

At the instant the trigger pulse is received, the base is driven to −6 volts by the differentiated negative pulse resulting from the preceding element turning off, as shown in base waveform *H*. The base voltage then begins to decay exponentially, reaching approximately −4 volts when the trigger pulse is removed. At this instant the voltage of the primed base is approximately 3 volts more negative than the base voltage of any of the other ring elements, and therefore the primed element conducts, as shown in waveforms *G* and *I*.

Satisfactory operating margins are achieved in the simplified ring

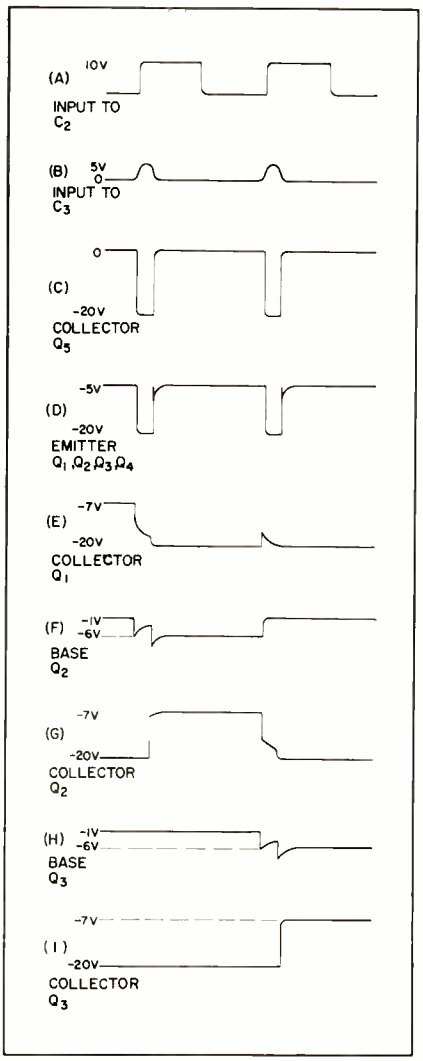


FIG. 4—Waveforms of ring counter

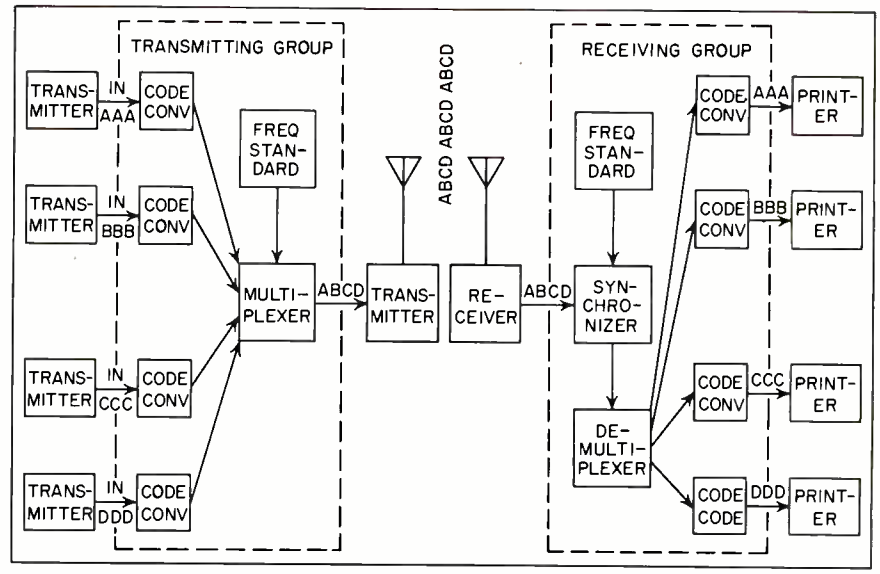


FIG. 5—Complete new multiplex system

counter without adjustment of the circuit constants. The basic ring counter element is biased to be stable only in the on condition and therefore is not dependent upon interception of the emitter load line (R_5 in Fig. 2) more than once with the emitter input characteristic curve. No stabilization circuits are required.

This circuit was designed to operate with transistors which have emitter to collector current gains as low as 1.8 and which allow reverse current flow at 20 volts and 60 C to be as high as 3 ma.

Use of Ring Counter

A block diagram of the complete multiplex system is shown in Fig. 5. It consists of the transmitting and receiving terminal groups and the associated telegraph and radio equipment. On the sending side, independent transmitters deliver randomly timed start-stop telegraph signals to the individual transmitting group code converters.

A ring counter distributor in each converter assists in transforming the information from serial to parallel form. The converter outputs are scanned, channel by channel, by another ring counter distributor within the multiplexer, picking up a complete character in turn from each. The signal elements within these characters are then transmitted in sequence, under the control of a third ring counter, to the external equipment at the multiplex frequency rate.

On the receiving side, the operation is exactly reversed, with distributors performing the complementary functions. The information contained in the incoming multiplex signal is separated, channel by channel, and delivered to the proper code converters. The start-stop signals are then reconstructed and delivered to the telegraph receivers. Initial framing of the receiving channel ring distributors is necessary to insure that the information will be delivered to the proper channels.

The operating speed of each terminal is controlled by a frequency standard using a transistorized crystal oscillator. To obtain high stability, the oscillators operate at the relatively high frequency of 63 kc. Ring counters are used, because of their simplicity, to divide this down to the required scanning frequency. At the receiving terminal, a synchronizer operates in conjunction with the frequency dividers to maintain exact synchronism between the incoming signal and the demultiplexer.

Figure 6 shows a block diagram of the oscillator, frequency-dividing and multiplexer distributing circuits used in the transmitting terminal group. The oscillator output is applied directly to the drive amplifier transistor for the first ring counter. The square-wave output from the first element is used to drive the second ring counter. This

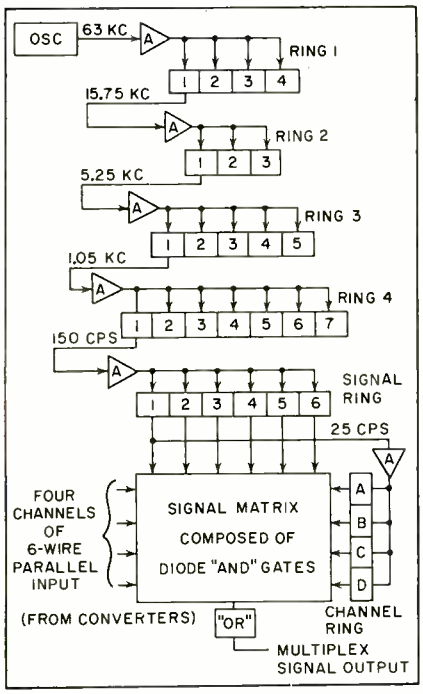


FIG. 6—Transmitting terminal frequency dividers and multiplexer

procedure is continued throughout the remainder of the dividing and distributing circuits. In this way, counter rings 1 through 4 divide the 63 kc exactly 420 times to generate the multiplexer signal ring driving frequency of 150 cps.

The signal ring, channel ring and signal matrix comprise the multiplexer portion of the transmitting terminal. Here the six-wire parallel input from each of the code converters is transformed into a sequential channel-by-channel multiplex output signal.

The signal ring contains six elements, corresponding to the six pulses contained in the signal code. The channel ring contains four elements, corresponding to the four channels of information handled. The signal matrix is composed of 24 diode AND gates. Each AND gate has three inputs: signal ring, channel ring and code converter output, all of which must be present simultaneously to produce an output signal. The output signals of the 24 AND gates are then combined, by means of a diode OR gate, into the sequential multiplex signal output.

Digital Synchronizer

To maintain the receiving terminal in exact synchcronism with the incoming multiplex signals, it is necessary to compensate for the effects of oscillator drift and long-term signal distortion resulting from radio circuit multipath. This is accomplished by a unique digital synchronizer circuit designed to operate in conjunction with the receiving terminal frequency dividers. By noting the time location of on-off transitions in the incoming multiplex signal, the exact phase relationship between the incoming signal and the demultiplexer signal ring driving frequency is established.

Common Oscillator

Synchronizer action is accomplished by adding or subtracting drive pulses to the second frequency divider stage until the proper time relationship is achieved. This system of synchronizing permits the use of a single crystal oscillator to drive both the transmitting and receiving groups in a given location, since the frequency of the crystal oscillator remains fixed.

Figure 7 shows a block diagram of the oscillator and frequency-dividing circuits used in the receiving terminal group. These circuits, and the demultiplexer not shown, are essentially the same as those of the transmitting group. The synchronizing circuits (Fig. 8) have been added to the block diagram of Fig. 7.

A normally open SUBTRACT gate has been placed in series with the normal drive input to dividing ring 2 in Fig. 7. This provides a means of subtracting drive pulses from the normal synchronous drive to ring 2. In addition, an output from the third element of ring 1 has been connected through a normally closed ADD gate to the normal drive input to ring 2. This arrangement provides a means of adding extra drive pulses to the normal drive.

The synchronizer circuits also include a group of phase-detecting gates. Any deviation of the incoming multiplex signal from the demultiplexer sweep frequency will be detected and the appropriate ADD or SUBTRACT gate action initiated.

When the receiving terminal is in exact synchronism with the incoming multiplex signal, the leading edge of the on time of element 1 of ring 4 will coincide with the trailing edges of the incoming multiplex signal code pulses. The incoming multiplex signal is inverted and applied to a signal pulse univibrator whose function is to generate a pulse for each negative-going transition in the multiplex signal. This pulse, adjusted to have a width slightly less than the on time of one element of ring 4, is applied to the six phase-detection AND gates. The second input to each phase-detection gate is obtained from ring 4.

No connection to a phase detection gate is made from element 1 of ring 4. Therefore, when the receiving terminal is in synchronism with the incoming multiplex signal, the output of the signal pulse univibrator will fall within the boundaries of the output of element 1, and there will be no output derived from any of the phase-detection gates.

If the incoming multiplex signal should be lagging, the output pulse from the signal pulse univibrator overlaps with elements 2, 3 or 4 of ring 4. This coincidence will be

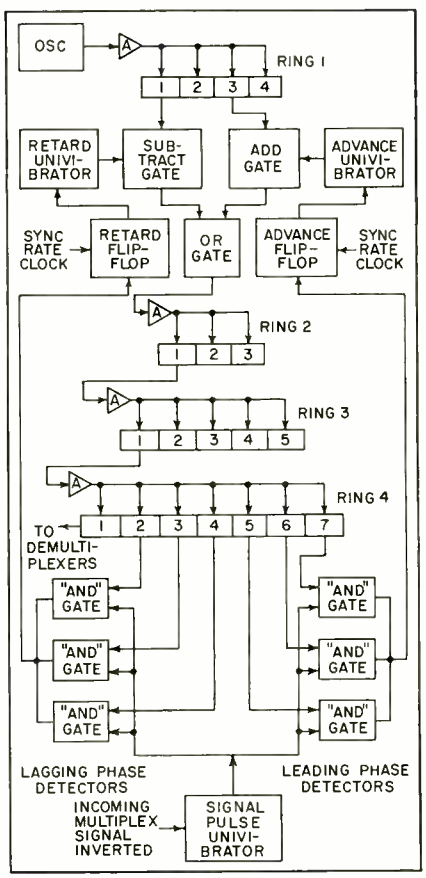


FIG. 7—Receiving terminal frequency dividers and synchronizer

detected by the lagging phase detectors, resulting in the RETARD flip-flop being turned on. The need for retard action is thus stored. In like manner, if the incoming multiplex signal is leading, detection will be made by one of the leading phase detectors, and the need for advance action will be stored in the ADVANCE flip-flop.

Amount of Correction

The ADD and SUBTRACT gates are each controlled by a univibrator. Thus when the RETARD univibrator is triggered, the SUBTRACT gate is closed for a period of time equal to the univibrator relaxation cycle. When the ADVANCE univibrator is triggered, the ADD gate will be opened for a length of time as determined by the univibrator.

The amount of correction provided per correction rate cycle is controlled by adjusting the operating time of the ADVANCE and RETARD univibrators. By varying the univibrator operating period, one or more drive pulses can be added or subtracted per cycle. Each pulse added or subtracted will advance or retard the succeeding rings approximately 63 microseconds, or 1 percent of the on time of a signal ring element.

Rate of Correction

The correction rate cycle is established through the action of the RETARD and ADVANCE flip-flops. An externally generated sync rate clock pulse is applied at periodic intervals to the RETARD and ADVANCE flip-flops. If one of the flip-flops has been previously turned on, due to the detection of an out-of-phase condition, the arrival of the next sync rate clock pulse will reset the flip-flop and cause the associated univibrator to be triggered. Thus, the rate of correction can be controlled by adjusting the frequency of the sync rate clock input. The rate of correction can be varied from 6.25 pulses per second to one pulse per 20 seconds.

A slow correction rate is generally used to slow down the action of the synchronizer circuits during poor signal periods. Since the phase detectors will respond to every change in the phase relationship between the incoming multiplex signal and the receiving demultiplexer signal ring driving frequency, the synchronizer circuits will attempt to establish an in-phase relationship, not only with normal signals, but with all extraneous bursts of noise and distortion which may be received.

The multiplex equipment described was developed under the direction of T. A. Hansen, project engineer, with circuit design assistance from F. D. Biggam, R. J. Reek, R. A. Slusser and the author.

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(1) F. D. Biggam, A Transistorized Time Division Multiplex Telegraph Set, *AIEE Trans Paper* No. 56-987.

(2) T. A. Hansen and R. D. Slayton, An Electronic Time Division Multiplex Terminal Set, *AIEE Trans* 70, 1951, p 1.

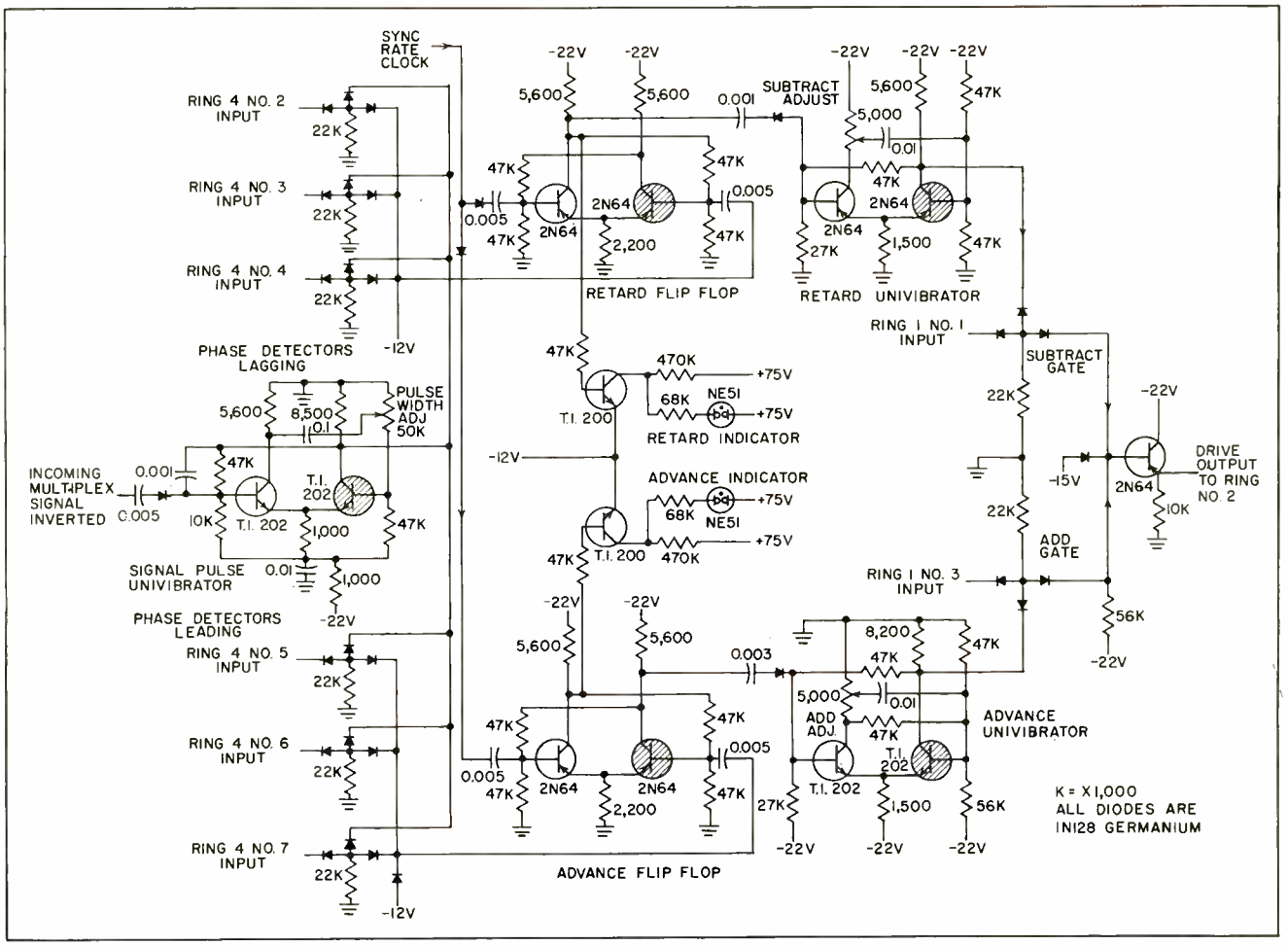


FIG. 8—Synchronizer circuit compensates for effects of oscillator drift and long-term signal distortion resulting from multipath radio transmission

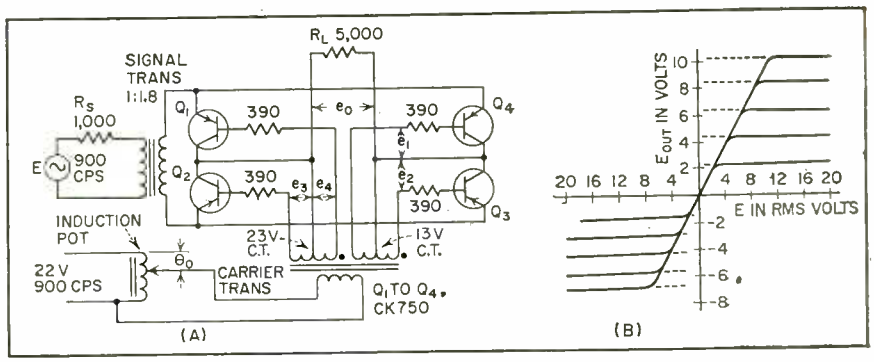


FIG. 1—Autopilot demodulator-limiter has nonsymmetrical and adjustable limit levels (A). Commanded limit levels based on shaft angle θ_0 of induction potentiometer are shown as dashed lines (B)

Demodulator-Limiter for Control System Signals

SUMMARY —— Transistor circuit for carrier-based control systems limits while modulating or demodulating. Circuit operates at high signal-conversion efficiency, produces hard limit and has excellent linearity

By N. L. JOHANSON
Boeing Airplane Company
Seattle, Washington

MANY CONTROL SYSTEMS require hard limiting of control signals to predetermined levels. It is sometimes also desirable to have independent control of the plus and minus, or phased, signal limit levels, such that either or both can be fixed or varied according to some desired function.

In systems which employ medium-level phase-sensitive modulators or demodulators, this flexibility of limit control can be achieved without additional components by using the modulator or demodulator circuit shown in Fig. 1. Where the signal source is isolated from the load, this circuit provides full-wave operation at high-signal conversion efficiency without requiring a center-tapped signal transformer.

Circuit

Assuming a demodulator application for the circuit of Fig. 1A, operation in the linear range is as follows: during one-half cycle of the carrier frequency the bases of Q_1 and Q_3 are negative with respect to their collectors, offering a low impedance to signal current flow through their emitter-collector paths. During this same half-cycle, the bases of Q_2 and Q_4 are positive with respect to their collectors, offering a high impedance to signal current flow through their emitter-collector paths.

During the next half cycle, Q_1 and Q_3 act as open switches and Q_2 and Q_4 as closed switches, resulting in full-wave rectification of the signal input.

As the signal level is increased the mode of operation changes at a predetermined level, causing the output to limit.

During one-half cycle Q_2 presents a high impedance to current flow through its collector-emitter path only as long as its base is positive with respect to both its emitter and collector.

When output voltage e_0 exceeds switching voltage e_1 current flows through the base-emitter path of Q_4 creating a low impedance path for signal current through its collector and emitter. This shunt across the load automatically regulates the voltage at the input terminals of the circuit by virtue of its decreasing impedance as a function of increasing signal. During the next half cycle switching voltage e_2 determines the output limit level.

If the signal phase is reversed, switching voltages e_3 and e_4 replace e_1 and e_2 in determining the limit level on alternate half-cycles of signal voltage. Thus, nonsymmetrical, symmetrical, fixed or variable limits can be attained by the proper choice or variation of the two center-tapped switching voltages. To obtain a hard limit the signal voltage and the switching voltage must have the same wave-form.

Application

Figure 1B shows the limiting characteristics for the circuit of Fig. 1A which was designed for an autopilot system. This application required nonsymmetrical and variable limit levels for the acceleration commands to an elevator servo. Since the two limit levels were to be varied by the same function, the circuit requires only one carrier transformer. In this case, the transformer primary voltage is varied by a servo-driven potentiometer.

Acknowledgement is due Kenneth D. Johanson for assistance in preparing this article and Earling Johnson for constructing and testing the unit.

Magnetic Field Pickup

By ROGER R. WEBSTER and JAMES M. CARROLL

Senior Engineer
Semiconductor Components

Project Engineer
Apparatus Division

Texas Instruments, Inc.
Dallas, Texas

SUMMARY — Enhanced sensitivity and reduced size of portable, watertight, detector make this unit ideal for tracing underground or underwater cable systems used for airport and harbor lights. Instrument locates open circuits by sudden drop or loss of 250-cps signal generated by vibrator. Ferrite core is used in the detecting element pickup coil. Signal is amplified by a three-stage, transistorized, tuned amplifier

TRACING buried or submerged cables and locating cable faults, is a serious problem in the maintenance of airfield lighting systems. Faults may vary from direct shorts to open-circuited cables, but high-resistance leaks which break down in wet weather probably give the most difficulty.

Insensitivity and inaccuracy of previous detectors have made fault-locating difficult. Incomplete and inaccurate records of the location of underground cables contribute to the difficulty. Thus, when a fault develops, it has been more practical to abandon existing cables rather than spend long fruitless periods attempting to locate the fault.

Faced with this continuing problem, the Navy Bureau of Aeronautics desired a cable-fault detector that would replace the older vacuum-tube model tester.

Detector

The answer, the transistorized AN/TSM-11 cable test detector follows underground cables buried as deep as 12 to 15 feet. Open-circuited cables are followed and the fault located to within a short distance when the cable is not too far from the detecting element. Sufficient charging currents will flow in buried cables with open circuits to permit the cable test set to follow with good accuracy.

The detecting set consists of two major units, the signal generator and the completely transistorized amplifier-indicator, which together with the magnetic field detecting element, comprise the receiving system.

Operator traces underground cable at airport installation and pin-points cable fault. The detecting-element coil is mounted on the telescoping boom connected to the amplifier-indicator case. Signal strength is indicated on an output meter and headset monitors the output

The amplifier-indicator, Fig. 1, operates on a single internal 22.5-v battery, while the signal generator requires an external 6-v d-c source. A power supply delivering 6 v at 5 amp with low ripple content powers the signal generator. A 6-v auto storage battery may be used.

A 250-cps a-c signal, from the signal-generator is applied, through an impedance matching transformer which accommodates various cable conditions, to the end of the cable to be tested. Signal current in the cable produces a magnetic field which induces voltage in the pickup coil of the magnetic-field detecting element. The induced signal is amplified and applied to an indicating meter and headset. Cable faults are located by a sudden change in the intensity of the received signal, usually by a sudden drop, or by complete loss of the 250-cps signal.

Signal Generator

The signal-generator circuit is shown in Fig. 2. The signal is generated by a 250-cps vibrator, coupled to the output terminals through a tapped transformer. The output impedance of the signal generator can be approximately matched to the cable under test to provide maximum-signal current. Open-circuit voltages are approximately 250, 64, and 16 v in the high, medium and low output positions respectively, corresponding to output impedances of approximately 2,750, 170, and 10 ohms. Relay *K* interrupts the 250-cps signal at about two cps. This distinctive modulation permits fault identification in regions where harmonics of 60-cycle fields cause high background noise.

A push-pull connection on the

Follows Buried Cables

primary of the output transformer avoids d-c saturation of the transformer core and allows the use of a small transformer. Input current requirements are minimized and vibrator life increased because of the decreased contact current.

In the input and output circuits, r-f filtering gives a better wave shape and minimizes high-frequency noise generated by the vibrator.

Amplifier-Indicator

The signal from the magnetic-field surrounding the cable is amplified and rectified. Signal strength is indicated on an output meter and the headset is used for monitoring the amplifier output.

Ferrite Core

Sensitivity was greatly increased by using a ferrite core in the pick-up coil. Coil and core are mounted on a telescoping boom connected to the amplifier.

The three-stage amplifier is mounted on an etched circuit board. It is tuned to 250 cps by the series L-C circuit in the emitter circuit of the second stage. The output is down 5 db from maximum at 215 cps and 285 cps. Three type

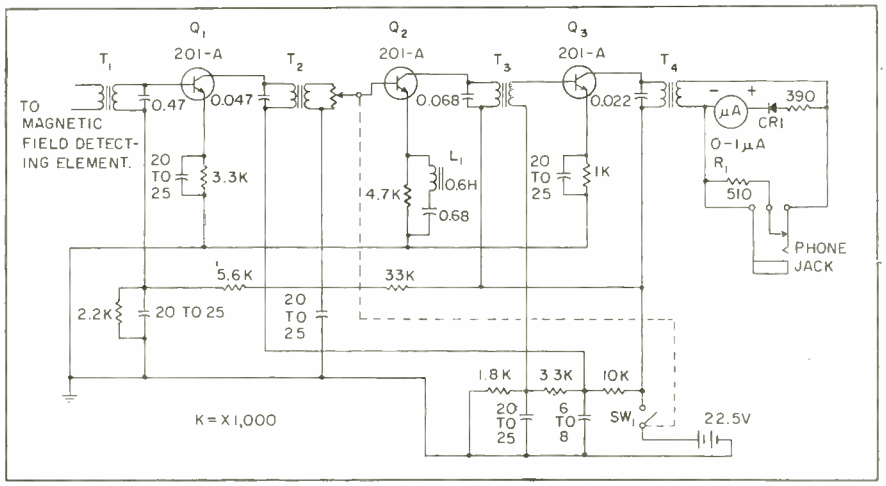


FIG. 1—Amplifier-indicator unit of cable detector is tuned to 250 cps by the series 1-C circuit in the emitter of the second stage. Three transistors give overall gain of 85 db

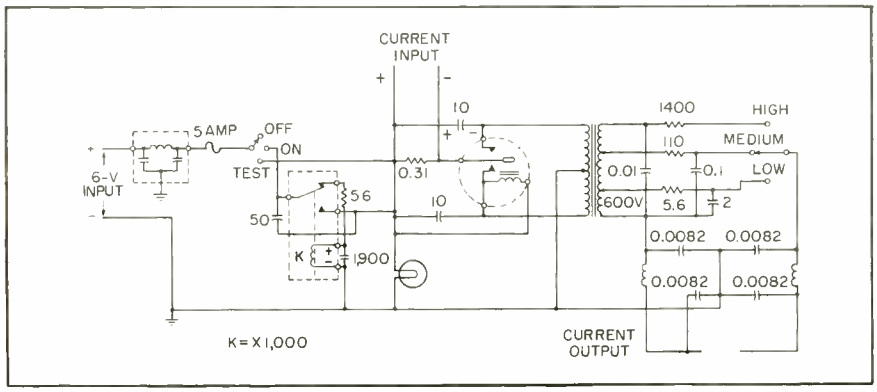
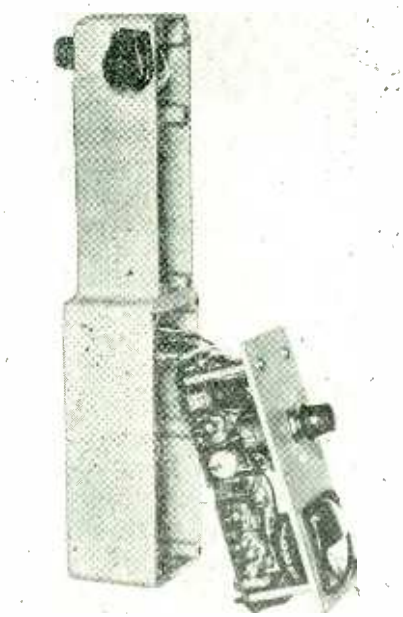


FIG. 2—Signal generator of cable detector. A range of output impedance allows matching the cable under test to provide maximum signal current



The amplifier unit is mounted on an etched-circuit board. The detecting element may be rotated by knob at top to obtain maximum signal deflection

201-A triode *npn* grown-junction germanium transistors in the amplifier give minimum overall gain of 85 db. The input impedance of the unit is approx. 10 ohms, designed to match trailing leads in sea water when following submerged cables. Output impedance of approx. 600 ohms matches the headset.

Amplifier output, rectified by a diode, is indicated on a d-c meter. Resistor, (R_1) in Fig. 1, terminates the output when headset is out.

Watertight Case

The amplifier case is watertight to a submerged depth of 3 feet, except for the phone jack which may be plunged when the headset is not in use.

The complete unit is carried easily in two watertight portable cases, which house the major units.

The cable-fault detector can localize practically all types of cable faults so that the cable may be exposed and repaired.

Telemetering System

By EDWARD K. NOVAK

Electronic Engineer
Convair Div. of General Dynamics Corp.
San Diego, California

SUMMARY —— Modification of standard Weather Bureau type radiosonde permits use of 1,680-mc carrier with three simultaneous channels of information, one of which is time-multiplexed into 12 additional channels with sampling rate of one sample per minute. Equipment utilizes f-m/a-m telemetering principles and has probable max range of 360 miles

ALTHOUGH highly efficient and completely adequate for its intended purpose the weather bureau's AN/AMT4 balloon-carried telemetering system is restricted, in its commercially available form, to measurements of only those parameters that can be represented by a variable resistance. Also, it is restricted by its inability to obtain simultaneous measurements of two or more parameters because of its single-channel nature. Furthermore, measurements are referred to altitude rather than time so that data usually is obtained only during the ascending period of the balloon.

In an effort to utilize the desirable features of this system while also increasing its utility, to include time sequencing, simultaneous channels and other features, the equipment to be described was developed.

The telemetering methods utilized in this equipment are basically f-m/a-m. The r-f transmitter is frequency modulated and the subcarriers are amplitude modulated. However, since two channels contain frequency information and the third conveys amplitude information in terms of frequency, a-m is used to indicate a change in the signal, not the degree of change, thereby avoiding the disadvantages in amplitude modulation while retaining its advantage of simplicity.

System Description

A simplified block diagram of the system is shown in Fig. 1. The main system consists of a 5794 pencil-triode uhf oscillator transmitter, frequency modulated by the multiplexed signal obtained from simultaneously summing three amplitude-modulated subcarriers. Two of the subcarriers convey pulse information and the third carries d-c voltages representing various measured parameters.

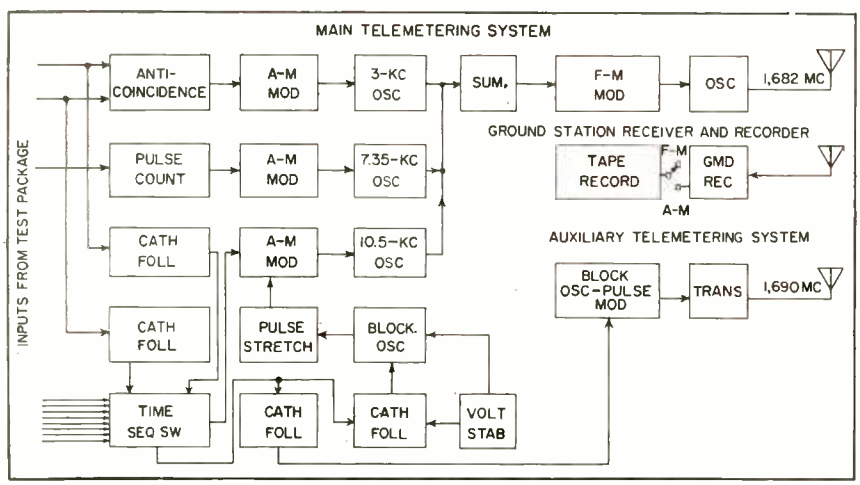


FIG. 1—Block representation of main telemetering system and auxiliary equipment

Rectangular waves from astable and bistable multivibrators in the test package are fed to the anticoincidence circuit, which compares these signals and amplitude modulates the 3-kc subcarrier channel when anticoincidence occurs.

Short random pulses, originating at a test amplifier in the test package, are applied to the pulse counter. The counter selects only positive or negative pulses of a predetermined level and triggers a bistable multivibrator, which in turn amplitude modulates the 7.35-kc subcarrier channel.

Eight signal input wires, originating in the test package and the power pack, apply to the sequencing switch voltages representing measurements of test circuit electrical parameters, test package temperature, battery pack temperature, voltage standards and power supply voltages.

The output of the sequencing switch is applied to a cathode follower and then to a blocking oscillator whose output frequency is a linear function of the voltage applied to its grid. The output pulses of the blocking oscillator are stretched and used to amplitude modulate the 10.5-kc subcarrier oscillator. A second pole on the

Is Balloon Borne

sequencing switch is utilized to measure the frequency of the astable and bistable multivibrators by time sequencing them along with the voltage measurements on the 10.5-kc channel.

Emergency System

The output of the sequencing switch is also applied through an isolating cathode follower to a second blocking oscillator which, with its associated transmitter, constitutes the auxiliary or emergency telemetering system. This system, carrying its own water-activated batteries, is a time-sequenced channel completely independent of the main telemetering system and provides partial data, in case of failure of the main system.

The ground station receiving equipment consists of a GMD receiver and tracking antenna or other suitable receiving equipment and a single channel 15-ips magnetic tape recorder. Under normal operating conditions, the main telemetering system only is tracked and recorded by the ground station. In the event of failure of the main system the receiver is switched to a-m and locked to the auxiliary transmitter.

When two receiving equipments are available, both telemetering systems are tracked and recorded, affording a cross-check on the data being measured by the time-sequenced channel.

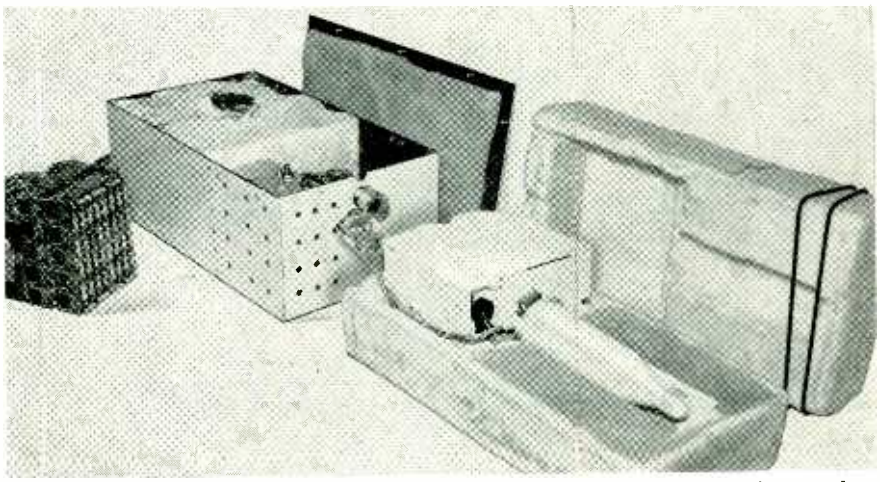
Data Reduction

The data reduction system is shown in Fig. 2. The multiplexed or pulse-modulated tape recorded data is played back and fed into the reduction unit.

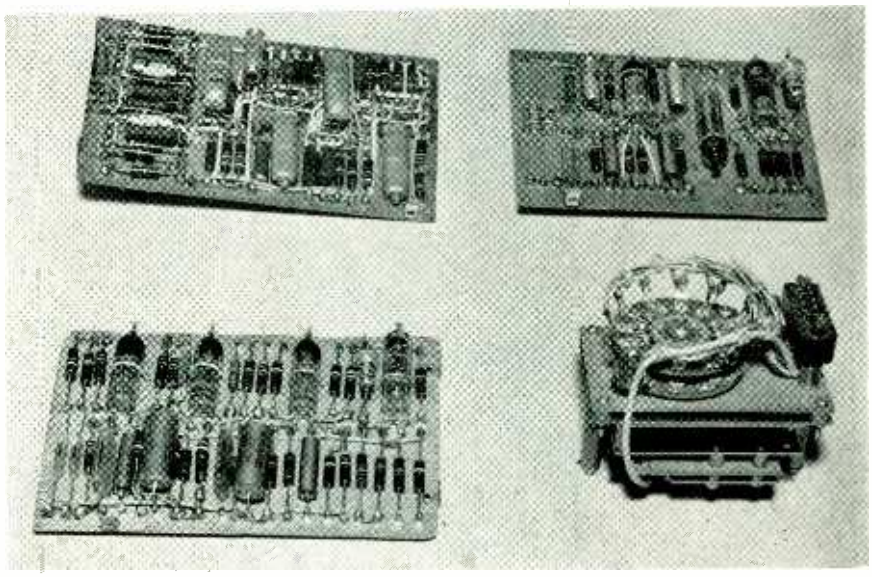
When pulse-modulated data only is recorded, such as is obtained from the auxiliary telemetering system, the playback signal is fed into an amplifier to make the signal level suitable for application to a slicer circuit. The slicer eliminates noise and shapes and limits the signal before it is applied to the discriminator. The output of the discriminator, consisting of the recovered test package parameter measurements, is applied to a paper-pen recorder.

To minimize errors due to striking of the mechanical pen stops on the paper recorder by the pen in the event of loss of signal or extraneous signals, electronic pen stops or pen travel limiters are used. The limiters prevent voltages larger or smaller than those normally applied to the pens from being applied to the pen driving amplifiers.

When multiplexed data is present on the tape, such as is obtained



Complete balloon-carried telemetering system has subcarrier oscillators and transmitter embedded in foamed plastic shell for protection against rough launchings and landings



Measuring circuit subchassis include: pulse counter, upper left, cathode followers, upper right; anticoincidence circuit, lower left and sequence switch, lower right

from the main telemetering system, the playback signal is applied through an impedance matching amplifier to three band-separation filters tuned to the subcarrier frequencies. The frequency-separated outputs of the band-pass filters are amplitude demodulated and the recovered data appears at the output of the unit. The 3-kc and the 7.35-kc channel output signals are applied directly to the paper-pen recorder; the 10.35-kc time-sequenced channel output is first fed to the f-m discriminator in a manner identical to that used for pulse-modulated data.

The output of the paper-pen recorder is a strip-paper record containing each of the three channels. Since the output of the 3-kc channel may contain pulses recurring at 100 to 200 cps, which cannot be conveniently recorded by a pen recorder, an electronic counter is also connected to the 3-kc channel output. When pulses occur they are totalized by the counter and manually recorded on the paper record.

The output of the 10.5-kc channel consists of d-c levels at a 1/12-cycle per minute rate, corresponding to the sequencing switch speed and is recorded directly on the paper record. The data is transferred to a graph by manually reading off the number of pulses per time interval in the 3-kc and 7.35-kc channels and by converting the data in the 10.5-kc channel into voltage, current, frequency and temperature with a calibration curve.

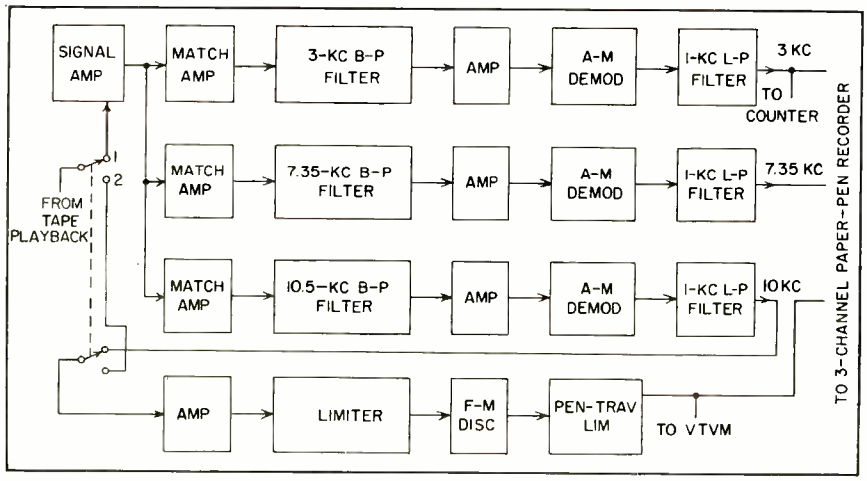


FIG. 2—Data-reduction system feeds three-channel paper-pen recorder

Circuit Description

The transmitter, shown in Fig. 3, consists of a pencil triode, cavity resonators and a dipole antenna.

The nominal frequency of operation as determined by the cavity resonators is 1,680 mc and can be adjusted to any frequency from 1,668 mc to 1,692 mc. Nominal carrier output of the transmitter is 0.5 w with a plate input of 120 v at 25 ma.

Due to the inability of the 5794 to maintain oscillations at plate voltages lower than 60 to 70 v, plate modulation results in a maximum attainable modulation of only about 25 percent. The frequency-modulation effects observed with plate amplitude-modulation led to the adaptation of this method for plate-frequency-modulation. Identical to a conventional choke-coupled plate modulator, the circuit utilizes the inherent dependence of frequency upon plate voltage in an oscillator to effect frequency modulation.

Although the effect is normally small enough to be neglected, it is adequate in this application since

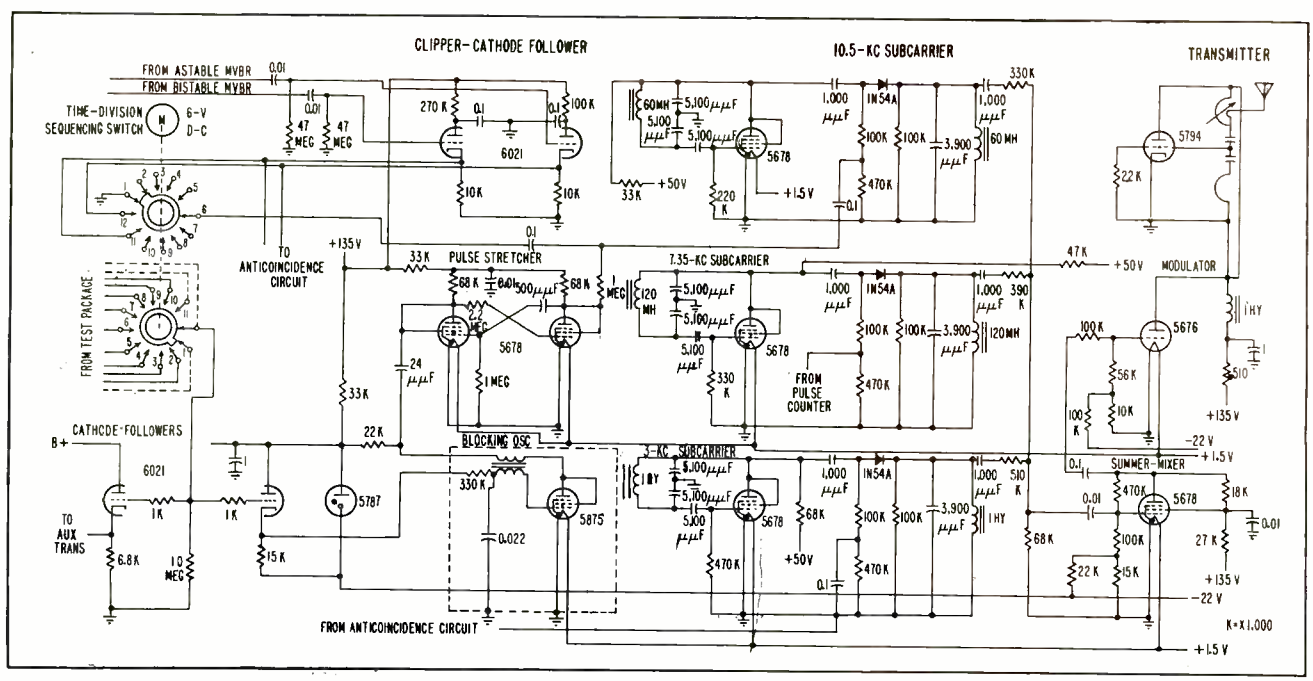


FIG. 3—Transmitter employs 5794 pencil triode whose operating frequency can be adjusted by cavity resonators

the required deviation is only a very small percentage of the center frequency.

A first approximation for the frequency dependence of an oscillator upon plate voltage is given by $f = [1/(LC)]^{-1} [1 + R/(2r_p)]$ where R is a series resistance in the plate tank circuit representing the entire load; r_p is the plate resistance, a variable dependent upon plate voltage such that for a low-μ triode the r_p changes by 2 to 3 percent per volt change in the plate voltage. The value of R in this circuit is in the order of 18 ohms; thus a 1-v change in the plate voltage results in a carrier frequency shift of 0.004 percent or about 60 kc. The incidental amplitude modulation under these conditions is 1 percent.

Modulation

Typical operation with the circuit illustrated in Fig. 3 shows that a 1 v p-p swing at the 5676 modulator output produces a frequency deviation of ±50 to ±60 kc. The modulation characteristic is linear up to 3.5 to 4 v p-p, producing a frequency deviation of ±200 to ±250 kc and resulting in a modulation index of about 20 for the highest modulating frequency. Power requirements for the modulator are comparatively negligible as is the small amount of amplitude modulation present under these conditions.

The modulator is preceded by an 5678 amplifying stage whose function is to linearly sum, or mix, the three modulated subcarrier oscillator outputs. The summing resistors are selected consistent with adequate signal to the modulator and a linear preemphasis response curve. Under these conditions the subcarriers appearing at the modulator plate have the amplitude ratios 0.3, 0.75 and 1, relative to the 10.5-kc subcarrier, for the 3-kc, 7.35-kc and 10.5-kc channels, respectively.

The subcarrier units each utilize one 5678 subminiature pentode in a modified Colpitts oscillator circuit and one IN54A diode a-m modulator. Input voltages to the modulator of 4 to 5 p-p result in an output of 3 to 4 v p-p, modulated 94 to 98 percent. The oscillator-modulator is operated at relatively low levels to hold operation within the range of the diode so a linear modulation characteristic is obtained and to maintain high Q in the subminiature toroids utilized for the oscillator tuning elements.

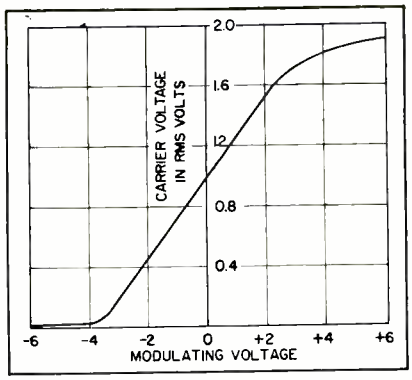


FIG. 4—Modulation characteristic of 1N54A-diode 10.5-kc subcarrier modulator

Relatively high input impedance to the modulator, about 100,000 ohms, is maintained to minimize loading of the test package circuitry. No inductor is required in the plate feed to the oscillator in this type of operation thus freeing that inductor for use in a tuned circuit at the output of the channel. The resulting band-pass filter produces a distortionless sinusoidal output at the subcarrier frequency to prevent cross modulation between channels. Since the modulation consists of rectangular waves, damping of the output tank circuit is necessary.

A circuit Q of 12 to 15 is adequate to obtain a satisfactory compromise between purity of carrier frequency wave shape and modulation distortion under these conditions of operation. Modulating frequencies in the range 80 to 400 cps are used in the 10.5-kc channel, 100 to 200 cps in the 3-kc channel and 0 to 200 cps in the 7.35-kc channel. The modulated output is linear for a modulation voltage range from −2 to +2 v peak or d-c as shown in Fig. 4.

10.5-KC Channel

The 10.5-kc subcarrier channel is modulated through the output of the time-sequenced switch by the 5875 blocking oscillator, which converts voltage into frequency, and a pulse stretcher. Since the output of the blocking oscillator consists of pulses only 30 to 100-μsec in width the 5678 pulse stretcher widens the pulse to a width such that several cycles of the subcarrier frequency are encompassed.

To include a minimum of 10 cycles of the subcarrier within one half cycle of the modulating signal at a maximum modulation pulse rate of 500 cps, a pulse width of 1,000 μsec is used in the univibrator-type pulse stretcher. The 1-megohm resistor in series with the output of the univibrator reduces the 40-v output pulse to the 4 v required for full modulation of the subcarrier and isolates the univibrator. The resistor also serves in conjunction with the output impedance of the cathode follower to reduce the output of the pulse stretcher to a negligible value when the sequencing switch applies the test package multivibrator outputs to the modulation terminal of the 10.5-kc subcarrier channel.

Conversion

The voltage to frequency conversion is accomplished by the use of a modified quenching-type blocking oscillator such as is used in the standard radiosonde for resistance to frequency conversion. In operation, a bias voltage E_1 exists at the grid of the blocking oscillator at which high-frequency oscillations (10 to 12 mc) can build up. The resulting grid current charges the grid capacitor rapidly to a more negative grid voltage E_2, at which oscillations are cut off. When oscillations cease, no further charge is contributed to the capacitor and it begins to discharge exponentially through the resistors in the grid circuit. When the voltage on the capacitor has dropped to E_1, oscillations are resumed and the cycle repeats.

Within the limits of calculation accuracy, the voltage to frequency conversion over the required range is linear.

Because it is highly desirable in any system of telemetering to avoid absolute calibrations which depend upon tube characteristics, battery voltages, magnetic tape recorder speed and similar factors, no absolute calibration is used in this equipment. Rather, a standard unit of measure, a standard cell, is

used and applied such that it is handled by the equipment exactly as the data to be measured.

Reconversion

Since the voltage-versus-frequency characteristic of the blocking oscillator may be assumed linear, any unknown voltage E_x telemetered as a frequency f_x can be converted to voltage upon reduction of the data by the relation $(E_x - E_{x1})/(f_x - f_{x1}) = (E_{xh} - E_{x1})/(f_{xh} - f_{x1})$

where E_x = unknown voltage to be measured, E_{xh} = standard voltage where $E_{xh} > E_x$, f_x = frequency corresponding to E_x, f_{xh} = frequency corresponding to E_{xh}, f_{x1} = frequency corresponding to E_{x1}, and E_{x1} = standard voltage where $E_{x1} < E_x$.

If E_{x1} is chosen equal to zero $E_x/E_{xh} = (f_x - f_{x1})/(f_{xh} - f_{x1})$ and the unknown may be obtained by simple calculation or graphing.

The parameters to be telemetered on the 10.5-kc subcarrier are applied to the channel through a motor-driven rotating switch. The two-pole 12-position switch is driven at 1 rpm by a minature 6-v d-c motor developing a torque of 10 in.-oz. at a drain of 10 to 12 ma.

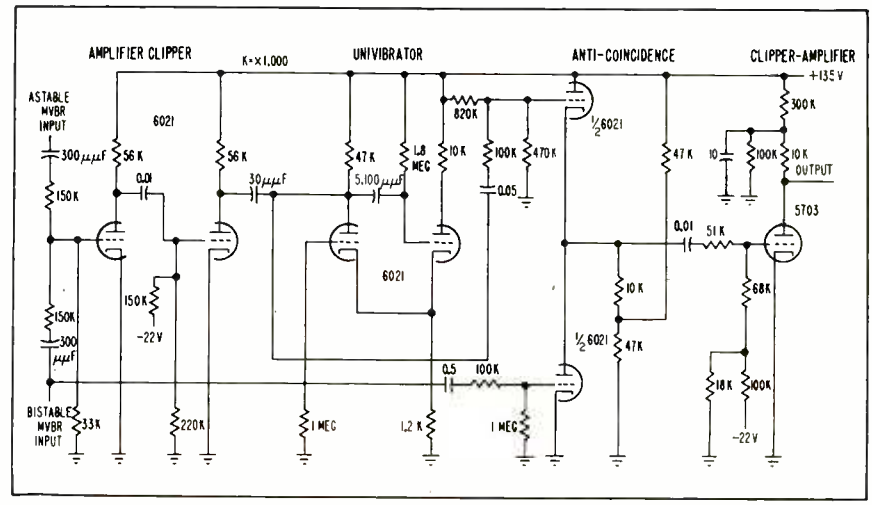


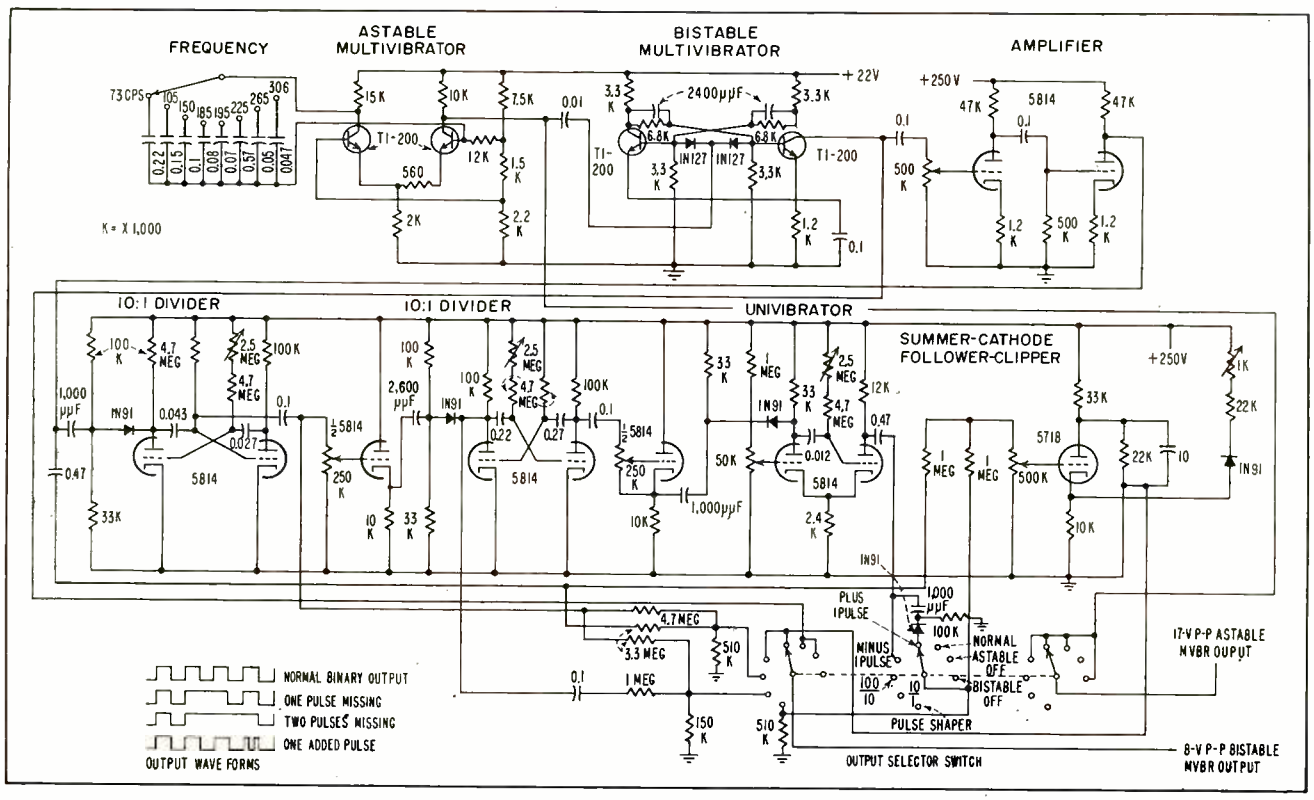
FIG. 6—Anticoincidence circuit amplitude modulates 3-kc subcarrier channel when anticoincidence occurs between rectangular waves generated in test package

Contact dwell time is about 4 sec and open time is 1 sec, resulting in one measurement for 4 sec per minute per parameter.

The voltage parameters are applied through nine positions of one of the switch sections to the 6021 isolating cathode follower in Fig. 3. The output of the cathode follower is applied to the blocking oscillator. The 5787 voltage stabilizer reduces blocking-oscillator drift due to shifts in both the plate voltage of the oscillator and the cathode follower cathode voltage with changing battery voltages. In addition, the reduced plate voltages on both the cathode follower and the oscillator are utilized to obtain a larger voltage-frequency conversion factor.

Frequency Parameters

The frequency parameters telemetered by the 10.5-kc channel are applied through two positions of



Rectangular waves for anticoincidence circuit are generated in test package simulator by astable and bistable transistor mvbr

the second section of the rotating switch such that when each of the two frequencies, the astable multivibrator and the binary, appears at the output of the switch and thereby also at the input to the 10.5 kc channel modulator, the blocking oscillator is effectively disconnected from that input. When the switch is on the frequency-transmitting contact the low output impedance of the cathode follower forms a voltage divider in conjunction with the 1-megohm resistor in the blocking-oscillator output circuit, thereby reducing the blocking-oscillator output to a negligible value while at the same time passing the multivibrator frequency through to the subcarrier modulator.

Since the blocking oscillator never ceases to function because its grid is connected to a cathode follower and thereby never open, this method effectively turns it off without requiring additional switch contacts. In addition to this use for the cathode followers, their other function is to clip the multivibrator signals to equal levels and to couple them into the anticoincidence circuit.

Grounding position 1 of the sequencing switch results in a momentary removal, by the shorting-type wiper switch, of the bistable multivibrator from the input to the anticoincidence circuit. This is used to test the operation and to establish an operating level for the anticoincindence circuit.

Measuring Circuits

The anticoincidence circuit, shown in Fig. 6, produces an output pulse whenever pulses are gained or lost by the test package bistable multivibrator with respect to pulses produced by the astable multivibrator which is driving it.

After clipping in the cathode followers to establish relatively constant amplitudes, the astable and bistable multivibrator outputs are applied to R-C differentiators at the input of the circuit. After differentiation, the resulting pulses are summed, amplified and clipped by the folowing two amplifier sections and applied to the input of the univibrator such that triggering pulses appear only when either there are no miscounts or when there are pulses being lost by the binary. This effect is obtained by proportioning the amplitudes of the differentiated pulses so that a pulse is produced only when a negative pulse produced by the binary adds with a negative pulse produced by the astable multivibrator.

Thus, output pulses are produced only when the two waves are in coincidence because a negative pulse from the binary and a negative pulse from astable mvbr occur at the same time only once per cycle. Also, by proper proportioning, pulses are produced at the output when the binary misses a pulse, since subtraction of pulses is also utilized to prevent output of astable mvbr pulses.

When the binary gains pulses no signal results at the input to the univibrator since extra binary pulses do not add with other pulses to produce an output of sufficient amplitude to be passed by the circuit.

The output of the univibrator, if

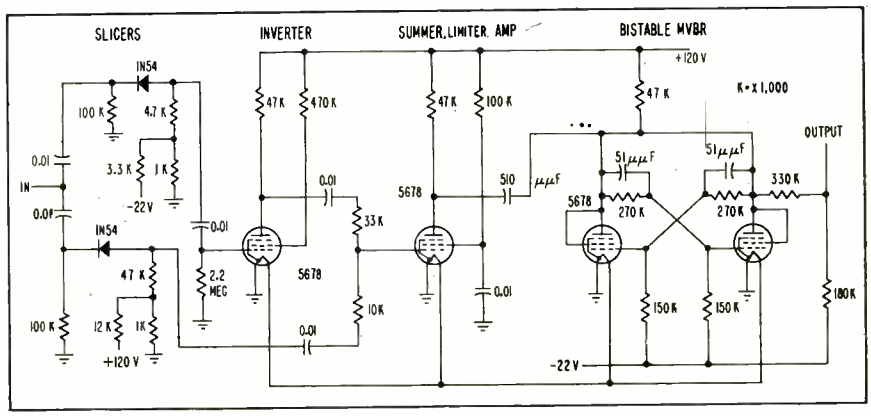


FIG. 7—Pulse counter uses biased limiters and bistable multivibrator to count randomly occurring pulses of either polarity and of 0.5 to several μsec width

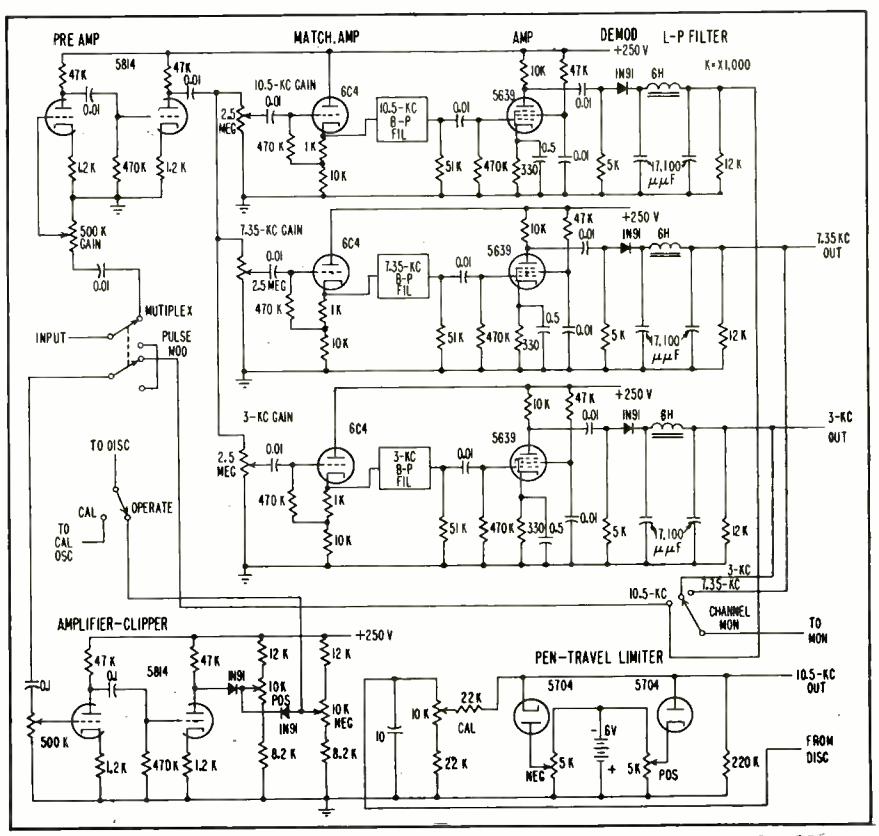


FIG. 8—Data-reduction system employs pen-travel limiters to prevent loss of calibration in the event of violent striking of the pen stops during periods of signal interference

there is one, is passed to one section of the anticoincidence tube. Two actions take place here.

If a signal is present at both inputs an output results. However, this output is smaller than would result if either of the two inputs were missing because of the cancelling action in the common load resistor, the 10,000-ohm resistor at the cathode-plate terminal. Thus, when pulses are missed by the binary a signal appears at the upper grid of the anticoincidence circuit, but the corresponding signal does not appear at the lower grid, thereby an output results. When pulses are gained a signal appears at the lower grid, but no corresponding signal appears at the upper grid and again an output results.

Clamping

The second circuit action is the result of the clamping action by each of the two grids of the anticoincidence tube. When a pulse is missed, the momentary loss of clamping action on the upper grid reduces its bias, increasing current flow through the common load resistor. Since the output of the anticoincidence circuit is applied to a biased clipper set to produce no output unless the input exceeds a preset level, but which is exceeded by the above increase, an output results. When a pulse is gained an equivalent action takes place at the lower grid.

The biased clipper amplifier at the output of this circuit is effective in both of the actions just described. In addition, it clips the positive portions of the waves at the plate to maintain equal and predetermined amplitudes so these signals can be used directly to fully modulate the 3-kc channel.

The anticoincidence-circuit-test contact on the sequencing switch causes the binary signal to be momentarily removed from the circuit input once per revolution of the switch. The effect on the circuit is that of several missing binary pulses and an output is produced, thereby resulting in a test of the circuit and a reference signal once per minute.

During the data reduction process this test signal indicates proper circuit operation and serves as an amplitude reference to set the electronic counter used to tally miscounts.

To exclude tallying of noise and other extraneous pulses the counter is set to tally only pulses as great or greater than the test reference signal.

The pulse counter counts randomly occurring pulses of 2 to 15 v peak, of positive or negative polarity and 0.5 to several μsec in width. The circuit shown in Fig. 7 uses conventional biased limiters and a bistable multivibrator to perform this function. The limiters remove the high circuit noise originating in the test unit preceding the counter and pass only the positive and negative pulse information.

Following the limiters, an inverter, resistive summer, amplifier and a bistable multivibrator are used to produce a binary type output corresponding to input pulses. The output, consisting of a change in d-c level between the two stable states of the binary, is used to directly modulate the 7.35-kc subcarrier.

Data Reduction

To convert the multiplexed data recorded on single channel, ¼-in. magnetic tape at 15 ips to a pen-paper strip recording, the output of the playback unit is applied to the subcarrier demodulator, shown in the schematic diagram in Fig. 8.

After passing through the multiplexed pulse modulated switch, the multiplexed signal passes through a signal preamplifier having a maximum voltage gain of 100. The amplified signal is then applied through matching amplifiers to the inputs of the three band-pass filters. The filters are standard RDB 15-percent bandwidth units and are connected for high-impedance input and output.

After separation by the filters the signals are amplified and demodulated by IN91's in conventional detector circuits. Simple low-pass filters with cut-off frequencies of about 700 cps remove the subcarriers and couple the demodulated signals to the output terminals of the unit. Since the 7.35-kc and 3-kc channels contain slow pulse information, they are coupled directly to a pen-paper strip recorder where they may be later read off visually.

The output of the 10.5-kc channel is in the form of a low-frequency recurrent wave which is switched from one frequency to another frequency every several seconds.

The signal is now in a form suitable to apply to a frequency to voltage converter or discriminator, after which it may be applied to the pen-paper recorder. In this system, however, the above signal is first passed through an amplifier-clipper so that some control over wave shape and amplitude is available should interference be present with the signals. In addition, the discriminator signal is passed through a pen-travel limiter before application to the paper-pen recorder.

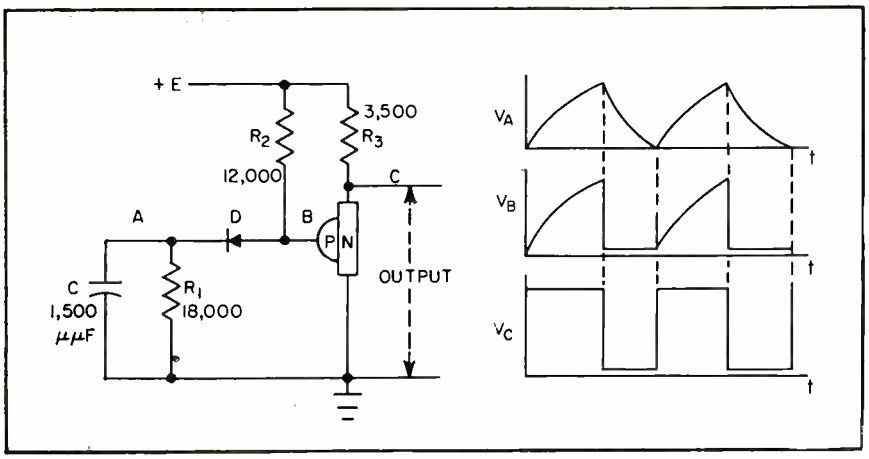
The limiters are used for the purpose of preventing loss of calibration in the event of violent striking of the mechanical pen stops during periods of signal interference. This expedient is necessary since the pens operate in an expanded-scale manner for greater reading accuracy; thus both zero and the higher voltages are off the scale limits such that loss of signal, corresponding to zero volts, would cause striking of the negative pen stop, interference or noise, corresponding to a large voltage would cause striking of the positive pen stop.

Performance

The maximum recorded range of the system, as determined by balloon cut-down rather than by minimum usable signal strength, was 180 miles. The signal level at this range, however, indicated a probable maximum range approaching the calculated vhf radio horizon at 360 miles.

Overall system accuracy based on records of several flights indicated frequency measurements were accurate to ± 1 cycle; other parameters referred to voltages having a full scale value of 10 v were accurate to ± 0.1 v.

The laboratory assistance of M. Ishihara and J. B. Hoover in the development of this system is acknowledged.



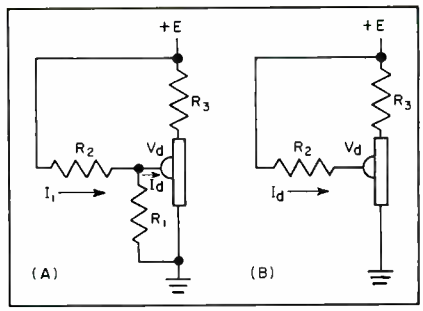


FIG. 2—Direct-current (A) and steady-state (B) equivalent circuits

FIG. 1—Basic unijunction transistor multivibrator (left) and waveforms for astable operation (right)

Unijunction Transistor FORMS FLIP-FLOP

By E. KEONJIAN and J. J. SURAN

Electronics Laboratory
General Electric Co.
Syracuse, N. Y.

SUMMARY —— Two-to-one economy in circuit components over conventional transistor multivibrators is afforded by multivibrator consisting of three resistors, one capacitor, one diode and one unijunction transistor. Circuit can be astable or monostable in operation and has particular application in digital computers and counters where component cost and network complexity can be restrictive

MOST FUNDAMENTAL of digital-type circuits is the multivibrator. The semiconductor multivibrator to be described may be considered as a diode flip-flop. Its active element is a unijunction transistor, which is a three-terminal, single-junction, negative-resistance device.[1, 2, 3]

An almost two-to-one reduction in circuit components required by the unijunction transistor multivibrator, compared to conventional transistor configurations, affords a higher degree of circuit simplicity, miniaturization and economy.

Operation

The basic circuit configuration of the unijunction transistor multivibrator is illustrated in Fig. 1.

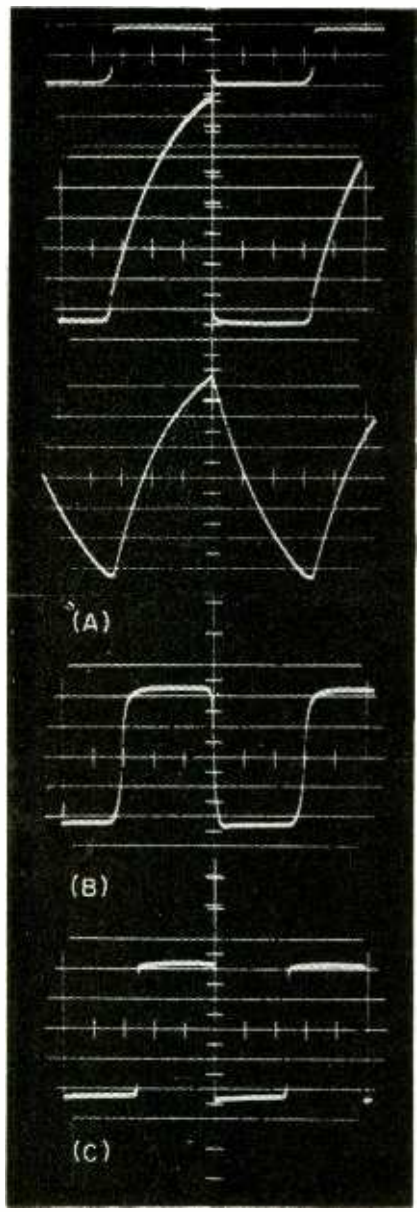
During astable operation, C is charged from the battery supply through R_2 and diode D. During the charging cycle of the capacitor, D is conducting but the unijunction transistor is in the cut-off state. When the potential across the capacitor becomes equal to or greater than the peak-point potential of the unijunction transistor, the latter becomes unstable and switches into the conducting state. The junction potential at point B is then clamped almost to ground potential, causing D to become cut off.

When D is in its nonconducting state, point A is virtually isolated from point B. The capacitor then discharges through R_1 until the potential at A is approximately equal to the junction potential of the unijunction transistor. At this instant, the diode becomes conducting again.

When the diode reverts to its conduction state, the current through the junction of the unijunction transistor decreases and the latter is driven into its cut-off state. Capacitor C will then recharge and the cycle will be repetitive.

Waveforms

Since capacitor C alternately charges and discharges through R_2 and R_1 respectively, the waveform at A consists of a periodic ex-



Waveforms for circuit of Fig. 1 operating as 10-kc astable mvbr (A); output waveforms for 55 kc (B) and 7 kc (C)

ponential rise and decay.

During the time D is conducting, the waveform at B is almost identical to that at A. However, when the unijunction transistor becomes conducting, the potential at B is clamped to a near-ground value until the capacitor has completed its discharge cycle.

When the unijunction transistor is in its cut-off state, the current through R_3 is comparatively low. However, when the unijunction transistor switches on, its bar resistance drops by an order of magnitude and the current through R_3 increases. Thus, the current through R_3 is either high or low, depending upon the operating state of the unijunction transistor and the waveform across R_3 at point C is a square wave. Frequency and symmetry of this square wave are dependent upon the time constants associated with resistors R_1, R_2 and capacitor C.

Graphical Analysis

A better understanding of the operation of the multivibrator may be obtained by considering its equivalent circuit. Figure 2A illustrates the d-c equivalent circuit of the unijunction transistor when D is conducting. The capacitor is omitted and the diode is assumed to have negligible forward resistance.

The loop equations for this circuit are

$$E = (R_1 + R_2)I_1 - R_1 I_d \quad (1A)$$
$$0 = -R_1 I_1 + R_1 I_d + V_d. \quad (1B)$$

In Eq. 1B, $V_d = f(I_d, E, R_3)$, which represents the input characteristics of the unijunction transistor for a battery supply E and load resistance R_3.

Solving for V_d as a function of I_d

$$V_d = \frac{R_1}{R_1 + R_2} E - \frac{R_1 R_2}{R_1 + R_2} I_d. \quad (2)$$

When D in Fig. 1 is nonconducting, the steady-state equivalent circuit of Fig. 2B is obtained. It is assumed that R_1 is effectively isolated from the unijunction transistor by the high back resistance of the diode. For this circuit

$$V_d = E - R_2 I_d. \quad (3)$$

The application of Eq. 2 and 3 to the operating characteristics of the unijunction transistor permits the graphical load-line analysis of Fig. 3.

For the condition that the diode conducts, the steady-state input load line is determined by Eq. 2 and is represented by the dashed line. The intersection of the load line with the ordinate axis is at a point $V_d = (E)\ [R_1/(R_1 + R_2)]$ and the slope of the load line is the parallel combination of R_1 and R_2.

For the condition that the diode is nonconducting, the load-line characteristic is determined by Eq. 3 and is represented by the solid load line (slope = R_2) in Fig. 3.

Astable Operation

For the diode multivibrator to be astable, or free running, the input load line should not intersect the unijunction transistor characteristic in the cut-off region when the diode is conducting.

When the diode is nonconducting, the input load line must intersect the unijunction transistor operating characteristic in the transition, or negative-resistance, region. Circuit conditions are

$$R_1 E/(R_1 + R_2) > V_p \quad (4A)$$
$$E/R_2 \leqq I_v. \quad (4B)$$

In Eq. 4A and 4B, V_p is the peak-point potential of the double-base diode and I_v is the input current corresponding to its valley point. The operating path of the multivibrator, in relation to the input characteristics of the unijunction transistor, may be approximately determined from the graphical analysis, as indicated in Fig. 3.

10-KC Generator

Figure 4 shows the characteristics of an experimental unijunc-

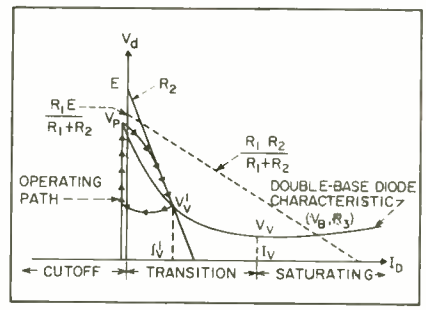


FIG. 3—Graphical load-line analysis of unijunction transistor characteristics

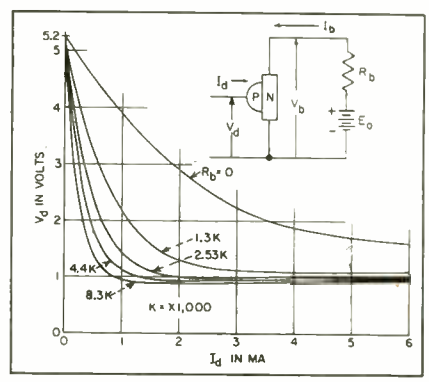


FIG. 4—Characteristics of experimental transistor similar to 4JD5SA1

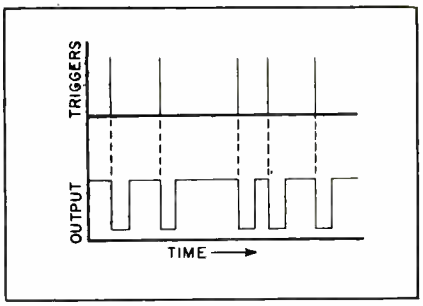


FIG. 5—Input and output of circuit of Fig. 1 for monostable operation

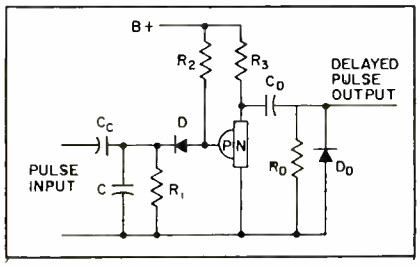


FIG. 6—Basic delayed-pulse generator

tion transistor, similar to the 4JD5A1, that was used in the circuit of Fig. 1 to obtain a 10-kc symmetrical waveform multivibrator with a maximum output of 3.7 v.

The period of oscillation can be determined from

$$t_T = -R_1C\left\{\frac{R_2}{R_1+R_2}\ln\left[\frac{1-\left(\frac{V_p}{E}\right)\left(\frac{R_1+R_2}{R_1}\right)}{1-\left(\frac{V'_v}{E}\right)\left(\frac{R_1+R_2}{R_1}\right)}\right]+\ln\frac{V'_v}{V_p}\right\} \quad (5)$$

where all parameters are determined from Fig. 1 and 3.

By changing the value of C to approximately 300 $\mu\mu$f and 2,000 $\mu\mu$f, operating frequencies of 55 kc and 7 kc, respectively, were obtained.

Monostable MVBR

Referring again to the basic circuit of Fig. 1, the multivibrator may be made monostable if

$$R_1E/(R_1+R_2) < V_p \text{ and} \quad (6)$$
$$E/R_2 < I_v. \quad (7)$$

Equation 6 fixes the stable operating point of the unijunction transistor in the cut-off region and Eq. 7 insures that this is the only stable operating point. If Eq. 6 and 7 are satisfied, a positive pulse will trigger the unijunction transistor from the off to the on state. The unijunction transistor will then remain conductive until the capacitor discharges through resistor R_1.

When the diode reverses at the end of the capacitor discharge cycle, the transistor becomes nonconductive. Since it is stable in cut-off state, the multivibrator circuit remains stable until the next positive trigger pulse is applied. Thus, the regenerated output waveform duration is

$$t_D = -R_1C\ln(V'_v/V_p) \quad (8)$$

Figure 5 shows the waveform generated by a monostable multivibrator. Minimum spacing of the trigger pulses is limited by the circuit's time constants.

On the other hand, if

$$R_1E/(R_1+R_2) > V_p \quad (9)$$
$$E/R_2 > I_v \quad (10)$$

a monostable circuit, having a stable operating point associated with the conductive state of the unijunction transistor is obtained. Negative pulses may then be used to trigger the circuit into its regenerative cycle.

Delayed-Pulse Generator

Use of the monostable multivibrator as a delayed-pulse generator is illustrated in Fig. 6. Here R_D and C_D are used as a differentiating network while D_D filters out the pulses of unwanted polarity. The output waveform consists of pulses which are generated by differentiating the trailing edge of the multivibrator output.

Diode D_D filters out the pulses which are generated by the leading edge of the multivibrator waveform. Hence, the output of the delayed-pulse generator consists of a train of pulses which have the same polarity and repetition rate as the input pulses but which are delayed in time by an interval t_D determined by the time constants of the monostable circuit.

Figure 7 illustrates the relationship between the pulse delay t_d and the magnitude of the multivibrator capacitor C for the experimental delayed-pulse generator circuit shown. In this circuit the conditions defined by Eq. 6 and 7 are required for operation. Time delays from 50 μsec to 2 millisec have been obtained for pulse repetition rates from 0 to 5 kc. The time delay is related to the magnitude of C in a linear manner. This relationship is convenient in design and facilitates constructing simple variable-delay pulse generators.

The advantages of this new circuit should be particularly significant in complex systems such as digital computers and counters where component cost and network complexity can be restrictive.

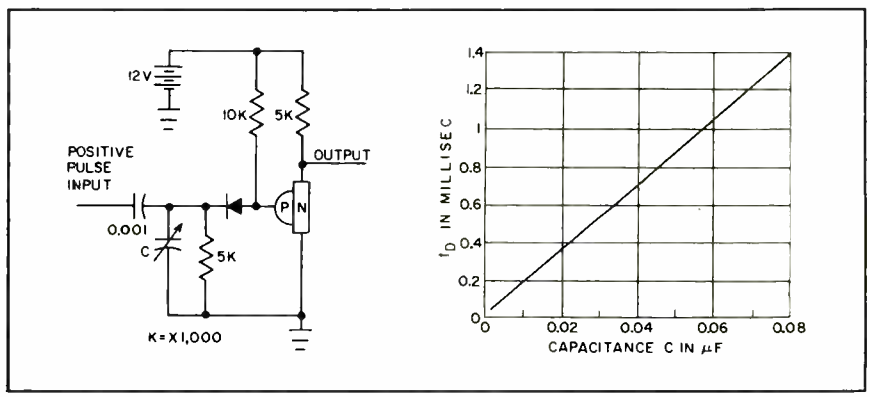


FIG. 7—Experimental delayed pulse generator and delay characteristics. Transistor used is similar to 4JD5A1

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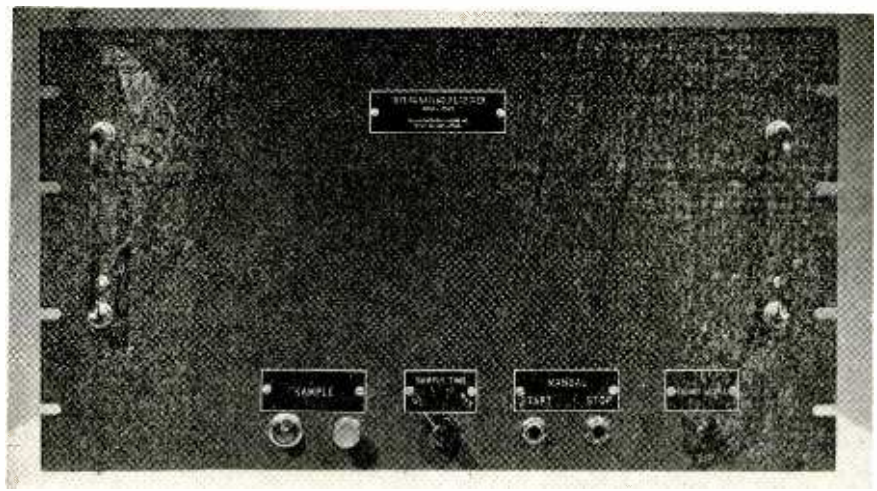


Rack-mounted front panel and external controls of comparison integrating receiver

Modular assemblies on top of chassis

Receiver Detects Signals

By WILLIAM L. BLAIR

Senior Engineer
Haller, Raymond and Brown, Inc.
State College, Pa.

SUMMARY —— Integrating receiver digitalizes noise output from superheterodyne second detector. Result is integrated over any of several measured time intervals. Input to integrator switches at 500 cps to compare radiated noise with that from dummy antenna. Presence of signal is indicated by increase in average count difference from two inputs in the integrator. Error probability is about 20 percent for missed signals and two percent for false alarms at levels as much as 26 db below ambient noise

DETECTION of electromagnetic radiations is difficult when they are obscured by noise, generated either within or outside the receiver. Such a signal may sometimes be detected by a narrow-bandwidth receiver, but this is tedious since only a small portion of the r-f spectrum can be examined at one time. The integrating receiver technique used in radio astronomy determines the presence or absence of a signal well below the noise level in a wide-band receiver. The receiver integrates over extended intervals by digitalizing the noise output from the second detector of a superheterodyne and accumulating the total on conventional pulse counters.

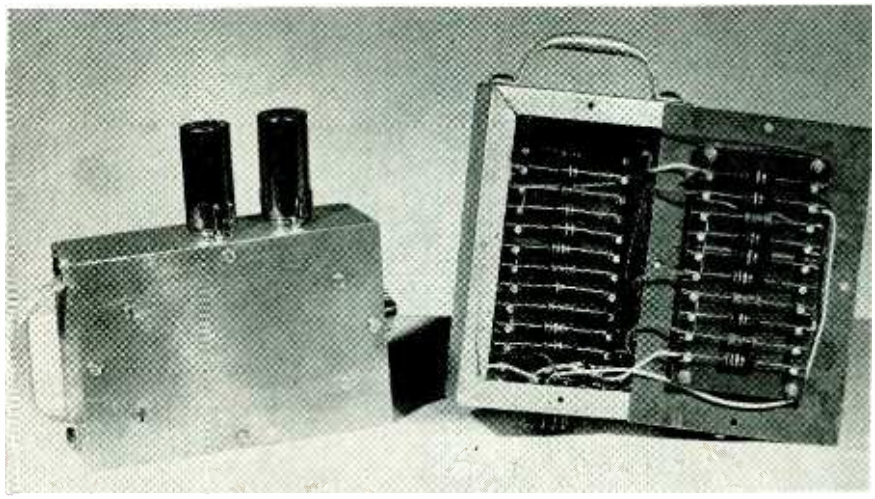
Figure 1 shows an actual antenna and a terminating-resistor dummy antenna providing two inputs to the system. A crystal r-f switch driven by the cycle controller changes the superheterodyne input between the signal antenna and the reference 500 times a second. The cycle controller also operates the gates in synchronism with the crystal switch; with gate 1 open when the receiver is on the reference antenna, and gate 2 open when the signal antenna is connected.

Operating Principles

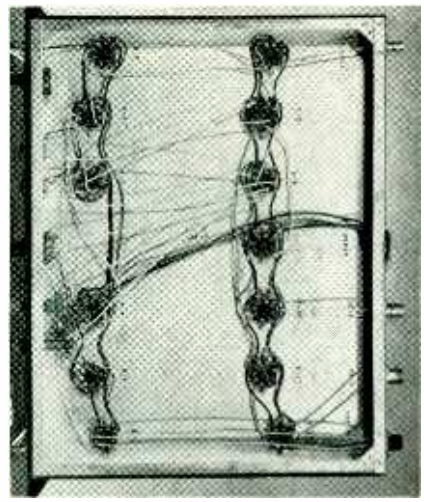
The resistance of the reference antenna equals the impedance of the signal antenna. When there is no signal at the receiving antenna, the difference between the average noise levels from the two inputs is constant, but even a feeble signal raises the output slightly. The sampler produces at the gate input a quantity of pulses proportional to the average noise voltage from the receiver.

The cycle controller automatically measures integrating time intervals of 0.1, 1.0 and 10 sec, or manually for any desired interval. After a sample, count 1 is proportional to the reference antenna noise and count 2 proportional to the noise from the signal antenna, both integrated over the predetermined period.

Rapid switching between inputs insures that any low-frequency changes in receiver gain or line voltage affect both channels equally and therefore do not cause false



Typical modules, with side removed showing internal construction and wiring method



Modules minimize under-chassis wiring

Below Noise Level

increases in count difference. After a reference difference is measured with no signal at the receiving antenna, the arrival of a signal is noted by an increase in the difference between the counters.

Circuit Techniques

The detailed block diagram of Fig. 2 will help to visualize the techniques used to obtain these functions. The circuit schematic in Fig. 3 has each stage or group labeled in accordance with the blocks in Fig. 2.

An electron-coupled 100-kc crystal oscillator *V*1 and monostable multivibrator *V*2 comprise *Z*-1. Their output is a positive pulse of about 4 μsec. This provides the medium for sampling the second detector output level as well as a reference for all timing intervals.

The crystal diode at the input to *Z*-2 clamps the base line of the pulses to ground potential. The triode section of the amplitude modulator *V*3*A* is diode-connected and the pentode section *V*3*B* is an amplifier whose plate voltage sets

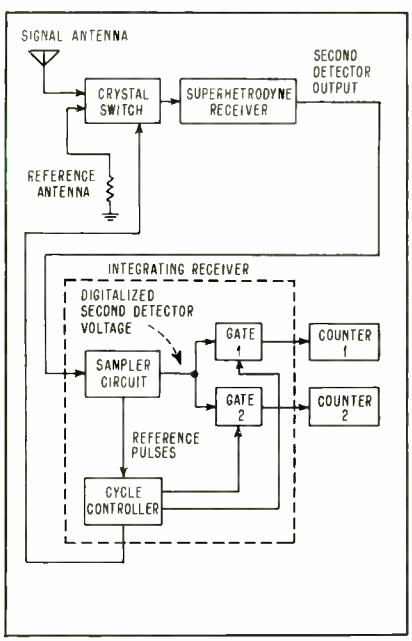


FIG. 1—Block diagram of complete system

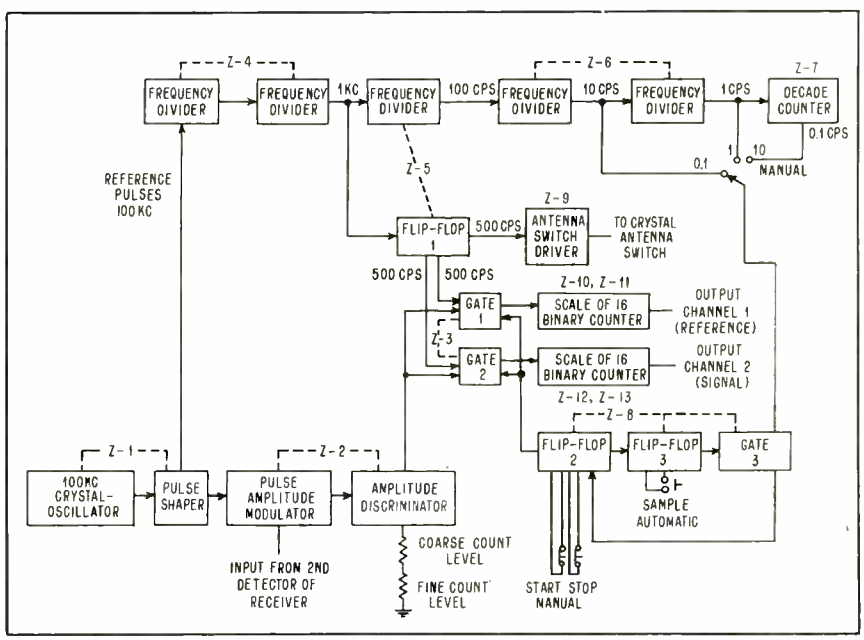


FIG. 2—Detailed block diagram of integrating receiver functions outlined in Fig. 1

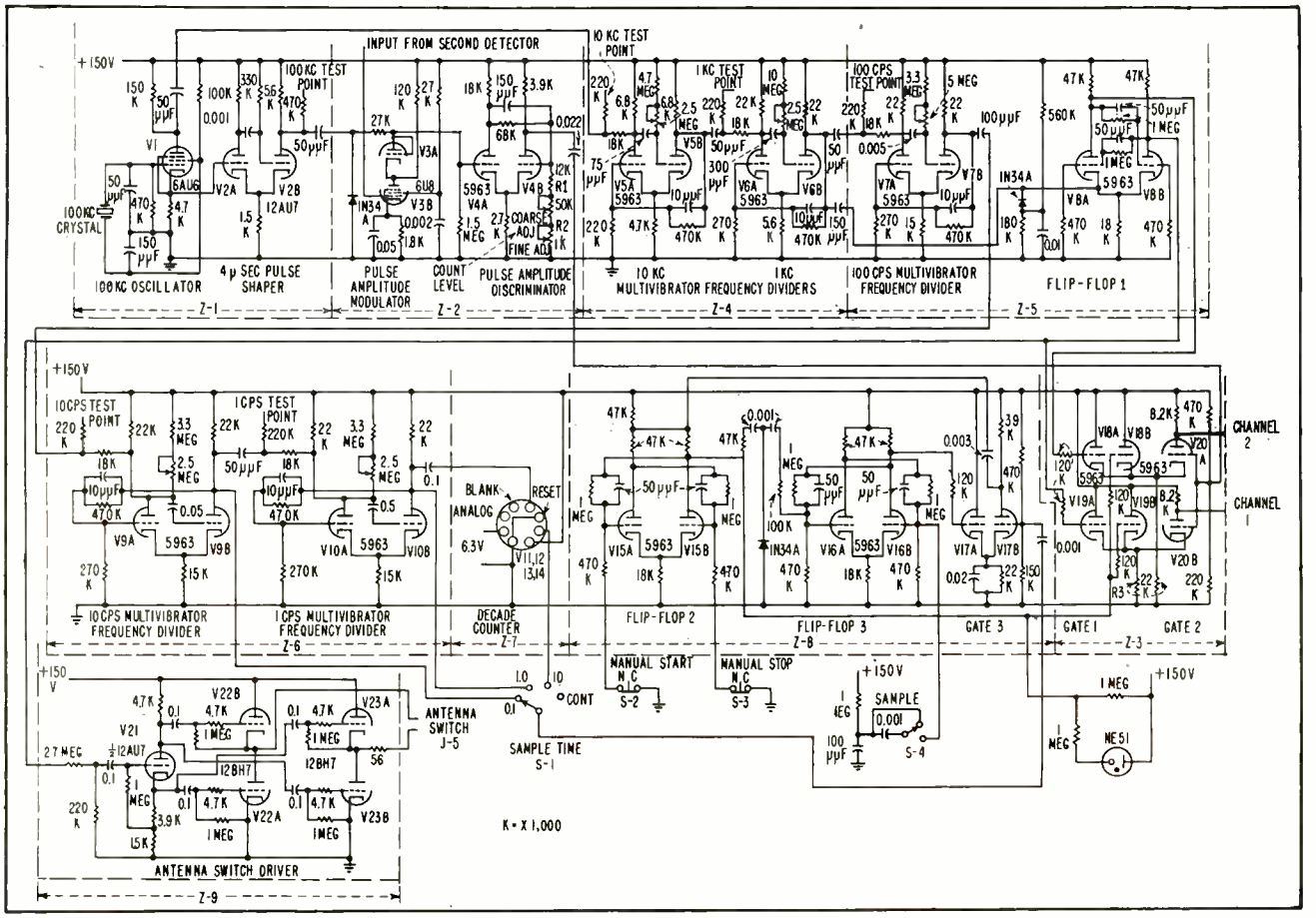


FIG. 3—Schematic diagram of integrating receiver. Output of each channel feeds counters shown in Fig. 4.

the bias level on the diode. The pulse amplitude is about 100 v and the average bias is 90 v. Diode *V3A* therefore acts as a clipper limiting the pulse amplitude to that of the bias. Since this bias level is fluctuating randomly with the input signal, the pulses are effectively amplitude modulated.

V4 is a Schmitt multivibrator triggered by any pulse above a critical amplitude. This level is adjustable by coarse control *R1* and by the fine count level control *R2*. The optimum setting of this discriminator permits the multivibrator to be triggered by about 20 percent of the pulses, but this percentage is not critical.

Gates and Counters

Gates 1 and 2 in *Z*-3 each consist of three triode sections connected with a common cathode resistor. Two of the sections are cathode followers while the third is an amplifier. There is d-c coupling between flip-flops 1 and 2 and the grids of the cathode followers. Considering gate 1, with *V8B* of flip-flop 1 and *V15B* of flip-flop 2 both cut off, there are large positive potentials on the grids of *V19A* and *V19B*. The resulting heavy conduction through these tubes develops a high voltage across *R3B* and biases *V20B* far below cutoff. If *V8B* is changed to the conducting state *V20B* remains cut off, but if *V15B* is also triggered to conduction the voltage across *R3* reduces to place *V20B* just at cutoff. Then the positive pulses from the amplitude discriminator are amplified by *V20B*. There must therefore be a coincidence of all these inputs to each gate before there is any output. Flip-flop 1 switches continuously back and forth between gates 1 and 2, but flip-flop 2 switches on only for a precise interval of 0.1 sec, 1 sec, 10 sec, or the interval determined manually depending upon the selection at *S*-1. Four binary scale-of-16 counter stages

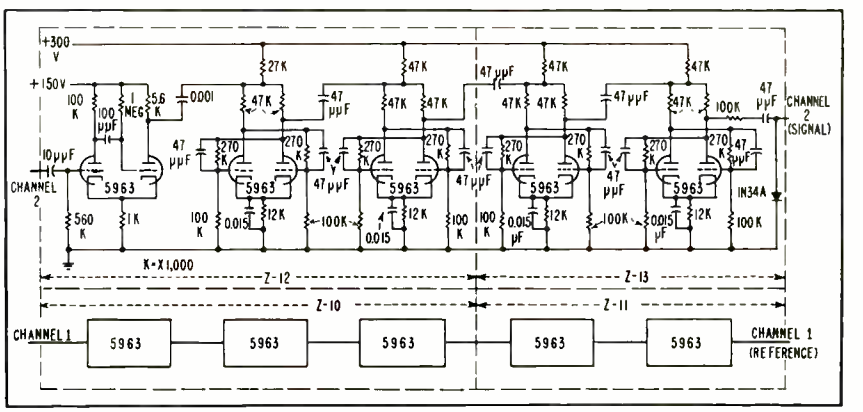


FIG. 4—Schematic of counters following integrator. Channels 1 and 2 are identical

Z-10, 11, 12 and 13, shown in Fig. 4 preceding channels 1 and 2, lower the speed requirements on the counters.

Frequency Dividers

Frequency division from the 100-kc reference oscillator occurs in Z-4, 5, 6 and 7. The first five dividers are monostable multivibrators each having a period approximately ten times its predecessor. Each multivibrator is triggered to its semistable state by one pulse, remaining there insensitive to the next nine pulses, returning just in time to be re-triggered by every tenth pulse. The output pulses are then 0.1 of the input frequency. The 10-sec period required of the last divider is impractical using a multivibrator of this type, so decade counter Z-7 is used instead.

The three stages of the cycle controller are in Z-8. Flip-flops 2 and 3 are bistable multivibrators and gate 3 is similar to gates 1 and 2 except that only two triode sections are required.

Initially V16B is cut off and high plate voltage causes V17A to conduct heavily, biasing V17B well beyond cutoff. No pulses from S-1 are passed, V15B is cut off and its high plate voltage closes gates 1 and 2. With S-1 in the 1-sec position, pressing the sample button S-4 supplies a momentary trigger which changes the state of flip-flop 3 and opens gate 3. The next pulse coming from S-1 is passed and triggers flip-flop 2, thus initiating the sample time by opening gates 1 and 2. The pulse from flip-flop 2 to flip-flop 3 is not of correct polarity to trigger and gate 3 remains open. One second later the next pulse from S-1 triggers flip-flop 2 again, terminating the sample time by closing gates 1 and 2 and pulsing flip-flop 3 with the proper polarity for triggering. Gate 3 is then closed to subsequent pulses from S-1. Start and stop pushbuttons S-2 and S-3 change the conducting state of flip-flop 2 so as to open and close respectively, gates 1 and 2 during manual operation of the cycle controller.

The antenna switch driver stages are in Z-9, but switch J-5 is a separate unit connected in the antenna of the receiver. The driving current for this switch is a square wave. The circuit is equivalent to an arrangement of four spst switches with V22A, 22B, 23A and 23B each acting as one of these switches. V21 is a phase inverter controlling the other tubes. The initial driving voltage from flip-flop 1 is thus synchronized with the operation of gates 1 and 2.

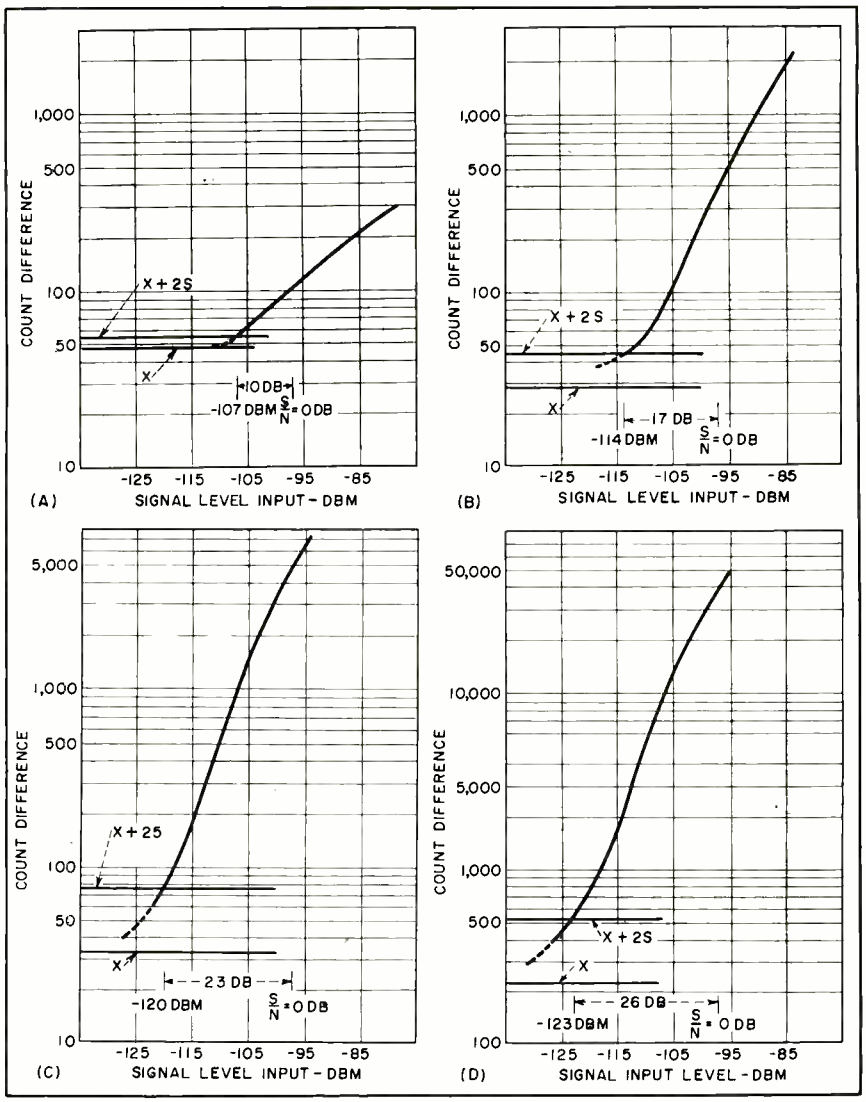


FIG. 5—Sensitivity for 0.1-sec (A), 1.0-sec (B), 10-sec (C) and 100-sec (D) samples. Slight inequalities in switching cycle tend to make count difference negative, so a constant value X is added to each quantity in order to permit positive plotting on the logarithmic scale

Application

The fundamental application for this development involves the searching or monitoring of a wide band of frequencies for the presence of a signal. The integrator in conjunction with a "wide-open" receiver will improve the characteristic low sensitivity of a wide-band system. Once the presence of a signal is indicated, more precise information can be obtained by a narrow-band receiver. This application is common to radio astronomy and ionosphere research.

The improvement over conventional receivers through the addition of the integrating receiver is constant down to 1-percent duty cycles, slowly decreasing below this point. Even at 0.1-percent duty cycle, however, a considerable improvement in sensitivity is still realizable.

The author expresses his appreciation to Messrs. Albert F. Lopez, Howard L. Schneider, Ronald M. Spackman and John C. F. Walker for their contributions to the development of the integrating receiver. Research was conducted under Signal Corps Contract DA-36-039-SC-64421.

NAVIGATION TRAINER

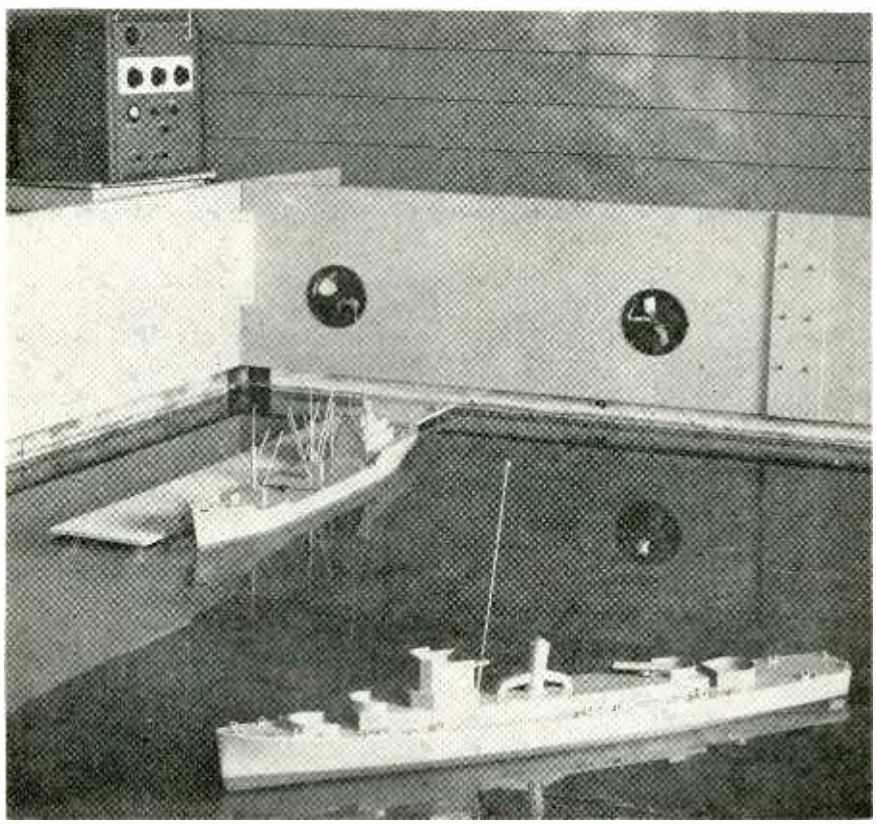
By ALAN L. RICH

Senior Project Engineer
Teletronic's Laboratory, Inc.
Westbury, L. I., N. Y.

SUMMARY —— Two self-powered radio-controlled ship models, a control center and a water tank, scaled 75 to 1, train naval personnel in the art of ship handling. Ship characteristics such as response to helm, engine telegraph, acceleration and deceleration have time lags similar to full-scale ships. Device also simulates wind and water currents. Control is proportional, utilizing three audio channels modulating a single carrier frequency in the 30 to 42-mc band

INTENDED for use at naval training schools and reserve training centers for demonstration and exercise in the art of ship handling, the ships'-characteristics demonstrator consists of a control unit, two self-powered radio-controlled ship models and a tank.

Only one model is used at a time. The operator steers the ship and actuates the engines by three knobs on the control-unit panel which correspond to the helm and the engine telegraphs. Rudder control is continuous. Engine control is in the following steps: flank speed ahead, full speed ahead, standard speed ahead, 2/3 speed ahead, 1/3 speed ahead, stop, 1/3 speed back, 2/3 speed back and full speed back.



Control unit on table, upper left, has three knobs which control the cargo-vessel model beside the pier and the destroyer-escort model in foreground. Fans and ductwork are seen around the tank

The control system is the proportional type and utilizes pulse-duration modulation of three audio channels modulating a single r-f carrier. The control unit contains the modulator circuitry, transmitter, power supply and the ships' battery charger. The transmitter is low powered, crystal controlled and conventional. It is presently operating on an assigned frequency of 34.54 mc, but may be tuned to any frequency in the 30 to 42-mc band with suitable crystals.

Single-screw ships are represented by an AK cargo vessel model. The other model, a destroyer escort DE 51 class, has twin screws independently controlled and twin rudders. Both models have molded fiberglass hulls four feet long and are scaled approximately 75 to 1 in length with corresponding scaling of displacement, speed, turning radii and advance and transfer.

Time lags similar to those of a full-scale ship are incorporated into all responses; response of rudder to helm, response of ship to rudder, response of engines to engine telegraphs and response of ship to engines.

The ships' circuitry is transistorized, with servomechanisms to position the rudder and actuate the

Controls Ship Models

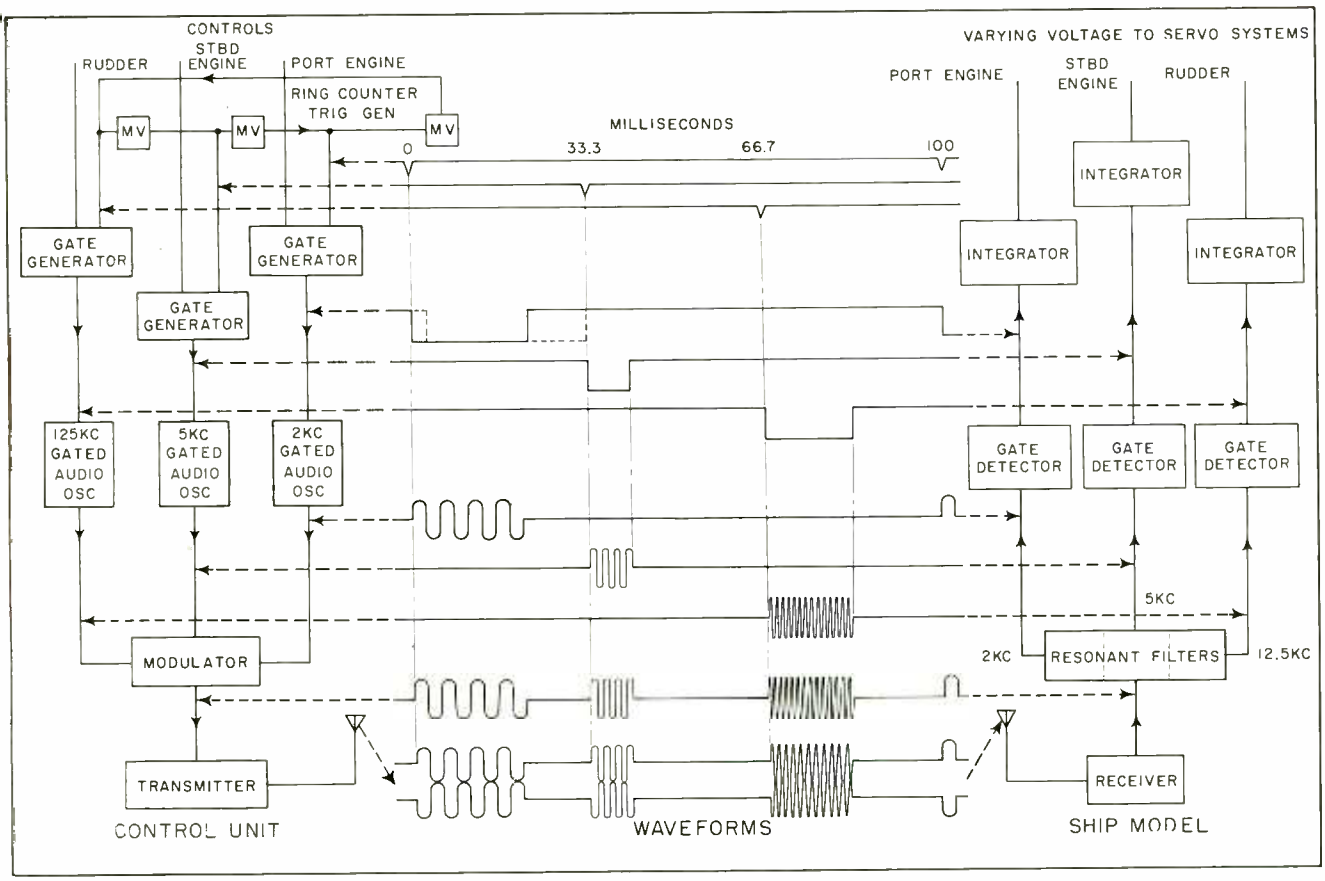


FIG. 1—Information transmission link of naval trainer showing waveforms. Control information is transmitted at 10 cps

drive motors. The batteries are easily removable, provide 6 hours of continuous operation and can be recharged in less than 2 hours.

The tank has a 20-ft-square water surface corresponding to scaled dimensions of 1,500 ft by 1,500 ft. When filled to a depth of 6 in. it has a scale depth of 37 ft. Associated with the tank are a wind generator and a water current generator. Either or both may be introduced into the demonstration.

Information Control

The information transmission link includes the generation, transmission and reception of the signals used to control the operation of the ship models. Block diagrams and waveforms of the system are shown in Fig. 1. Control information is transmitted to the models at a basic rate of 10 cps. Timing triggers are generated in a ring-of-three counter, and drive three variable-delay gate generators in sequence. The gate widths are determined on the front panel of the control unit by the port engine, starboard engine and rudder Controls. Each gate may be varied from virtually zero to one-third of the repetition period. The three channels time-share the repetition period.

Each gate actuates an audio oscillator. The oscillator generates an audio pulse of the same duration as, and coincident with, its initiating gate. Audio frequencies generated are 2 kc, 5 kc and 12.5 kc for the port engine, starboard engine, and rudder channels respectively. Outputs of the three oscillators are combined and amplitude modulate the radio transmitter.

Gate Generators

The ring-counter trigger generator, shown in Fig. 2, consists of three plate-coupled monostable multivibrators V_1, V_2 and V_3, each introducing a delay of 33⅓ milliseconds. The differentiated output of each stage triggers the next, with diodes used to steer the triggers and maintain unilaterial propagation around the ring.

Ring-counter operation is initiated by pressing a normally-closed pushbutton switch which momentarily interrupts the cathode current of V_{2B}. A neon incator lamp, connected across the plate resistor of V_{2A} flashes at 10 cps.

The output of each ring-counter stage also triggers, through a steering diode, a similar monostable multivibrator V_4, V_5 and V_6. However, the duration of delay of these gate generators is controlled by varying the grid return resistors of the normally-on triode sections V_{4B}, V_{5B} and V_{6B}. The gate width may be varied from 2 to 33 millisec. Negative output gates are available at points X, Y and Z.

Each gate is fed to points X, Y

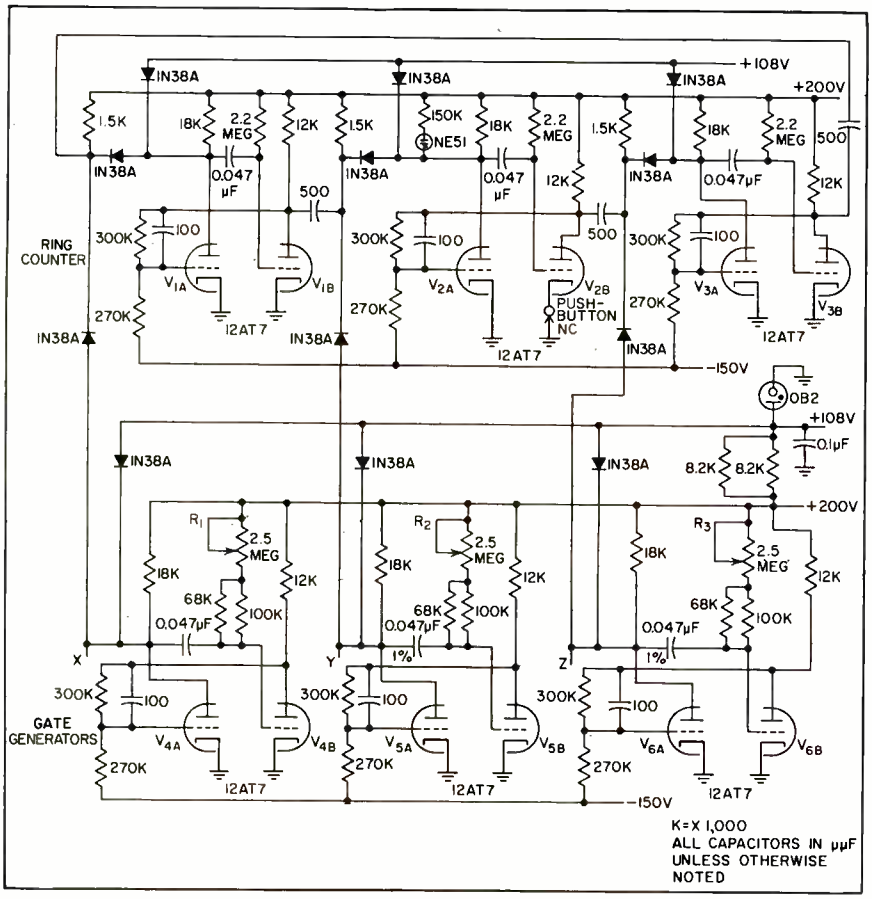


FIG. 2—Control unit of ship demonstrator showing ring counter and gate generators. A diode clamp returned to 108-v limits the plate voltage of the normally-off triode sections V_{1A}, V_{2A} and V_{3A} and determines the initial amplitude of the timing waveforms

and Z in Fig. 3. This turns off triodes V_{7A}, V_{8A} and V_{9A}, each connected across an oscillator resonant circuit, raising the circuit Q sufficiently to permit sustained oscillation and to shock-excite the oscillator.

Gated Oscillators

Each gated oscillator is a grounded-anode Hartley circuit comprising the cathode, control grid and screen grid of a pentode section of V_{7B}, V_{8B} and V_{9B}. Oscillations are electron-coupled to the plates, with the three plates driving a common load.

The combined output is R-C coupled to a paraphase amplifier V_{10}, which is the phase inverter and driver for a push-pull class-B modulator V_{11}.

In the transmitter, a Butler cathode-coupled two-stage r-f oscillator, V_{13} drives a buffer stage V_{12} that is broadband-coupled to the plate-modulated final amplifier V_{14}. A pi-section tank couples the final amplifier to a short antenna.

In each receiver, Fig. 4, a diode detector drives a high-gain three-stage transistor audio amplifier. With the transmitter located adjacent to the tank there is a 40-db variation in received signal-strength. In lieu of agc, the audio amplifier limits at a low input level so that the output amplitude remains constant over a large range of signal strength. Distortion introduced by clipping results in negligible crosstalk since the audio frequencies of the 2 kc, 5 kc and 12.5 kc—channels bear no low-order harmonic relationship.

Channel Subassemblies

The resonant filter, gate detector, limiting amplifier, integrator and the electronic portion of the servo system of each of the channels comprise a small subassembly. The schematic is shown in Fig. 5.

Servo System

Proportional control is achieved by an on-off or relay-type servomechanism. Referring to the servo system block diagram shown in Fig. 6, the varying d-c input from the integrator is fed to a voltage comparator. The second input to the comparator is obtained from the rotor of the control potentiometer mounted on the servo shaft. This voltage is proportional to shaft position. The operation of the servo system is illustrated by examples which relate the sense of all electrical and mechanical quantities involved.

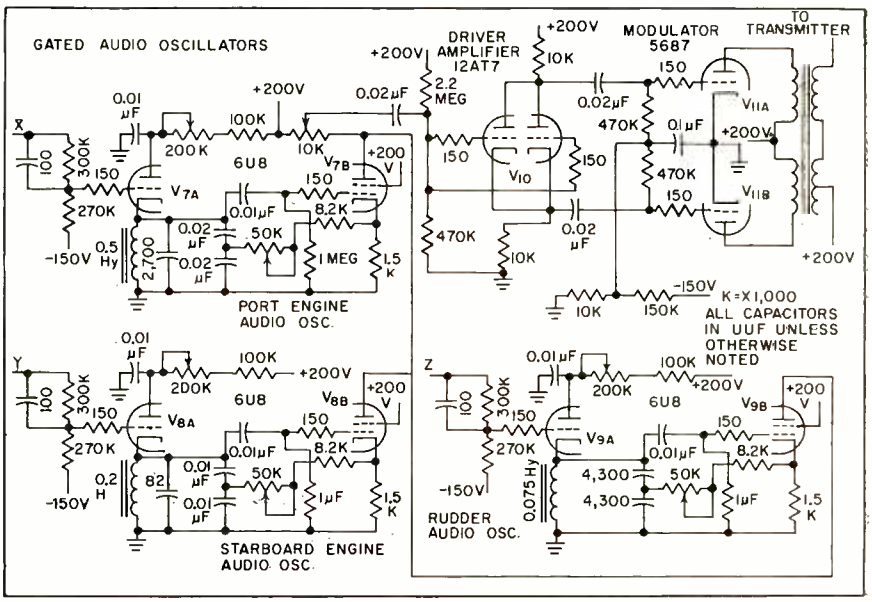


FIG. 3—Gated oscillators, modulator and transmitter in the control unit. Each gate is fed to points X, Y and Z, turning off triodes V_{7A}, V_{8A} and V_{9A} connected across an oscillator resonant circuit, raising the circuit Q enough to sustain oscillation

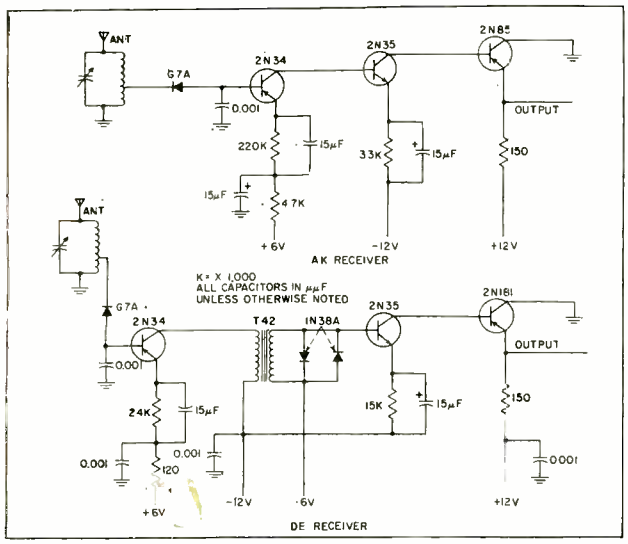


FIG. 4—Receivers in the ship models. In each receiver, a diode detector drives a high-gain three-stage transistor audio amplifier

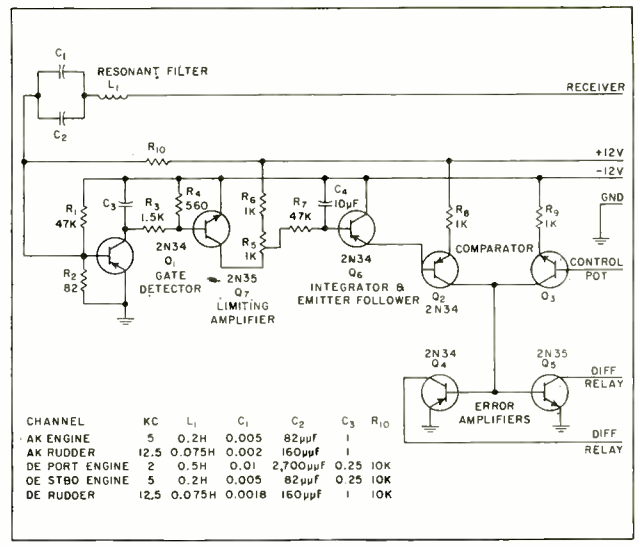


FIG. 5—Resonant filter, gate detector, limiting amplifier and the electronics of the servo-system in the ship model

Rudder is 35 degrees right, engine is running flank ahead, Control knob is at 35 deg right rudder flank ahead, 5 kc rudder channel gate or pertinent engine channel gate is at minimum width 2 millisec. The integrator output, as fed to the comparator is at a d-c level of +12 v.

Flank Ahead

The servo shaft is fully counterclockwise, resulting in 35 deg right rudder in the one case or a control switch position yielding flank ahead speed in the other. The voltage on the control potentiometer rotor is −12 v.

Since the magnitudes of the two inputs to the comparator are equal, there is no error output.

Relay is at neutral and the control motor is not energized.

In another example of equilibrium the rudder 35 deg left: engine full reverse, control knob agrees with rudder, or engine, state and the channel gate is at the maximum width of 33 millisec.

Input to comparator from integrator is +6 v d-c, servo shaft is fully clockwise and the control potentiometer voltage is −6 v, zero error, relay at neutral and control motor not energized.

Equilibrium is achieved at any intermediate angle of the servo shaft provided the rudder or engine performance agrees with the corresponding control knob setting.

Rudder Position

To Change Rudder Position Or Engine Speed:

With the system in equilibrium, counterclockwise rotation of the control knob, towards 35 deg left rudder or towards full reverse, will increase the duty cycle. The integrator output goes toward +6 v. A positive error appears at the comparator output, is amplified by Q_5 and actuates the differential relay, applying +6 v to the control motor. The control motor rotates the servo shaft clockwise, driving the control potentiometer wiper towards the −6 v end of the potentiometer and turns the rudder to the left or steps the engine towards full reverse. This movement continues until the comparator is balanced again.

Clockwise rotation of control knob: right rudder correction or engine speed change towards flank ahead:

Integrator towards +12 v, negative error; amplifier Q_4 actuates relay, relay contacts 2 and 3 close; −6 v applied to motor, motor drives servo shaft counterclockwise; control potentiometer wiper moves toward −12 v; rudder moves right or engine steps towards progressively slower reverse speeds or progressively faster ahead speeds; when system is again balanced, servo shaft stops.

The entire engineering staff of Teletronics Laboratory, Inc. working in cooperation with the engineering personnel of the United States Naval Training Device Center made the development of this device possible.

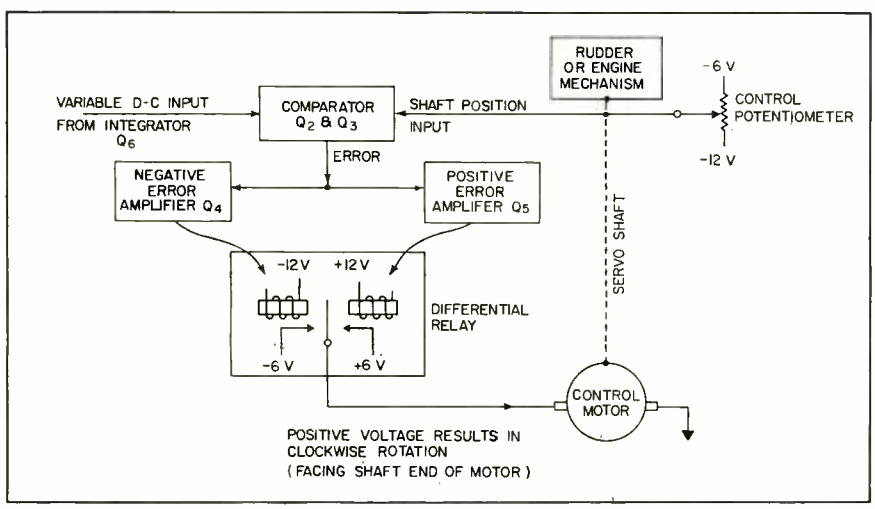


FIG. 6—Servo system in ship models. Relay-type servo achieves proportional control

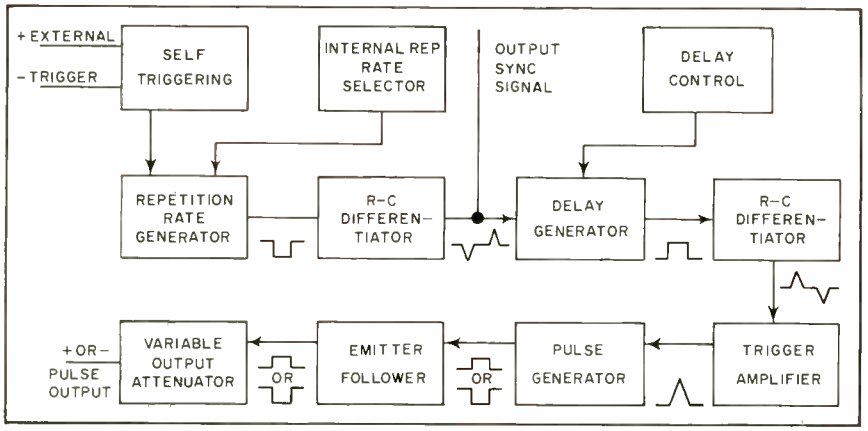


FIG. 1—All-transitor pulse generator employs repetition-rate generator, both free-running and externally triggered. Delay is achieved by using a variable-width monostable multivibrator in conjunction with a RC differentiator

By EDWARD J. FULLER

Microwave Electronics Division
Sperry Gyroscope Company
Division of Sperry Rand Corporation
Great Neck, New York

Pulse Generator Uses

SUMMARY — All-transistor pulse generator achieves pulse amplitudes of 28-v negative, 50-v positive with widths continuously variable from 1.0 to 10 μsec and rise-decay time of 0.3 μsec. Internally generated repetition rates vary in steps from 50 to 5,000 pulses per second with external triggering by either positive or negative pulses, and 1 to 100 μsec time delay internally

DURING the course of the design and development of a completely transistorized pulse generator, it was soon apparent that presently available junction and surface barrier type transistors imposed certain limitations upon the desired performance. The completed unit, presented here, is one approach to the problem and particularly emphasizes how these limitations were overcome and what refinements were necessary to fulfill certain definite requirements.

The use of transistors offers several advantages: excellent adaptability to printed circuitry; economy of power consumption; reliability over an extended period of time, and small size.

Basic Circuit

Figure 1 shows the basic circuit in block form. The overall schematic diagram is shown in Fig. 2.

The repetition rate generator is an astable multivibrator with a provision for switching to monostable operation so that it can be externally triggered. The common-emitter circuit used allows for phase reversal between base and collector.

The 904 npn silicon-junction transistor used allows a maximum collector potential of 30 volts and a collector current of 25 ma.

Common Emitter

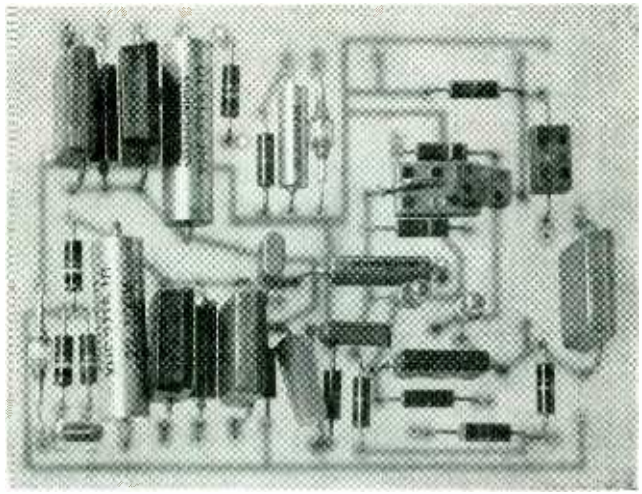
A typical measured set of common-emitter characteristics is shown in Fig. 3. To achieve an amplitude of about 22 volts, the load line is drawn from $I_c = 0$ ma, $V_c = 30$ v to $I_c = 10$ ma, $V_c = 0$ v. The calculated load resistor = 22 v/0.010 ampere = 2,200 ohms.

The load line is intersected by base current $I_b = 300$ μa at $V_c = 8$ volts which allows for the 22-volt collector swing. Therefore, the value of R_b must be determined for $I_b = 300$ μa and is calculated at 100k ohms.

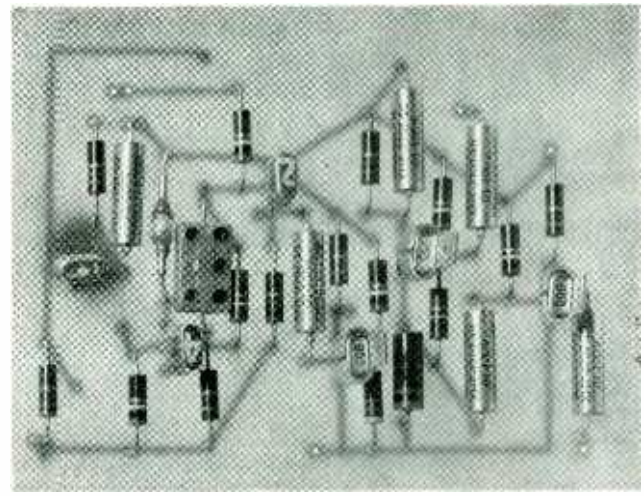
The values of the coupling capacitors are determined to give the proper R-C time constant to generate the designated repetition rates. Because the inherent resistance between the base and the emitter is considerably smaller than the value of R_b, timing capacitor C_c will discharge through the transistor between base and emitter to ground, thus limiting the value of the R-C time constant.

To insure that the R-C time constant is determined solely by R_b and C_c, a diode is placed between the emitter and ground. The back resistance of the diode is so large that the capacitor C_c must discharge through R_b.

The circuit is unsymmetrical to free-run over a wide range of repe-



Repetition-rate generator and time-delay circuits excluding controls. Back-lighting shows the printed circuitry



Wide-band amplifier, pulse generator, emitter follower and amplifier circuit show adaptability to printed-circuit techniques

Junction Transistors

tition rates, especially at values below 500 pulses per sec (where R_{L2} should be approximately twice the value of R_{L1}). To achieve a large variation in the repetition rate, the value of C_c is varied from 0.018 to 0.22 μf, as changing the value of R_b changes the d-c operating point of the transistor, seriously affecting the voltage waveform.

Triggering

For monostable operation, a negative bias is applied to the base of Q_2. The circuit permits self-triggering or external triggering either positively or negatively. An external signal of $\pm$ 5.5 volts with a width greater than 0.7 μsec triggers the generator during monostable operation. When the emitter of Q_2 is triggered positively, it is grounded directly instead of being connected to ground through a diode, as in the free-running position. This allows the multivibrator to trigger on a smaller signal than when the diode is in the circuit. The output waveforms are shown in Fig. 2.

Delay

To achieve delay, a variable-width, monostable multivibrator is used with an R-C differentiating circuit. To attain a pulse width of less than 1 μsec, a transistor with a high β cutoff frequency is used.

In the common emitter configuration, the β cutoff frequency $(f_{c\beta}) = (f_{c\alpha}(1-_{\alpha})$, where α and $f_{c\alpha}$ are the common-base configuration gain and bandwidth parameters.

The 904 A transistor was considered. Of those measured, $F_{c\alpha}$ varied from 7.5 mc to 15 mc and α from 0.981 to 0.964, giving values of $f_{c\beta}$ from 0.171 to 0.480 mc. The other transistor considered was the SB-100 surface-barrier type. The measured $f_{c\alpha}$ was in excess of 50 mc for all of the transistors tested and α varied from 0.944 to 0.978, giving values of $f_{c\beta}$ greater than 1.1 mc.

The 4.5-v max collector voltage and 5-ma max collector current of the SB-100 limit the magnitude of the output signal to a value of less than 4.5 volts, but this value is sufficient for a delay generator.

The surface-barrier transistor gave a much narrower pulse in a monostable multivibrator circuit than any of the other available types of junction transistors. Pulse width of 0.3 μsec were obtained with rise times of 0.03 μsec and decay times of 0.05 μsec.

The value of R_{L1} was determined to give a collector voltage swing of 4.2 volts and the base resistance value was taken from the load line in the same manner described for the repetition-rate generator.

Stage Q_1 is normally on and Q_2 is held off by a positive bias on the base.

To vary pulse widths from less than one μsec up to 100 μsec, the R-C time constant must be varied. The conventional R-C circuit used in the repetition-rate generator allows only C to be varied. Over a range of one to 100 μsec, the dynamic range of the capacitor would be excessively large. Therefore, the pulse width variation is brought about by a special R-C circuit.

Pulse Shape

The base resistance for Q_1 equals 27,300 ohms and the value of C is determined by the values of C_{T1} and C_{T2} in series with each other. C_{T1} isolates the collector of Q_2 from the base resistance of Q_2 and the 25,000-ohm variable resistor allows a pulse width variation from about 0.8 μsec up to over 100 μsec. Although pulse widths narrower than 0.8 μsec can be obtained with the SB-100, the R-C values are not practical when widths of 100 μsec are to be achieved with the same

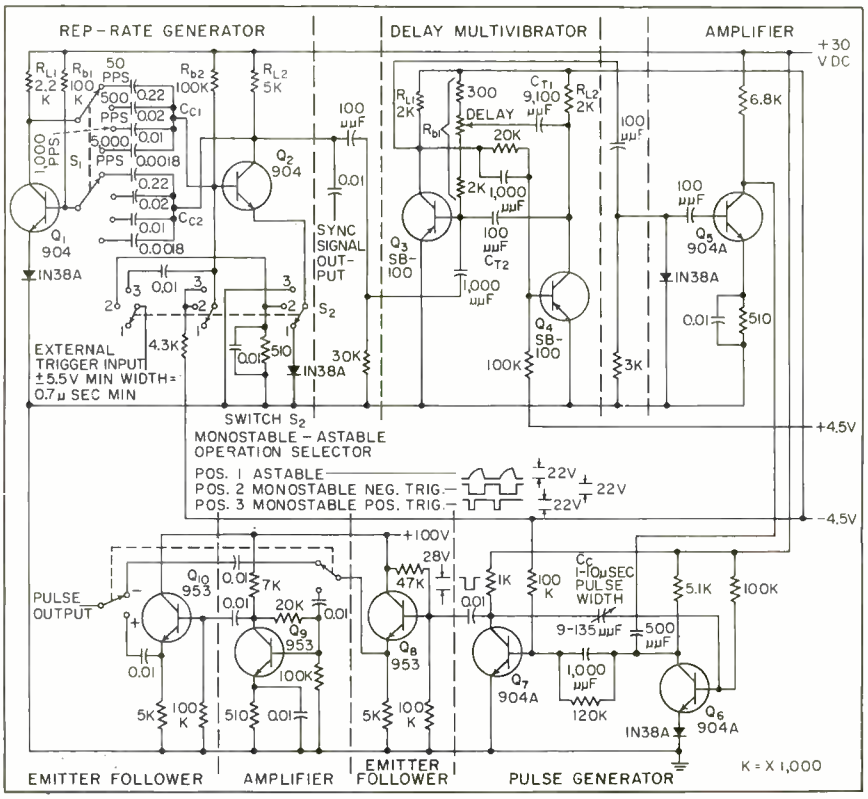


FIG. 2—Pulse generator circuit uses 904 junction transistors and produces pulses with amplitude of 100-v width, continuously variable from 0.1 to 10 μsec

type of circuit.

The optimum pulse shape is achieved by driving the transistors into saturation, which gives a flat top. Decay time can be improved by lowering the value of R_{L2}, so that the transistor is just into saturation. Values lower than 2,000 ohms are feasible for narrow pulses, but attempts to achieve widths greater than about 10 μsec cause the pulse amplitude to droop excessively.

The delay multivibrator output pulse shapes are shown in Fig. 4 for widths of 1, 10 and 100 μsec. The pulse amplitude is 4.2 volts in a positive-going direction. The differentiated pulse gives a delayable positive voltage spike of 1.1 volts.

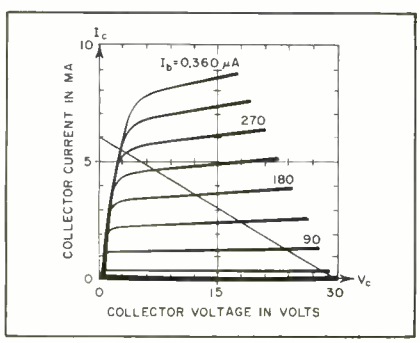


FIG. 3—Common-emitter characteristics

Pulse Forming

The pulse waveform generator is a monostable multivibrator. As the surface-barrier SB-100 allows a maximum voltage swing of only about 4.3 volts, the output pulse must be greatly amplified making their use in this application impractical.

Transistors capable of swinging a signal of 100 volts are the 953 and 970 *npn* silicon-junction transistors, whose collector potentials are rated at 120-v maximum. The 953 transistors were tried out in a monostable multivibrator circuit.

Transistor Selected

Though the output pulses had amplitudes greater than 100 v, the minimum pulse width obtainable was about three to four μsec, with poor rise and delay times. In addition, the output impedance of a common-emitter configuration is high, necessitating the use of an emitter follower when pulsing a low impedance oscillator so that the output stage of the multivibrator is not loaded.

The transistor finally chosen for the pulse generator was the 904-A npn junction type which has a f_{α}

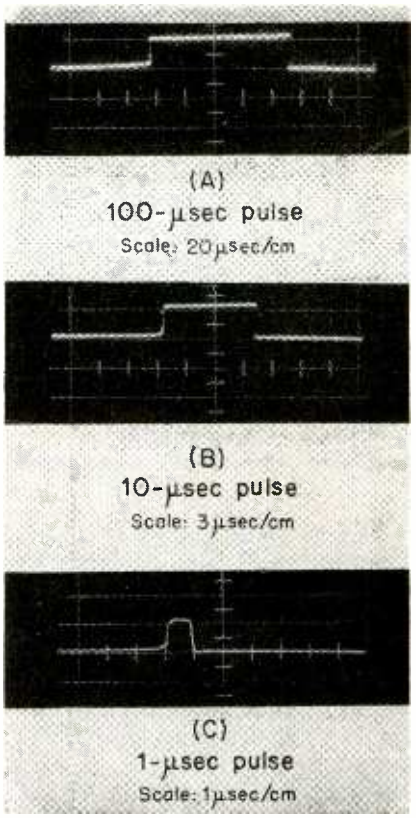


FIG. 4—Output pulse shapes of the delay multivibrator are shown for widths of 1, 10 and 100 μsec at 4.2-v amplitudes

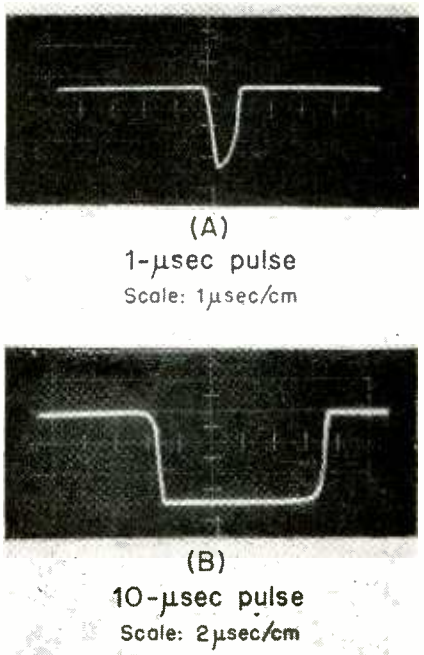


FIG. 5—Minimum and maximum pulse width output wave forms of the pulse generator circuit

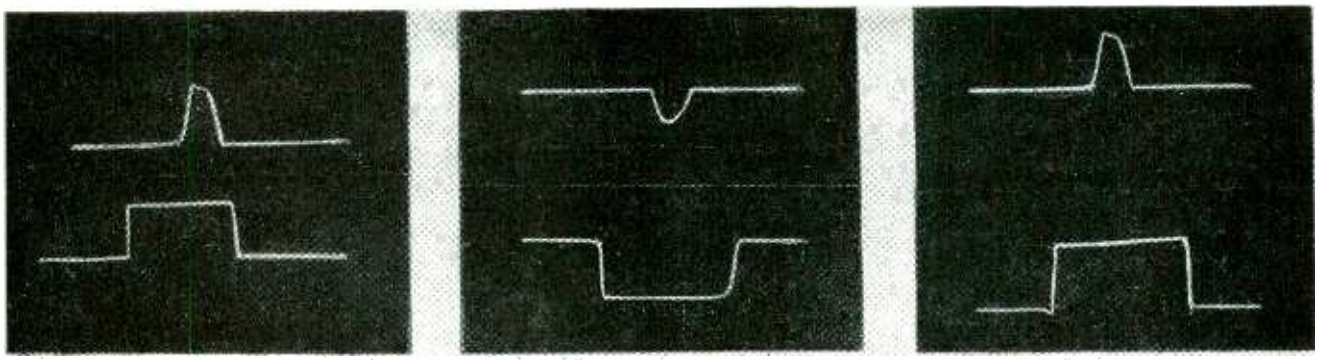


FIG. 6—Amplifier output waveforms (A) for 1 and 10-μsec pulses. Negative (B) and positive (C) output pulses from the bases of the emitter followers Q_{10} and Q_8 respectively

greater than 8 mc and a maximum collector potential of + 30 volts. This transistor possessed the best high frequency characteristics of any of the higher-voltage transistors investigated (maximum collector potentials of at least 25 volts) and proved to be the best compromise, giving consideration to both collector potential and bandwidth.

Varying capacitor C_6 from 9 to 135 μμf gives a continuously variable pulse width ranging from 1 to 10 μsec. This width may also be varied as was shown for the delay generator. The minimum and maximum width output waveforms are shown in Fig. 5. The amplitude is 29 v in the negative-going direction.

Trigger Amplifier

The negative-going spike of the differentiated pulse from the collector of Q_4 has an amplitude of 1.1 volts, which is not sufficient to trigger the pulse generator, and requires amplification. Turning off the normally conducting transistor of the pulse generator gave a better waveform than turning on the nonconducting transistor. Therefore, the triggering waveform was taken from the collector of Q_3. It is important that this spike remain as narrow as possible since its width affects the minimum width of the pulse generator.

The amplifier utilizes a 904A transistor. A voltage gain of six was achieved with no noticeable loss of fidelity. This signal triggers the pulse generator for a pulse as narrow as one μsec.

Emitter Follower

The pulse output taken from the collector of Q_7 is negative-going. The positive-going waveform at the collector of Q_6 has poor shape and is not suitable for use as the positive output pulse.

To get a good positive-going pulse, it is necessary to invert the negative pulse through a common-emitter amplifier circuit, the only configuration that gives phase inversion.

Amplifying Input

The common-emitter circuit also has a low input impedance, which would load the multivibrator output. Thus, to generate a positive pulse, the negative pulse must be passed through the emitter follower and then amplified.

The 953 and 970 transistors are the only ones capable of passing and amplifying an input signal of 28 volts. Emitter follower Q_8 presents a higher impedance to the collector Q_7 and prevents any loading effects by the low impedance inputs. The 47,000-ohm resistor from the collector to the base of Q_8 puts the necessary positive bias on the base so that the large negative-going signal can be passed properly.

Amplifier Q_9 inverts this negative-going signal and Q_{10} is an emitter follower which provides a low impedance output.

The amplifier output waveforms at both one and 10 μsec are shown in Fig. 6A. The negative and positive pulses from the bases of emitter followers Q_{10} and Q_8 respectively are shown in Fig. 6 B and C.

Performance

The achieved results were as follows: 1) pulse amplitudes 28-v negative, 50-v positive; 2) pulse widths continuously variable from 1.0 to 10 μsec; 3) rise and decay times of 0.3 μsec; 4) internally-generated repetition rates varied in steps from 50 to 5,000 pulses per second; 5) external triggering by either a positive or negative pulse at any repetition rate from 50 to 5,000 pulses per second; 6) internally generated time delay from 1 to 100 μsec.

Available Transistors

These results bring out the two inherent weaknesses of the present transistors: low collector potential and limited high-frequency response. However, the use of recently developed transistors will increase the pulse amplitude and allow for the generation of a much narrower pulse.

The author thanks Thomas O'Brien for his encouragement and comments, and George Pate and William Shephard for their suggestions and assistance.

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Transmitter Tuned By

By C. RICHARD ELLIS, KENNETH OWEN and G. R. WEATHERUP

General Electric Co., Syracuse, N. Y. — *McIntosh Electronics Inc., Binghamton, N. Y.* — *U. S. Air Force RADC, Rome, N. Y.*

SUMMARY — High-power, quick-tuning uhf transmitter system uses low-distortion amplifier-modulator to cover the 225 to 400 mc range. Demodulated output feedback gives less than 3-percent rms harmonic distortion over the audio range 200 to 20,000 cps and over the stated r-f range, with 80-percent amplitude modulation of a 1,000-watt carrier

DEVELOPMENT of scatter communications techniques to improve operation over line-of-sight distances reaffirms the need for a high-power, quick-tuning uhf transmitter capable of radiating an amplitude-modulated signal having very low distortion over a wide audio-frequency band.

The amplifier-modulator, AN/GRA-24, described here provides a high-level modulated one-kilowatt signal from 225 to 400 mc when driven by an 80-watt exciter. Eighty percent continuous amplitude modulation of the one-kilowatt carrier is obtained from 200 to 25,000 cps with less than 3 percent total rms harmonic distortion at any frequency in the range. Over 90 percent amplitude modulation on a continuous basis is possible from 200 to 22,000 cps.

Operation

Figure 1 is a block diagram of the system. The r-f input is coupled to the GL 6182 grid circuit. A lumped circuit equivalent of the grid and plate cavities is shown.

Audio input, at about + 20 dbm, is supplied from the remote preamplifier thru the test-operate switch to the modulator. Both the plate and screen of the r-f tube are modulated and the amplified and modulated r-f is coupled out of the tuned plate cavity to the antenna.

A diode detector recovers a sample of the modulation envelope in the output transmission line. This recovered audio is amplified and applied to the modulator input as negative feedback.

Operator at left is adjusting power supply of amplifier-modulator while coworker records data. Left to right are the power controls, r-f amplifier and radio modulator. Transmitter is at the right

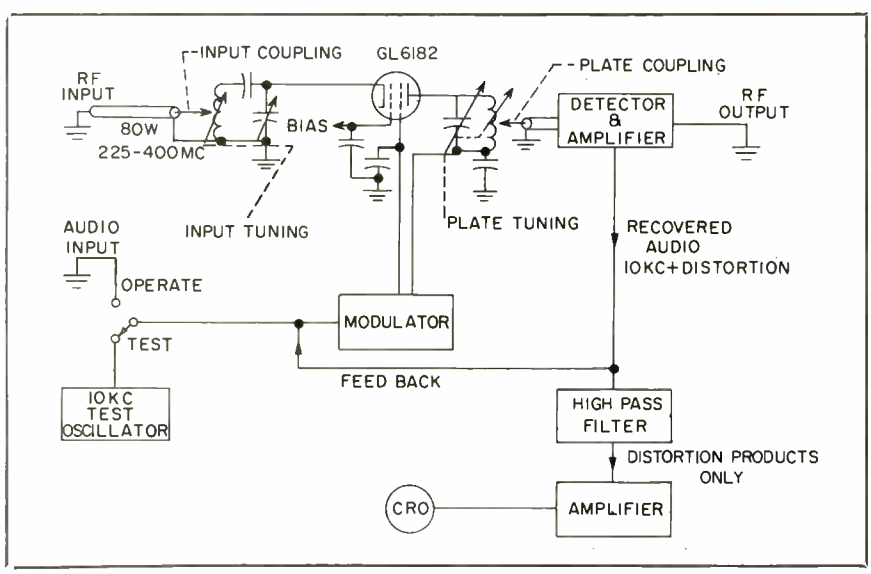


FIG. 1—Block diagram of the 1-kw high-level modulated uhf amplifier

The r-f Amplifier

The GL 6182 tetrode, designed for full plate input operation up to 900 mc, is housed in a re-entrant coaxial cavity. Variable conductive coupling is employed in both the input grid and output plate circuits.

In Fig. 2, the plate coaxial cavity and the outer conductor of the grid coaxial cavity are cross hatched, while the thick horizonal cross-hatched area represents the main drive casting which supports the cavities. Above this casting, the

Distortion Indicator

cavity consists of four concentric cylinders. The outer two form the plate coaxial cavity, the inner two the grid cavity. Between the inner cylinder of the plate coax and the outer cylinder of the grid coax is a dead space through which the d-c leads for the control and screen grids are brought.

No socket resonances exist over the operating range. The screen contacts and by-pass capacitor are critical to avoid holes in the operating range. A low inductance contact system provides nonresonant operation over the 225 to 400-mc range.

Straightforward tuning provides smooth operation over the entire frequency range. The conductive coupling permits a continuous increase in coupling from almost zero to extreme overcoupling, with motion in one plane only and with no problems of direct cavity radiation. Tuning and coupling adjustments will match a wide range of impedances.

For sufficient emission in limited space, the GL 6182 employs a bombarder. This element, indicated as a cathode in Fig. 2, is operated approximately 600 v above the filament potential. The resulting diode current causes the bombarder to emit the main electron stream. The bombarder is operated at d-c ground potential and the filament at about 600 v negative, depending on the setting of the bombarder-adjust.

The entire coaxial cavity is operated at d-c ground with a convenient bias supply for the control grid. The grid operates at −50v d-c with no r-f and the filament at −600 v. Under drive, the tube operates class C with a plate efficiency of from 40 to 60 percent, depending on frequency.

An attenuator switched into the input circuit limits the vswr presented to the exciter to less than

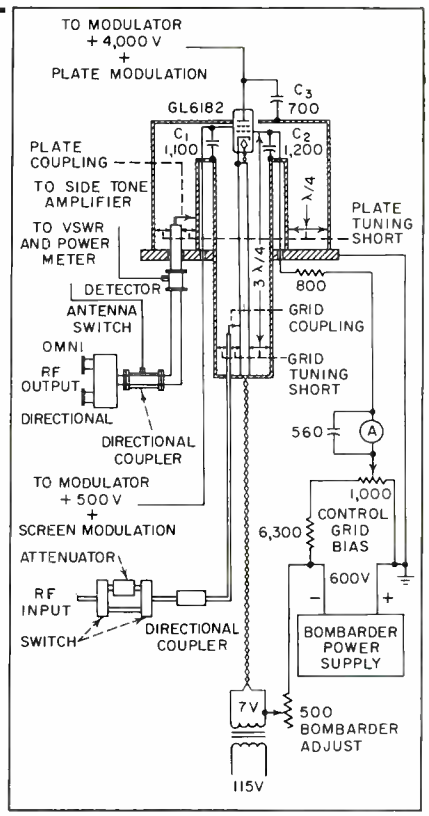
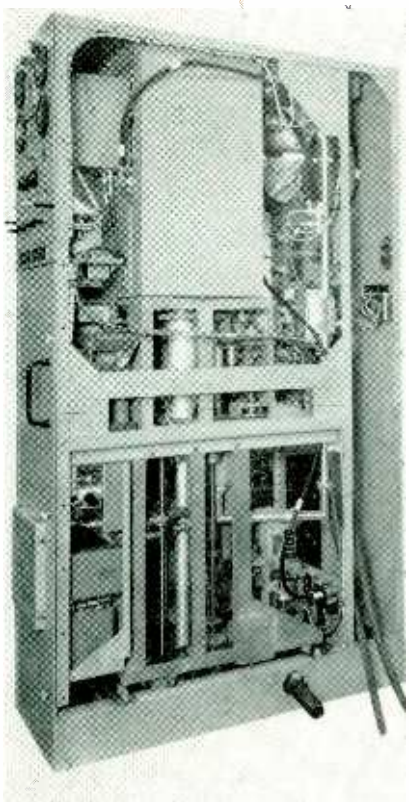


FIG. 2—The r-f amplifier employs a tetrode in a grid separation in a three-quarter wave mode and the plate in a one-quarter wave mode



Side view of the r-f portion of the amplifier-modulator unit. Castings maintain precision alignment of lead screws and gearing

3 to 1, regardless of amplifier tuning. When the amplifier has been tuned, the input vswr drops to better than 1.2 to 1. The attenuator is removed automatically when the amplifier is switched to operate.

A two-position coaxial switch allows quick selection of either of two antenna connections.

It was found during the development period that a lower distortion modulation envelope could be obtained if the screen grid of the 6182 were modulated more than 100 percent in the positive direction. A diode is incorporated, as shown in the modulator schematic, to allow positive over-modulation and prevent the screen from going negative.

Distortion Indicator

It was also found that minimum distortion was obtained only when the load presented to the r-f amplifier tube was a pure resistance. There are many combinations of output tuning and coupling which present the proper load to the tube to obtain one kilowatt output. However, only a load with zero reactance allows minimum distortion operation. Consequently, it was necessary to provide an indication to the operator of minimum distortion tuning conditions, if the maximum performance capability of the equipment was to be realized.

The Modulator

The modulator output circuit works into a high-impedance load which has one end connected to ground and is shunted by the capacitance of the r-f amplifier plate circuit by-pass capacitor. Difficulty in obtaining an acceptable load balance to the audio output tubes from this type load, using a conventional push-pull class B output circuit, made it advisable to employ the output circuit shown in Fig. 3.

In this circuit one output tube is plate loaded and the other is

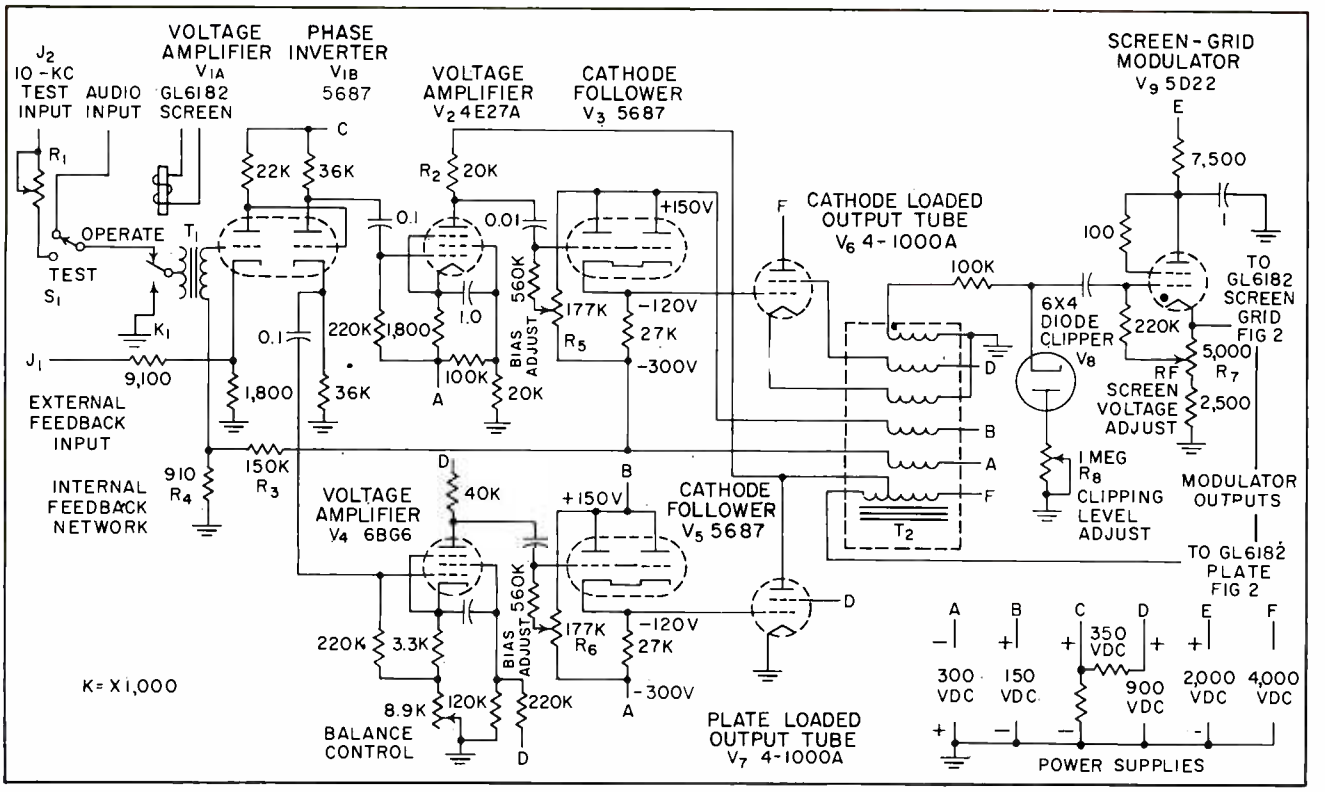


FIG. 3—The modulator has a cathode-loaded output tube, V_6, and plate loaded output tube, V_7. The grids of these tubes are driven push-pull at 180 degrees difference but plates are in phase

cathode loaded. The grids of these tubes are driven push-pull at 180 deg but their outputs are in phase. This makes possible parallel connection of the two primary sections.

Advantages

Important advantages of this arrangement are first, the end-to-end primary impedance is reduced to one fourth. Second, the in phase, unipotential voltage distribution along the two primary sections and including most of the secondary coil allows these coils to be tightly coupled without concern over the intercoil shunt capacitance thereby reducing leakage inductance and the resultant switching transients to negligible values. The third advantage is that load balance of the two output tubes over the entire band-pass of the output transformer is automatically attained.

Most of the secondary of the modulation transformer is common to the plate load section of the primary winding. An extension of this common portion of the winding raises the modulating voltage to the value required for the desired modulation.

An additional winding on the output transformer develops the modulation voltage required for the screen grid of the r-f amplifier.

Cathode follower V_9 eliminates oscillation, provides a low driving impedance and allows convenient adjustment of the d-c voltage on the screen grid. Variation of R_7 changes the bias on V_9 and in turn the d-c voltage to the screen grid of the tube.

Diode V_8 allows more than 100 percent modulation of the screen grid in the positive direction, but prevents excessive negative swing.

Reducing Distortion

The circuitry required to provide low-distortion performance is shown in Figs. 4 and 5.

The 10-kc oscillator, Fig. 5, generates the sinewave test signal to tune for minimum distortion. Dual triode V_8 is a phase-shift oscillator with networks connected as low-pass filters to attenuate higher harmonics. Two ganged pots allow frequency readjustment and compensate for component aging. Oscillator output is isolated from the grid-cathode capacitance of the following amplifier by a 10 to 1 voltage divider.

The amplified signal from the plate of the second stage of V_8 drives the cathode follower V_9. The signal at the cathode of V_9 is a 10-kc wave with about 4 percent rms harmonic distortion. The low-pass filter in the output of V_9 has a cut-off frequency of 12 kc and an attenuation at 15 kc of about 60 db. Distortion products of the 10-kc wave are virtually eliminated and the test signal gives less than one-tenth of one percent distortion.

When the modulator input test-operate switch is in the test position for final tuning, the 10-kc test-oscillator signal is applied to the modulator. Voltage across the cathode resistor of V_8 consists of the original 10-kc wave plus distortion added by the system. The input filter has a cut-off frequency of 12 kc and an attenuation at 10 kc of 60 db. The fundamental 10-kc component is practically eliminated, leaving the distortion products. Amplified by V_6 in Fig. 4, the signal is applied to the vertical deflection plates of V_7. No horizontal deflection is used. With 80 percent modulation of a 1,000-watt carrier, and with the cro gain at

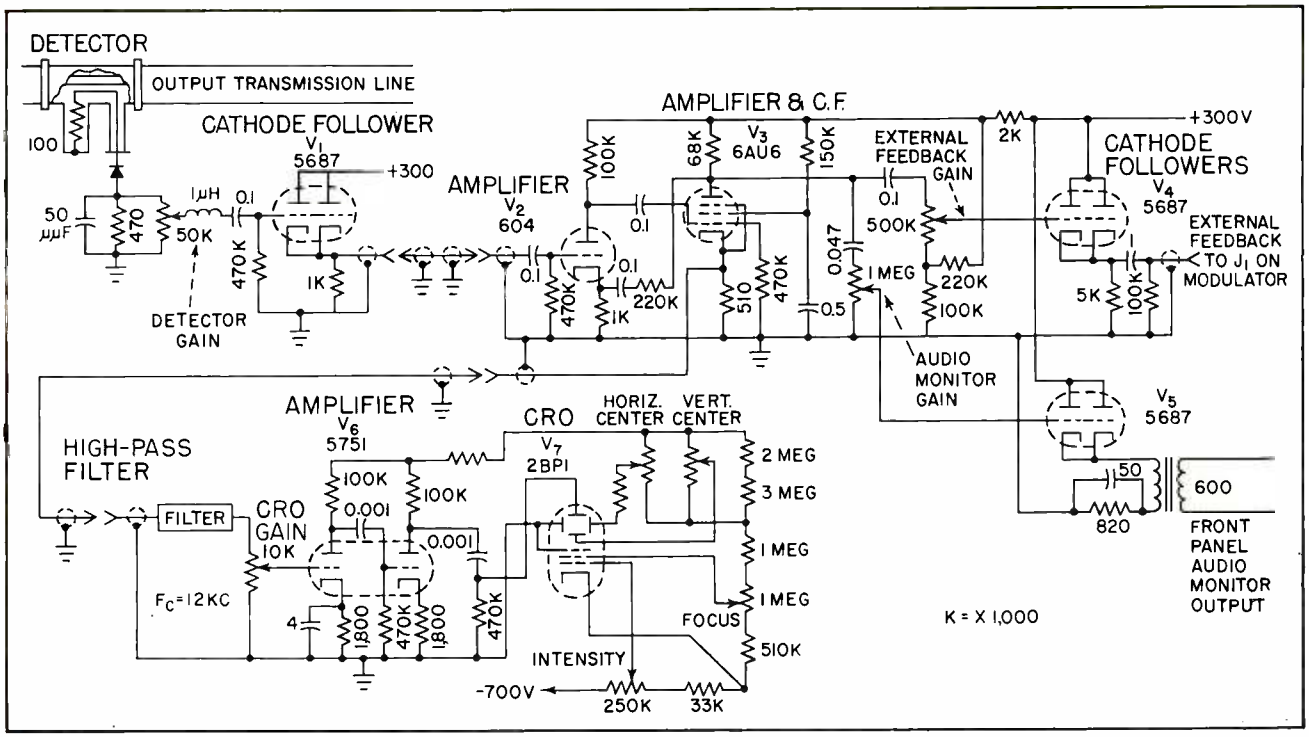


FIG. 4—Detector and amplifier reduce distortion and control phase shift. Output of V_4 is external feedback that returns to the modulator. Output of V_5 monitors the test

maximum, a one-inch vertical deflection on the cro represents about 5 percent distortion. When the amplifier is tuned properly, this deflection drops to about one-quarter inch, representing less than 2 percent distortion.

Test Results

Data was recorded with a 1,000-cps test signal applied to the audio input, audio gain set for 80-percent amplitude modulation and the equipment tuned for minimum distortion consistent with 1 kw or more output by means of the cro. Maximum distortion at the high end of the r-f band is 2.1 percent. Increasing modulation to 90 percent gives about 4 percent distortion across the band.

With the equipment tuned at 300 mc, the audio input frequency is varied over 200 to 20,000 cps. There is an increase in distortion at both ends of the audio range. This is due to the characteristics of the feedback circuit, the capacitive load on the modulator, and the modulator itself. At 25,000 cps, the distortion is estimated to be under 4 percent.

Distortion Values

Maximum and minimum distortion values were obtained for all audio frequencies from 200 to 20,000 cps. When tuned by the cro for minimum distortion at all radio frequencies in the band and over the audio range 200 to 20,000 cps, the equipment provides at least 1,100-watt output with less than 3 percent rms total harmonic distortion.

All data was taken with a carrier power of at least 1,100 watts and with at least 80 percent amplitude modulation.

The authors thank R. E. Bullard of the General Electric Co. who was responsible for the mechanical design of the equipment. The following people contributed greatly to the electrical and mechanical design: J. F. Adams, J. W. Boortz, R. R. Frost, H. A. Grant, R. C. McClure and I. J. Popejoy of the General Electric Co.; E. O. Crow and Sidney A. Corderman of McIntosh Electronics, Inc.; and Lt. E. E. Selover of the Rome Air Development Center of the U. S. Air Force.

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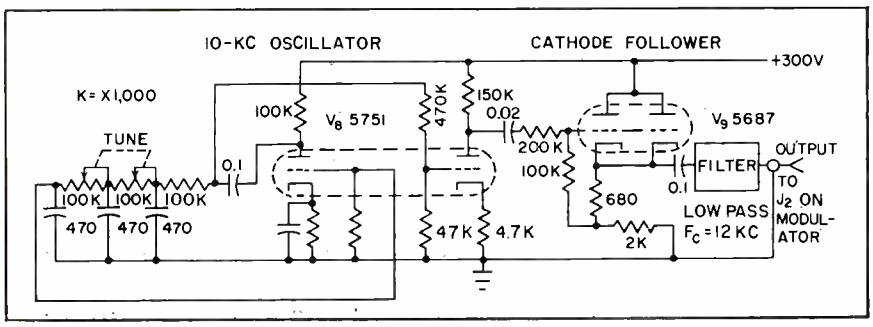

FIG. 5—The 10-kc test oscillator generates the sine-wave test signal. Dual triode V_8 is a phase-shift oscillator. The test signal at the output gives less than one-tenth of one percent distortion

VOLTAGE REGULATOR

SUMMARY —— Pulse-type transistor voltage regulator uses voltage-controlled pulse generators. Astable multivibrator has square-wave output over frequency range of 100 to 3,600 cps; frequency is determined by magnitude of control voltage over 12-to-one range. Pulse width of monostable multivibrator is varied over 10-to-280 microsecond range

By WILLIAM A. SCISM

Senior Engineer, Convair Astronautics, San Diego, Calif.

LOW SATURATION RESISTANCE of presently available power transistors suggests their use in pulse-type power voltage regulators.

In the pulse-type regulator shown in Fig. 1, reduction of the input voltage is accomplished by turning a gate transistor off at a repetition rate determined by the regulation requirements. The gate is controlled by a series of drivers which, in turn, are controlled by a variable-width one-shot transistor multivibrator. The pulse of no conduction at the gate is smoothed by the low-pass filter which delivers the average value of the wave to the load. This load voltage is attenuated and compared with a Zener reference diode.

The difference voltage is amplified and used to control the frequency of a voltage-controlled multivibrator as well as the width of the one-shot pulse. Since the one-shot is triggered by the variable-frequency multivibrator, the net result is that increasing line voltage increases the width and repetition rate of the pulse cut out of the line by the gate. The average value of the load voltage is thus kept constant.

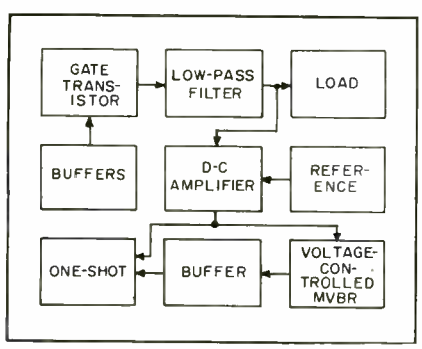

FIG. 1—Block diagram of regulator

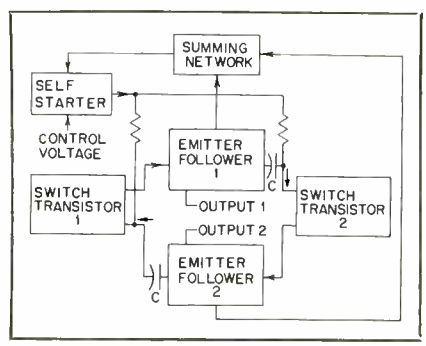

FIG. 2—Basic of monostable multivibrator

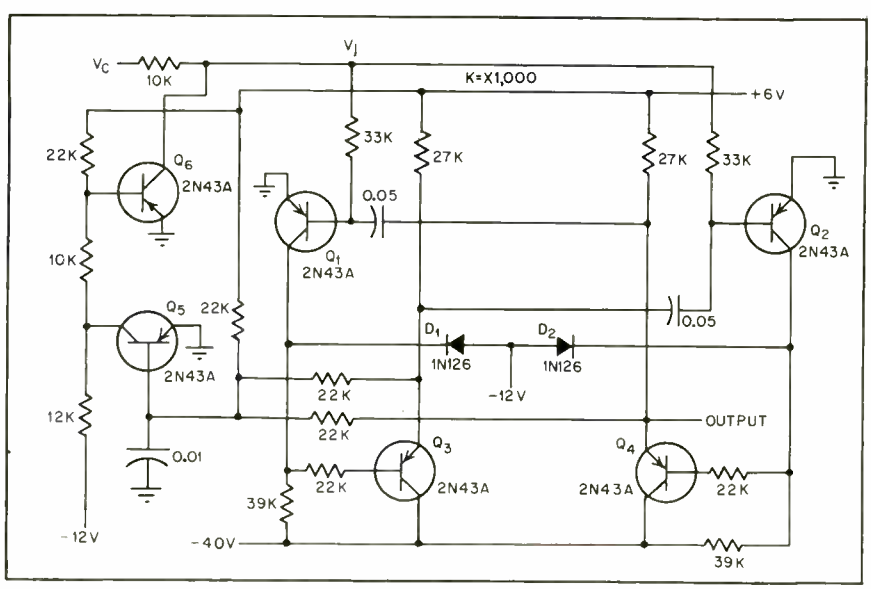

FIG. 3—Frequency of multivibrator is determined by varying return voltage of Q_1 and Q_2

Voltage-Controlled Multivibrator

Figure 2 is the block diagram of the variable-frequency multivibrator and Fig. 3 the circuit diagram. The chief difference between transistors and vacuum tubes in this application is that the transistor requires power into the base to turn it on or off, whereas the tube will bottom if no power is applied to the grid.

A transistor multivibrator will oscillate if the bases are returned to ground, but the waveform is most unsatisfactory and the period is subject to considerable variation with temperature and transistor interchange.

Returning the bases to a negative

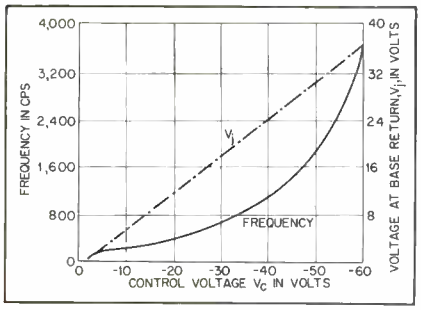

FIG. 4—Characteristics of variable-frequency circuit shown in Fig. 3

supply (in the case of *pnp* transistors) through a resistor will permit sufficient current to be drawn to hold the transistor in the saturated condition. The voltage return for the base resistors can then be varied so the frequency of the multivibrator will be proportional to the base return voltage.

The collectors of multivibrator transistors Q_1 and Q_2 in Fig. 3 are returned to a large voltage and are clamped at a small voltage by diodes D_1 and D_2, utilizing only the first position of the rise time which is, by nature, fast. Emitter followers are also used between the collectors and the bases of the opposite transistors to permit the collector of the cutoff transistor to rise against the base resistor of its emitter follower for a rapid rise of voltage. The associated timing capacitor is driven by the low output impedance of the emitter follower, which also provides a convenient output takeoff point.

The collector resistor can thus be a fairly high value, as shown in Fig. 3. This offers the advantage of a short-base base which is comparable to the grid base of a tube. The transistion region of operation is thus made short compared to the voltage swing of the timing capacitor.

Starting Characteristics

The base resistors could be returned directly to a variable voltage, but the circuit will not start when the control voltage is large. Application of power will bottom both transistors when there is a large value of base return current present. Advantage is taken of the fact that the circuit will always start when the base is returned to zero volts; the base resistors are returned to the collector of Q_6 which is also connected to the control voltage.

When the circuit is oscillating properly, there is a square wave at the emitters of both emitter followers, Q_3 and Q_4. Summation of both these square waves through the 22,000-ohm resistors at the base of Q_5 keeps Q_5 in the saturated condition. This in turn biases Q_6 so it draws no current.

In this condition, the control voltage is applied to the base-return resistors through the 10,000-ohm resistor connected to the collector of Q_6. Failure of the circuit to oscillate, either upon application of power or due to excess loading in operation, will result in the emitters of Q_3 and Q_4 remaining at essentially zero volts; Q_5 is cut off and Q_6 is turned on, effectively grounding the base resistor return.

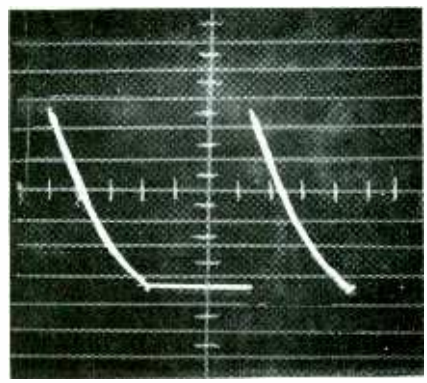

FIG. 6—Waveform at base of Q_1 in Fig. 3 has 6,500-μsec period

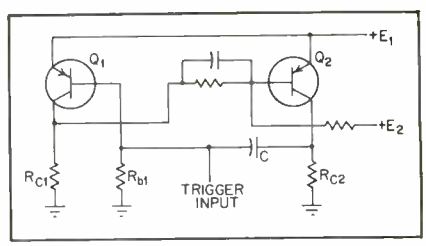

FIG. 7—Basic one-shot multivibrator

With zero volts on the return, the circuit starts oscillating and control voltage V_c governs the frequency of operation.

Calculation of the frequency of operation at $V_c = -20$ v gives a period of 2,750 μsec compared to the measured 2,500 μsec.

Performance

Figure 4 is a plot of voltage versus frequency for the circuit of Fig. 3. Base return voltage V_j is also plotted against the control voltage to determine the loading of Q_6 when the circuit is oscillating. The circuit provides a useful square-wave output from 100 cps to 3,600 cps. The output voltage over the

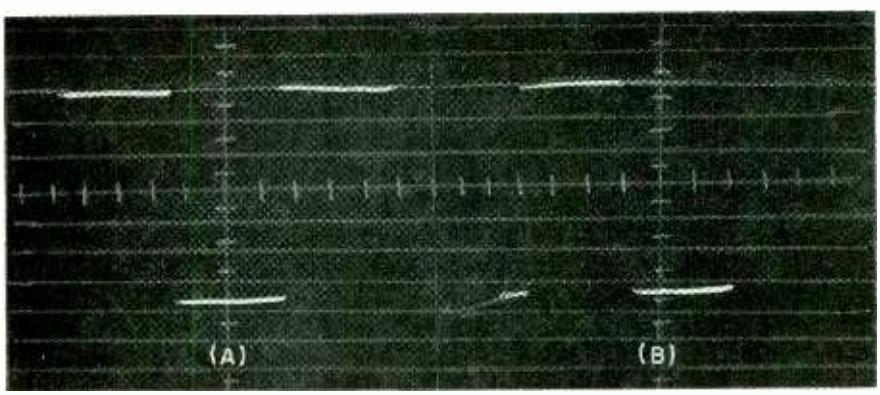

FIG. 5—Control voltages of 5.5 and 52 v applied to multivibrator of Fig. 3 produce 6.500 (A) and 600-μsec (B) outputs respectively

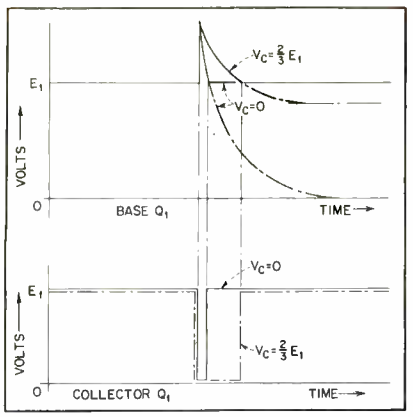

FIG. 8—Effect of change in return voltage on pulse width

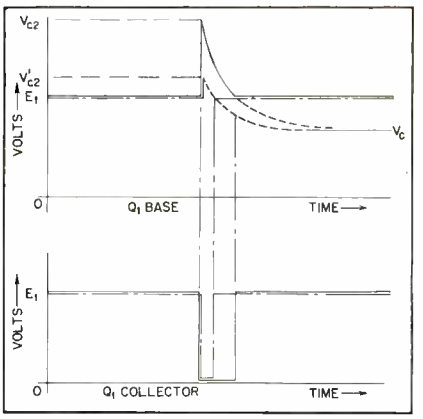

FIG. 9—Effect of change of Q_2 collector clamp voltage on pulse width

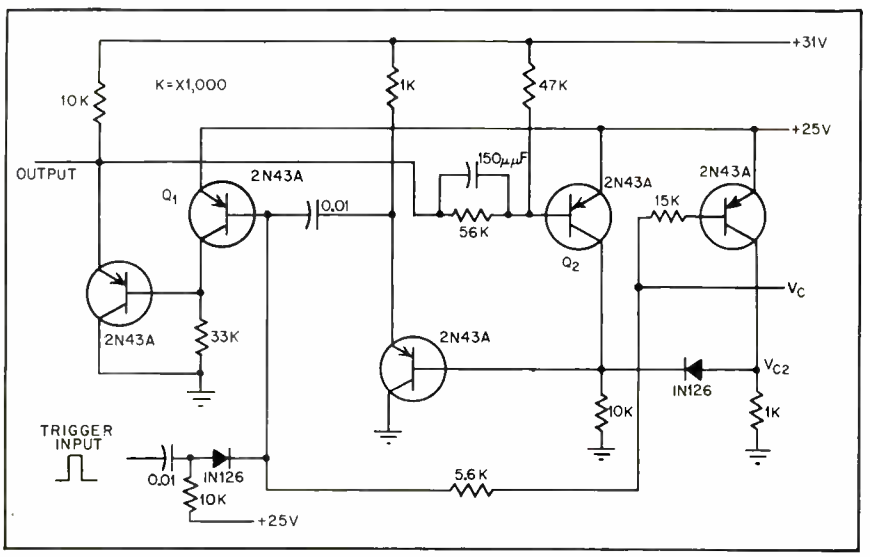

FIG. 10—Variable pulse-width monostable multivibrator with compound control

operating range is fixed at a constant level of 12 v by the diodes.

Figure 5 shows the output waveform with the control voltage near the low and high ends of the range. Figure 6 shows the base waveform. Note that the timing exponential still has considerable slope as it enters the transition region, resulting in greater stability of the half-period.

One-Shot Multivibrator

Development of the regulator called for a one-shot multivibrator whose pulse width is a function of a d-c control voltage.

A conventional transistor one-shot multivibrator is shown in Fig. 7. Transistor Q_1 is held on in the absence of a trigger by the current through R_{b1}. The collector of Q_1 is at a potential of $+E_1$ and the current from positive return $+E_2$ keeps Q_2 nonconducting.

A positive pulse applied to the base of Q_1 cuts it off; it's collector voltage drops toward ground causing it to draw current through the base of Q_2, turning it on and holding it in the saturated condition. As the collector voltage of Q_2 rises toward $+E_1$, the voltage across C drives the base of Q_1 positive, cutting it off.

If R_{b1} is returned to some voltage V_c other than ground, the pulse width can be varied. Figure 8 shows the effect of changing V_c.

The range of pulse widths is limited by this arrangement because the current drawn through R_{b1} becomes insufficient to keep Q_1 on in the no-pulse condition as V_c approaches E_1. This condition can be partially remedied by increasing R_{c1} so less base current is required to keep Q_1 saturated. However, this necessitates an increase in R_{c2} and the net result is a lower limit for the value of R_{b1}.

By using emitter followers in the coupling networks, R_{c1} and R_{c2} can be made quite large and low-impedance outputs are made available at the emitters of the followers. To extend the degree of control, the collector of Q_2 can be clamped to variable voltage V_{c2}. Figure 9 illustrates the effect on pulse width of different values of this clamp voltage with timing-capacitor return voltage V_c held constant.

The clamp voltage is derived from a grounded-emitter amplifier as in Fig. 10, whose base is driven from control point V_c. This amplifier provides the necessary phase inversion for the control voltage and compounds the effect of V_c on the pulse width.

Figure 11 shows pulse width with variation in the timing capacitor return voltage, for constant clamp voltage, and the pulse width for the compound-control circuit shown in Fig. 10. There is a noticeable improvement in slope and range due to the clamp voltage.

Figure 12 shows regulation action of complete circuit.

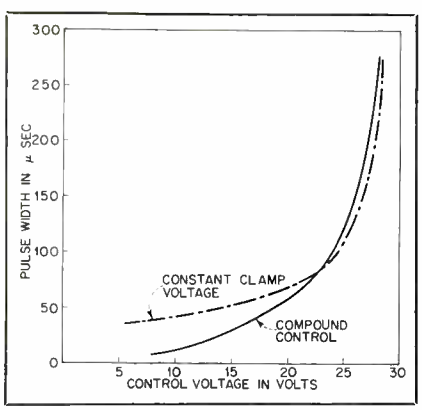

FIG. 11—Operating characteristics of multivibrator of Fig. 10

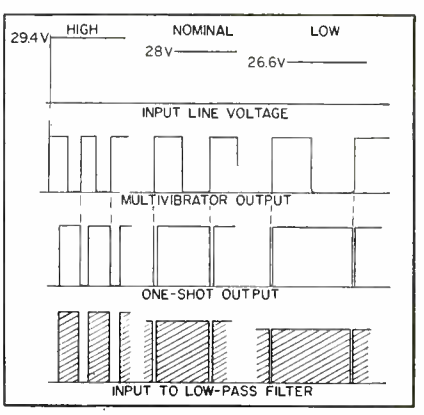

FIG. 12—Overall regulation action for different input line levels

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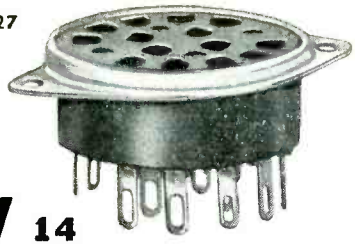

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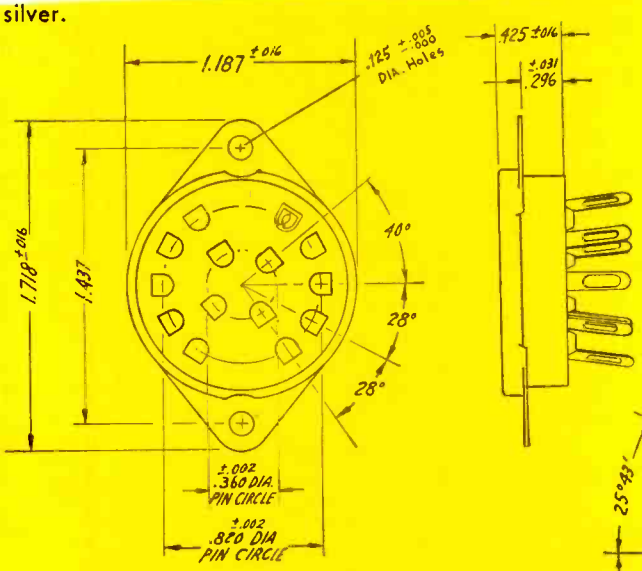

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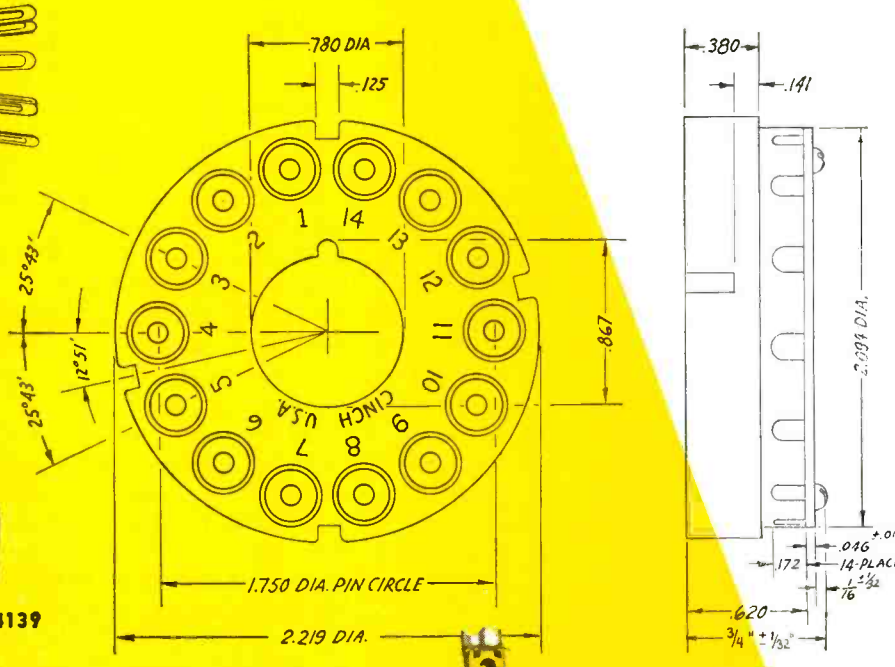
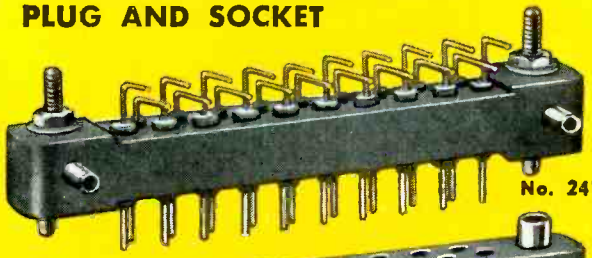


19 CONTACT PRINTED CIRCUIT PLUG AND SOCKET



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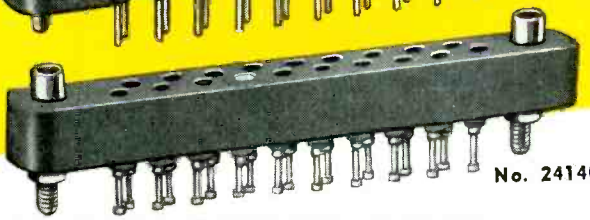

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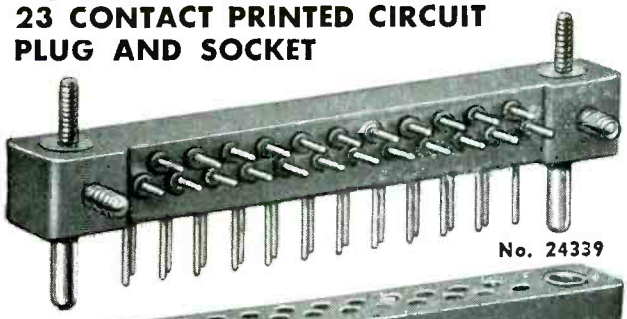

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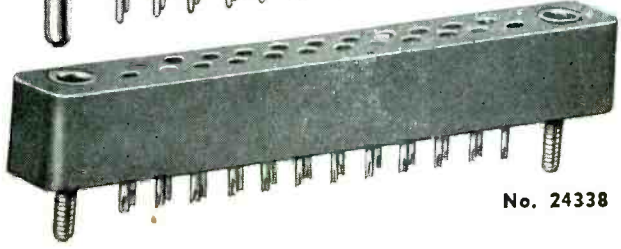

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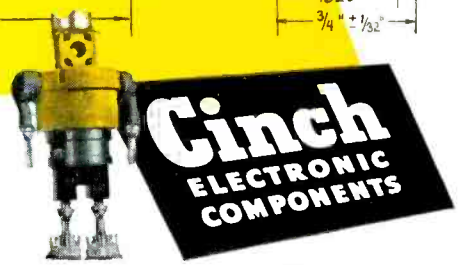

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Nos. 24139 and 24140 (Left, above) Insulation material MME. Socket tail termination turret type. Plug has right angle pins for terminating in printed wire board on .1"x.1" grid. Hollow rivets are molded in the plug unit for mechanically fastening to board prior to soldering.

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Nos. 24339 and 24338 (Left) Insulation material MME. Socket tails terminate in solder pot for No. 20 AWG wire.

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Diode-Clamp Nomograph

By GEORGE H. MYERS*

Rome Air Development Center
Griffiss Air Force Base, New York

SUMMARY — Chart simplifies determination of standard diode clamp circuit parameters for rectangular wave input when maximum tilt and deviation from clamp voltage are specified

CLAMP CIRCUITS can insure that a portion of a waveform is kept at a certain voltage with respect to ground or is clamped to that voltage.

If the signal of Fig. 1A is applied to the clamp circuit in Fig. 1B, the actual waveform at the output is that shown in Fig. 1C where the positive section of the wave, of duration T_1, is clamped to E_o. The positive portion rises slightly above E_o, while the negative part has a slope or tilt.

The nomograph of Fig. 2 permits determining the parameters for the circuit of Fig. 1B and a rectangular input voltage if the maximum deviation from the clamp voltage and the tilt are given, or conversely, determining the deviation and tilt if the circuit values are given.

Parameters

Time T_2 is that during which the input is most negative in Fig. 1A; the input is most positive during T_1. The circuit time constant when the diode is conducting heavily is $T_f = C\,R_f R/(R_f + R)$, where R_f is the forward resistance of the diode. In most cases, $T_f = R_f C$ and R may be neglected.

The circuit time constant when the diode is conducting in the reverse direction is $T_b = C\,R_b\,R/(R_b + R)$, where R_b is the back resistance of the diode. In mosts cases, it is accurate enough to use $T_b = RC$. The peak-to-peak voltage of the input rectangular wave is E.

In Fig. 1C, the maximum deviation of the output from the clamp voltage when the diode is conducting is E_1 and the tilt is the slope of the output during the period the diode is conducting in the reverse direction; tilt $= (E_2 - E'_2)/E_2$. If the diode is reversed, T_1 and T_2 would be interchanged. It is desirable to have E_1/E and the tilt as small as possible, because then the output will be more nearly a replica of the input, except for a change in d-c level.

*Now with Bell Telephone Labs., Whippany, N. J.

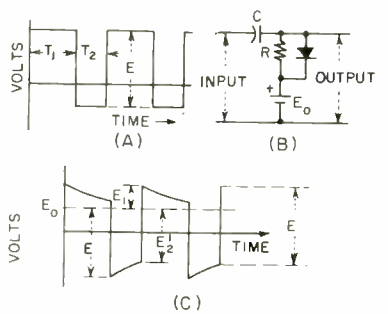

FIG. 1—Input with arbitrary d-c level (A) to diode clamp circuit (B) and output (C)

Example

Suppose it is desired to clamp a rectangular wave for which $T_1 = 400$ μsec, $T_2 = 200$ μsec and the peak-to-peak amplitude E equals 50 v. The maximum deviation from clamp voltage E_1 is to be 3 v and the tilt 4 percent. If a diode with a forward resistance of 200 ohms and infinite back resistance is available, what are R and C?

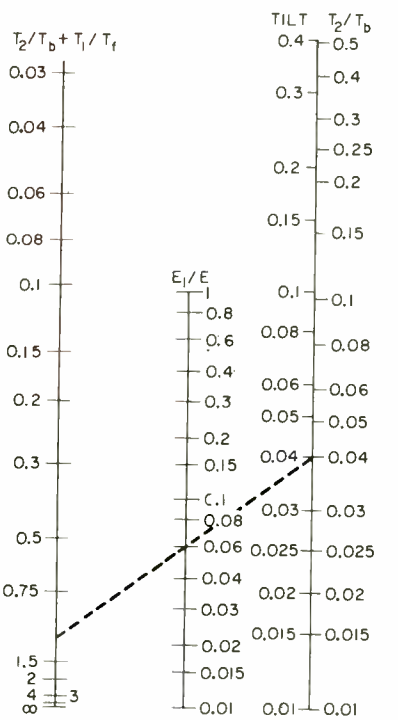

FIG. 2—Nomograph for determining circuit parameters

A line is drawn on Fig. 2 connecting 0.04 on the tilt scale and 0.06 (= 3/50) on the E_1/E scale. From Fig. 2, T_2/T_b equals 0.04 and $T_2/T_b + T_1/T_f$ equals 1.1; T_1/T_f is then 1.06.

Using the given data and assuming $T_f = R_f C$ and $T_b = RC$, T_f becomes 378 μsec and $T_b = 5{,}000$ μsec, leading to $C = 1.89$ μf and $R = 2{,}650$ ohms.

From the value of R, it may be seen that the decision to neglect it in T_f was justified. For a germanium diode, it may be necessary to include the effect of R_b in calculating T_b.

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Electrons At Work

Edited by DAVID A. FINDLAY

Radio-Controlled Toys Use Spark Gap

A LINE of radio-controlled toys manufactured by the Masudaya Toys Co., Tokyo, Japan, goes back to one of the oldest methods of radio transmission and reception, the spark gap and coherer.

Radiation from the spark gap is wideband, 150 kc to 180 mc, and prone to cause interference with radio and tv reception, but the radiated signal is very weak.

The Japanese equivalent of our FCC, the Kanto District Radio Regulatory Office, tested the devices and gave approval for their use. Field strength measurements and tests with radio and tv receivers showed that interference would not be produced farther than five meters from the transmitter.

The bus receiver uses a coherer, a glass envelope filled with carbon powder. The antennas indicated in Fig. 1 are short vertical whips. The drive mechanism of the bus is mechanically arranged so that successive pulses cause the bus to start, turn right, go straight, turn left, go straight and stop.

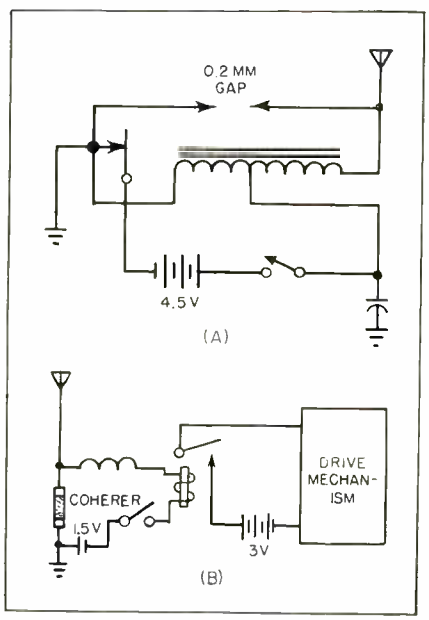
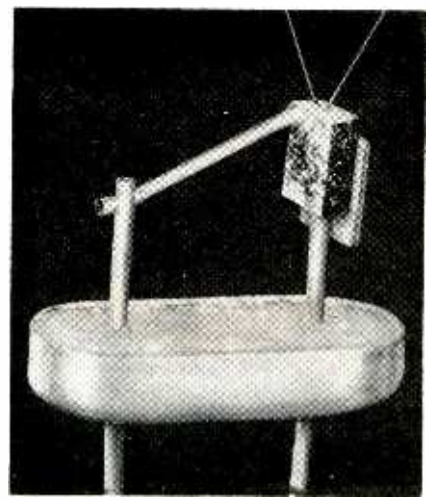


Fig. 1—Schematic of transmitter (A) and receiver housed in bus (B)



Extreme closeup of experimental spacistor assembly on transistor mount

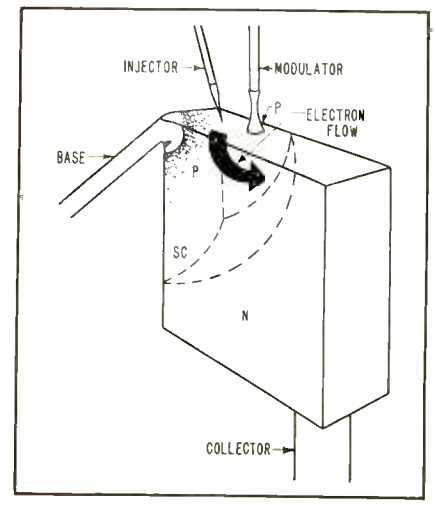


Fig. 1—Construction of present experimental spacistors

Low Transit Time Semiconductor Amplifier

SLOW DIFFUSION of charge carriers through an essentially field free base region is the principle reason for the high frequency limitations of the transistor. Many attempts to extend the transistor's frequency range have been directed at decreasing transit time by applying a field to the base region.

Latest addition to the semiconductor amplifier family, the spacistor, takes advantage of the high field strength found in the space-charge regions of reversed-biased junctions. Electron transit times are such that Raytheon, who developed the spacistor, predicts it will eventually amplify effectively at 10,000 mc.

The body of the spacistor is a reverse-biased *p-n* junction with a space-charge region marked *SC* in Fig. 1. In Fig. 2, contact *I* is the injector, a tungsten-wire pressure contact, and *M*, the modulator is a gold-wire alloyed contact containing *p*-type doping material.

As shown in Fig. 2, battery B_1 biases *I* negatively with respect to the underlying space-charge region *SC*. Contact *I* is still positive, however, with respect to point *B*. Emission of electrons from *I* into *SC* is space charge limited.

Modulator *M* is connected to *SC* between *I* and the *N* region of the body. Battery B_2 biases *M* negatively with respect to *SC* preventing holes from flowing from the *p*-type doping materials to *SC*. As a result, *M* draws practically no current.

The field produced by *M* affects the entire space charge region, varying the emission of the injector *I* and thereby modulating the d-c bias with the input signal. The modulator also makes the injector bias practically independent of the base-to-collector voltage. As a result, the output impedance is greater than 30 megohms for an injected current of 0.3 ma.

Because of the wide space-charge region, the output capacitance is very small. Values less than 1 $\mu\mu$f are feasible.

Present experimental spacistors have transconductances considerably smaller than those of good vacuum tubes. Nevertheless, they are expected to operate at over 1,000 mc. This frequency is equivalent to the inverse transit time through the space-charge regions.

Operation of the spacistor is practically independent of charge carrier lifetime. This makes it feasible to supplement germanium and silicon with other semicon-

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OUTPUT VOLTAGE DC: 0-30 volts continuously variable.
OUTPUT CURRENT DC: 0-1.5 amperes continuous duty.
REGULATION: In the range 0-30 volts, the output voltage variation is less than 0.02 volts for load variation from 0 to maximum current, and less than 0.02 volts for line fluctuation from 105-125 volts.
RIPPLE VOLTAGE: Less than 3 millivolts RMS.
FUSE PROTECTION: Input and output fuses on front panel.

OUTPUT #2

OUTPUT VOLTAGE DC: 0-30 volts continuously variable.
OUTPUT CURRENT DC: 0-1.5 amperes continuous duty.
REGULATION: In the range 0-30 volts, the output voltage variation is less than 0.02 volts for load variation from 0 to maximum current, and less than 0.02 volts for line fluctuation from 105-125 volts.
RIPPLE VOLTAGE: Less than 3 millivolts RMS.
FUSE PROTECTION: Input and output fuses on front panel.

RECOVERY TIME: Less than 50 microseconds. The excursion in the output voltage during the recovery period is less than .05 volts for line fluctuations from 105 to 125 volts or load variations from 0 to maximum current.

STABILITY: The output voltage variation is lesss than .05 volts for a period of 8 hours.

OUTPUT IMPEDANCE: Less than 0.1 ohms from 1KC to 100KC. Less than 0.01 ohms from DC to 1KC.

POWER REQUIREMENTS: 105-125 volts, 50-400 cycles.

OUTPUT TERMINATIONS: DC terminals are clearly marked on the front panel. All terminals are isolated from the chassis. Either positive or negative terminal of each DC output may be grounded. A terminal is provided for connecting to the chassis. The DC terminals are also brought out at the rear of the unit.

PHYSICAL SPECIFICATIONS: Height 7", width 19", depth 11", color gray hammertone. This unit is designed for relay rack mounting or bench use. Carrying handles are provided.

METERS: Voltmeters: Two 0-30 volts, 2½"
Milliameters: Two 0-1.5 amperes, 2½"

CONTROLS: Power on-off switch; outputs 1 and 2 DC on-off switch; outputs 1 and 2 ten turn voltage controls.

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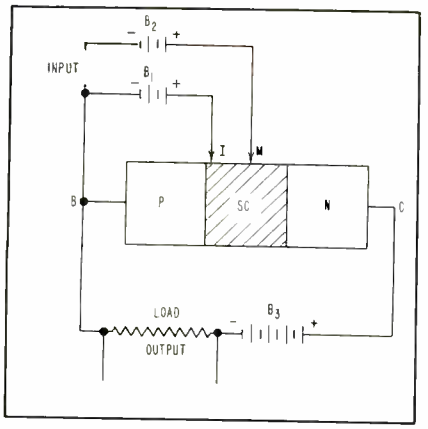


Fig. 2—Basic spacistor circuit

ductors whose short charge carrier lifetime makes them unsuitable materials for transistors. Raytheon expects that silicon-carbide spacistors will operate up to 500 C.

The output and input circuits of the spacistor are not coupled by internal feedback, as in the case of the transistor. This, as a result, makes the spacistor well-suited for use in multistage amplifiers.

Focusing Oscilloscope Cameras

CLELLAND D. NAIL
University of California
Radiation Laboratory
Livermore, California

FOCUSING an oscilloscope camera having a fast lens requires accurate adjustment, since the depth of the field of such lenses is very limited. A simple accurate focusing system requiring minimum apparatus is needed.

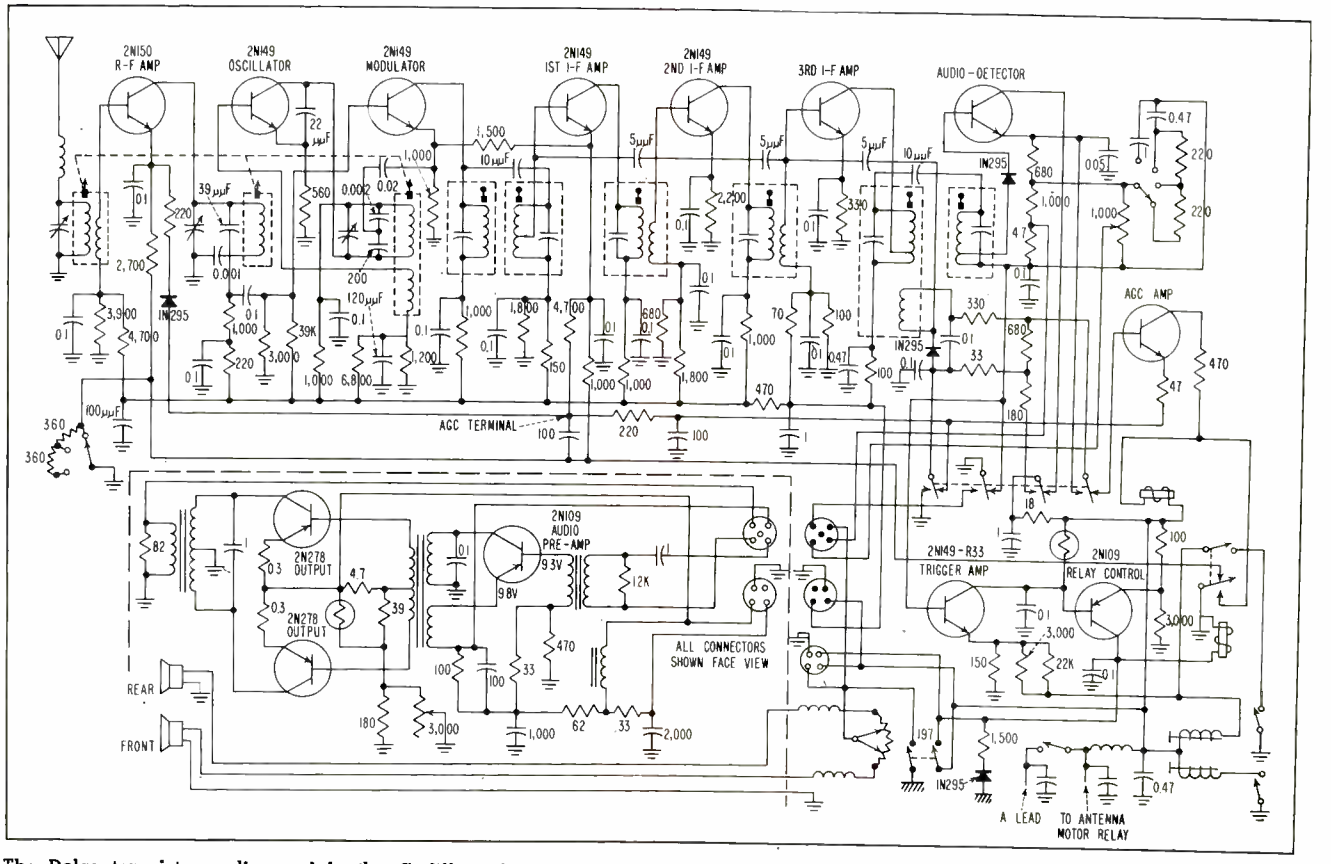
An extension of the Foucault knife-edge test can be used to determine the exact focal point of a lens very simply and accurately. The apparatus needed consists of a point source of light and a sharp-edged tool or knife.

▶ **Method**—The Foucault knife-edge test is made by directing a point source of light upon a lens or reflector and observing by eye the illumination at a point slightly beyond the focal point as shown in Fig. 1. A sharp edge is moved into the region of the light rays at the suspected focal point, and by the distinct characteristics of the illumination the exact point of convergence can be ascertained.

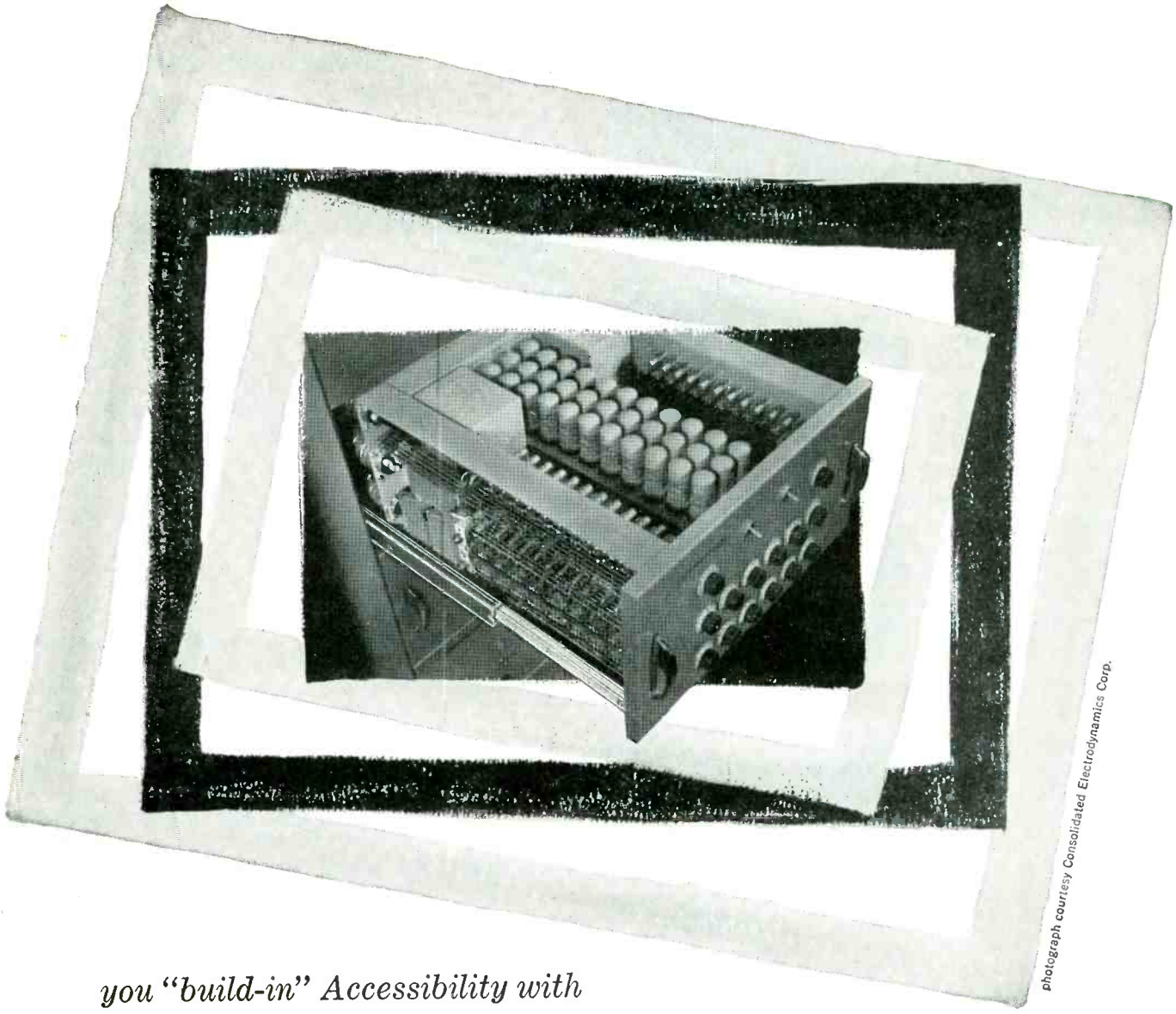
When the rays are intercepted at their exact point of focus, the illumination of the field appears to diminish uniformly as shown in Fig. 2A. If the knife edge enters the cone of light rays at a point in distinct characteristics of the illumination will appear to be eclipsed by a dark shadow that moves in opposition to the tool motion. Conversely, if the knife edge is beyond the point of focus, the shadow will appear on the knife side and will move across the field as the knife is moved. Figures 2A and 2B illustrate the latter cases.

To adjust an $f/1.5$ oscilloscope camera a knife-edged tool was made of brass. The undeflected

Deluxe Automobile Transistor Receiver



The Delco transistor radio used in the Cadillac El Dora brougham employs 11 transistors together with two more in the relay control circuits. Push-pull output stage supplies 10 watts to loudspeakers.



Photograph courtesy Consolidated Electrodynamics Corp.

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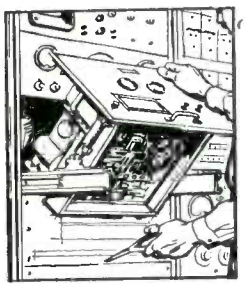

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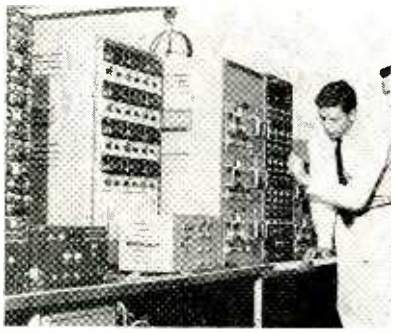
Grant Pulley & Hardware Corporation, 23 High Street, West Nyack, N. Y., Long Beach Avenue, Los Angeles 21, Calif.

The Front Cover

DEVELOPMENT of jet aircraft engines requires precise measurement of many variables within the engine while it is in operation.

Electronic equipment is used at the Pratt & Whitney Aircraft Co. to translate and record this information while the engine is running on the test stand under the wide range of temperature and pressure conditions that it would encounter in actual flight.

Shown in the photograph, here, is a bench of equipment in a test-stand control room. In the racks second from right are strain-gage translators. These units translate variations in resistance of strain-gages located at various points in the engine into a varying voltage. These



are amplified by oscillograph recording amplifiers for display on a 12-channel oscilloscope. These units monitor the signals from the strain-gage translators on separate channels.

Information other than strain gage readings such as fuel flows, engine speeds, and pressures can also be monitored.

oscilloscope beam was used as a point source of light. With the lens aperture and shutter open and the camera back removed, the knife edge was positioned at the film plane and the spot viewed from the open back of the camera, placing the viewing eye quite close to the film plane.

When the lens was properly focused, the image was clearly seen to darken uniformly over the entire area of illumination. The 0.006 in. thickness of one film layer placed beneath the knife-edge tool was sufficient to cause the illumination to darken from one side. Clear and sharp pictures taken after the adjustment confirm the focus accuracy.

Since phosphor illumination is used as the light source, no error from tube glass reflection or refraction can be present. A low-intensity spot, not harmful to phosphor, has been found to be sufficient.

This technique was originally developed about 1850 by telescope makers to determine the shape and nature of the parabola of a reflecting element.

The work described here was performed under the auspices of the U. S. Atomic Energy Commission.

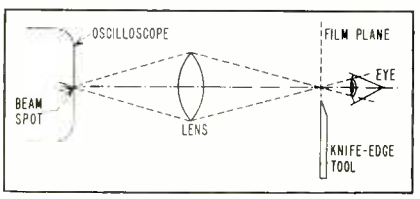


FIG. 1—Foucault knife-edge test requires a point source of light

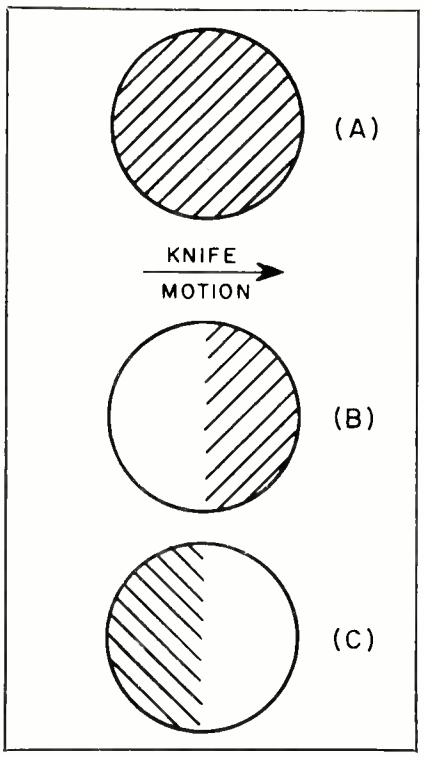


FIG. 2—Focus is at off where uniform diminution of illumination is obtained

Exact Calibration From a Standard

BY OVE SIMONSEN
U. S. Navy Electronics Lab.
San Diego, Calif.

IN MOST cases the technique employed when a standard-frequency source is unmodulated, is to adjust the frequency meter undergoing calibration until zero beat is obtained. This method fails when extreme accuracy is required because zero or near zero beat note between the equipment to be calibrated and the standard will not pass an ordinary receiver such as is generally found in communication systems.

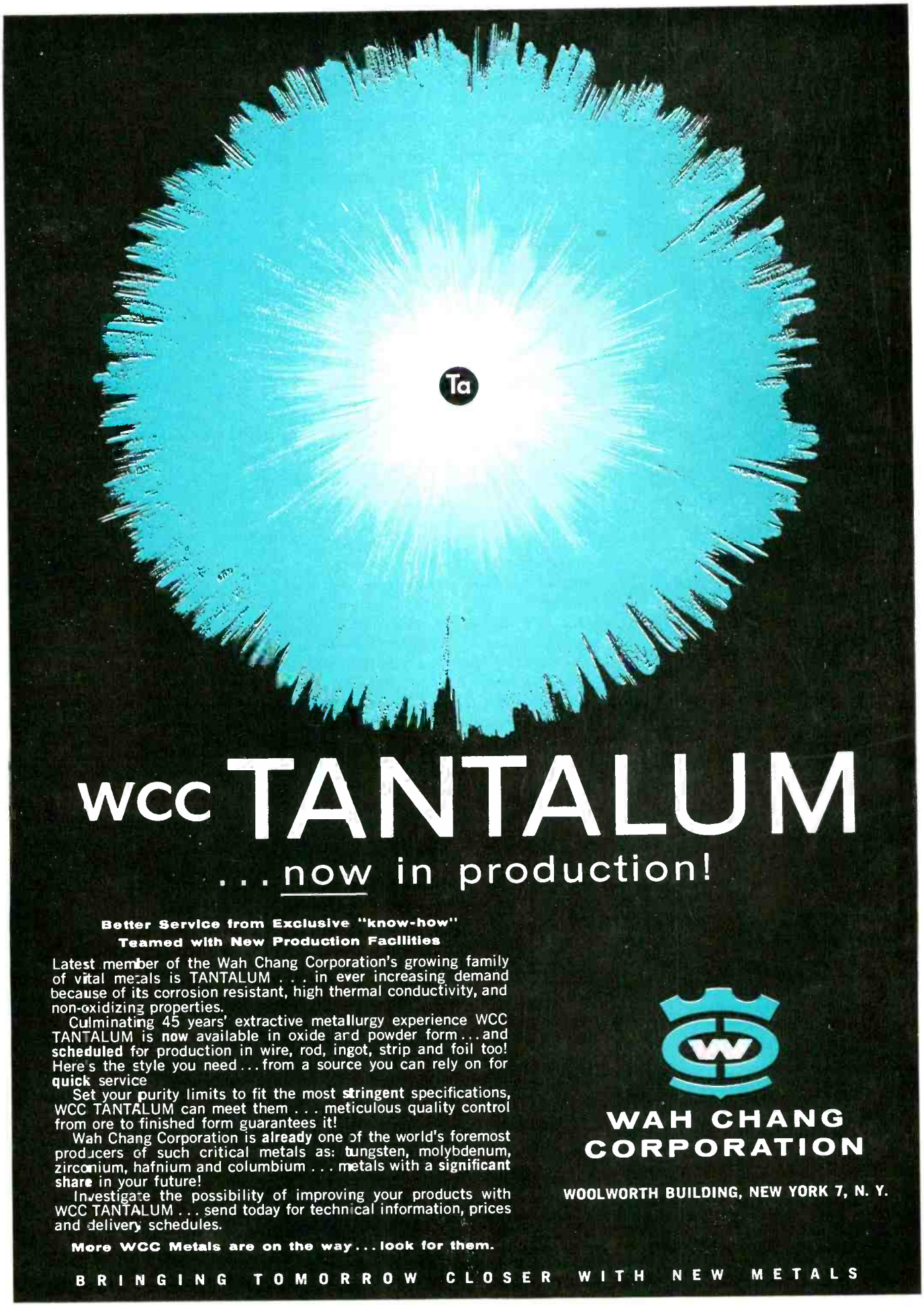
The best that can be hoped for would be limited to the lowest note the ear can detect (perhaps not below 27 cycles a second). If an oscilloscope is used, accuracy is limited to the lowest frequency the receiver will pass (perhaps not much below the limit of the ear).

This article describes a simple method requiring no precision equipment. Two ordinary receivers and a radio-frequency oscillator, which does not even need to be extremely stable, are arranged as shown in the diagram.

►**System Features**—The difficulty of not being able to pass low audio frequencies does not now exist as the r-f oscillator is set to give any convenient difference frequency. Only when the meter is at exactly the same frequency as the standard will the pattern be a circle. The r-f oscillator does not have to be stable. Should it drift, the effect will show up on both receivers and the net effect will be zero.

Suppose the two difference frequencies between the common and the standard and the common and the meter to be calibrated are 1,000 and 1,005 cycles, respectively. If the common generator drifts five cycles downward, the difference frequencies would become 1,005 and 1,010 cycles respectively. Consider now that the common generator drifts upward five cycles; the difference frequencies now will be 995 and 1,000 cycles.

As far as the inequity in frequency between the standard and substandard is concerned no change



Circle 135 Readers Service Card

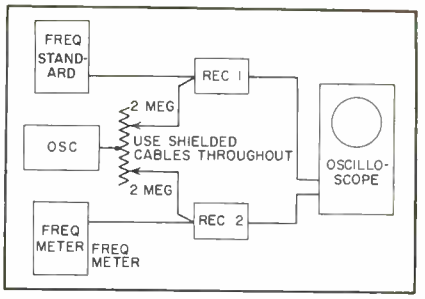
has occurred and any necessary adjustments to the substandard therefore can be made as if the common generator did not exist. In other words, drift in the common generator will not be noticed and neither will it effect the accuracy of the calibration.

▶ **Approach** — When using this method, it is essential that if the standard is below or above the common generator, the substandard should be made to approach the standard from a frequency that also initially is below or above the common generator. Otherwise, the meter when calibrated to the standard will be off by twice the difference frequency of the common signal generator and the standard. This is verified by an example.

Suppose the standard frequency is above the common and the meter to be calibrated is below an equal amount, like 1,000 cycles. The standard and the meter to be calibrated are then separated by 2,000 cycles and the circle obtained in this case evidently does not indicate frequency coincidence between the standard and the substandard.

Fortunately there is little danger that the precaution given above will be overlooked as there are unmistakable signs when error exists. A drift now in the common signal generator of 5 cycles upwards would make the upper frequency difference 995 cycles while the lower would become 1,005 cycles.

The change in separation of two difference frequencies ($f_{std} - f_{com}$ and $f_{com} - f_{substd}$) would be twice



Arrangement of the calibrating equipment

the common signal generator drift. The result would make it nearly impossible to obtain a circle on the scope. However, if by careful manipulation it is possible to arrest the pattern, the least bit of drift in the common would quickly wipe out this counterfeit circle.

In short, should abnormal difficulties be experienced when trying to obtain coincidence between standard and substandard, it should be suspected that the frequencies of the two equipments are not arranged on the same side of the common signal generator frequency.

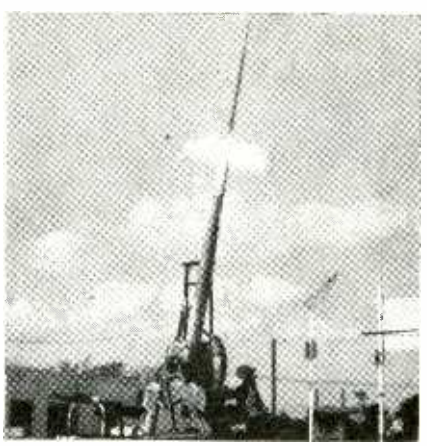
▶ **Drift Advantage**—The inference might be made that it is desirable that the common signal generator drift and such is actually the case.

The 2-megohm resistors shown in the circuit are not critical as long as they are large enough to prevent the signals from the frequency standard from reaching receiver 2 and small enough to permit a signal of desirable strength from the r-f oscillator to reach both receivers.

Rocket Telemeters Weather Data

RAPID gathering of weather information is promised by DART, a high altitude missile now under development at the Naval Ordnance Laboratory.

Launched from a ship's five-inch gun and driven by a rocket motor to a speed of 3,000 mph, the missile will reach a height of 110,000 ft. in 70 sec. Future models will reach



Test firing of weather missile from land based five-inch gun. Rocket motor, fired electrically, causes blast. There is no recoil since gun is not fired

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This new film not only permits contact and projection prints, and eliminates image reversal, but also enables use of the Polaroid-Land process in recording ultra-high-speed phenomena — even single transients.

Utility of the 302 is further broadened by the availability of adapter backs which permit the camera to use various standard roll and cut films. **Write for full information...**

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- Alphax #2 shutter, bulb and 1/25 to 1/100 sec. with f/2.8 lens. Alphax #3 shutter, time, bulb and 1 sec. with f/1.9 lens.
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Permits either continuous or single-frame recording. Perforated or unperforated film or paper in 100 or 400 foot reels. Variable film drive speeds from 0.8 to 10,800 in./min. 321-A with f/1.5 lens **$1270.00**, 321-A with f/2.8 lens **$1120.00.** (50 cps models available)

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300,000 ft. At the height of its trajectory, the missile will split open, allowing an instrument case, slowed by balloon, to float earthward.

Continuously telemetered temperature and humidity data together with position data obtained from the ship radar, will furnish meteorological information.

▶ **Missile**—The rocket nose section shown in Fig. 1 after its rocket engine has detached, is 40 inches long, with 26 cu in. available for electronic equipment.

The balloon, inflated by chemically generated nitrogen, is six feet in diameter. The difficulties involved in tracking a six-foot object over 20 miles distant are avoided by an active system of radar. The missile receives signals from the ship-based X-band radar and retransmits them on a 403-mc carrier. The repeated pulses are of constant height, but each has a length proportional to the received strength of the corresponding X-band pulse.

The radar beam is slightly inclined with respect to the antenna axis and rotates about the axis at 30 rps. Thus, if the balloon is close to, but not exactly on the antenna axis, the envelope of the received pulses is amplitude modulated at 30 cps. This appears as pulse-width modulation of the repeated pulses. From the amplitude of this modulation and its phase with respect to the rotation of the beam, the position of the balloon referred to the axis of the radar antenna can be determined.

▶ **Telemetering** — Since the reply pulses are at most 10 μsecs wide, at 403 mc an interval of nearly 700 μsec between pulses is available for telemetering. By omitting pulses periodically, the pulse train is divided into groups. A specific position in each group is then assigned for temperature data, humidity and reference pulses.

Positioning half microsecond pulses in a 700 μsec band, allowing for the accuracy of the equipment, over 400 graduations are available.

▶ **Pickups**—The temperature sensor is about ten feet of half-mil tungsten wire coiled about the outside of the instrument case. The wire forms one arm of a bridge circuit whose output drives a transistor amplifier.

Humidity sensors with the rapid response required are still a problem, but development of thin film electrical conductivity type sensors appears promising.

As shown in Fig. 2, the outputs of the sensors and the signals derived from the X-band radar are connected through individual gates to an amplifier supplying the phantastron. Upon being triggered,

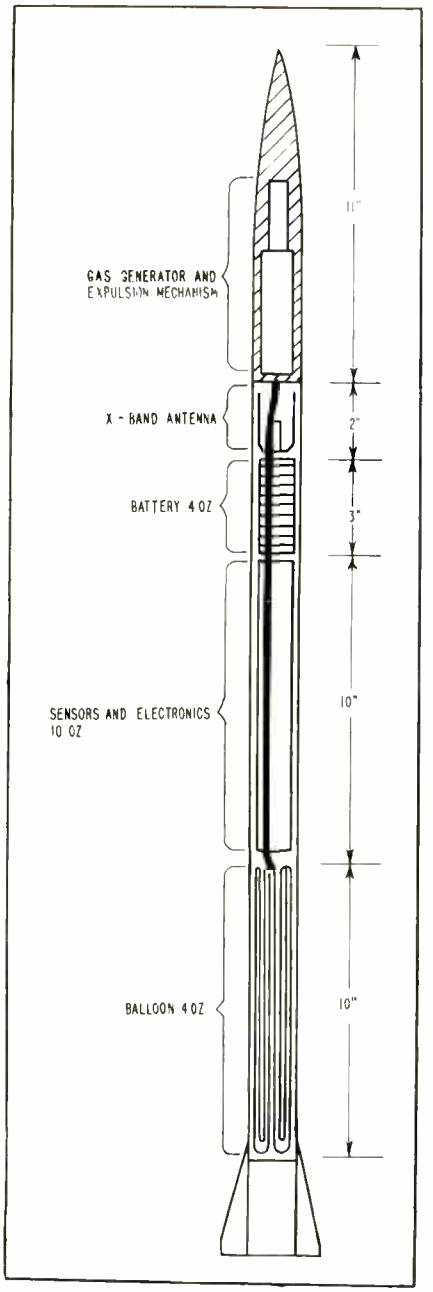

FIG. 1—Telemetering missile is 40 in. long, 1⅜ in. outside diameter and weighs 6.3 lbs. About 26 cu in. is for electronics

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2 Watts (DK-102, DK-102R).
6 Watts (DK-106, DK-106R).

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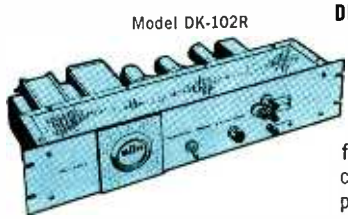
Model DK-102R



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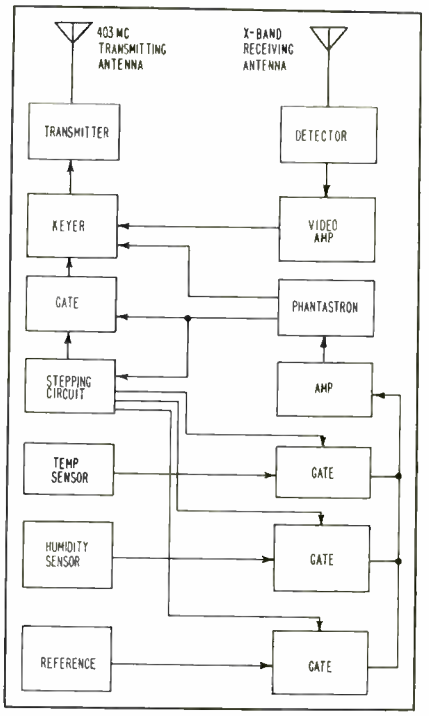

Fig. 2—Block diagram of system contained in DART missile

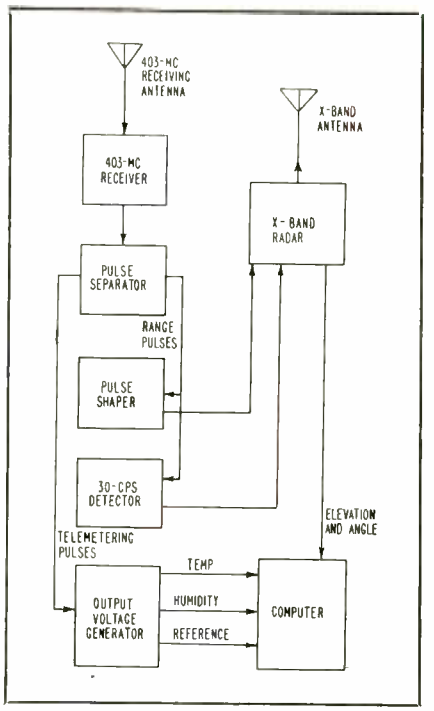

Fig. 3—Shipboard equipment includes non-directional 403-mc receiver

the phantastron generates on output pulse after a time delay determined by its bias voltage.

► **Radar** — Aboard the ship, as shown in Fig. 3, the 403-mc pulses are received by a nondirectional receiver. The range pulses, separated from the shorter telemetering pulses, allow the radar to determine the range, bearing and elevation of the missile.

The several channels of data telemetered are separated and delivered to suitable data handling equipment.

To prevent errors, incoming pulses of improper length are prevented from reaching the data computer.—*N.H.*

Transistor Complementary Symmetry

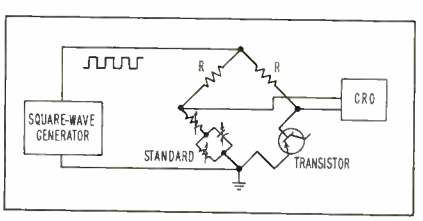

FIG. 1—Giacoletto's circuit

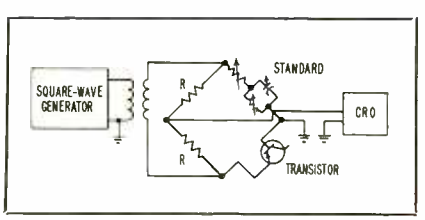

FIG. 2—Circuit with an ideal transformer

By YASUO TARUI
Electrotechnical Laboratory
Tokyo, Japan

FOR measurement of $r_{bb'}$, which is one of the most important high-frequency figures of merit of transistors, Giacoletto proposed a multifrequency bridge for which the schematic circuit is shown in Fig. 1 (see also ELECTRONICS, p 144, Nov. 1953). Since one of the output terminals of the square-wave generator is grounded in this case, a differential oscilloscope is required for the detector. If, however an ideal transformer that will pass square waves without distortion is obtained, the circuit can be altered to a normal bridge arrangement as shown in Fig. 2.

Complementary symmetry of high frequency *pnp* and *npn* tran-

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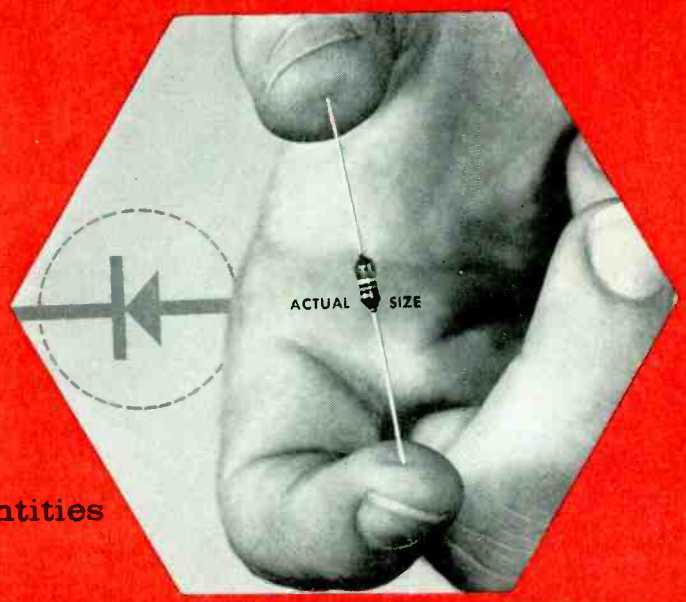

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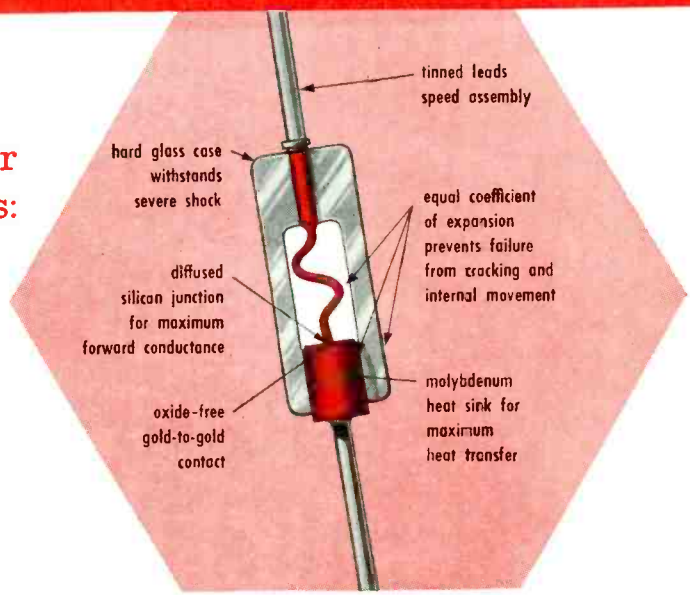

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	1N645	1N646	1N647	1N648	1N649	
Peak Inverse Voltage at −65 to +150°C	225	300	400	500	600	V
Average Rectified Forward Current at +25°C	400	400	400	400	400	mA
Average Rectified Forward Current at +150°C	150	150	150	150	150	mA
Recurrent Peak Forward Current at +25°C	1.25	1.25	1.25	1.25	1.25	amp
Surge Current, 1 Second DC at +25 to +150°C	3	3	3	3	3	Amp
Power Dissipation at +25°C	600	600	600	600	600	mW

specifications

Minimum Breakdown Voltage at +100°C	275	360	480	600	720	V
Maximum Reverse Current at PIV at +25°C	0.2	0.2	0.2	0.2	0.2	μA
Maximum Reverse Current at PIV at +100°C	15	15	20	20	25	μA
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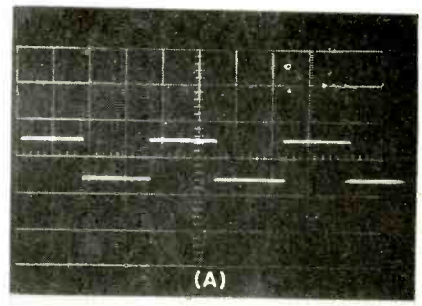
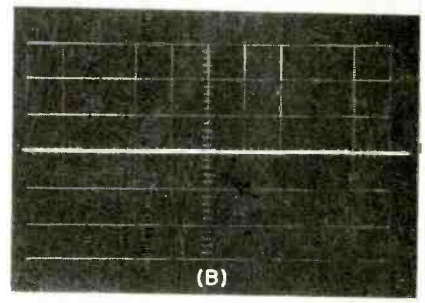
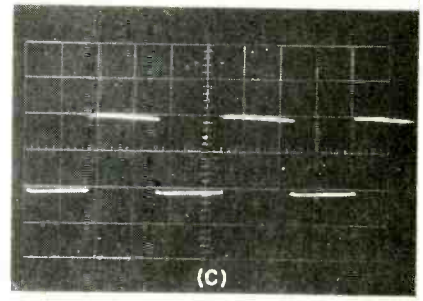
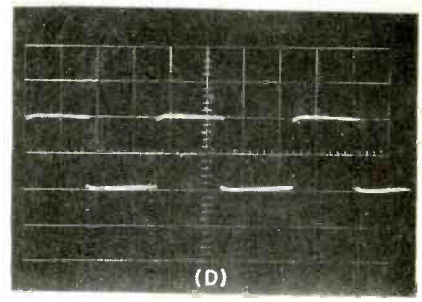
sistors can be used for this purpose. The circuit of the bridge is shown schematically in Fig. 3. Analysis of the equivalent circuit









Input signal (A) balanced signal at C of Fig. 4 (B) pnp collector to ground (C) and npn collector to ground (D)

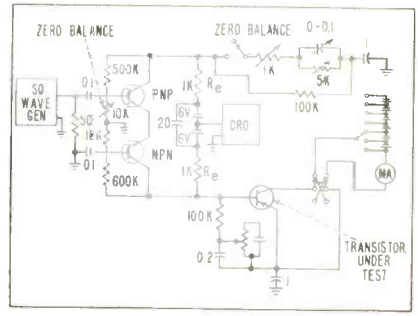
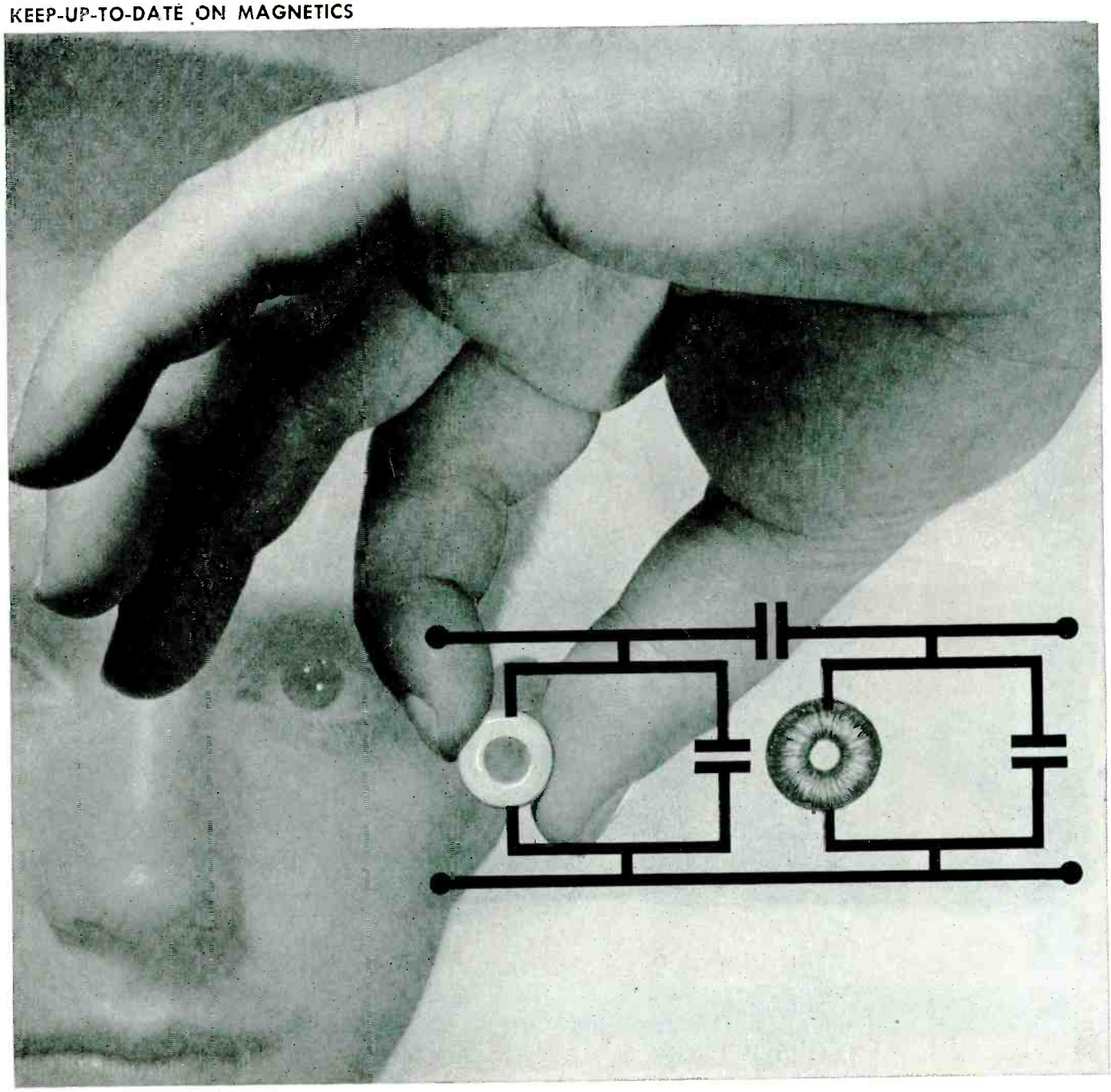


FIG. 3—Circuit with transistor complementary symmetry



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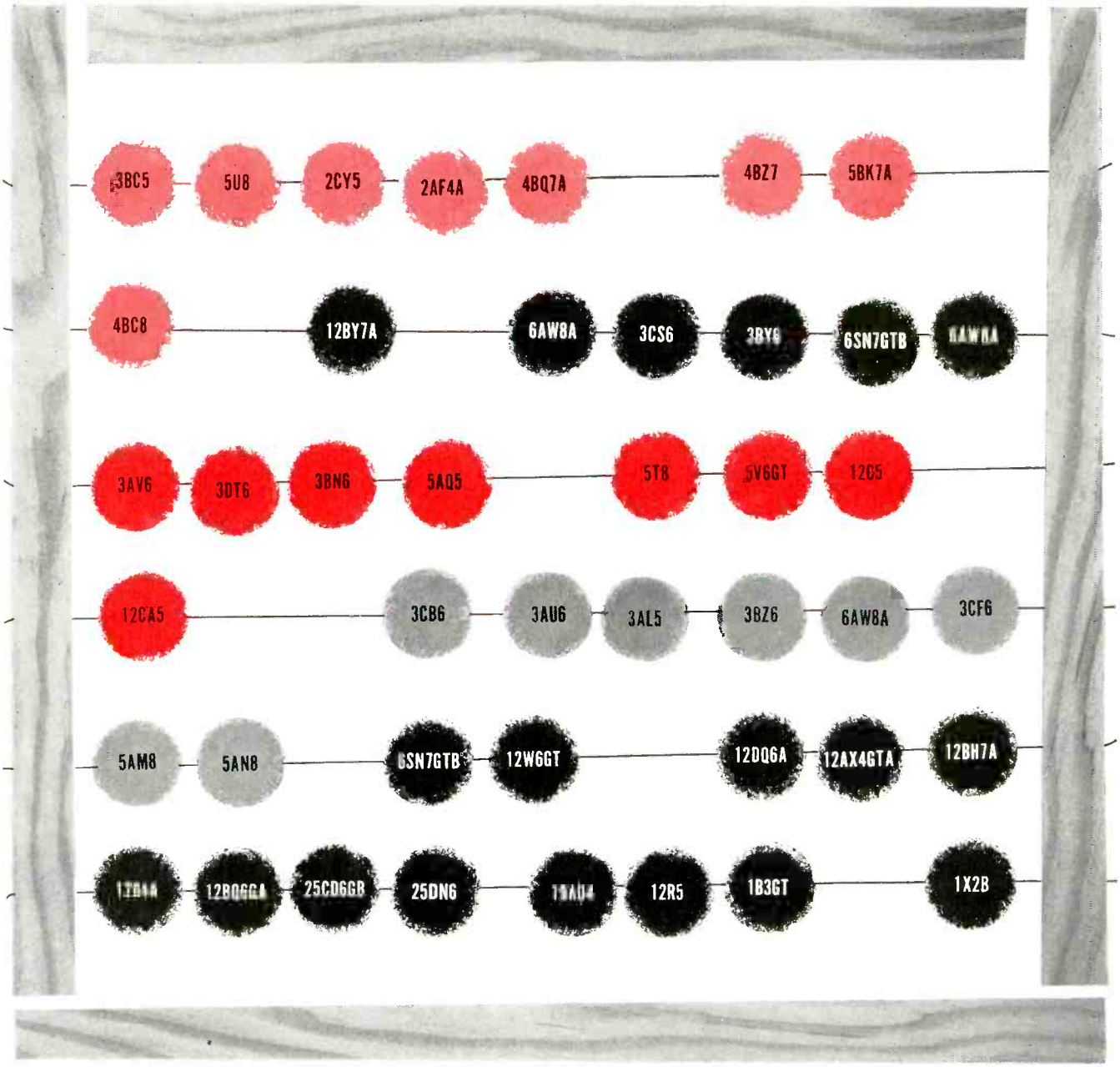

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shown in Fig. 4 shows that the potentials at A and B, denoted by V_1 and V_2 respectively, are approximately given as follows

$$V_1 = -Z_{c1} \cdot A\ (1-a_1)$$
$$V_2 = Z_{c2} \cdot A\ (1-a_2)$$

where

$$A = \frac{i_2}{i_1} = \frac{a_1 Z_{c1} + a_2 Z_{c2}}{Z_{c1}(1-a_1) + Z_{c2}(1-a_2)}$$

Therefore the important parameters that must be considered for selection of transistors are Z_c, a, f_{ac}.

With high frequency *pnp* and *npn* transistors ($f_{ac} \approx 10$ mc) an

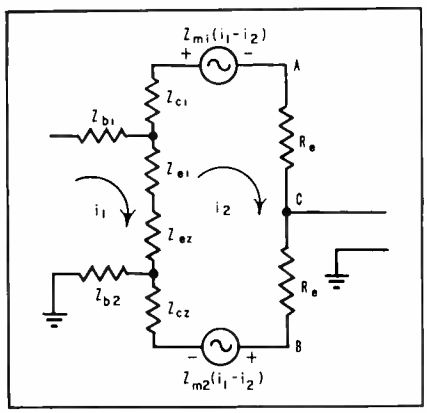

FIG. 4—Equivalent circuit

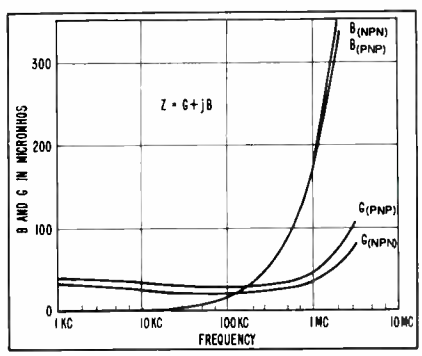

FIG. 5—Output impedances of two transistors

experimental set was constructed. Representative pulse figures at respective points are shown in the photographs.

On null condition the point C is ground potential. Hence, no error is introduced from the transistor output impedances, provided they are well balanced. Figure 5 shows the measured output conductances and susceptances of A to ground and B to ground with exclusion of R_e. The differences of those two

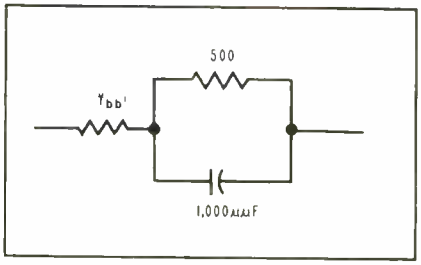

FIG. 6—Elements of a dummy transistor

Table I — Accuracy Check with Dummy

Dummy $r_{bb'}$	Measured $r_{bb'}$	Error in prtcent
99.7	100.4	+0.7
199.9	199.5	−0.2
300.6	299.0	−0.53
400.0	399.0	−0.25
500.0	498.0	−0.5
599.2	596.5	−0.52
699.2	695.0	−0.6
799.0	794.3	−0.6
901.0	894.0	+0.78
1001.0	992.0	−0.9

halves is almost negligible up to 1 mc in comparison with 1/1 k.

The accuracy of this bridge was checked with a dummy transistor like that shown in Fig. 6. The dummy, with accurately measured value of $r_{bb'}$, was inserted in place of the transistor specimen and the bridge was balanced. Examples of the inserted $r_{bb'}$ and measured $r_{bb'}$ are given in Table I. Fairly good agreement can be seen.

Long Scope Probes Using Passive Elements

By W. F. Santelmann, Jr. and A. J. Hingston
Massachusetts Institute of Technology Lexington, Mass.

In maintenance of large digital computers, it is desirable to have all critical waveforms on hand at the maintenance console for oscilloscope monitoring. To accomplish this, cathode-follower probes driving long terminated lines have been necessary, but a successful probe has been designed using completely passive elements.

A typical computer waveform, Fig. 1A, the output of a mercury-wetted contact relay, is a step with

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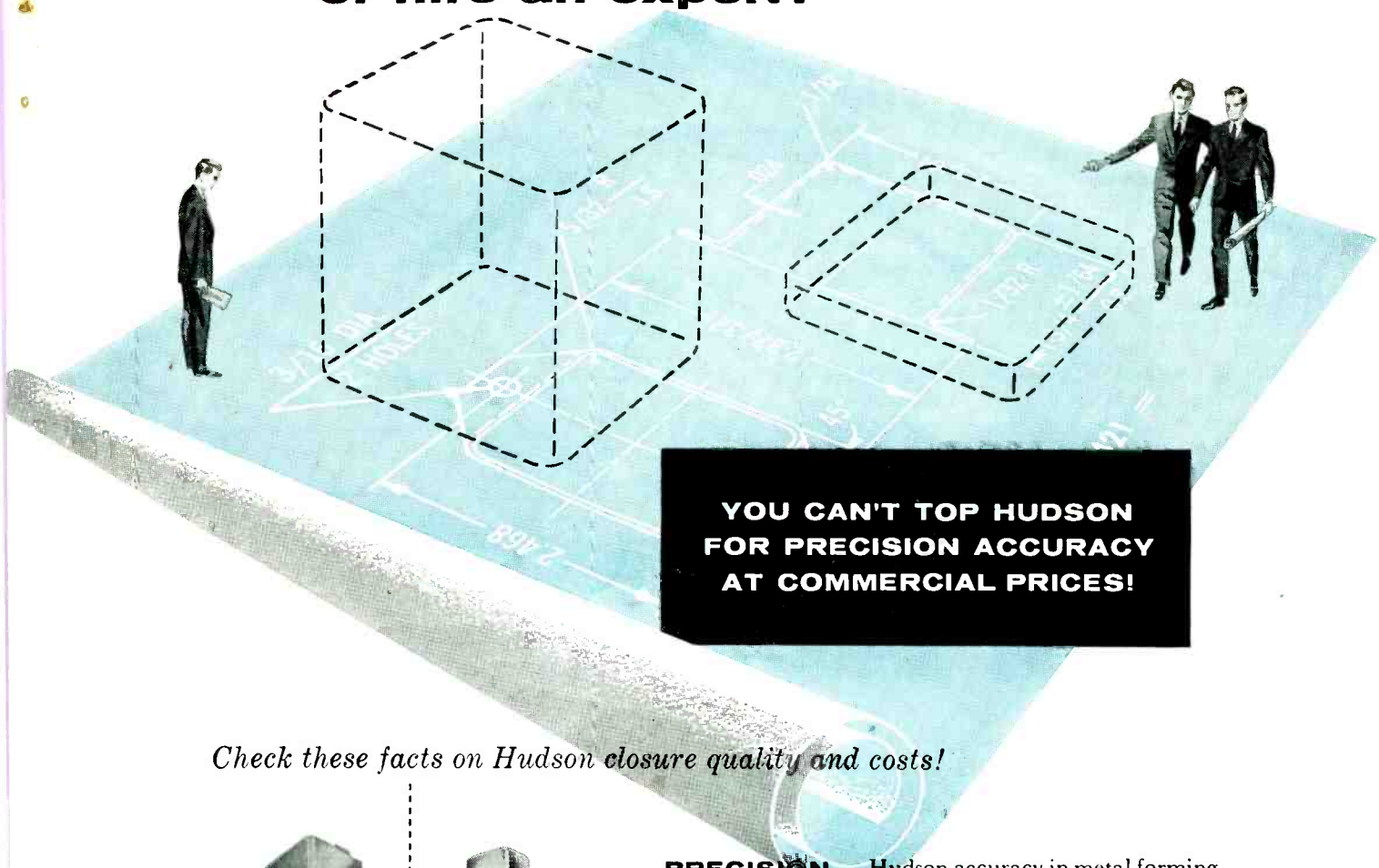

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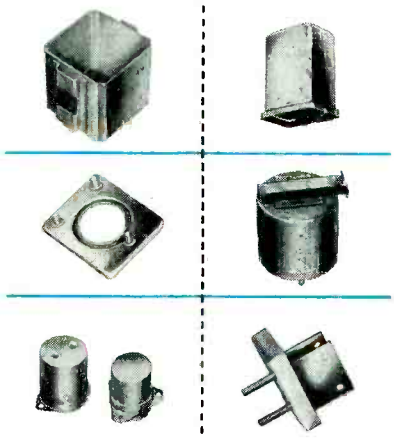

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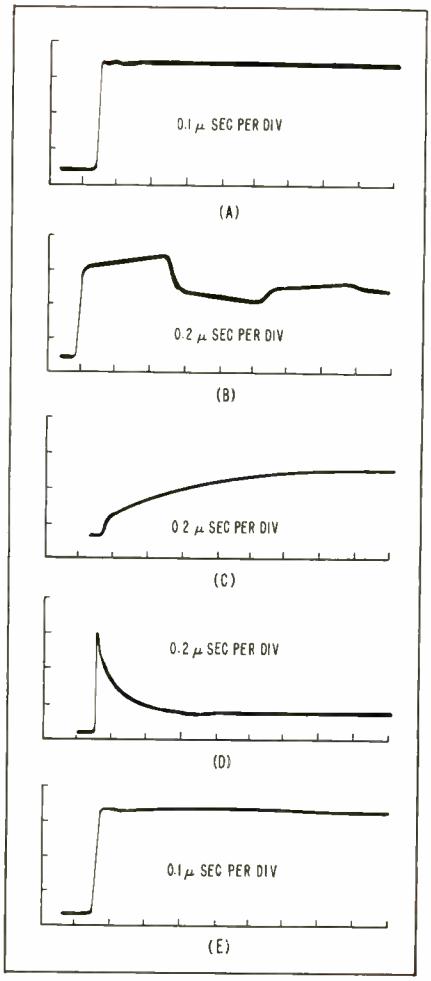

FIG. 1—Significant waveforms on scope with 12 μsec rise time

a rise time of a few μsec. Figure 1B shows the deleterious results on this step of a 227-ft unterminated line.

When the center conductor of this coaxial cable is replaced by resistance wire, the reflections are absorbed, as shown in Fig. 1C. Best results are found when the total line resistance is between 350 and 700 ohms.

▶ **Skin Effect**—The skin-effect impedance of the resistance wire causes the knee in the waveform of Fig. 1C. The knee distortion increases with cable length. Up to about five feet, no knee distortion is evident, however with 227 ft of cable, the effect is severe.

To transmit the step waveform faithfully, it is then necessary to provide an equalizer with the characteristic shown in Fig. 1D. Such a network, constructed with completely passive components, is

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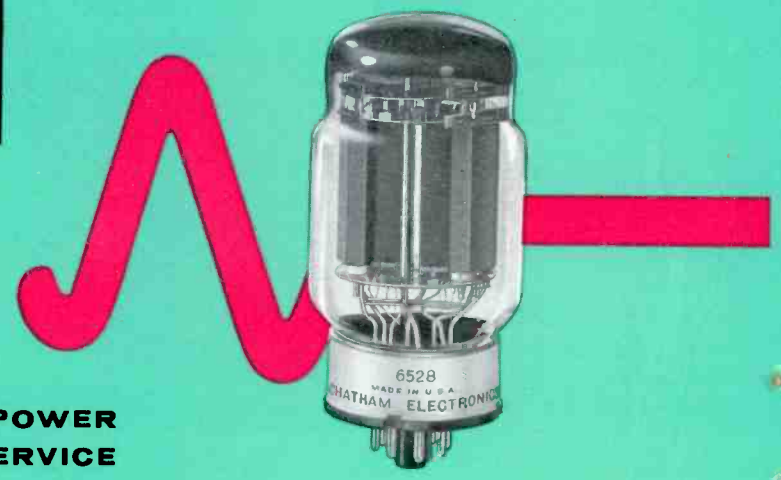

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Circuitwise, the 6528 may be used with both triodes in parallel for one high current output, or they may be separated to provide two different regulated outputs. The possibilities for circuit simplification, space conservation and production economies are, of course, apparent.

For more information about the 6528, or for help with any special tube problem, write Commercial Engineering Section, Chatham Electronics, Division of Tung-Sol Electric Inc., Livingston, N. J.

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For reliable long life operation the 6528 features:

1. Hard Glass Envelope—permits tube to be more fully out-gassed in manufacture and to run at higher temperatures during life without gas evolution—more resistant to thermal shock.

2. Graphite Anodes—zirconium coated to provide one of the best "gettering" agents known—graphite undergoes virtually no expansion with temperature changes.

3. Extra Rugged Grids—gold plated molybdenum lateral wires supported by massive chrome copper side rods.

4. Oversized Cathodes—provide adequate emission reserve—no deterioration on standby.

5. Rugged Construction—mount is supported by six flexible metal snubbers and ceramic stand off insulators—heavy button stem has widely separated support leads.

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Max. Plate Dissipation per tube	60 watts
Max. Plate Dissipation per section	30 watts
Max. Steady State Plate Current per section	300 ma
Max. Plate Voltage	400 volts
Max. Heater Cathode Voltage	300 volts
Amplification Factor*	9
Transconductance per section*	37,000 umhos

*Average characteristics at Eb = 100v, Ec = —4v, Ib = 185 ma.

TYPICAL VALUES FOR REGULATOR SERVICE

Current per Triode Section	Range of Tube Voltage Drop	Minimum Tube Drop	Grid Voltage Swing
200 ma	65 v.	70 v.	10 v.
150	120	60	20
100	225	45	35

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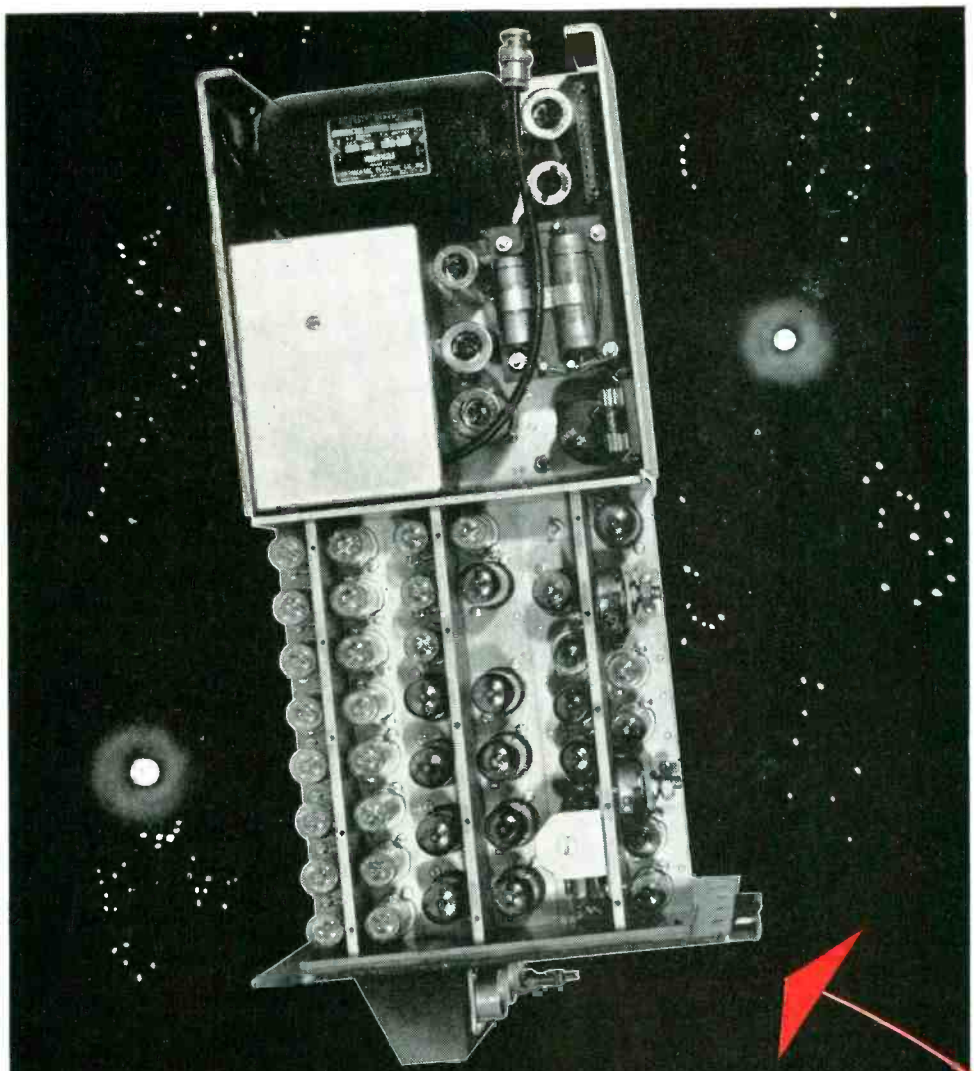

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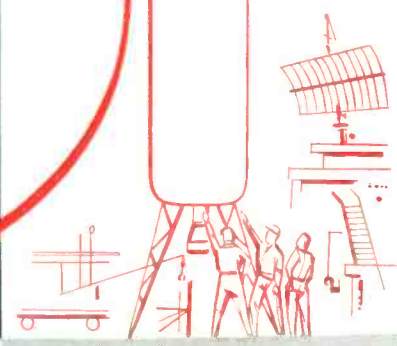

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shown in the circuit of Fig. 2.

The purpose of each element of the attenuator-equalizer may be shown by reference to Fig. 3.

The output of a resistance wire cable when driven by standard attenuator, R_1, R_4, and C_1, has a large overshoot, as shown in Fig. 3A. This may be controlled, Fig. 3B, by the addition of R_5 and C_2. The height of the leading edge may then be controlled by adjusting C_2.

During the first 0.5 μsec after the rise, a bulge is evident in the

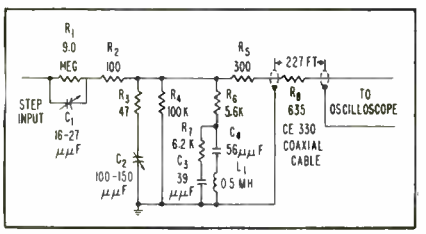

FIG. 2—Total cable resistances of 350 to 700 ohms may be used, but cables between 400 and 500 ohms perform best

waveform of Fig. 3C, identical to Fig. 3B, but taken at a sweep speed five times slower. The addition of R_6, R_7, C_3, C_4 and L_1, reduces the bulge considerably as shown in Fig. 3D. If transient distortions up to five percent are tolerable, then it is often practical to omit this network.

Resistor R_2 is added to prevent ringing in the input leads when viewing extremly fast waveforms. If input leads no greater than 2 in. are used, the resistor may be omited, thereby decreasing the probe rise time.

R_1 and R_4 must be 1-percent units for accuracy of d-c attenuation. Otherwise, the fixed components require no more than the customary five-percent tolerance, and some will perform consistently with ten-percent tolerances.

▶ **Application**—The Sage installation at Lincoln Labs uses 200 ft cables wired in the computer frame. Each cable goes from a conveniently located connector on the frame to a jack board at the maintenance console. Each passive probe, with its 27 feet of cable, may then be plugged into the nearest cable outlet and selected at the jack panel for viewing in the

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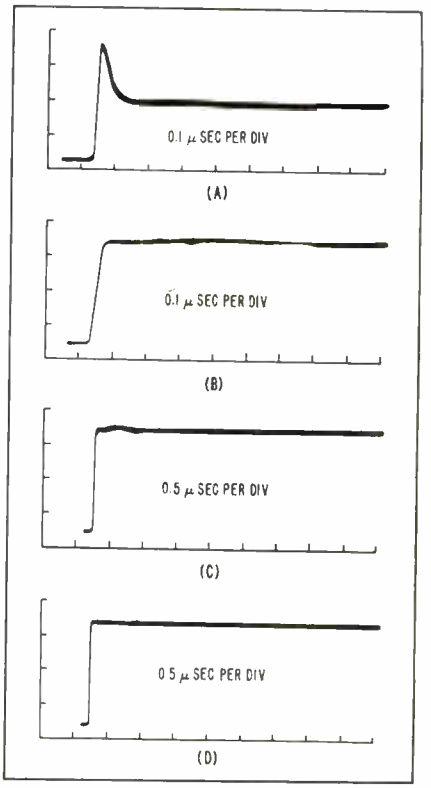

Fig. 3—Waveforms showing operation of attenuator-equalizer. Final response of the system is seen in Fig. 1E and Fig. 3D to different scales

oscilloscope. As each probe is at the end of 227 ft of cable, all time relations are preserved.

Since the probe must be grounded

Antenna Test Chamber

Altitude chamber designed for use at Stanford Research Institute to simulate high altitude conditions for testing antennas is set up by designer Jerry Brisco. Under the simulated high-altitude conditions, r-f power is applied to the antenna from measurements of voltage breakdown characteristics

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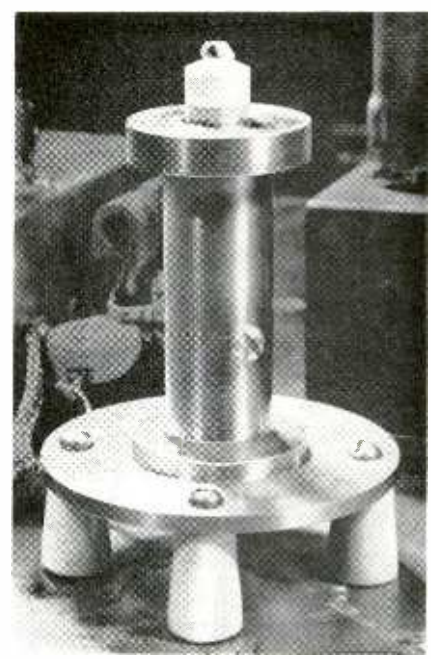
The 227 ft probe displays a 16 μsec rise time, one percent transient distortion, and 30 $\mu\mu$f input capacitance at an attenuation ratio of 100 to 1. A similar probe, 55 ft long, for a medium-size computer, has a rise time of 14 μsec, transient distortion of 2 percent, input capacitance of 15.5 $\mu\mu$f and an attenuation of 50 to 1.

Since the probe must be grounded at the waveform source and the oscilloscope must also be grounded, it is often found that power-frequency voltages on the computer ground bus are delivered by the probe system to the oscilloscope. A capacitor of about 0.001 μf in series with the probe ground lead, will block the flow of the hum without disturbing computer waveforms. Direct-coupling still exists since the waveform source and the oscilloscope are both grounded to the computer ground bus.

Measuring Elastic Moduli By Ultrasonics



Diamond specimen to be measured in place on top fused-silica buffer rod. Quartz transducer is at lower end of rod

AN ULTRASONIC technique for the determination of elastic moduli has been developed. Basically, the system measures the velocity of propa-

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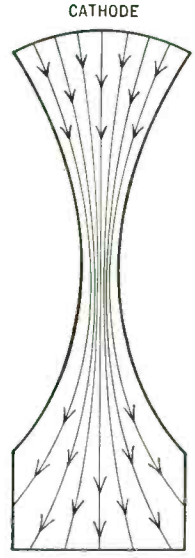

New Space Charge Focus principle of beam control is shown in diagram. New Sperry tube design utilizing this principle reduces size, weight, power consumption and cooling needs.

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Main applications for the SAS-61 are as an output tube in low-power radars, or as a driver for higher-powered klystrons in radar and linear accelerator systems. Its unusually long service life, however, makes it highly desirable for any application requiring 15 kw in the S-band. The SAS-61 with its internal tunable cavities is a *complete* microwave unit. No external equipment is required.

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gation of the vibrations within the material.

Two parallel surfaces are ground on the specimen to be measured. Using a thin film of viscous liquid, one surface is attached to a fused-silica buffer rod which is fastened to a quartz-crystal transducer.

As shown in Fig. 1, short pulses of r-f are applied to the specimen through the transducer. Although the ultrasonic vibrations are reflected principally at the buffer-

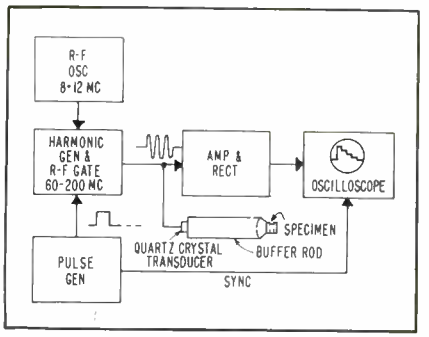


FIG. 1—Oscilloscope indicates when reflections from specimen are in phase

specimen interface, some vibrations are transmitted into the specimen and reflected back and forth between its parallel surfaces. At certain critical frequencies, these reflections combine in phase, causing a characteristic pattern on the oscilliscope.

▶ **Velocity**—From these frequencies and the measured thickness, the velocity of propagation in the specimen may be determined. Knowing the material's density, its elastic constant may then be computed.

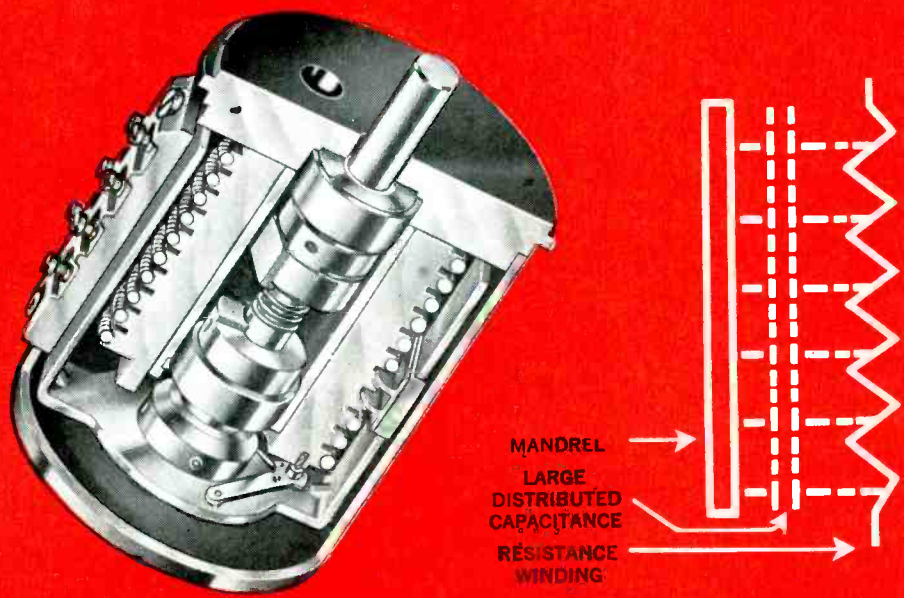
The technique, developed at Bell Laboratories, is applicable to a large variety of materials under widely varying conditions of temperature and pressure.

PERTINENT PATENTS

By Norman L. Chalfin
Hughes Aircraft Co.
Culver City, Calif.

Computers and stable oscillators are among the devices of high current interest. Included here are details on a readout device, a crystal

DRIVER-HARRIS ALLOYS AT WORK IN PRODUCT ADVANCEMENT



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SPECIAL D-H ALLOYS MAKE AIR-CORE WINDINGS PRACTICAL!

Helipot's purpose in designing its new, air-core wound series 7700 Potentiometers was to make possible operation at higher frequencies with 0° phase shift—thereby eliminating compensation circuitry.

In nearly all multi-turn potentiometers, resistance wire is wound on an insulated copper-wire mandrel. This type of mandrel is used because it has uniform diameter, good heat conductivity and high thermal capacity. However, a disadvantage of such construction is the relatively large distributed capacitance between the resistance winding and the mandrel. When such a potentiometer is used as an AC voltage divider, the output generally differs in phase and magnitude from the desired output. This interferes with the effective use of high accuracy potentiometers unless compensation is applied somewhere in the circuit.

Helipot engineers desired to eliminate these problems by eliminating the copper-wire mandrel. But the elimination of the mandrel also eliminated the support for the winding. Needed, therefore, was a type of wire that would make a self-supporting air-core winding.

At Helipot's request, Driver-Harris went to work with these specifications: The wire must be of dependable uniform hardness so that in stretching it, equal spacing between turns is obtained, free of creep. This is essential to linearity. The wire also must be of unvarying diameter for uniform resistance. And its surface must be extremely clean—free of oxide coating to minimize contact "noise".

Driver-Harris produced the wire—a special hard-drawn form of Karma* and Nichrome* V. And Helipot produced its new 10-turn series 7700 potentiometers in a resistance range from 200 to 5000 ohms. With this radically new air-core winding, linearity approaches the resolution of the unit without resort to padding or shunting. And phase shift in AC circuitry is reduced to less than 0.1°.

Since 1899, Driver-Harris has produced 132 special-purpose alloys in just this fashion—in answer to a particular problem and extraordinary specifications. If your own engineering and product development plans currently hinge upon a special alloy—why not bring your problem to Driver-Harris. Your inquiry is invited.

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

Driver-Harris Company*

HARRISON, NEW JERSEY • BRANCHES: Chicago, Detroit, Cleveland, Louisville

Distributor: ANGUS-CAMPBELL, INC., Los Angeles, San Francisco • In Canada: The B. GREENING WIRE COMPANY, Ltd., Hamilton, Ontario

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oscillator and spin echo storage technique.

Read-Out Device

Instantaneous read-out devices for computers and other instruments speed utility of such equipment. An example of an illuminated indicator is recent patent 2,766,447 issued to W. E. Woodson, Jr. and J. I. Morgan of San Diego, Calif.

These inventors have stacked clear plastic sheets with fine line engraved numerals in an array of

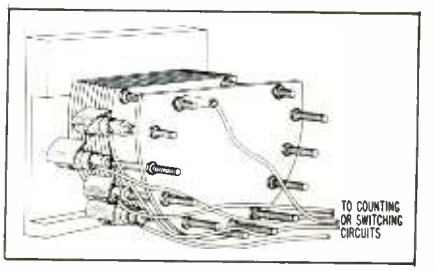


FIG. 1—Complete assembly of the illuminated indicator

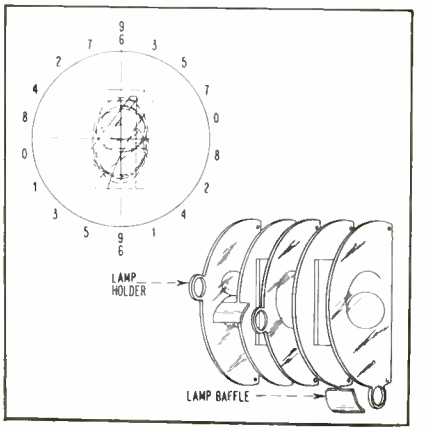


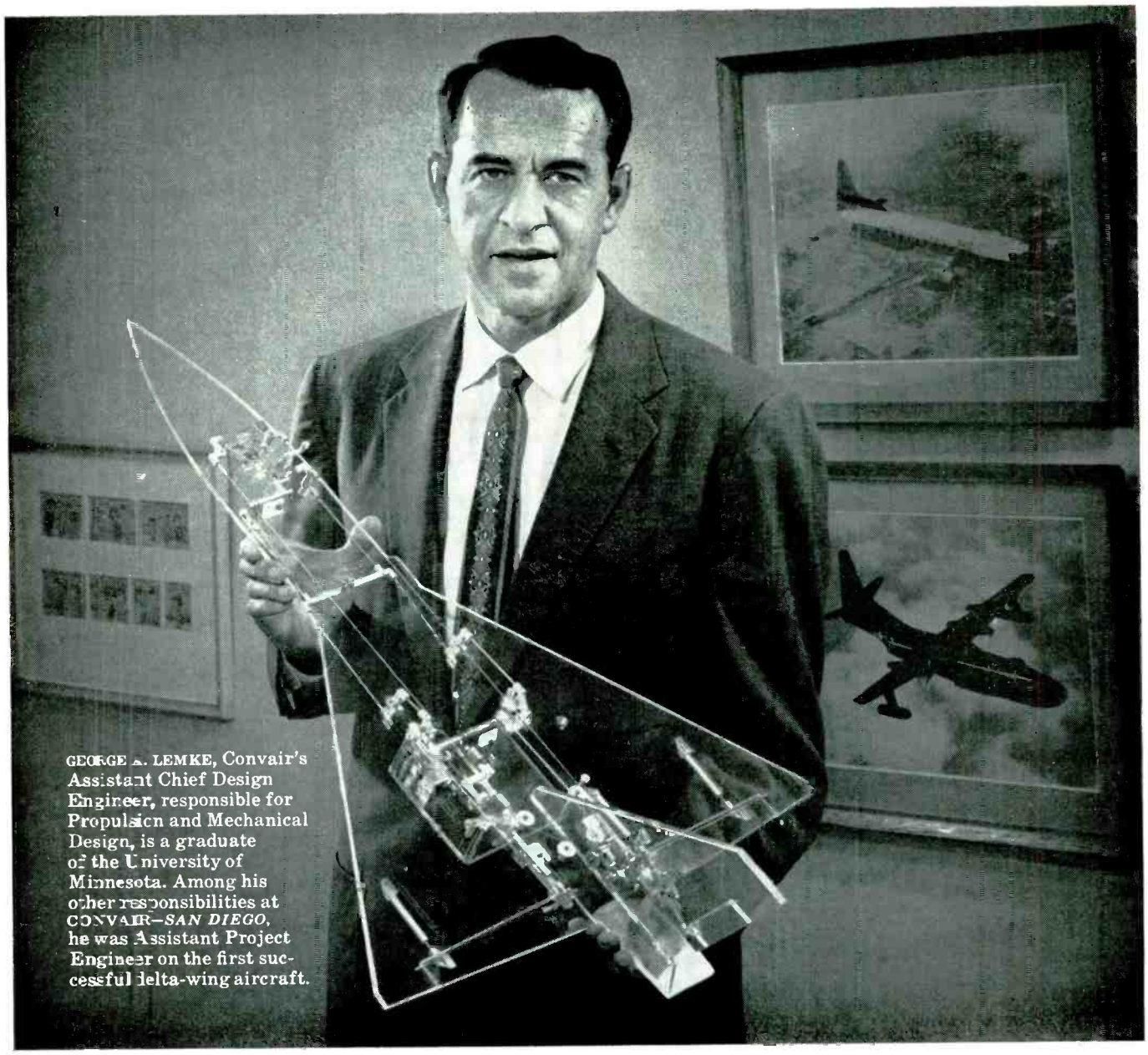
FIG. 2—Arrangement of lamps (top) and baffles alternating with plastic (bottom)

alternate numerals and baffles. The baffles all have central openings so that any numeral may be viewed from the front of the stack. The positions of the lights on the side of the plastic sheet are such that the greatest illumination of the engraved numeral will be obtained.

In Fig. 1 the complete assembly is shown. Figure 2 shows the arrangement of lamp positions for uniform illumination of each numeral and the arrangement of the stock is shown in exploded form.

Crystal Oscillator

A crystal-controlled oscillator that has an inherent stability of one



GEORGE A. LEMKE, Convair's Assistant Chief Design Engineer, responsible for Propulsion and Mechanical Design, is a graduate of the University of Minnesota. Among his other responsibilities at CONVAIR–*SAN DIEGO*, he was Assistant Project Engineer on the first successful delta-wing aircraft.

"Engineers—here's the story of the 'G-Limiter' development."

"The specifications for Convair's F-102A required that this supersonic delta-wing interceptor *fly itself* during part of a tactical mission.

"To safeguard both pilot and aircraft while operating in this automatic flight mode, it was necessary to develop a 'fail-safe' feature in the control system.

"This 'G-Limiter', as it came to be called, is an electronic measuring device which sums the angular and normal acceleration of the aircraft. Then, by comparing the 'sum' to a critical reference, this device anticipates the point at which the structural limits of the aircraft will be exceeded, and initiates corrective action.

"You, as an engineer, will appreciate this kind of creative assignment—and the resulting atmosphere of accomplishment at CONVAIR–*SAN DIEGO*. You will also appreciate being an integral part of a 'systems team' of specialists—while actively contributing to programs like the USAF F-102A and our 880 commercial jet transport. Not least, you'll *enjoy* living at its best in beautiful San Diego."

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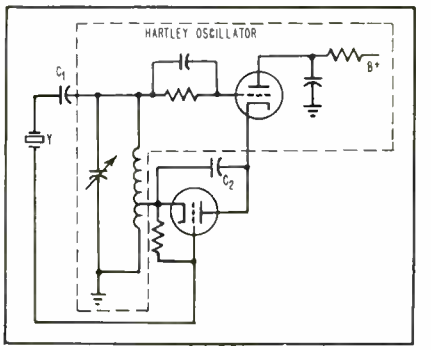

FIG. 3—Modified Hartley oscillator circuit

part in 10^7 is described in patent 2,757,288 issued to L. R. Jacobsen of Lynwood, California. The patent is assigned to Hoffman Electronics Corp. of California.

In Fig. 3 a Hartley oscillator is shown in the dotted outline. The Hartley oscillator cathode return, which conventionally is connected to a tap on the oscillator tank coil, in this instance is connected through a triode to the tap. Quartz crystal Y in series with capacitor C_1 is coupled between the control grid of the series cathode tap tube and the hot side of the oscillator tank coil and tuning capacitor.

Circuit stability of 1 part in 10^7 is claimed to be independent of B+ potential and independent of any variations in oscillator parameters.

If, for example, the oscillator tank circuit should be tuned slightly higher than the series resonant frequency of the crystal, the currents in the circuit will appear capacitive while with respect to the same conditions the current in the crystal is inductive.

These 180-deg opposed relationships result in similarly opposed voltages impressed on the grid and cathode of the series tube. The resonant frequency is thus restored regardless of the changes in the parameters of the oscillator tube.

Storage Technique

A new and highly complex Spin Echo Storage Technique is the subject of a patent 2,714,714, issued to A. G. Anderson and E. L. Hahn, assignors to the International Business Machines Corp. of New York.

Spin echo technique in general is a method of storing information in the form of electrical pulses applied to samples of suitable chemical substances and thereafter recovering

New....ARNOUX miniature

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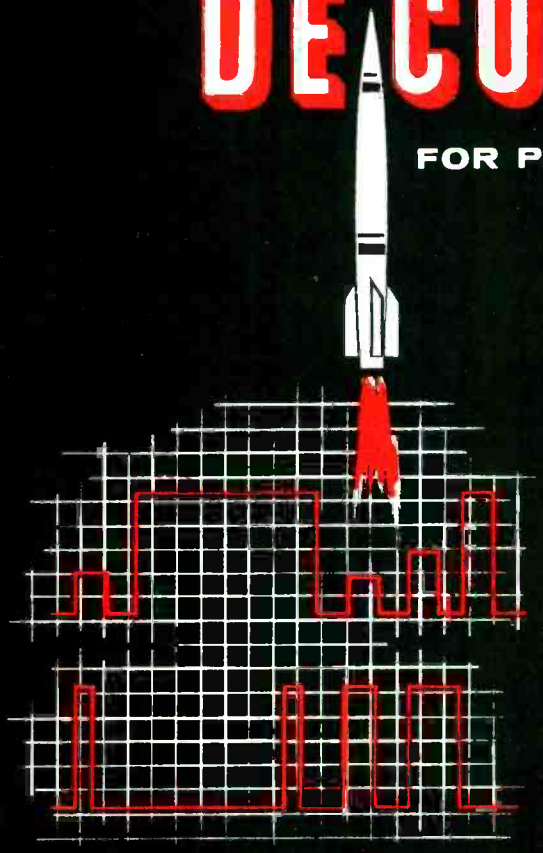

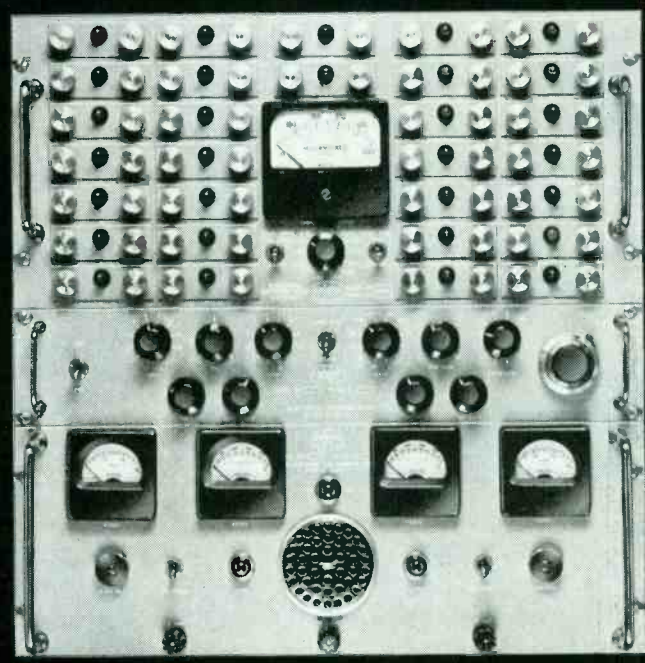

The new Arnoux Model TDS30-1 Decommutation System is completely self-contained within three chassis assemblies consisting of: Gating Unit (TOP), Pulse Selector (MIDDLE) and Regulated Power Supply (BOTTOM). The unit handles 28 channels of information and occupies only 19½ inches of panel height in a standard relay rack. Overall depth behind panel is 13 inches.

The Arnoux Model TDS30-1 Decommutation System is compactly designed for use in airborne or trailer installed telemeter receiving stations and in portable check-out equipment.

- Miniaturization is the natural result of a new circuit design allowing the entire system to contain only 76 tubes as opposed to several hundred in competitive systems.
- Modular construction permits easy expansion of system to any desired channel capacity.
- Novel circuitry design does not reflect errors due to center frequency drift of sub-carrier oscillators, drift of discriminator D. C. output level, or tape playback speed errors.
- Built-in test selector permits visual inspection of waveforms throughout system for quick malfunction detection.
- Neon indicators on each gating unit give continuous visual indication of correct sequential operation.
- System accepts all standard IRIG inputs, either PAM or PDM, at any sampling rate from 75 to 900 per second.
- Overall linearity is within ± ½ % at maximum level. Long term level drift is within ± ½ %. Gain drift is negligible.
- Modular plug-in gating units allow quick replacement of faulty channels.
- Two spare units are maintained on standby for instant use.
- Power required is 115 volts, 60 cps, single phase. Optional 115 volt, 400 cps, power supply available for airborne application.

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the information as echo pulses produced by free nuclear induction.

A sample of a material such as glycerin or water is surrounded by coils to which is applied an r-f field. The sample and its coils are placed in a strong magnetic field so the r-f field is perpendicular to the magnetic field. Coils excited by d-c are placed in the field to provide another field across the magnetic field to correct any irregularities in the permanent magnet field and add any additional desired inhomogeneities.

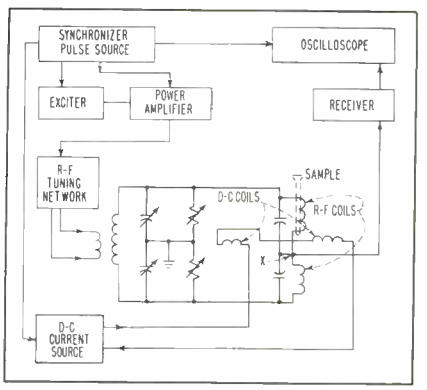


FIG. 4—Basis of the spin echo storage technique

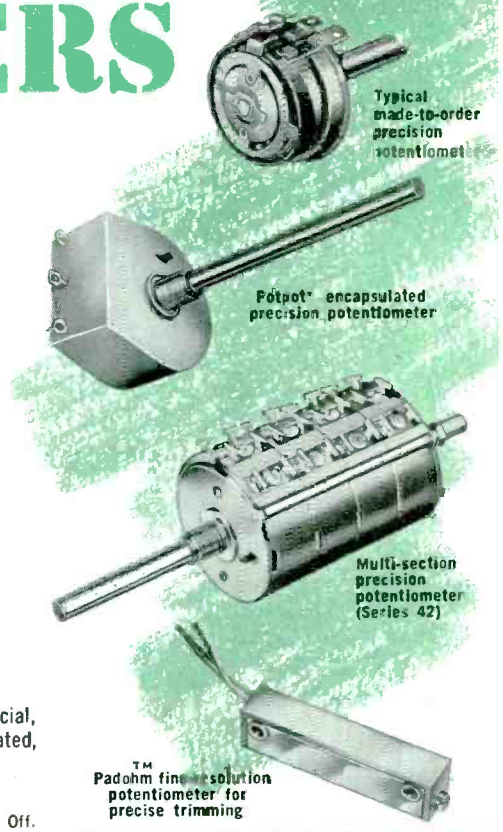
Figure 4 shows the energy sources for the r-f and d-c coils. In the balanced condition of the r-f circuit there will be essentially no signal applied to the receiver from junction X even though considerable r-f power is applied to the r-f coils.

To initiate a spin echo effect the sample is first exposed to the field of fixed magnets H_o until its gyromagnetic nuclei become aligned. The sample is then subjected to two or more pulses of the r-f current creating a field H_1. After a quiescent interval the sample spontaneously develops its own magnetic field also normal to field H_o and rotates about the direction of the H_o field.

The rotating field builds up to a maximum and then decays. The build-up and decay is picked up by a properly oriented coil and applied to the receiver where it is detected and amplified as an electrical pulse which can be displayed on the oscillograph. This pulse is termed an echo of one of the pulses of the H_1 field.

PRECISION POTENTIOMETER

HEADQUARTERS



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Production Techniques

Edited by JOHN MARKUS

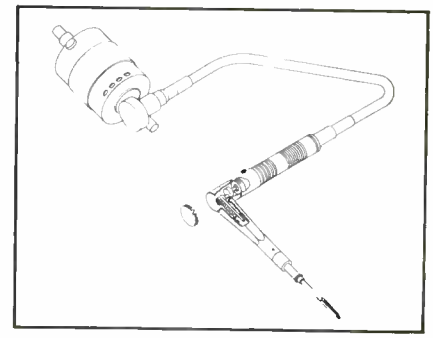
Reciprocating Filer Removes Flash Inside Welded Waveguides

DEVELOPMENT OF a reciprocating filer for flexible-shaft drive has eliminated tedious hand filing formerly required at Dalmo Victor to remove molten metal left inside the intricate shapes of waveguide assemblies after welding.

Many methods of mechanical filing had been tried, but nothing contained the successful combination of light weight and sturdiness until employee Lloyd Larsen devised a reciprocating filer which vibrates automatically to do the profiling job. Reciprocating motion is attained by using a Fordom electric motor with flexible shaft coupled with eccentric drive. Files are soldered to a threaded shank which may be locked in any radial position in the chuck of the filer.

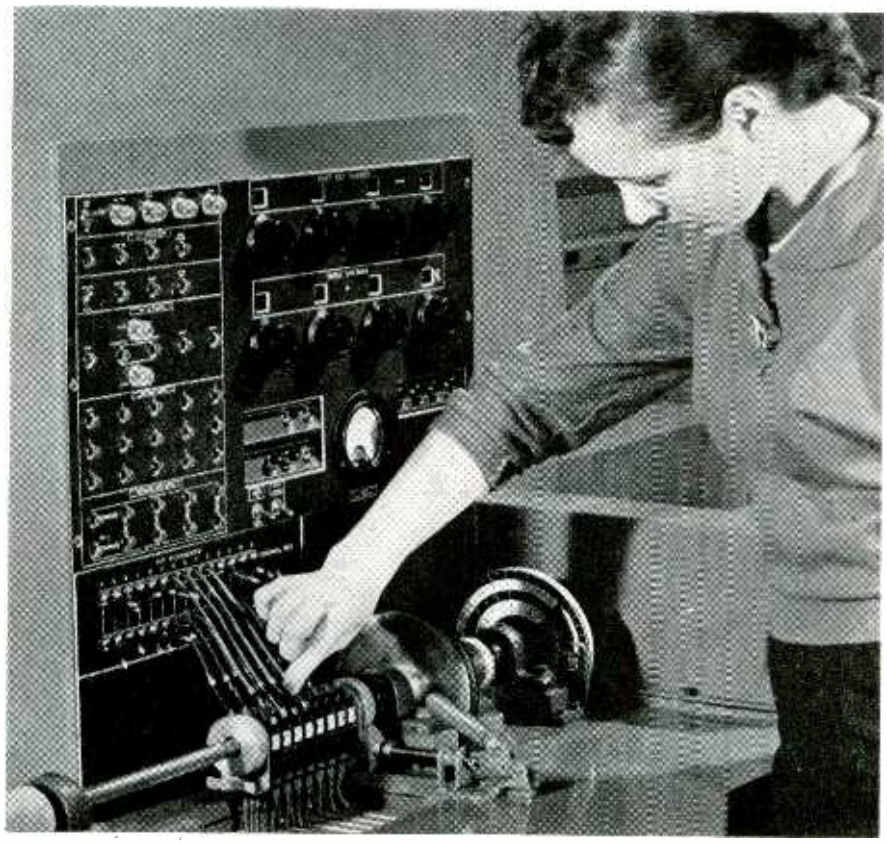
Lloyd Larsen demonstrates how automatic file is used for removing welding flash inside complicated waveguide section

Filer fits standard flexible shaft to provide reciprocating motion of hard filing



Construction of reciprocating filer

Card-Programmed Automatic Tester for Ganged Potentiometers



Making clip corrections to eight-cup ganged potentiometer in preparation for completely automatic card-programmed testing. Lamps give go and no-go indications

GANGED PRECISION potentiometers used in computers for fire control systems are automatically rotated in precise angular increments and checked for resistance with a new card-programmed tester developed by Westinghouse engineers in their Baltimore Air Arm Division plant.

Over 50 checks of resistance to 0.05 percent per exact angular posion can be made for each cup of a 5 to 13-cup gang. The equipment will test a computing potentiometer gang for resistance, linearity of conformity, dielectric strength and electrical noise.

A specially connected combination of stepping switches and mercury relays is used to accomplish a fixed program of switching among the six terminals of each potentiometer.

▶**Shaft Positioning.** The function conformity test presents, in addition to voltage programming and measurement, the problem of accurate shaft positioning. This is accomplished by a special indexing device capable of indexing the shaft

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through 360 degrees in 7.5-degree increments at the rate of one increment per second. The great variety of function curves requires the use of an extremely flexible system of generating voltages corresponding to the various shaft angles. A punched card system controlling a set of digital voltage dividers is used to generate voltages accurate to 5 parts in 100,000. Test time is speeded by 16-to-1 factor.

Printer Eliminates Drying Of Resist on Printed Wiring Boards

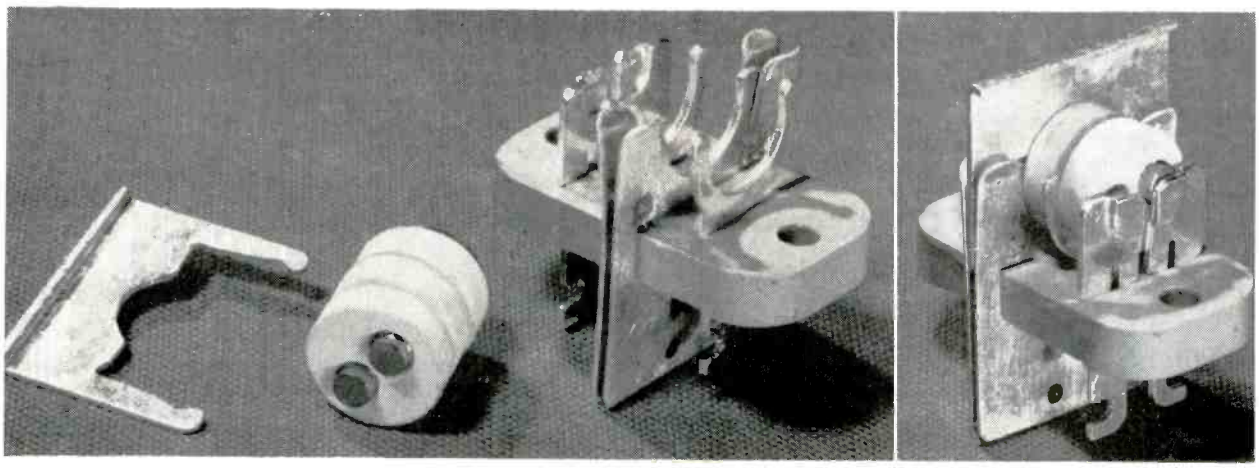
Removing panel after resist pattern has been applied, to complete printing cycle

THERMOPLASTIC melted resist is applied through a temperature-controlled screen onto copper laminate for printed circuits by a new semi-automatic press having a capacity of over 600 panels per hour. The resist hardens almost instantly as it reaches the relatively cool copper surface of the laminate, so that printed boards can go directly into the etching bath or be turned over immediately for printing the resist on the reverse side.

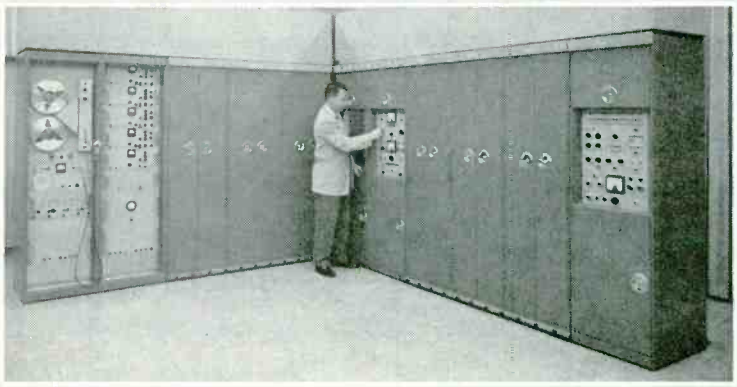
The operator loads and registers the laminate panel on the illuminated bed of the press. Panels may be up to 18×28 inches in size. Pushing a button starts the printing stroke, wherein a squeegee forces the preheated resist through the screen to the panel. After printing, the machine opens automatically for unloading.

At the end of the work day, the

Design of the Month: SOCKET FOR CERAMIC TRIODE



Floating contact design in new Jettron grounded-grid uhf socket for GE's 6BY4 ceramic-titanium high-mu triode makes pressure contact around almost entire periphery of grid ring while achieving required low socket inductances and capacitances. Silver-plated beryllium-copper contact strips are easily assembled in slots of base molded from Alkyd 446 plastic, rated for up to 400 F. Grid contact has fixed lower shield and removable upper shield, to permit easy removal of tube. Lower shield is sandwich, with thicker center member making over 200 deg of wrap-around contact with recessed grid ring of tube; two thin outer members serve to align upper shield. Grid contact assembly floats in base insulator to allow for accumulated tolerances in tube element diameters and concentricity. Cathode and anode connections are made with single fork-shaped floating pieces. Offsets in heater contacts prevent tube from going into socket unless heater buttons are in horizontal position at end of tube. With grid grounded, capacitance between cathode and plate is only 0.02 micromicrofarad. Socket was developed by Jettron Products, Hanover, N. J. Tube is shown here greatly enlarged, being only 5/16 inch in diameter and 7/16 inch long

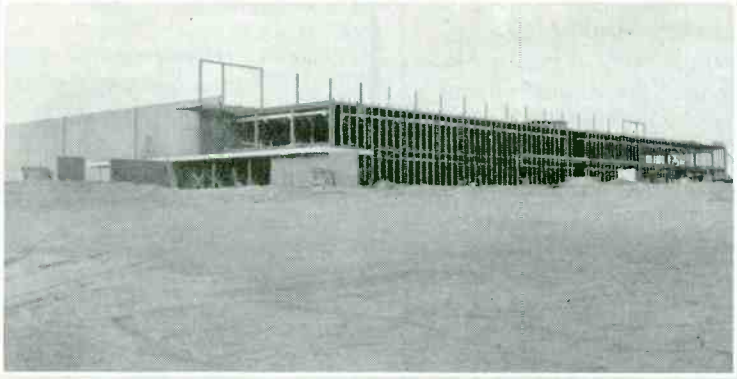


30-channel, analog-digital converter connecting 300-amplifier analog computer to 1103A digital computer

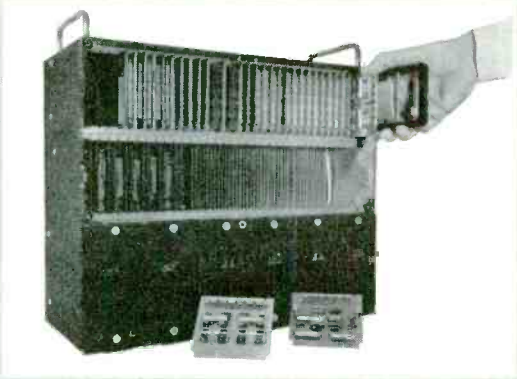
Production of communications equipment in new Los Angeles manufacturing plant

Data Reduction Center designed and built by Ramo-Wooldridge

One of three new research and development buildings completed this year



First unit of Denver manufacturing plant now nearing completion



Input-output unit of the Ramo-Wooldridge RW-30 airborne digital computer

Pictorial **PROGRESS REPORT**

The photographs above illustrate some of the recent developments at Ramo-Wooldridge, both in facilities and in products. Work is in progress on a wide variety of projects, and positions are available for scientists and engineers in the following fields of current activity:

- Communications and Navigation Systems
- Digital Computers and Control Systems
- Airborne Electronic and Control Systems
- Electronic Instrumentation and Test Equipment
- Guided Missile Research and Development
- Automation and Data Processing
- Basic Electronic and Aeronautical Research

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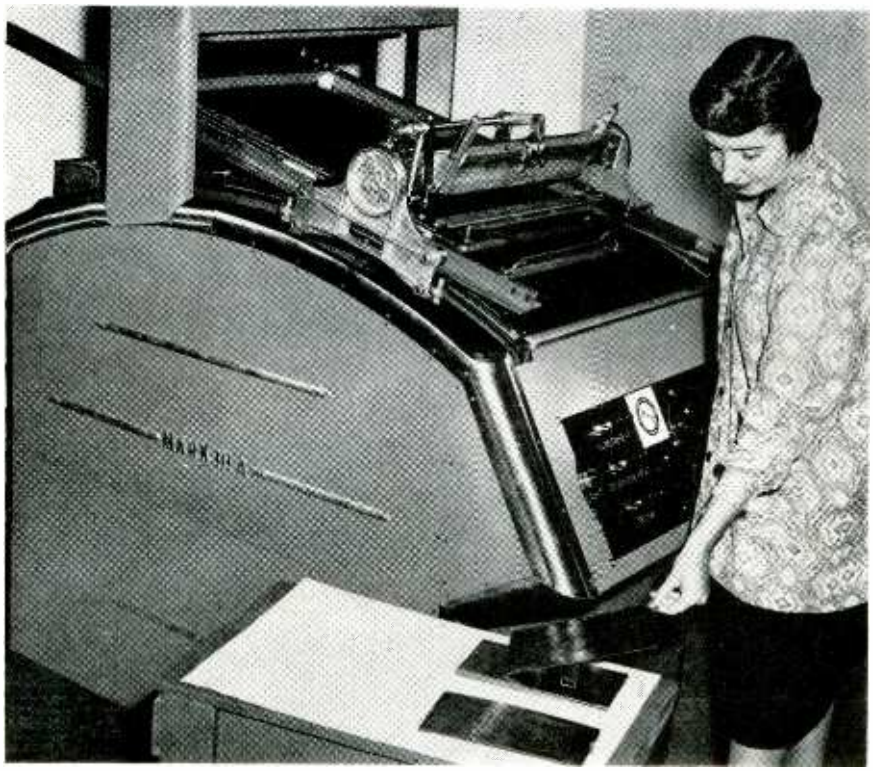


Mechanized squeegee forces molten thermoplastic resist through stainless steel cloth screen, which may be either 180 or 230 mesh depending on detail required

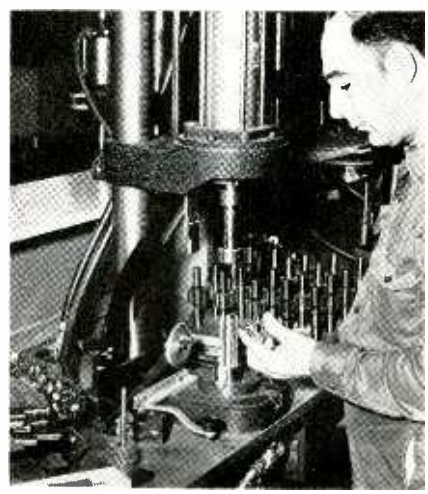
machine can be shut off without cleaning. The resist will harden overnight, but printing can be continued the next day after only a few minutes of warmup.

After etching, the resist can be removed with wet steam, leaving a clean surface ready for punching, assembling and soldering. The machine is made by Dry Screen Process, Incorporated, Pittsburgh, Pennsylvania.

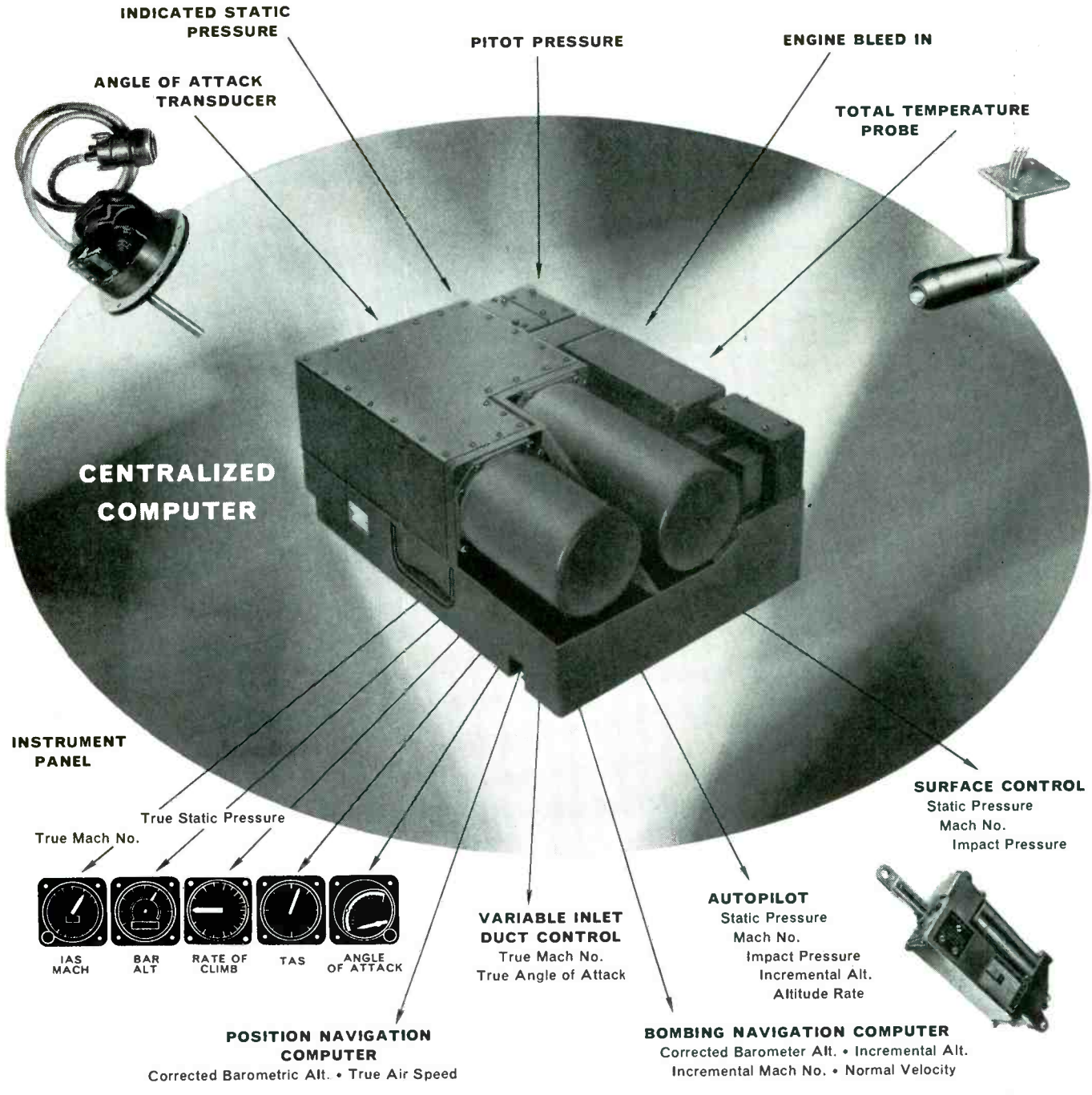
Stacking Stator Laminations of Servo Motors

FRAGILE PUNCHED laminations for outside-wound stators of synchronous motors are stacked in precise alignment and compressed with the aid of a simple positioning fixture on an air-actuated arbor press. The operator first places in the fixture a temporary steel arbor having the precise inside diameter of the stator. A stiff end spider is placed on the fixture and forced down with the press. The operator places laminations on the projecting positioning pins of the fixture a few at a time and operates the press to push them down against the end spider. The stacking and pressing is repeated until the desired stack height is reached, after which the final end spider is dropped on and driven into position. An ejection button is then pressed to push the arbor and stack far enough out of the fixture so the operator can grasp the arbor and complete the withdrawal.

Stack height is indicated auto-



First step in assembly, after central arbor has been dropped into fixture, is positioning of heavy end spider over arbor and slot alignment pins



All illustrated components are designed, developed and manufactured by AiResearch

Centralized Air Data System

This AiResearch computer system eliminates duplication of components, cutting down space and weight requirements over decentralized systems by many times. It can cover a wide area of functions while meeting the most rigid specifications in regard to accuracy and dependability. Since the great majority of its components are AiResearch products, both compatibility and reliability are assured.

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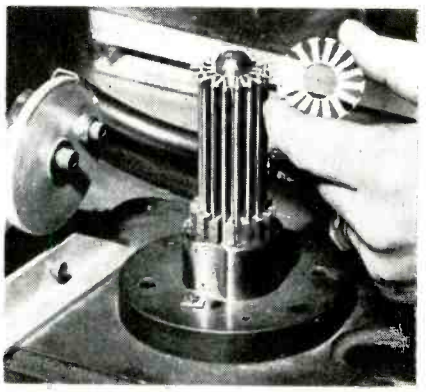
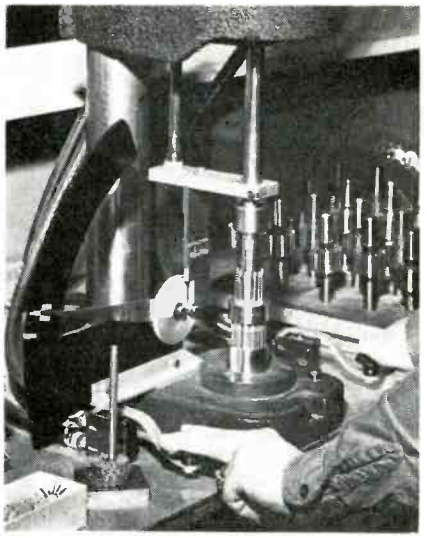


Method of loading laminations on fixture. About half an inch of stack in position

matically by a pointer actuated by a projection attached to the ram of the press. Each time the ram comes down to press laminations into position, the pointer moves upward over a scale arc on which desired nominal stack height and tolerance range are indicated. With experience an operator learns quickly how many more laminations must be added to bring the stack to the desired height. This assembly technique is used in the Mechatrol Division of Servomechanisms, Inc., Westbury, L. I., N. Y.



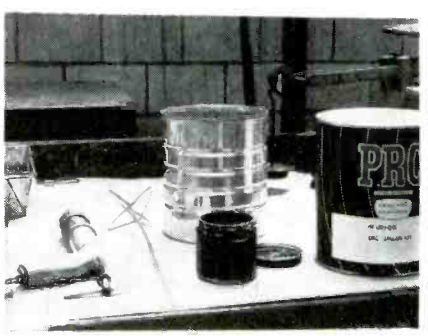
Pointer of indicator, at center line on scale, indicates that stack is at desired height. Pointer is actuated by downward projection bolted to ram of press. For safety, operator must press down two valves as shown when operating press

Potting of Connectors Cuts Airborne Weight

By Charles DeLaHaye
Production Design Engineer
McDonnell Aircraft Corp.
St. Louis, Mo.

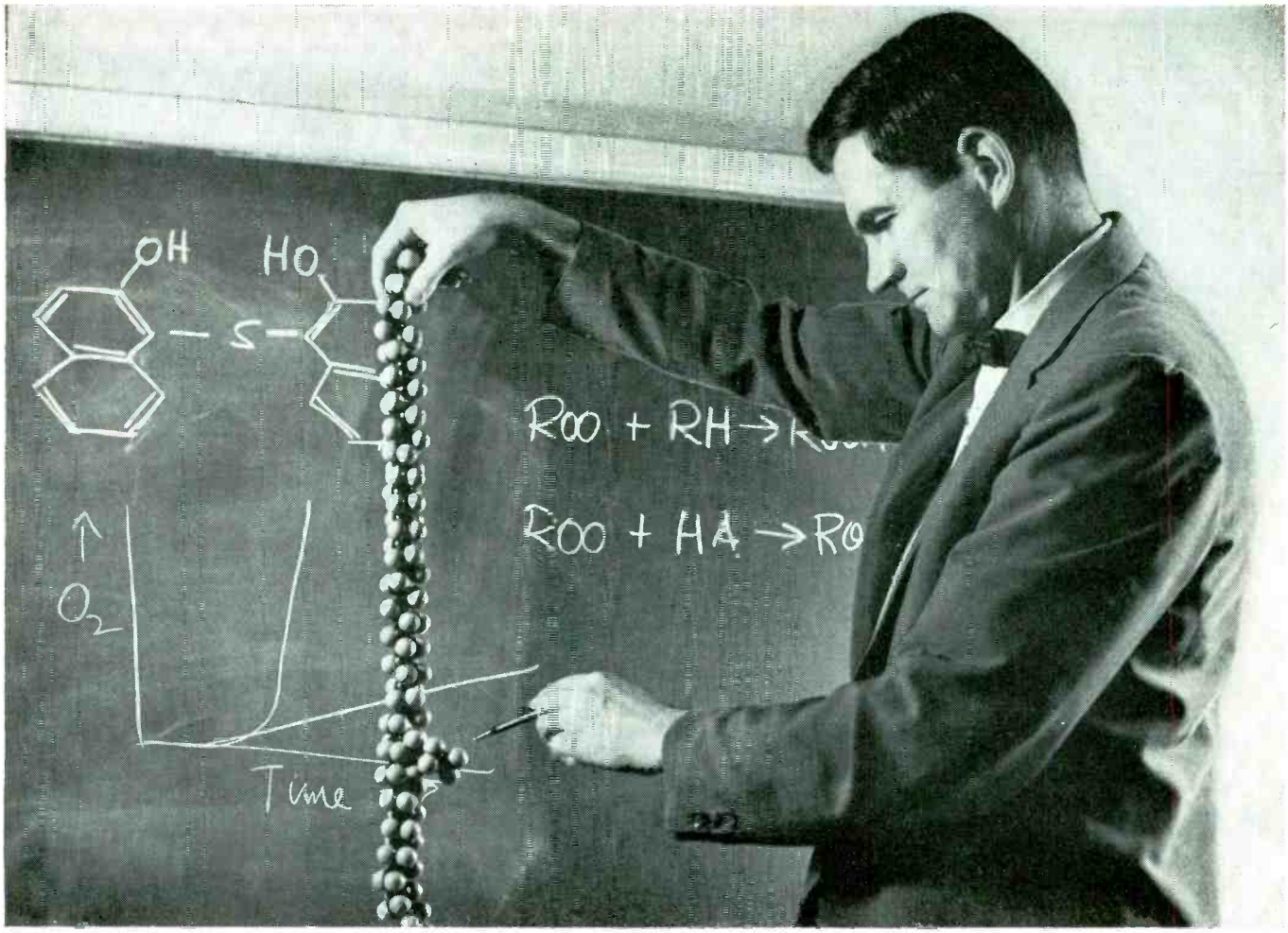
Development of new potting techniques for waterproofing electrical connectors on aircraft electrical systems and elimination of back shells has saved as much as 64 lb per plane at McDonnell Aircraft Corp., as compared to the old grommet and clamp method of holding wires at connectors.

▶ **Material**—The potting compound now being used is specified by MIL-S-8516B and consists of a two-part mix, classified as an accelerated synthetic rubber sealing compound. More technically, it is a two-part catalyzed organic polysulphide liquid polymer, one commercial version of which is PRC



STEP 1—Preparing potting compound. After accelerator is added, whipper in slow-speed air motor is used to achieve thorough mixing

STEP 2—Pouring mixed potting compound into plastic liners used in commercial potting gun. At left are foil liners used with modified caulking gun



Bell Laboratories chemist Field H. Winslow, Ph.D., Cornell University, with a scale model of a small section of a polyethylene molecule. Branch formation indicated by pencil is vulnerable to oxidation. Dr. Winslow and his associates worked out a simple way to protect long polyethylene molecules needed for durable cable sheathing.

THE DILEMMA OF GIANT MOLECULES

Solution: 2 plus 2 equals 5

Polyethylene is used to protect thousands of miles of telephone cables. It is tough, light and long lasting. Its strength lies in its giant molecules—a thousand times bigger, for example, than those of its brittle chemical cousin, paraffin wax.

But polyethylene has a powerful enemy: oxidation, energized by light and heat, shatters its huge molecules to pieces. This enemy had to be conquered if polyethylene was to meet the rigorous demands of cable sheathing. Paradoxically, it was done by making the whole better than the sum of its parts—just as though 2 plus 2 could be made to add up to 5.

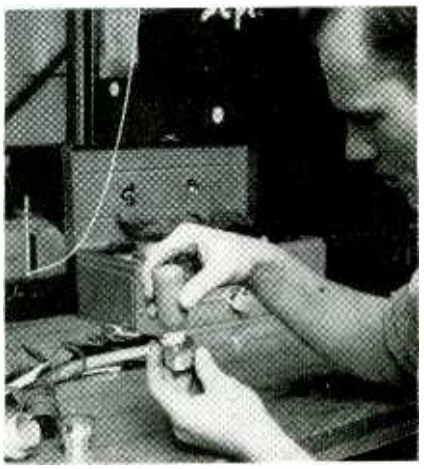
To check the ravages of light, Bell Laboratories chemists devised the simple yet highly effective remedy of adding a tiny dose of carbon black. Then antioxidants, such as those commonly used to protect rubber, were added to check attack by heat. But here the chemists encountered a dilemma: although the carbon black protected against the effects of light, it critically weakened the effectiveness of the antioxidants.

To solve this dilemma, Bell Labs chemists developed entirely new types of antioxidants—compounds not weakened by carbon black but which, intriguingly, are very much more effective when carbon black is present. The new antioxidants, plus carbon black, in partnership, provide long-lasting cable sheath—another example of how research at Bell Telephone Laboratories works to improve your telephone service.

BELL TELEPHONE LABORATORIES

WORLD CENTER OF COMMUNICATIONS RESEARCH AND DEVELOPMENT

STEP 3—Wired connectors are dipped in solvent-type cleaner as at left, then dried with filtered air at right. Jet spray is now used instead of dip here



STEP 4—Filling holes in split-back shells with potting compound in squeeze bottle

STEP 5—Applying rubber-band anchors to hold connectors steady for potting

type PR-1201-Q-K (Products Research Co., Los Feliz Blvd. & Edenhurst Ave., Los Angeles, Calif.)

The compound does not depend upon solvent evaporation for setting as do some other types of sealants. The solvents present are aromatic hydrocarbons, eliminating benzene and other highly toxic solvents. No elemental sulphur is present either originally or as a result of the curing action. The potting compound, when mixed, is the consistency of heavy cream and is easily pourable at normal room temperature. After curing it becomes about as hard as a pencil eraser. Shrinkage is under 15 percent by volume. Adherence is good to aluminum alloys, cadmium plating and melamine and diallyl phthalate resins. These properties are retained down to — 60 F and up to 200 F.

Under normal environmental and operational conditions in aircraft, electrical properties are: Dielectric constant 10.5; dielectric strength 200 volts per mil; power factor 0.01 to 0.03; resistivity 10^{10} to 10^{11} ohm-cm; insulation resistance 5,000 to 10,000 megohms.

▶ **Mixing**—A slow-speed air-motor whipper or a newly developed commercial mixer can be used for mixing the potting compound. The mix ratio is 10 to 12 parts of the curing agent or accelerator for 100 parts of the base.

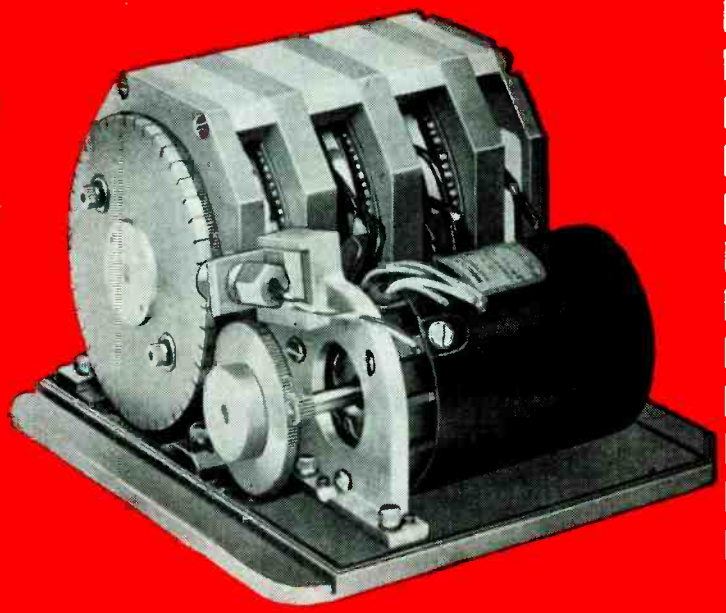
Working time of the mix at room temperature is approximately 90 minutes. It can be stored at — 20F for as long as 24 hours before using. This low temperature temporarily suspends the curing action, allowing a full day's mix to be prepared at one time.

After mixing, the compound is poured into foil paper liners used in a modified caulking gun or in plastic gun cartridges used in a newly developed commercial potting gun. The filled liners and cartridges are marked with date and time and stored at — 20F in a deep-freeze chest.

Both potting guns are air-oper-

Circle 169 Readers Service Card →

DESIGN ACHIEVEMENTS WITH SUPRAMICA* ceramoplastics



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Precision-molded SUPRAMICA* 555 ceramoplastic Commutation Plate, CP-348, with 360 Contacts and 2 Slip Rings. Other Standard Plates are Available.

SUPRAMICA* ceramoplastics

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In thousands of military and industrial applications, SUPRAMICA ceramoplastics are contributing to better, safer, more reliable operation of electrical and electronic equipment

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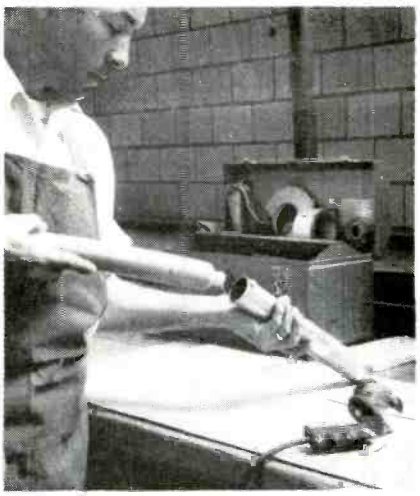


STEP 6—Loading filled plastic liner in potting gun

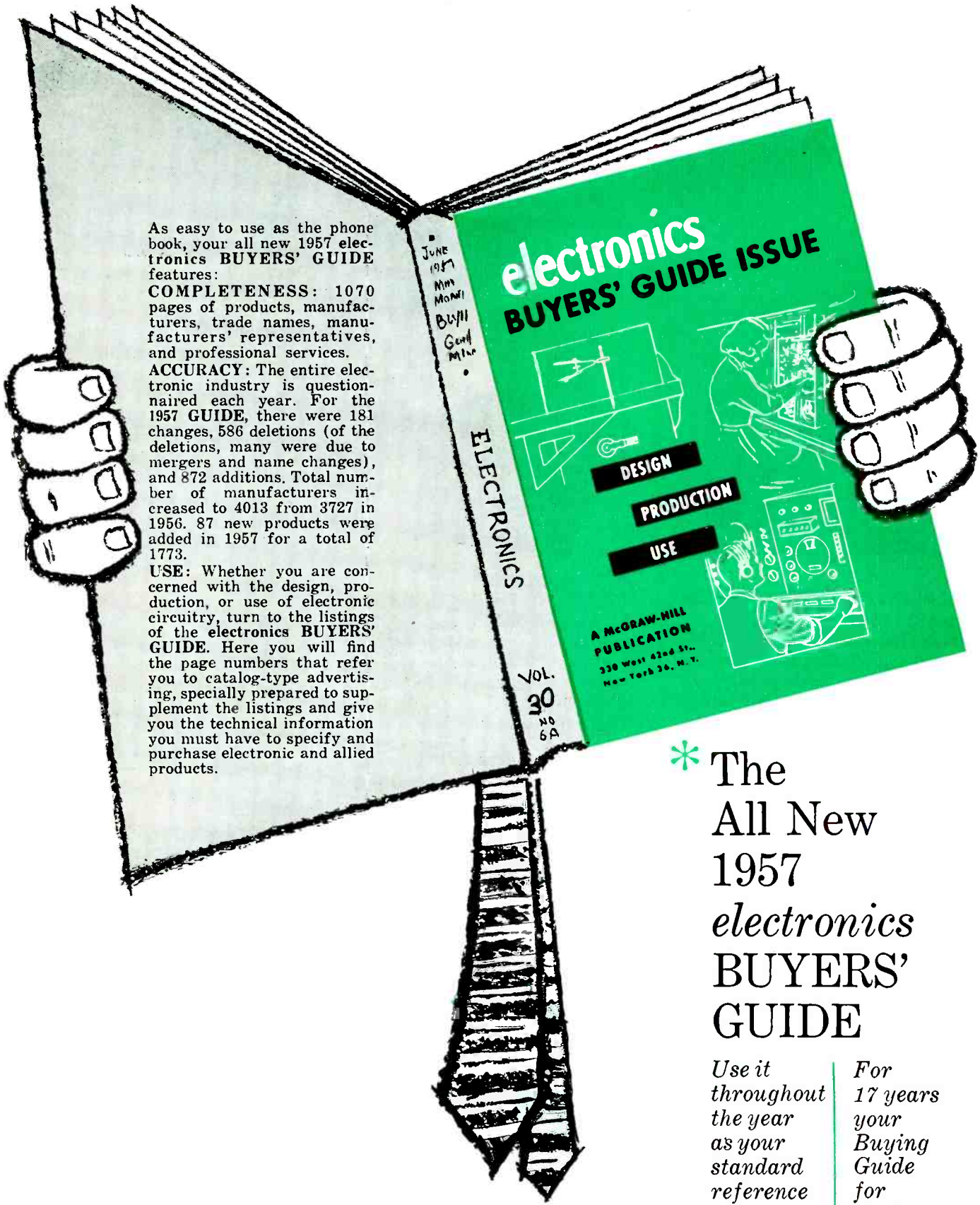
ated. The expendable plastic liner can be reused by allowing the remaining compound to become cured, then stripping it out.

▶ **Cleaning**—The key to successful potting of electrical connectors lies in cleaning. Connectors as received from the vendor are cleaned by vapor degreasing excepting where the insert material may be affected by this method.

After the connectors have been

STEP 7—Filling connector by using air-operated potting gun

now in your hands . . .



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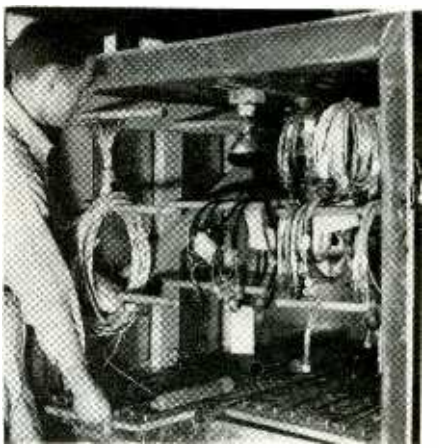


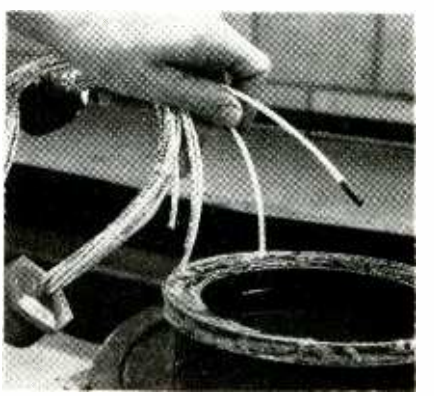
STEP 8—Heat lamps provide 120 F temperature for 2-hour cure cycle in oven

wired and made into a wire bundle, a final cleaning operation is performed with an approved solvent-type cleaner, using a jet spray. The cleaner dries quickly without leaving a film. Spray which misses or bounces off the connector is collected and passed through a filtering system for reuse.

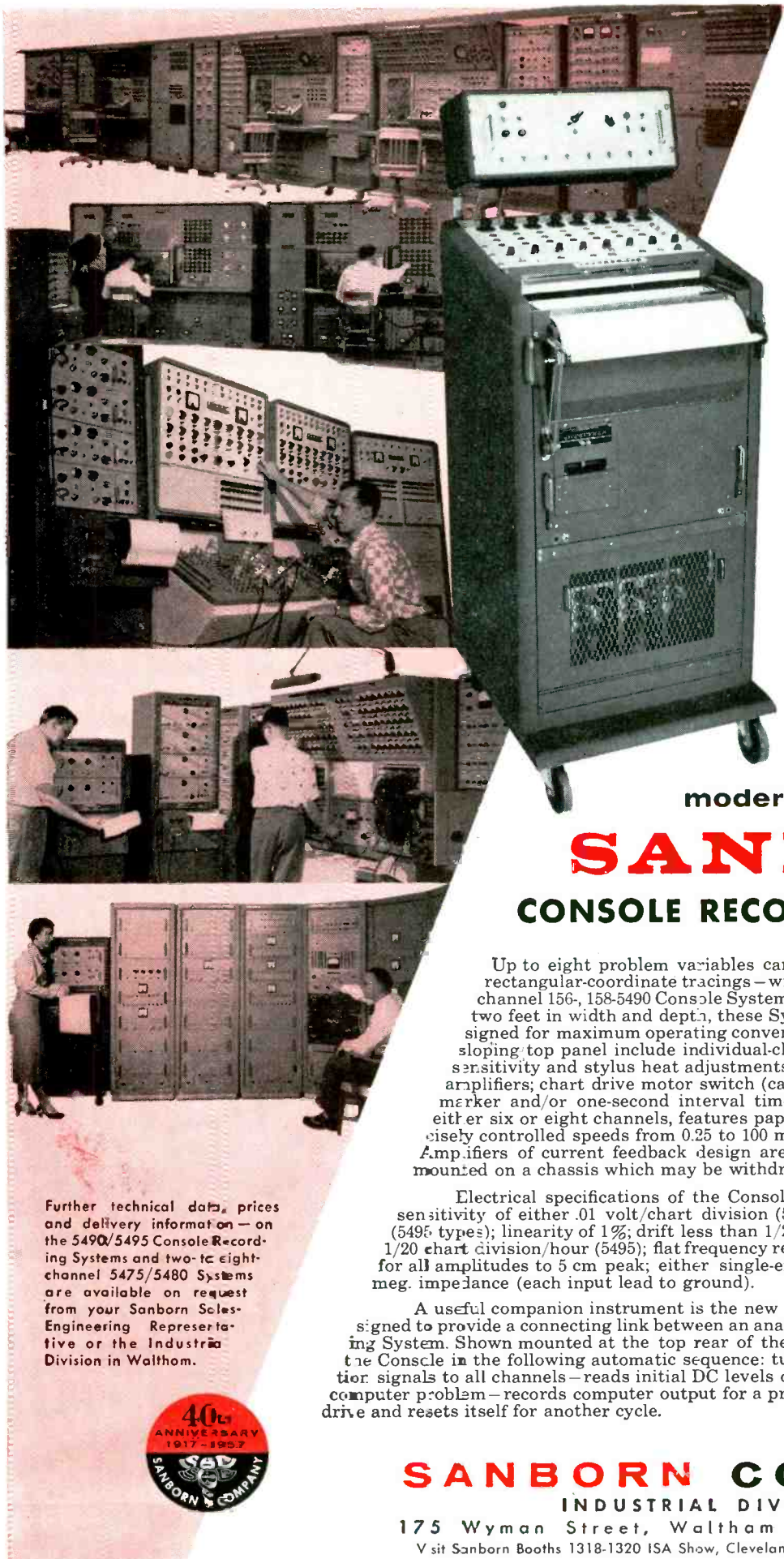
Evaporation of cleaner is speeded up by blowing the washed connector with filtered air from the plant's air line.

► **Preparation**—After washing, the threads between the barrel and the back shell are covered with potting compound. On split-back shells the portholes are filled with potting compound. The back shell is then secured to the barrel and the wires tied about ½ inch from the top of the back shell to keep them centered.

If the back shell is so short that there is less than ¼ inch between its top and the top of the longest solder pot, a snug-fitting polyvinyl sleeve is added to the back shell to



STEP 9—Sealing pigtails by dipping in hot plasticized ethyl cellulose



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analog computer
readout:

modern, compact, mobile

SANBORN

CONSOLE RECORDING SYSTEMS

Up to eight problem variables can be recorded in inkless, permanent rectangular-coordinate tracings—with Sanborn's improved six- and eight channel 156-, 158-5490 Console Systems. Less than four feet high and about two feet in width and depth, these Systems are completely mobile and designed for maximum operating convenience. Controls and indicators on the sloping top panel include individual-channel attenuation, position, balance, sensitivity and stylus heat adjustments; switch for turning off B+ of output amplifiers; chart drive motor switch (can also be remotely controlled); code marker and/or one-second interval timer stylus switch. The Recorder unit, either six or eight channels, features paper loading from the top, and nine precisely controlled speeds from 0.25 to 100 mm/sec. Four dual-channel DC Driver Amplifiers of current feedback design are housed below the Recorder, and are mounted on a chassis which may be withdrawn for inspection.

Electrical specifications of the Console Recording Systems include a basic sensitivity of either .01 volt/chart division (5490 types) or 0.1 volt/chart division (5495 types); linearity of 1%; drift less than 1/2 chart division/hour (5490), less than 1/20 chart division/hour (5495); flat frequency response to 20 cps, down 3 db at 60 cps for all amplitudes to 5 cm peak; either single-ended or push-pull input signals of 5 meg. impedance (each input lead to ground).

A useful companion instrument is the new Sanborn Model 183 Programmer, designed to provide a connecting link between an analog computer and the Console Recording System. Shown mounted at the top rear of the Console, the Programmer operates the Console in the following automatic sequence: turns recorder drive on—feeds calibration signals to all channels—reads initial DC levels of computer—closes contacts to start computer problem—records computer output for a preset chart length—turns off recorder drive and resets itself for another cycle.

Further technical data, prices and delivery information—on the 5490/5495 Console Recording Systems and two- to eight-channel 5475/5480 Systems are available on request from your Sanborn Sales-Engineering Representative or the Industrial Division in Waltham.

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form a mold so that the potting will extend at least ¼ inch above the solder pot. Cellulose or masking tape may also be used to form this potting mold.

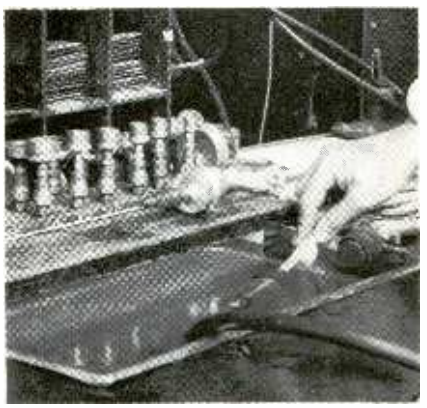
Most assemblies are racked to be potted and cured at room temperature. Connector assemblies that are to be oven-cured are hung on an oven rack where the connectors are carefully positioned to be vertical for potting. Rubber-band stays with pins and hooks are used to hold connectors steady.

▶ **Potting**—A plastic cartridge of potting compound is removed from the deepfreeze chest and placed in a clean potting gun. A trial ejection of potting compound is made on a paper towel to assure a full flow of the compound from the gun without entrapped air.

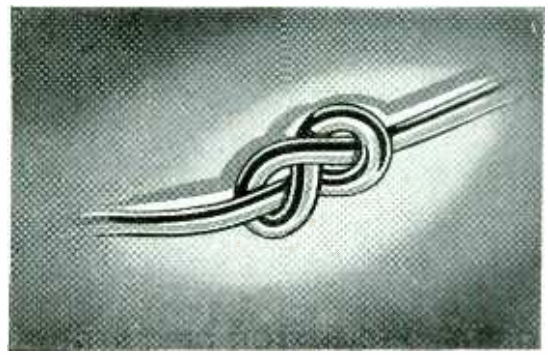
Filling the connector is done by placing the nozzle deep into the back shell between the wires and removing the gun slowly as the ejected potting compound rises. Connectors thus filled may be left in room temperature to cure within 7 hours or the rack can be lifted into the oven for rapid curing at about 120F in 2 hours. Higher curing temperatures are not recommended.

All connector pins have either a circuit wire or a pigtail soldered to them. These pigtails must be sealed to keep moisture from creeping into the back shell. This is done by dipping the pigtails into hot plasticized ethyl cellulose and letting them cool and harden.

▶ **Testing**—Following potting and



STEP 10—Testing for air leaks by screwing air hose fitting over connector and immersing in water. At rear are hose fittings for other sizes of connectors



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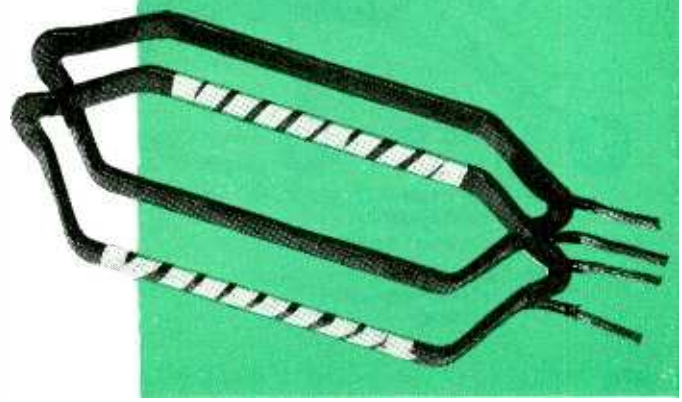

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Natvar Isolastane is now making important savings possible. It makes it unnecessary to use expensive Class H materials to solve temperature problems during the manufacture of products which do not require Class H rating.

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Full technical data and samples are available on request.

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STEP 11—Pressurizing test barrel used for testing feed-through bushings at pressures up to 15 psi

curing, the connectors are checked under 3 psi air pressure. Leakage must not exceed 2 bubbles per minute in water. The assemblies are then tested for high-potential, ground and continuity factors on a console testing machine designed especially for connectors.

Feed-through potted bushings are checked in a special pressurizing test barrel up to 15 psi. Leaks found are generally due to poor cleaning which keeps the compound from adhering to the connector back shell, the wires or the insert.

Heat Shields and Sinks Improve Reliability

MANY EQUIPMENT FAILURES are traced to the designer's disregard for the heat problem. Tubes fail because of excessive heat; materials deteriorate and insulation breaks down.

► **Tube Shields** — Heat-reducing tube shields should be used in practically every instance to keep glass envelopes cool. One Pasadena, California, manufacturer had 15 6AQ5 type tubes in service in an installation where maximum tube life was from one to two weeks. When he installed NEL tube cooling inserts in the tube shield, the 6AQ5 failure rate dropped to zero over a period of time in excess of six months.

► **Tube Voltages**—Where possible, operate tubes at reduced anode and filament voltages. Frequency multiplication, conversion and selec-

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tion, electronic counting and timing, gating, mixing and modulation may be done at low signal levels with electron tubes operating at low voltages. When large signals are required, amplification to the desired level may be done by a single power stage at the end of the circuit.

It has been said that tube failures increase with the 12th power of the filament voltage. In many instances receiving type tubes may be operated at 5 volts instead of the rated 6.3 volts. Exceptions to the reduced filament recommendation lie in applications where the reduced peak cathode emission would affect the electronic function, as in pulse circuits or modulated amplifiers.

►**Sinks and Baffles**—Heat dissipation devices help get rid of heat. Special heat-reducing tube shields should be used on all applications of electron tubes. Heat sinks should be used to conduct heat from heat-producing parts and tubes to suitable cooling systems. Heat radiation baffles should be used to interrupt and preferably absorb radiant heat from heat sources. Many parts susceptible to damage from radiant sources can be saved by the use of such baffles.

As it becomes necessary, the designer should use blowers to cool equipment. In one case, a two-to-one improvement in reliability was obtained in an equipment containing blowers, as compared to identical equipment without blowers.

The recommendations given here were abstracted from a paper by J. Roy Smith of U. S. Navy Electronics Laboratory, presented at the Third National Symposium on Reliability and Quality Control in Electronics.

Purifying Silicon

REMOVAL OF BORON as an impurity from commercially available silicon is achieved by reaction of the molten semiconductor material with water vapor, in a process developed by H. C. Theuerer of Bell Telephone Laboratories. This reaction oxidizes the

ASTRON'S reliable

New sub-miniature capacitors

ENGINEERING BULLETIN
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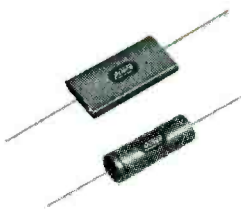
ASTRON Capacitors

FLAT AND ROUND MINIATURE MYLAR* DIELECTRIC CAPACITORS



ASTRON TYPES XPR & XPF capacitors use "Mylar"* polyester film as a dielectric. A new series of non-metallic cased units, employ a plastic thermosetting resin end seal to provide a secure bond between leads and case. Series XPR and XPF are for use in applications requiring minimum size, high insulation resistance and exceptional capacitance stability. For added flexibility in design, they are supplied in both flat and round case styles as listed.

PERFORMANCE CHARACTERISTICS AND TEST SPECIFICATIONS

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ASTRON Capacitors

METALLIZED MYLAR* CAPACITORS

ASTRON TYPE RLR metallized Mylar capacitors combine the advantage of metallized units with good insulation resistance, smaller size, less capacitance change and low power factor.

Because the RLR is an uncased unit, sealed with epoxy resin, and wrapped in Mylar tape, its size is further decreased and a reduction in price is effected, compared to conventional style — metallized capacitors.

PERFORMANCE CHARACTERISTICS AND TEST SPECIFICATIONS

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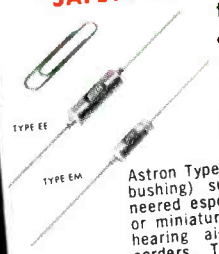
"SAFETY MARGIN" ELECTROLYTIC CAPACITORS

for miniaturized low voltage D.C. equipment



- Smallest hermetically sealed electrolytic capacitors (from 3/16" x 1/2" to 1/4" x 3/4")
- Very low leakage characteristics for minimum battery drain
- Long shelf and operating life
- Reliable performance at reasonable price

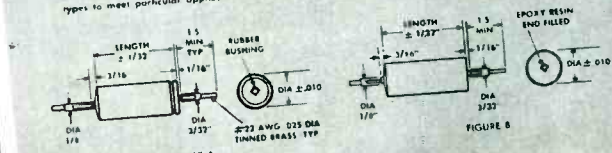
Astron Types EE (epoxy end fill) and EM (spun end with rubber bushing) sub-miniaturized electrolytic capacitors were engineered especially for transistorized circuits and other compact or miniaturized low voltage D. C. equipment — applications in hearing aids, transistorized pocket radios, miniaturized recorders. The most important features are extremely small physical size and exceptionally low leakage coupled with reliable operation.

Astron's "Safety Margin" construction provides reliable performance even under adverse conditions — your guarantee for equipment reliability.

PERFORMANCE CHARACTERISTICS AND TEST SPECIFICATIONS

I. PHYSICAL CHARACTERISTICS:

Standard sizes are as specified in the catalog listings. Special sizes and types to meet particular applications can be supplied to specification.



II. STANDARD OPERATING TEMPERATURE RANGE:

-20 to +85 C

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PERFORMANCE CHARACTERISTICS AND TEST SPECIFICATIONS

I. PHYSICAL

RQL standard sizes are as specified in catalog listings. Other case styles and construction variations are available similar to those of type CP04 thru CP033 in MIL C 25A.

II. TEMPERATURE RANGE

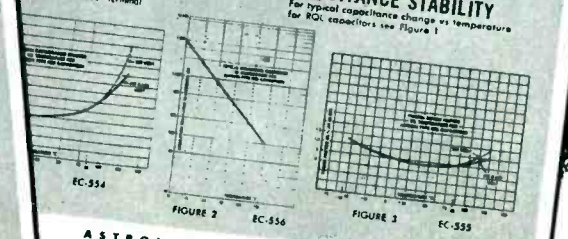
The standard operating temperature range is from — 55 C to +125 C without derating.

III. VOLTAGE RATING

Type RQL capacitors are available with standard and continuous voltage ratings of 200, 400, and 600 volts D. C.

IV. CAPACITANCE STABILITY

For typical capacitance change vs temperature for RQL capacitors see Figure 1



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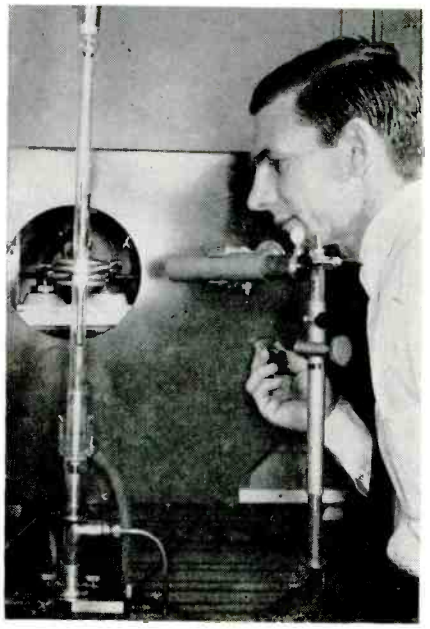


Silicon-refining setup

boron, and the oxidation products evaporate.

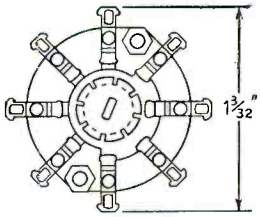
To carry out the reaction, a liquid silicon zone supported only by surface tension is caused to traverse a vertical silicon rod around which flows a mixture of hydrogen and water vapor. This technique prevents contamination from crucibles and provides a large interface between the silicon and the atmosphere. Under these conditions, removal of boron is very effective, increasing both with time and with water vapor concentration.

This method, used together with the zone refining technique, makes possible the production of silicon having a boron concentration below one part in ten billion and having a resistivity greater than 3,000 ohm-cm.

Press Speeds Assembly of Selector Switch

PRODUCTION AND assembly of multideck banks used in telephone selector switches by means of punch press techniques has definitely improved quality and reliability of this Kellogg Switchboard and Supply Co. product, now being made in the Clifton, N. J. plant of Federal Telephone and Radio Co., which is also a Division of IT&T. The eleven contacts and terminals for each

NEW miniature switch...



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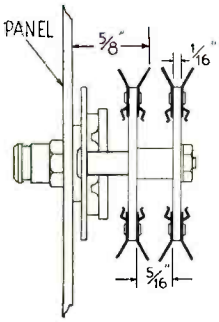

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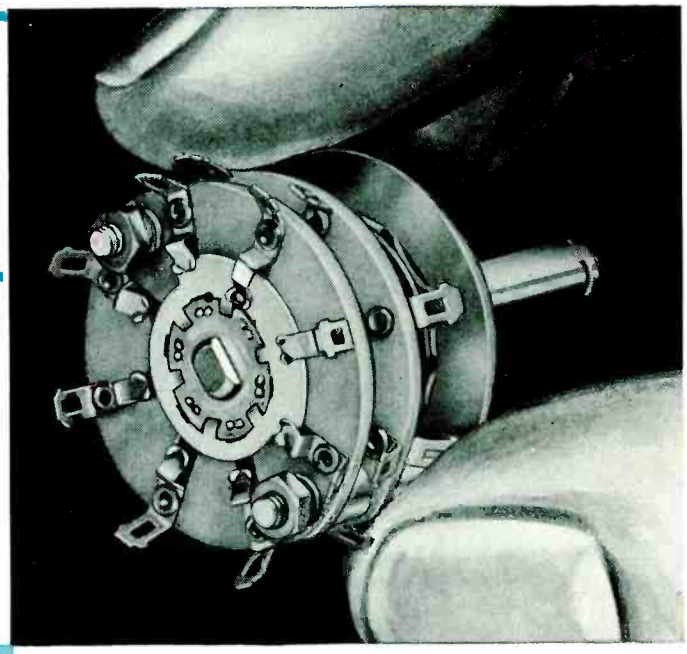

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SERIES "A"

LOW-CURRENT ROTARY SWITCH

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- LOW CAPACITANCE
- SAME HIGH QUALITY AND RELIABILITY AS LARGER OAK SWITCHES

Here's new help in the battle of miniaturization. This tiny switch can pare critical space and weight from your designs. The large number of contacts it provides enables you to handle complex circuits, too. The clips on the Series "A" are a miniature version of the famous Oak double-wiping design—long accepted as the standard of the industry for reliability and long life. Oak engineers will be glad to furnish complete information, and work with you in developing the exact variation you need.

Write on Company Letterhead for
a Copy of the Oak Switch Catalog

SPECIFICATIONS

Index—Double ball bearing, hill and valley type with stainless steel spring. Fixed and adjustable stops, and locating key available.

Shafts and Bushings—1/4" shaft with 3/8-32 bushing is standard; 5/32" shaft with 3/8-32 bushing and 1/8" shaft with 1/4-32 bushing can be supplied also. Water seal bushings optional.

Sections—8, 10, or 12-position, stacked in any number up to a total depth of three inches. The 12-position section provides up to 18 insulated contacts—12 on front, 6 on back. *No insulating blocks are needed on back.*

Poles	8-Position (45° throw)	10-Position (36° throw)	12-Position (30° throw)
1 pole	2 to 8	2 to 10	2 to 12
2 poles	2 to 4	2 to 5	2 to 6
3 poles	2 to 3	2 to 4	2 to 5
4 poles	2	2 to 3	2 to 3
5 poles	. . .	2	2
6 poles	. . .	. . .	2

Clips—Solid spring-silver alloy or silver-plated spring brass, fastened by solid rivets.

Insulation—Stator is silicone fiber glass, meeting specification MIL-P-997 type GSG; rotor is KEL-F®, known for its excellent mechanical and electrical properties.

Finish—Commercial or 50 and 200-hour salt spray.

OAK MFG. CO.

1260 Clybourn Avenue, Dept. G, Chicago 10, Illinois
Phone: MOhawk 4-2222

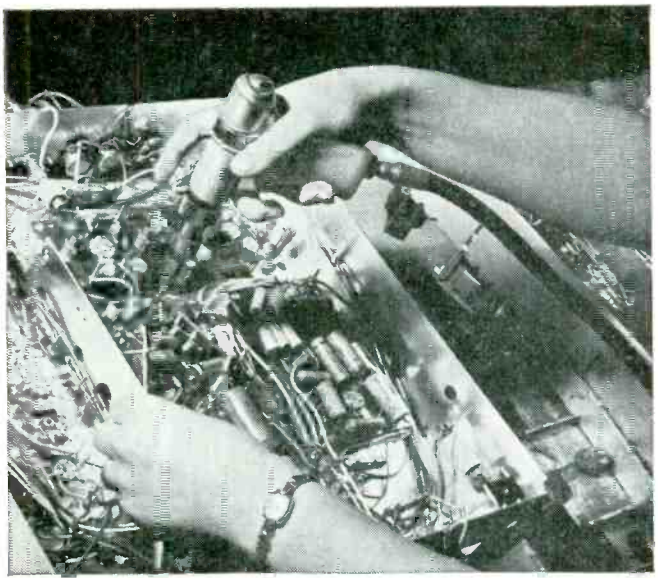
SWITCHES • ROTARY SOLENOIDS • CHOPPERS • SPECIAL ASSEMBLIES • VIBRATORS • TUNERS

Shearing press. Operator has pushed in slide by moving lever in front of her, and is here actuating controls of press

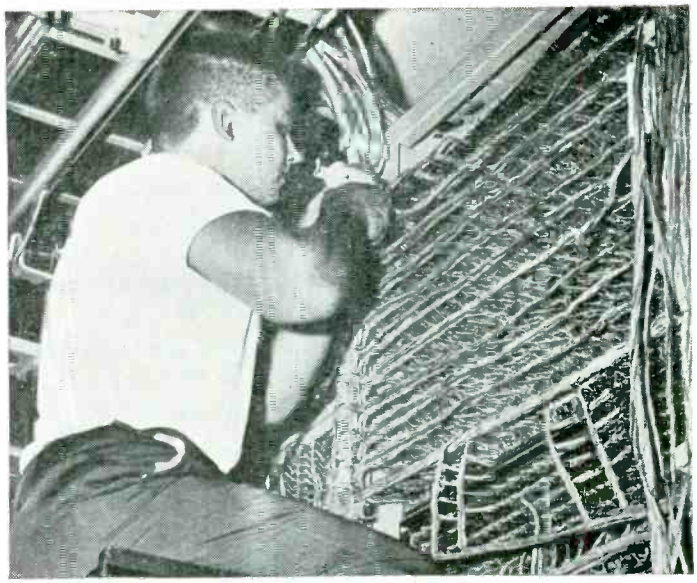
deck are punched out of sheet stock in a single operation which leaves the outer ends of the terminals attached to the sheet. This technique automatically insures correct spacing of terminals and means handling of only one part, rather than eleven separate contact strips, during the assembly operation.

▶ **Assembly** — Punched terminal decks and interleaving sheets of insulating material are sandwiched together on a two-pin metal pile-up fixture, heavy curved metal end plates are added, and four screws are inserted through the stack to lock all contacts in position. Surplus metal on the banks is now sheared off cleanly in one operation

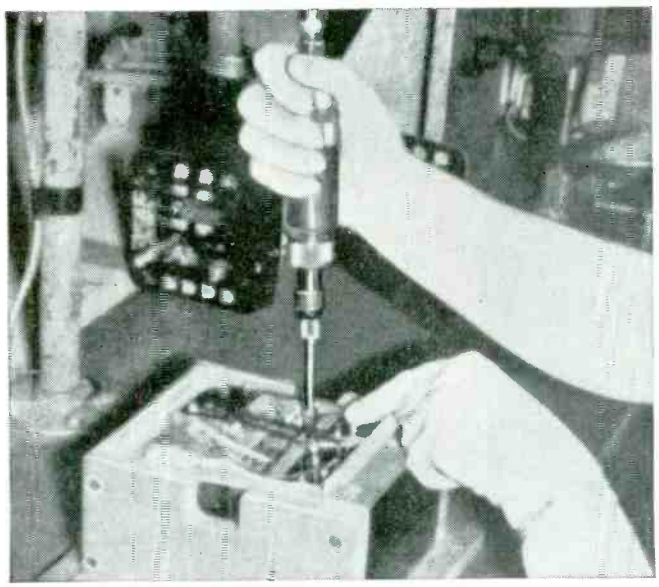
STEP 1—Loading position of slide, with operator preparing to insert assembled contact bank. Spacer comb is being placed between decks of switch with right hand



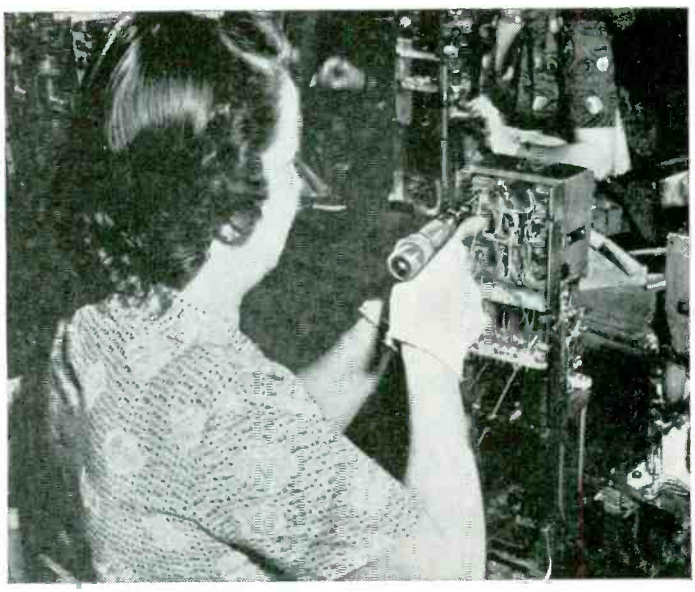
TV SETS — "Wire-Wrap" tool makes stable solderless connections.



TELEPHONE CONTROL PANELS — Small "Wire-Wrap" tool tip gets into tight places.



CONTROL DEVICES — "Wire-Wrap" tool speeds intricate electrical connection work.



COMPUTERS — Connections made with "Wire-Wrap" tool are uniform.

EVERY DAY MORE SOLDERLESS CONNECTIONS ARE MADE WITH KELLER "Wire-Wrap"® TOOLS

Five years ago Keller "Wire-Wrap" tools began saving time and materials in the assembly of electrical connections. The electronic industry was quick to see the advantages of a solderless, metal-to-metal connection that resisted vibration failure and corrosion. Today, "Wire-Wrap" tools have made well over 700 million connections without a reject.

ADVANTAGES

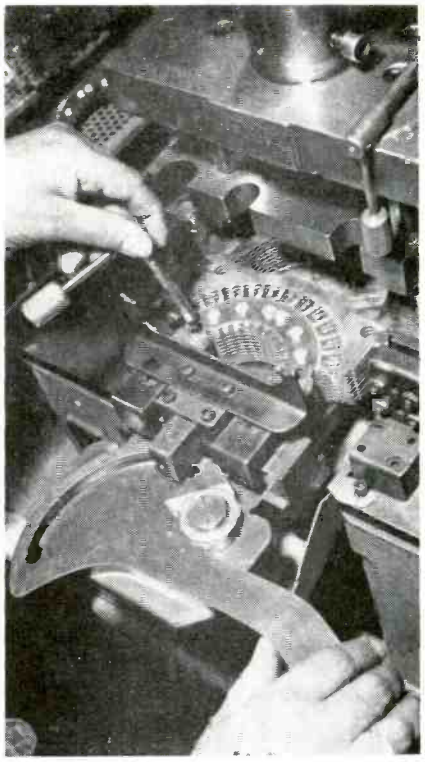
- SPEED—2 seconds total time per connection.
- NO OPERATOR FATIGUE—"Wire-Wrap" tool weighs only one pound.
- AIR OR ELECTRIC POWER TOOL—straight or pistol-grip handles.

WRITE FOR INFORMATIVE BOOKLET

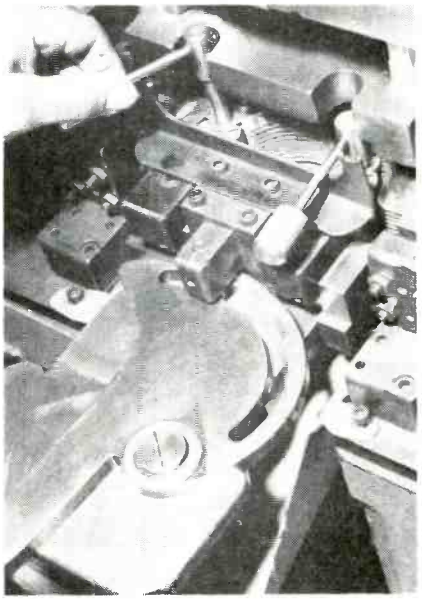
ENGINEERING FORESIGHT—PROVED ON THE JOB
IN GENERAL INDUSTRY, CONSTRUCTION, PETROLEUM AND MINING

GARDNER - DENVER

Gardner-Denver Company, Quincy, Illinois



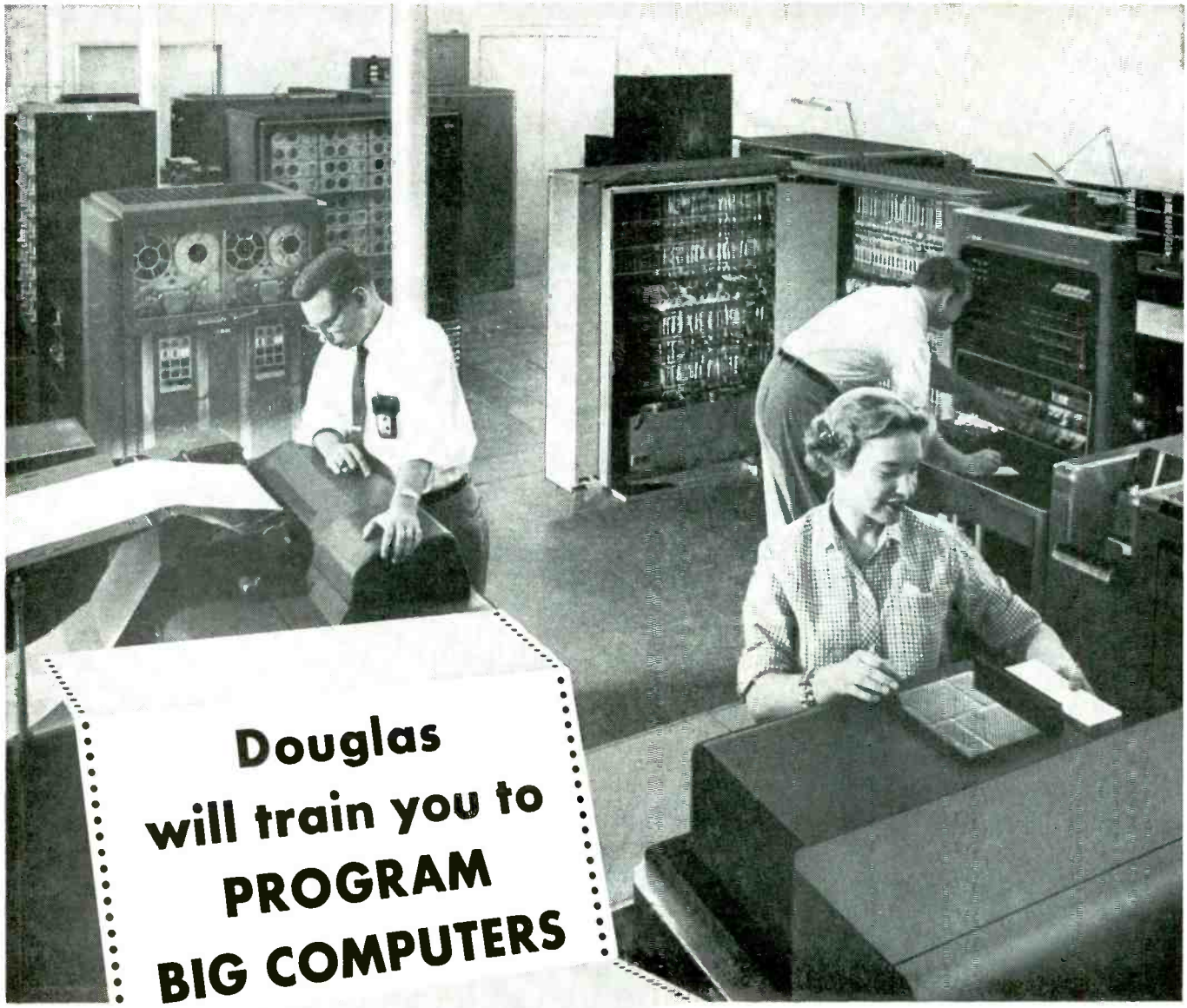
STEP 2—With bank assembly in position on slide, operator inserts positioning pin. Right hand is on lever which will later be pulled to move slide under press



STEP 3—After shearing, operator removes positioning pins, then retracts slide

of a special Denison Hydroilic Multipress, for sale as scrap.

▶ **Shearing**—The press operator pulls out the loading slide of the press and drops the untrimmed bank unit into it. The bank is so positioned that metal holding pegs can be inserted through holes in the bank end plates and through mat-



Douglas will train you to PROGRAM BIG COMPUTERS

...a challenging new field that offers ground-floor opportunities to qualified personnel

Five years ago, there were less than 100 specialists programming big computers. It is expected that by 1965, industry's needs will exceed 100,000.

Douglas Aircraft, a pioneer in this field, is rapidly expanding its computing operations. You will be trained while working with expert programmers. In Southern California, you can conveniently attend some of the nation's leading universities offering specialized courses in computing. Advancement will be as rapid as your ability to apply your new talents.

Our computing engineers are involved in every phase of aircraft and missiles work... including many long-range commercial and military projects of vital importance.

Programming requires an alert and logical mind and the ability to organize large projects without losing sight of details. If you have had formal training in mathematics, science or engineering, your professional future at Douglas in programming can be unlimited.

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For complete information, write:

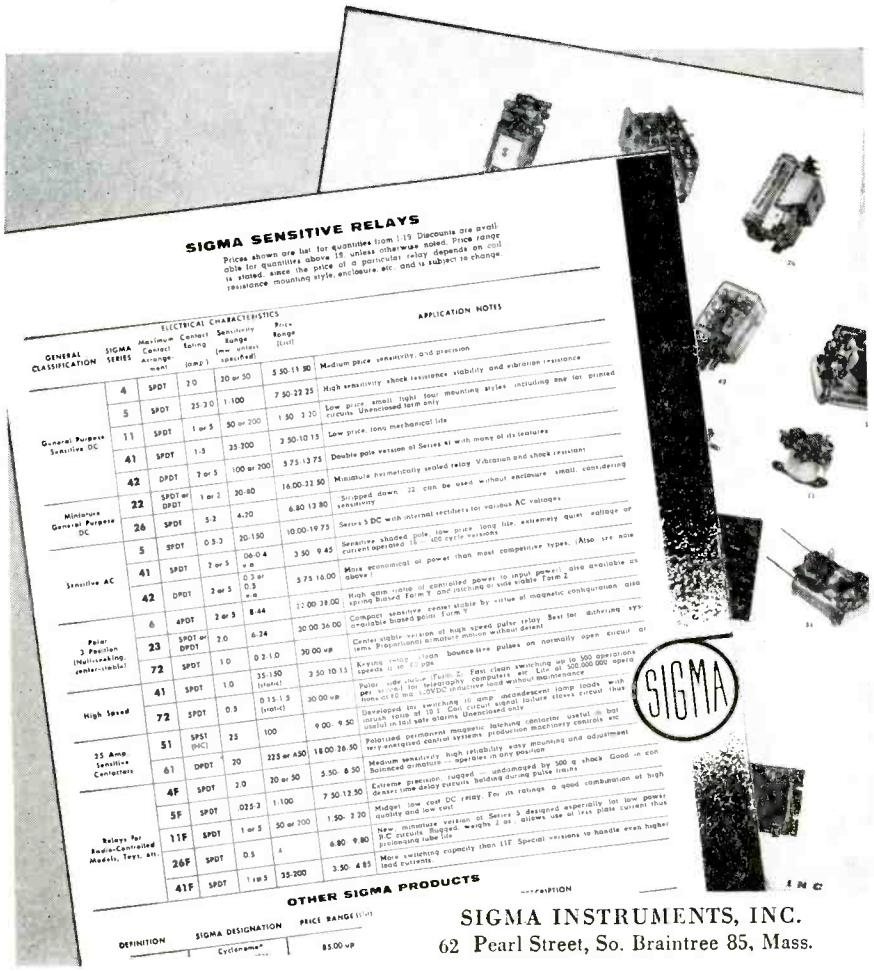
JOHN LOWE
CHIEF, COMPUTING
ENGINEERING SECTION
DOUGLAS AIRCRAFT COMPANY
BOX F-620
SANTA MONICA, CALIFORNIA

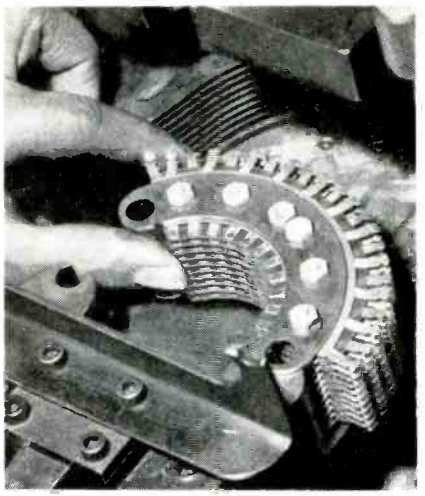
According to Mrs. L. B. Q. (who is pictured in the above candid photograph of the advertising department's mail department and is in charge of Sigma premiums, box tops, blown tops and the like) Sigma's July offer of free Slidecharts has turned into a polymorphous hydra.

Now it becomes necessary, due to the laws of Kirchoff and diminishing returns, to terminate the *free* offer. Hereafter we'll be glad to oblige, but at 25¢* (C. I. A.) per. (It's either this, fellows, or raising the price of Sigma relays.)

Don't think we do not appreciate the interest displayed — it's just . . . . . Still free is the EBG reprint which resumés SIGMA products and is big enough so you can read it.

*Cash, stamps or rare fiduciary objects.



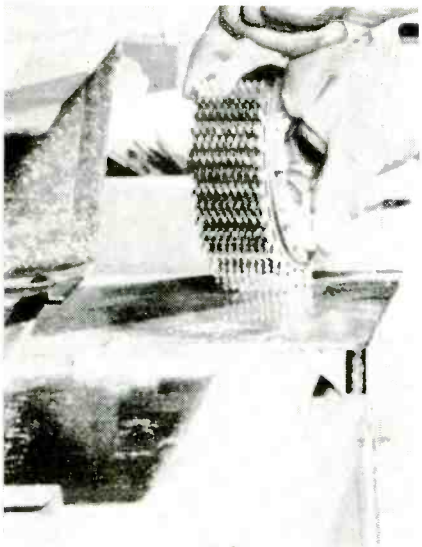


STEP 4—Removing sheared bank assembly from press after removing pins

ing holes in the fixture. This gives accurate positioning when the bank is moved into shearing position by pulling a lever.

Two important actions contribute to clean shearing. Before the bank assembly is inserted, the operator places a metal spacer comb on each side of the bank, to keep the surplus metal uniformly spaced. This insures that the surplus metal will mesh with metal spacers previously placed on the bed of the press. These spacers are equal to the thickness of the insulation used, so that they prevent deformation of the terminals during shearing. As the bank is moved into shearing

STEP 5—Tinning terminals in solder pot



STEP 6—Rubbing terminals across iron plate to knock off surplus solder while still molten

position, the permanent comb on the press pushes out the two temporary spacer combs. These slide down a chute into a pan below, in easy reach of the operator for use on the next bank.

With the bank unit in position, the operator pushes down the two actuating valves of the press. This shears all surplus metal at once. The scrap metal and the spacer assembly drop down through a hole in the bed of the press onto a forward-facing chute. The operator then takes the scrap pieces out of the spacer unit and places the spacer back on the press after removing the positioning pins, retracting the slide, and taking out the sheared assembly.

Tinning of terminals is the final operation. The operator rocks the terminals first through a pan of rosin flux, then slowly through a solder pot. Immediately after withdrawing from the pot, the terminals are quickly rubbed across an iron plate alongside the pot. This removes surplus solder and prevents bridging across terminals.

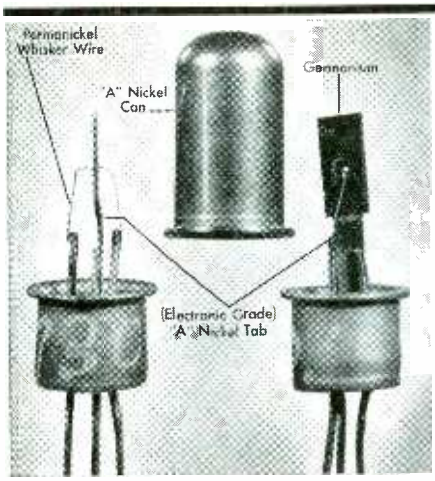
Installing Coils In Servo Motor Stator

CAREFUL ATTENTION to product design makes possible the installation of 16 coils in the external slots of stators for precision miniature servo motors with a minimum of

Nickelonic News

VOL. 1 — Developments in Nickel and Nickel Alloys and their applications — No 1

Sled trains snowhaul 34,000 tons of supplies to speed new Nickel mines into production



3 Nickels help Philco step up life of new HF transistors

These new Philco Surface Barrier Transistors demonstrate top-notch stability, life and performance to 50mc and above.

One reason is low power consumption . . . under one milliwatt. Another is Philco's use of three Inco Nickels.

To insure a strong, contamination-free support for the germanium, Philco makes the tabs of Electronic Grade "A" Nickel. Ductile "A" Nickel is used for the can, too . . . makes it rugged, corrosion-resistant. And for tolerance stability, the whisker wires are made from spring-temper Permanickel* age-hardenable, electrically conductive nickel.

New Name for Old Alloy

Recently a wrought alloy, widely used in cable shielding and in CR and other special tubes, was renamed. Formerly "326" Monel alloy, it is now "403" Monel* nickel-copper alloy. Above room temperature, this highly workable alloy stays practically non-magnetic. Permeability is 1.2 max. at 27°F. max. (H=0.5 oersteds.)

"403" Monel alloy... Nominal Composition %							
Ni (+Co)	58.65	Cu	38.75	Mn	1.80	S	0.005
Fe	0.40	Si	0.30	C	0.12		

POWER KLYSTRON FOR SCATTER TRANSMISSION

Nickel in gun components steadies tube operating characteristics

Last winter Inco-Canada shuttled 24 diesel sled trains over a 35-mile snow trail in northern Manitoba southwest of Hudson Bay. Object was to get a flying start on the construction of two new Nickel mines . . . part of an Inco program for adding over 100 million pounds a year to Nickel output.

1000 trips

In this gigantic snowhaul, sled trains made 1000 trips laden with equipment to start work on the mines and the new townsite while a railroad spur line was being built.

In addition to new mines, the project includes new concentrating, smelting and refining facilities. The expected boost in Nickel availability is good news for many now working on designs calling for the special properties of Nickel and Nickel alloys.

← This is a typical Eimac Klystron, employing an oxide coated Nickel cathode. A similar Klystron has shown no drop in cathode emission or efficiency after more than a year of operation at 8000 volts and 550 milliamperes.

To help achieve this, Eimac uses Inco Electronic Grade "A" Nickel... in cathode button, as the oxide base; in shields, cylinders, supports. The Nickel boosts life, aids conductivity, retains dimensions despite bombardment at high temperatures.

*Registered trademark

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

For more information on Inco products mentioned above, use reader service number or write.

special tools and fixtures. In the procedure used at the Mechatrol Division of Servomechanisms, Inc., the coils come in strings of eight, with coil sides already protected by Teflon tape and with color-coded leads attached.

▶ **Insulating**—At the assembly position, the operator places in a simple holder the temporary supporting arbor for the stator stacks, then applies Teflon tape over the

Applying insulating tape

sleeves projecting from the heavier end spiders of the stack.

▶ **Loading** — The operator now places the coils in the stator slots with her fingers. A packing tool is used to bottom the coils which have been inserted, to facilitate insertion of the second coil in each slot.

After all 16 coils have been in-

Work position for installing coils in stator

Get up in the world!

Your engineering career will thrive on the opportunity at Western Electric

How would you like to work in a place where there's a constant need for new products, new processes, new ideas? Where the technical job brings engineers in touch with such broad managerial functions as production, merchandising, installation, and many others? Where promotion from within is the policy . . . and over 8,000 management positions must be filled in the next ten years by newly promoted people?

Sounds good, doesn't it? Well, that's the kind of opportunity that awaits you at Western Electric. Here engineers shoulder key responsibilities in our job of making, distributing and installing Bell telephone equipment . . . in carrying out, at government request, major defense contracts such as the Nike guided missile system and Sage, the continental defense system.

As a member of this team you'd handle challenging assignments that could involve electronic switching, automation, radio relay for TV and long-distance calls. Your ideas would be welcome . . . you'd learn . . . you'd grow!

What's more, you'd be given every encouragement to grow. We sponsor a full-time Graduate Engineering Training Program during working hours to help new engineers more rapidly assume a full engineering role and to increase the capabilities of experienced engineers. We also offer a Tuition Refund Plan for out-of-hours study at nearby colleges.

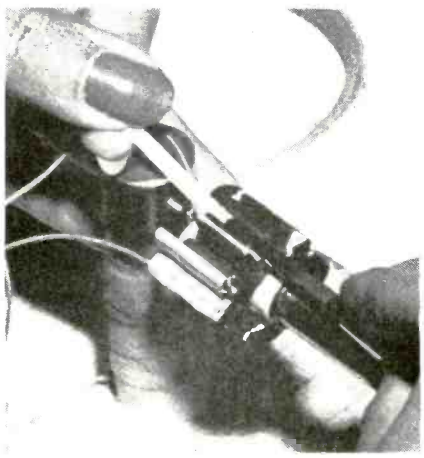
You owe it to your ideas and your future to determine the openings for which you may be qualified (mechanical, electrical, chemical, civil engineers, physicists and mathematicians). To apply, send resume of education and experience to Engineering Personnel, Room 1066 Western Electric Co., 195 Broadway, New York 7, New York.

Western Electric

MANUFACTURING AND SUPPLY UNIT OF THE BELL SYSTEM

Manufacturing plants in Chicago, Ill.; Kearny, N. J.; Baltimore, Md.; Indianapolis, Ind.; Allentown and Laureldale, Pa.; Burlington, Greensboro and Winston-Salem, N. C.; Buffalo, N. Y.; North Andover, Mass.; Lincoln and Omaha, Neb.; St. Paul and Duluth, Minn. Distributing Centers in 30 cities and Installation headquarters in 16 cities. Also, Teletype Corporation, Chicago 14, Illinois.

Packing second coil into stator slot



Pushing insulating wedge into slot

Placing guide thimble over stator in fixture on air-actuated arbor press

stalled, a flat-bladed packing tool is run into each slot in turn to make room for the Phenolite fiber-glass slot wedges which hold the coils in place. As the flat tool is pulled back, this stiff insulating strip is pushed in after it to the full length of the slot. The strip is then bent up sharply to break it off. The other 15 slots are closed in the

A Dip here does so much

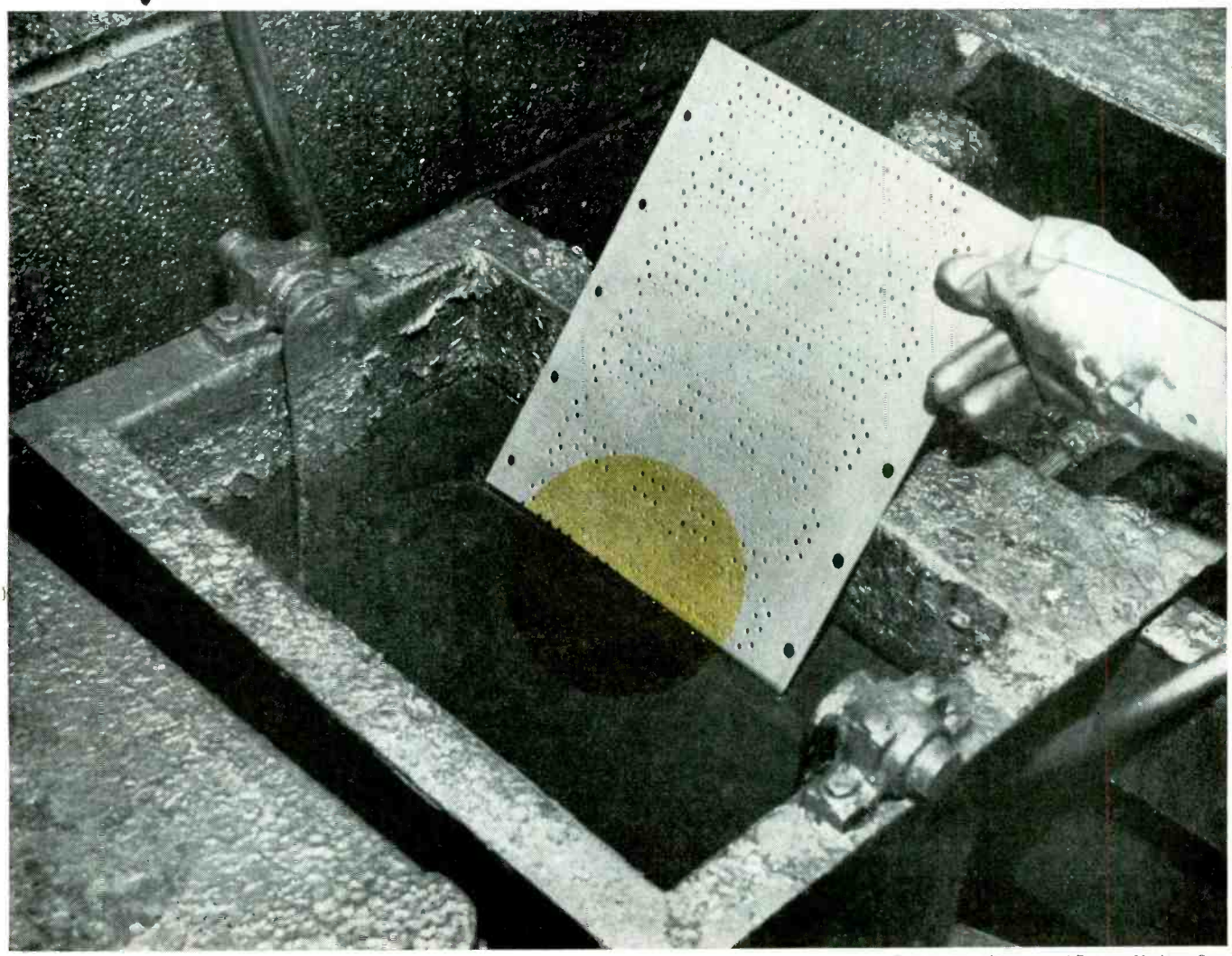


Photo courtesy International Business Machines Corp.

How 'dag'® can spell the difference between possible and impossible!

Take the case of International Business Machines Corporation, for example. At the company's Kingston, New York plant, a dip in a 'dag' dispersion makes it possible to plate a conductor through holes in copper clad phenolic sheets.

Used in the production of printed circuit cards, the pierced sheets are dipped in a solution of 'dag' dispersion #154 and alcohol. The sheets then pass through rubber rollers which remove excess solution from the surface and are then conveyed through an oven to dry. Following this, an automatic sanding machine removes excess graphite from the surface, leaving a graphite coating on the walls of the holes in the sheet.

Conductors are then plated through these holes in production of printed circuit cards for the IBM SAGE Computer produced for the U. S. Air Force.

This is only one of many practical benefits of 'dag' colloidal graphite dispersions. An Acheson Service Engineer will be glad to consult with you on any problem you may have, where a graphite coating can help you. Bulletin 433 will provide additional valuable information; for your copy, address Dept. E9.

dag®

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Port Huron, Michigan... also Acheson Colloids Ltd., London, England

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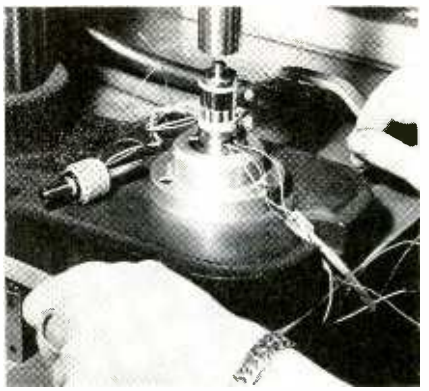


Operator has placed yoke rings in position on thimble and is preparing to operate press controls with both hands to push rings down against those already on stator. Complete stator with yoke rings can be seen on bed of press

same manner to complete assembly of the stator.

▶ **Installing Yoke**—The stator assembly is placed in a holding fixture on the bed of the press and a guide thimble is slipped over the top end of the temporary stator arbor to protect the windings. The electrical steel yoke rings are placed on this thimble a few at a time, then pushed down over the stator laminations with the air-actuated arbor press. The process is repeated until sufficient rings have been applied to cover the laminated section of the stator. These rings complete the magnetic paths.

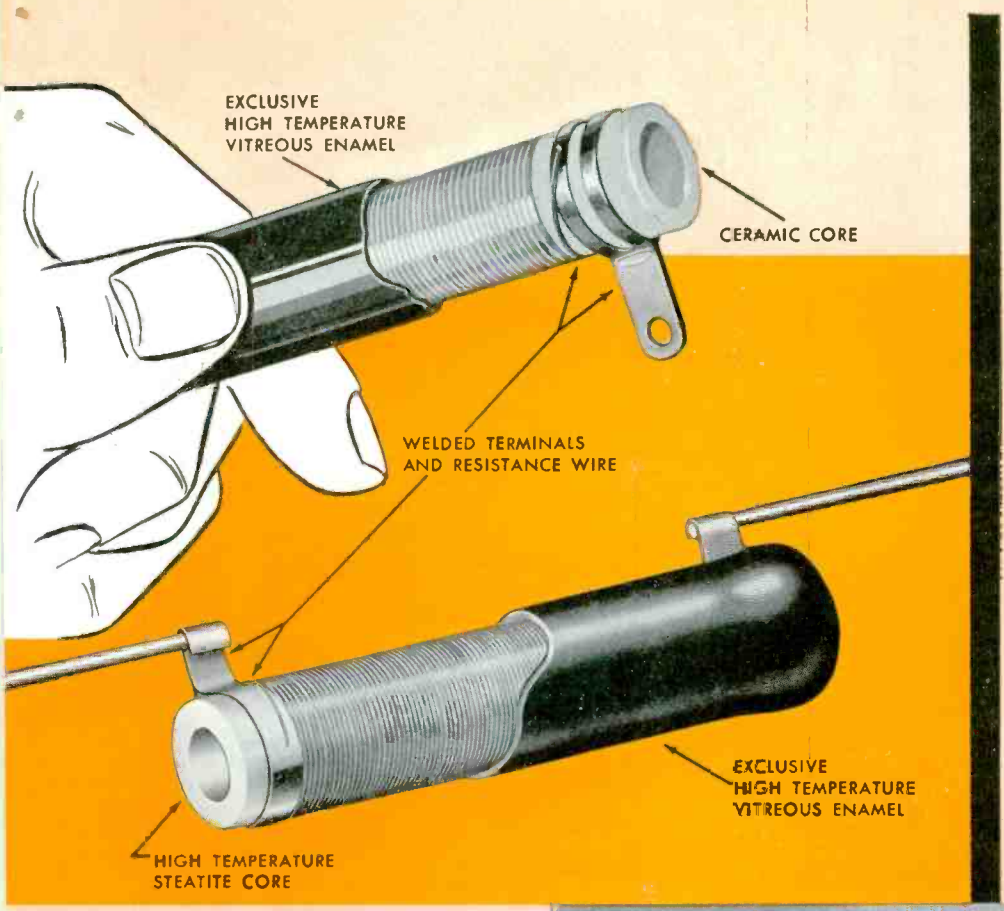
Conductive Films

OFTEN IT IS DESIRED to obtain a resistive coating of known resistance which will remain stable when heated in air. A method devised by H. O. McQuary of Naval Research Laboratory, Washington, D. C., eliminates many shortcomings of the conventional painting procedure. In this method a metallic coating is evaported onto a clean nonconductor, such as glass in a vacuum of 10^{-5} mm Hg or better. A test strip with electrodes attached is placed in the same plane close to the piece to be coated. Resistance of the test piece is monitored with an external meter. An auxiliary evaporator is arranged in the same bell jar to place a protective coating of silicon monoxide

OHMITE®

WIRE-WOUND, VITREOUS-ENAMELED

POWER RESISTORS . . . *industry's most complete line*



WELDED RESISTANCE WIRE Ohmite Resistors have the resistance wire welded to the terminals instead of soldered or brazed. This provides a perfect and permanently stable electrical connection that is unaffected by vibration or high temperature.

WELDED TERMINALS Another Ohmite Resistor feature is the welded terminal band. The band is permanently held together around ceramic core by means of welding, providing a strong, permanent fastening.

STRONG CERAMIC CORE This strong, rugged core has excellent electrical characteristics, and is unaffected by cold, heat fumes, or high humidity.

EXCLUSIVE HIGH TEMPERATURE VITREOUS ENAMEL This special-formula enamel was developed by Ohmite after extensive research. Its thermal expansion is properly related to that of core, terminal, and resistance wire.

Ohmite offers resistors in more than 60 sizes—ranging from 2½" diameter by 20" long to ¼" diameter by 9/16" long—to meet your exact requirements. MANY SIZES ARE CARRIED IN STOCK.

Ohmite offers the most complete line of wire-wound, vitreous-enameled POWER RESISTORS on the market . . . fixed, adjustable, tapped, noninductive, and precision resistors in many sizes, types of terminals . . . available in a wide range of wattages and resistances.

Write on company letterhead for Catalog No. 40.

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RHEOSTATS • RESISTORS • RELAYS • TAP SWITCHES
TANTALUM CAPACITORS • VARIABLE TRANSFORMERS

OHMITE MANUFACTURING COMPANY
3610 Howard Street
Skokie, Illinois

over the resistive coating before the latter is exposed to air.

By this method it has been possible to apply resistive coatings within 5 percent of a required value and stabilize these coatings to within 1 percent over a temperature range of 20C to 450C. The method has proved very valuable in the development of resistive vanes for variable r-f attenuators as well as broadband r-f loads.

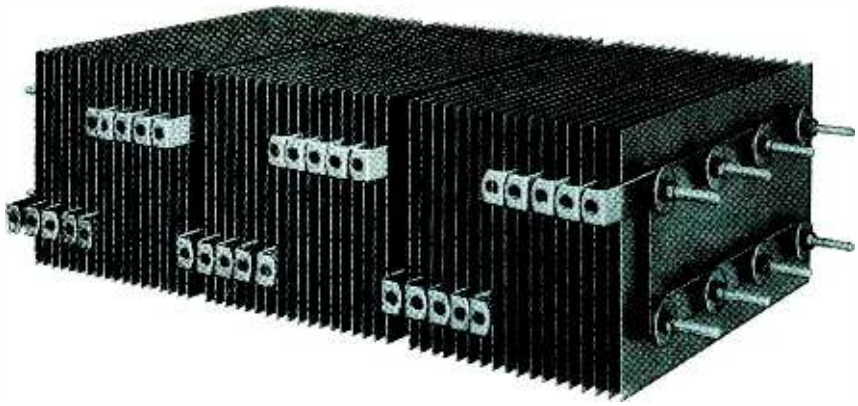
Inserting R-C Networks in Plated Wiring Boards

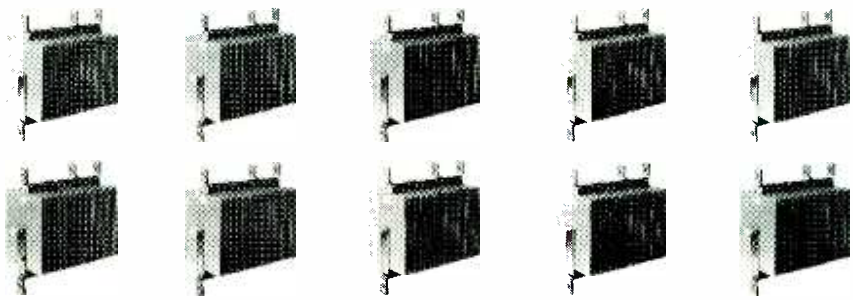
EPOXY-ENCAPSULATED resistor-capacitor networks designed for high humidity resistance and adaptability to manual or automatic placement in printed wiring boards are now in production at General Electric's Specialty Electronic Components Dept. in Auburn, N. Y.

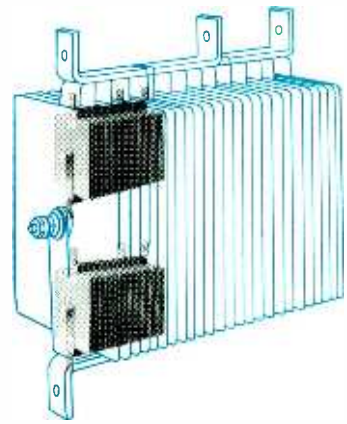
The network plate is encapsulated in an epoxy resin inside a molded nonporous phenolic case. The uniform size and surface of the

Manual placement in plated wiring board. Molded projections on phenolic housing keep unit above board so solder can form fillets around leads on top of board

Single New Rectifier Outperforms 12 full size conventional stacks!







Radio Receptor HCD* Petti-Sel *High current density*

Industrial Type Selenium Rectifiers

Produced by the improved new vacuum process developed by Siemens of West Germany and now manufactured exclusively by Radio Receptor in the U.S.

Smaller cell sizes

Lower voltage drop

No artificial barrier

Negligible aging with an estimated life of 100,000 hours!

Because the exclusive Siemens vacuum process eliminates the need of an artificial barrier layer, it is possible for Radio Receptor to offer smaller cell sizes operating at high current density, yet with lower voltage drop. In actual dimensions this means that just *one* RRco. HCD rectifier measuring 8" x 16" x 25", rated at 26V AC, 4500 amps DC, replaces *twelve* usual stacks 6" x 7¼" x 10".

RRco. Petti-Sel rectifiers do far more than save space. They reduce assembly time, require fewer connections and cost less per ampere. Their dependability has been proved for years in European circuits and the outstanding electrical characteristics are not even approached by other standard cells available today. For further information please write today to Section E-9R.

Radio and Electronic Products Since 1922

Semiconductor Division

RADIO RECEPTOR COMPANY, INC.

A Subsidiary of General Instrument Corporation

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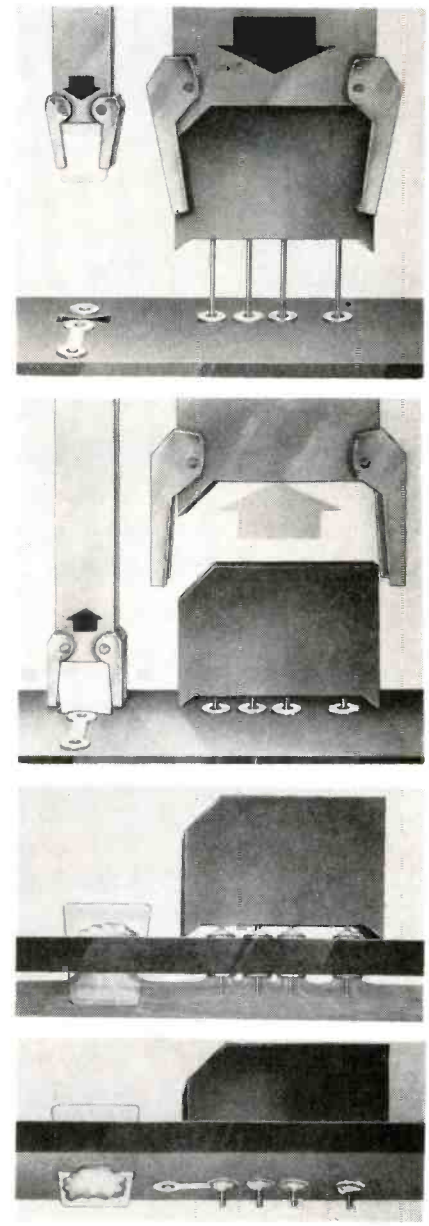
Radio Receptor products for Industry and Government:
Germanium and Silicon Diodes, Selenium Rectifiers, Thermatron Dielectric Heating Generators and Presses, Communications, Radar and Navigation Equipment

network case, and an index chamfer on the upper left corner of the case, facilitate magazine loading for automatic placement.

The networks have such radio and tv receiver applications as coupling, pulse-forming and R-C filter networks.

Resistor values range from 1,000 ohms to 10 megohms and capacitor values range from 100 to 10,000 micromicrofarads. Leakage resistance of the capacitors is greater than 10^{5} megohm-micromicrofarads. The operating temperature range of the networks is from 10 to 85 C.



Suggested method of automatic insertion of network and new GE Wejcap ceramic capacitor in wiring board. Action of solder in dip solder pot and appearance of soldered board are also shown

Circle 196 Readers Service Card →

Here's the answer to prototype parts and short run production . . .

DEEP DRAWING, HYDROFORMING, SPINNING, STAMPING, PIERCING, ASSEMBLING, SPOT WELDING, ANNEALING, TOOL MAKING, ETC.

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BRASS
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NICKEL
LEAD
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MAGNESIUM
MOLYBDENUM
TITANIUM
SILVER
SPECIAL ALLOYS

kaupp

KAUPP SAVES TIME REDUCES COSTS –

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For AIRCRAFT . . .

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New Products

Edited by WILLIAM P. O'BRIEN

82 New Products and 45 Manufacturers' Bulletins Are Reviewed . . . Control, Testing and Measuring Equipment Described and Illustrated . . . Recent Tubes and Components Are Covered

X-BAND MAGNETRON

lightweight 40-w unit

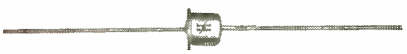
MICROWAVE ASSOCIATES, INC., Burlington, Mass. A 40-w, high reliability, X-band pulsed magnetron has been developed for operation in the frequency range from 8,800 to 9,600 mc. It is particularly suited for use in airborne radar beacon and navigation systems.

The tube is rated at 40 w peak pulsed power output at a 25-percent duty cycle for maximum pulse lengths of 5 μsec. Substantially higher peak powers may be achieved with shorter pulse durations and reduced duty cycle requirements. Frequency and amplitude modulation of the magnetron output pulse has been measured at less than ±30 kc modulation deviation in experimental models. Operating efficiency of the MA-215 is 20 to 30 percent. A ceramic cathode bushing structure is used for increased reliability.

The new magnetron weighs approximately 20 oz. **Circle 401 on Reader Service Card.**

SILICON RECTIFIERS

medium-power type



HOFFMAN SEMICONDUCTOR DIVISION, Hoffman Electronics Corp., 930 Pitner Ave., Evanston, Ill. Especially suitable for airborne supplies and other military and industrial applications, the Top Hat design silicon medium power rectifiers are available in the following RETMA types: IN536, IN537, IN538, IN539, IN540 and IN1095.

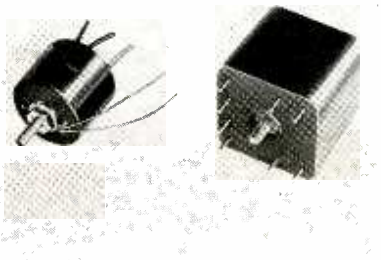
These rectifiers are the result of much research, testing and experimentation. Current ratings are up to 250 ma at 150 C ambient; peak reverse working voltages up to 500 are just two of the many features which can be found in technical data now available from the firm. Diffused junction of the rectifiers offers long life and high efficiency. **Circle 402 on Reader Service Card.**

PULSE TRANSFORMERS

meet rigid military specs

TELEX, Telex Park, St. Paul 1, Minn. High reliability encapsulated and hermetically sealed pulse transformers are now being manufactured to meet military and civilian requirements.

These units meet rigid military specifications such as MIL-T-27 and operate at ambient temperatures up to 85 C. Special designs for high acceleration applications are available for specific customer requirements.

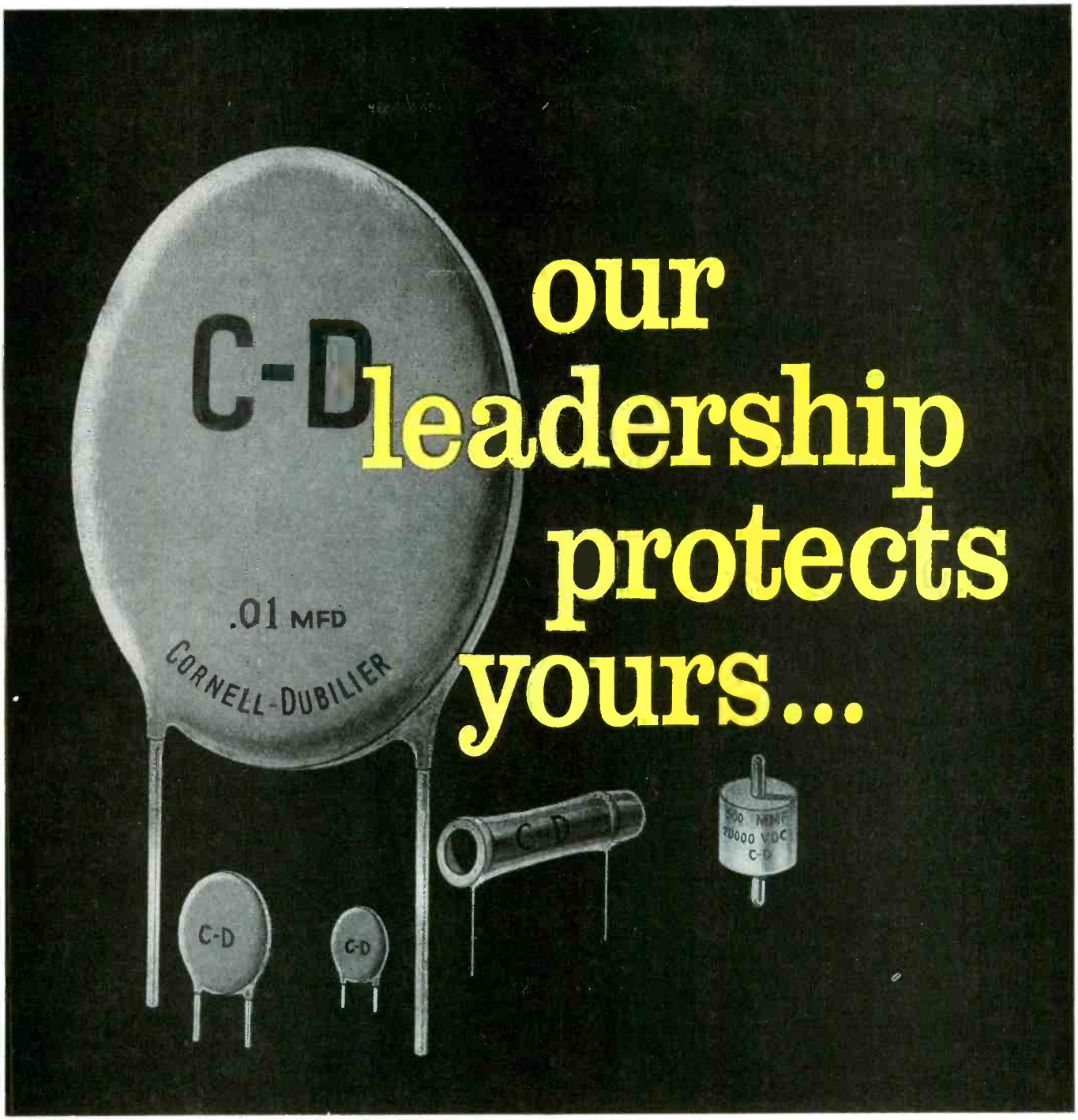


Also available are subminiature pulse transformers for printed wiring board, transistorized circuit and miniaturized circuit applications. All units meet standard voltage, life, pull, temperature, immersion and moisture resistance tests. **Circle 403 on Reader Service Card.**

COUNTER TUBE

tiny and rugged

ANTON ELECTRONIC LABORATORIES, INC., 1226–1238 Flushing Ave.,



Because *your* production lines must roll evenly, we've geared *our* production to roll in valleys and peaks, if need be—so that your C-D capacitors will arrive the day you need them. That's why seasonal production peaks are *never* too much for C-D's 16-plant manufacturing capacity.

Typical C-D "Million-Dollar Body" Ceramics:

DISC TYPES: Temperature compensating, stabilized capacity, general purpose bypass, high voltage, A-C line bypass.

AUTOMATION: Plug-in termination available in temperature compensating, stabilized capacity, general purpose bypass, close tolerance disc types.

SPECIAL DESIGN TYPES: Feed-thru, stand-off, spool types are among the many special design ceramic types developed by C-D in accordance with customers' specific requirements, with particular reference to the high frequency field.

Write for catalog to Cornell-Dubilier Electric Corporation, South Plainfield, New Jersey.

CONSISTENT HI-EPENDABILITY
CORNELL-DUBILIER CAPACITORS

SOUTH PLAINFIELD, N. J.; NEW BEDFORD, WORCESTER & CAMBRIDGE, MASS.; PROVIDENCE & HOPE VALLEY, R. I.; INDIANAPOLIS, IND.; SANFORD, FUQUAY SPRINGS & VARINA, N. C.; VENICE, CALIF.; & SUB.; THE RADIART CORP., CLEVELAND, OHIO; CORNELL-DUBILIER ELECTRIC INTERNATIONAL, N. Y.

Circle 197 Readers Service Card

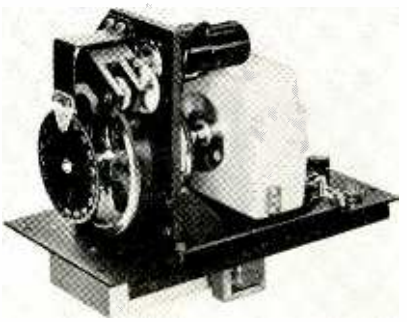
Brooklyn 37, N. Y. Type 307 is a miniaturized and ruggedized high sensitivity beta and gamma radiation counter tube especially designed to provide quantitative measurement of radioactivity for such purposes as uptake studies, medical diagnosis, tracer work and process control. It is especially useful for the localization of small amounts of radioactive tracers in body cavities.

The type 307 is filled with neon plus a halogen admixture; operates in the Geiger region; and cannot be damaged by overvoltage. Temperature changes within the range −55 C to +75 C will not affect the response or sensitivity. Transmission characteristics of the wall are given in the AEL tube catalog. Other technical information is available. **Circle 404 on Reader Service Card.**

SERVO DIGITIZER

operates from 400 cps line

INDUSTRIAL CONTROL CO., 805 Albin Ave., Lindenhurst, L. I., N. Y. The SL-1004 is a packaged, servo driven digitizer, designed to digitize an a-c input signal. It operates directly from the 400 cps line, and is packaged for inclusion in larger equipment. It includes a miniaturized, high gain transistor-magnetic servo amplifier and power supply.

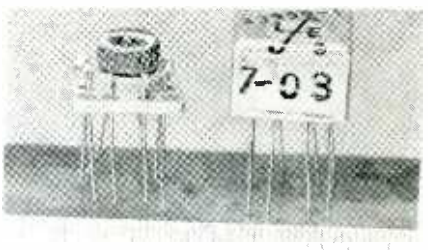


The output is binary-decimal, and the encoder shaft is driven ±170 deg from null. Full scale corresponds to 10 v rms 400 cps, in phase with the line. The static error is 0.15 percent of full scale, and fast rates can be followed with a velocity error constant of 500 sec^{-1}.

Typical applications are ground and flight instrumentation, analog translation to feed digital computers, as an input to a card or tape system, and for laboratory demonstrations. **Circle 405 on Reader Service Card.**

BINARY TRANSFORMER

is tape wound



LABORATORY FOR ELECTRONICS, INC., 75 Pitts St., Boston 14, Mass., announces a tape wound binary transformer which is shock mounted to withstand 10 g's at 2,000 cps. The tiny toroid coil is supported top and bottom with special silicone rubber which does not change in environmental conditions. This type of support prevents shock and pressure upon the core from changing the hysteresis characteristics.

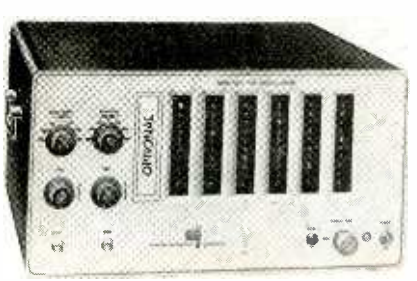
These transformers have been produced in production quantities for a military project and each has been hi-potted at 110 v for 100 hours while being cycled between −65 and 80 C. Binary transformers of this type are now available for general application to specific customer ratings. **Circle 406 on Reader Service Card.**

TIME INTERVAL METER

with ± 1 μsec accuracy

COMPUTER-MEASUREMENTS CORP., 5528 Vineland Ave., North Hollywood, Calif. Model 251-A time interval meter is designed for precise measurement of elapsed time between two events occurring in the range of 3 μsec to 1 sec. Optional features permit extension to 10 or 100,000 sec. Typical applications are: ballistics measurements, relay timing, photographic timing and testing of timing devices.

Among the features are two independent, continuously adjustable trigger level controls permitting full rated sensitivity—0.2 v rms—at any voltage level between −300 and +300 v. There is provision for oscilloscope marker signals for trigger level adjustment of start and stop points for time interval measurement of complex waveforms. **Circle 407 on Reader Service Card.**



POWER SYSTEMS

for electronic equipment

DYNAMIC CONTROLS CO., 1955 Massachusetts Ave., Cambridge, Mass. These control systems for the application of power and protection of electronic equipment are constructed to minimize downtime for the entire system. They contain the following features: automatic

Circle 198 Readers Service Card →

For ACCURATE HIGH SPEED SWITCHING..

Specify

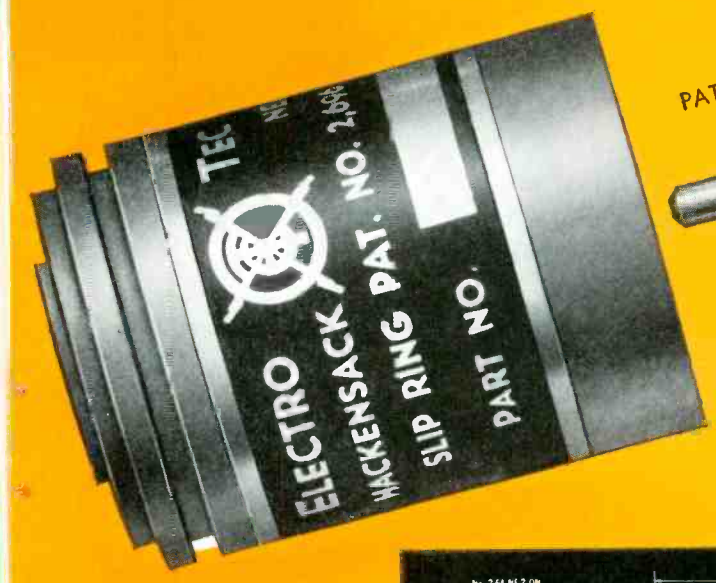
ELECTRO TEC

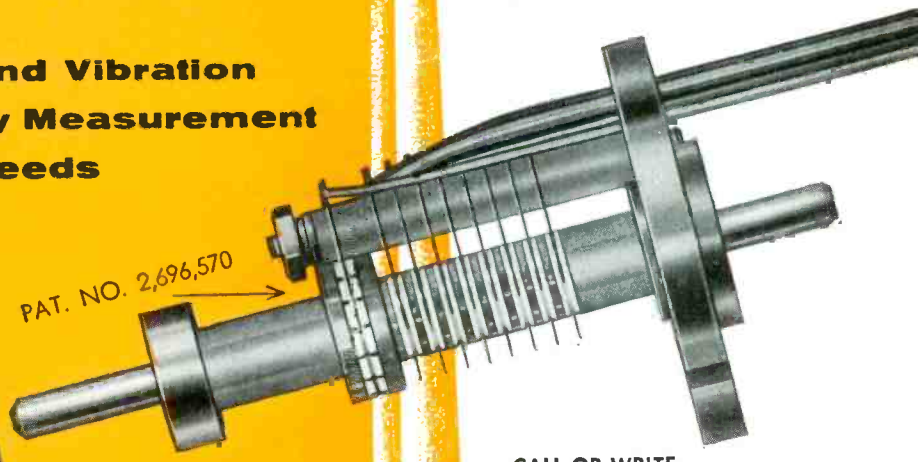
miniature ultra-low torque

Precision Selector Switch

- Withstands Shock and Vibration
- Offers High Accuracy Measurement
- Operates at High Speeds

This new Electro Tec Precision Selector Switch is ideal where miniature size, low friction torque, high accuracy, and low electrical noise at high speeds are requirements. Simplified circuits and long service life recommend it for a wide variety of uses including sampling, pulse generation for precision measurement, telemetering and strain gage applications, in aircraft, missiles, servos, computors, etc. Switch design incorporates many exclusive features that have gained industry-wide acclaim for Electro Tec precision slip rings, commutators and brush blocks.





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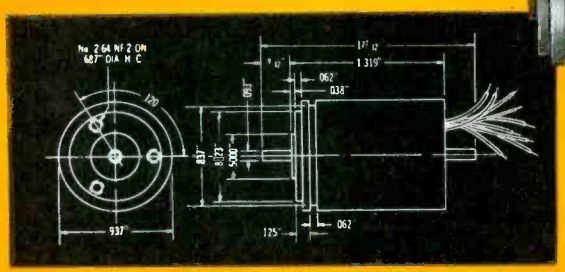
8 or 10 position switches in standard size 10 synchro housings are available for immediate delivery; other circuit combinations supplied to specifications.

ACTUAL SIZE



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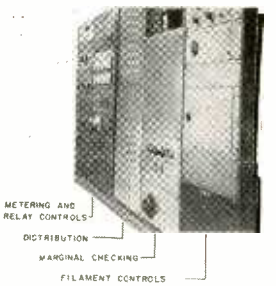
Tel.: HUbbard 7-4940



application and removal of power, gradual increase of filament voltage, sequencing of d-c voltages, voltage and temperature monitors, indications and alarms for quick trouble shooting, detection of power line transients, and automatic or manual marginal checking for the detection of weak components. **Check 408 on Reader Service Card.**

DATA DISPLAY UNIT
with built-in memory

ADVANCED ELECTRONICS MFG. CORP., 2025 Pontius Ave., Los Angeles 25, Calif., has developed a self-contained scope-type display unit which will present a visible record up to 20,000 alphanumeric characters per second. Using a 5-in. Typotron storage oscillograph tube, the new unit has a special storage feature which permits characters to remain visible until intentionally erased, by either manual or automatic control.

Designated the Typo-Scope 301, the unit is designed so that any one of 64 characters, approximately ⅛ in. high, may be selected by a six-digit binary code and recorded on the screen in any one of 1,024 positions selected by a

FORMULA for LONG LIFE

$$I = \frac{E}{\sqrt{R^2 + (\omega L - \frac{1}{\omega C})^2}} \qquad E$$

THE KEY COMPONENT

$$Z = \sqrt{R^2 + (\omega L - \frac{1}{\omega C})^2}$$

$$f = \frac{1}{2\pi\sqrt{LC}}$$

El-Menco Dur-Mica CAPACITORS

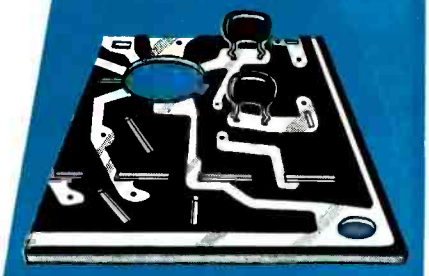
Rugged Endurance up to 18 years!

A series of the toughest trials prove El-Menco Dur-Mica DM15, DM20 and DM30 capacitors outlast all others under accelerated conditions of 1½ times rated voltage at ambient temperature of 125° centigrade. Can be used at higher operating temperatures with slight voltage derating. Longer life and greater stability made possible by specially treated phenolic casing.

7/16 Thick — 1-7/8 Long
29/32 Ht.

ACTUAL SIZE

DM 42
Up to 65,000 mmf at 300 WVDC
Up to 40,000 mmf at 500 WVDC



El-Menco Dur-Mica Capacitors meet all humidity, temperature and electronic requirements, including military specifications.

Write for FREE samples and catalog on your firm's letterhead.

El-Menco Dur-Mica DM15, DM20, DM30, DM40 and DM42 Capacitors Provide:

1. LONGER LIFE
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WITH NEW CRIMPED LEADS.

Improved parallel leads for greater rigidity and faster assembly. These parallel leads simplify use on miniature printed circuit boards in television, guided missiles, hearing aids, electronic brains, air conditioning and other government and civilian applications.

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Manufacturers of El-Menco Capacitors

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• tubular paper • ceramic • silvered mica films.

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10-digit binary code. A total of 400 characters may be displayed at one time. Characters may be positioned sequentially by means of a built-in counter. **Circle 409 on Reader Service Card.**

NULL INDICATOR
with oscilloscope display

MILLITEST Co., 88 Madison Ave., Hempstead, N. Y., offers a new electronic null indicator, Model 457, for use as a d-c voltage null detector in bridges. Use of a chopper-stabilized amplifier results in a sensitivity of 20 uv/in. with less than 1-μv drift and 1-μv noise.

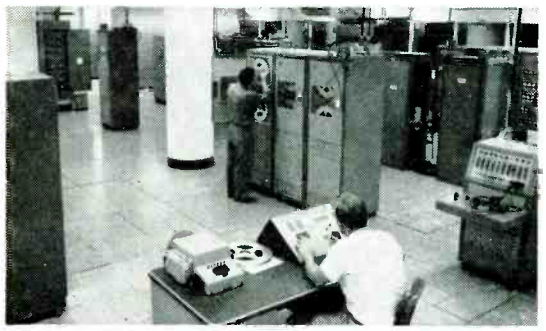
The balanced input shows an input resistance of 2 megohms. Power consumption is 40 w. Units are available for either cabinet or standard rack mounting. **Circle 410 on Reader Service Card.**

R-F PROBE
all transistorized

KAY ELECTRIC Co., 14 Maple Ave., Pine Brook, N. J., has introduced the Transiprobe, a new all transistorized broad-band, low capacity r-f probe. It has unity gain which

How to cope with an avalanche of urgent data

Tape keeps ballistic missile tests in manageable form



Four of the twenty-four Ampex FR-100 Tape Transports at the General Electric Missile and Ordnance Systems Department facility in Philadelphia.

Nobody intends to get buried, drowned, suffocated or trampled as the floodgates open on one of the biggest of all data-acquisition programs. For its ballistic missile development contracts, General Electric's Missile and Ordnance Systems Department has installed a data-processing and computation center to match the challenge.

A PREFERENCE FOR TAPE

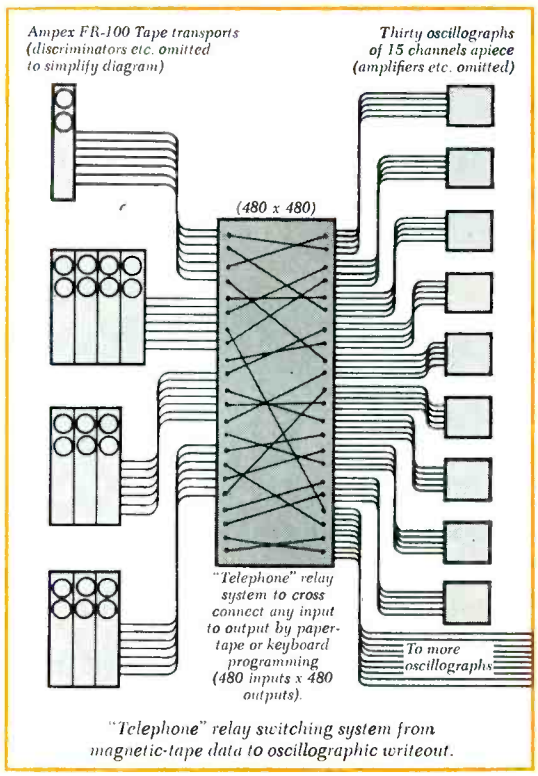
Of the test information received, about 90 percent will be on tape. Two facts about magnetic tape recording help keep the sheer mass of information under control: (1) hundreds of simultaneous parameters are recorded on one tape with a common time base; (2) tape gives live electrical voltages, hence reducing, correlating, computing and handling steps can be done automatically. General Electric's goal is to provide all interested engineering groups with both analog and computed data within three days of receipt of raw tapes.

Tapes from flight test, ground test and component development will be received from sources all over the U.S. These tapes will include quarter, half and one-inch widths. Hence most "tape stations" in the data-reduction system will have three Ampex FR-100 tape transports for the three widths. They will share electronics.

NOVEL USE OF A TELEPHONE TECHNIQUE

The right data must get to each of a large number of research and design groups. No traffic snarls allowed – so General Electric's engineers have made ingenious use of taped data's electrical form. They use a "telephone central station." After the necessary conversion steps, hundreds of channels of data from magnetic tape are fed into an automatic relay switching system. This connects them into 450 channels of oscillographic writeout (30 oscillographs with 15 channels apiece). When desired one input can go through a multiple relay putting the same data trace on two or more of the oscillograph records. Programming is done by a carefully checked paper tape. The end result is visual traces in a desired side-by-side relation. And each oscillograph record contains the data of interest to particular engineering groups.

Magnetic tape comes to life again in computation. The visual records are marked wherever special computer effort is required. Another group



"Telephone" relay switching system from magnetic-tape data to oscillographic writeout.

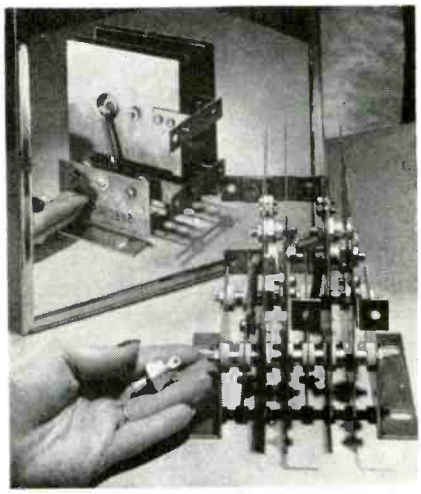
of Ampex FR-100 Tape Reproducers plays the tapes through a high-speed analog-to-digital conversion system which finds and converts selected sections to digital form at a rate of 45,000 conversions per second.

If mass of data is your problem, we would be pleased to discuss some practical answers. Or would you like to have this informative ad series mailed direct? For either request, write Dept. E-7.

is held constant by a transistorized feedback amplifier, insuring complete stability. The unit is powered by mercury cell batteries. Standard BNC connectors are provided to the scope and battery-box power supply.

The Transiprobe's low input capacity makes it ideal for use with all types of broad-band oscilloscopes and as an oscilloscope isolation amplifier.

Features include low power dissipation, no hum and open design for easy manipulation. Frequency response is 20 cps to 15 mc; 1 db down at 50 cps and 12 mc; 3 db down at 20 cps and 15 mc. **Circle 411 on Reader Service Card.**



SILICON RECTIFIERS
are hermetically sealed

WESTINGHOUSE ELECTRIC CORP., P.O. Box 2099, Pittsburgh 30, Pa. Two new silicon power rectifiers (types 302 and 303) are now available. They are hermetically sealed silicon rectifying cells providing d-c currents up to 35 amperes and 22 amperes halfwave, respectively, with a maximum peak inverse voltage up to 600 v.

The forward voltage drop of cell 302 will not exceed 0.9 v at a forward current of 10 amperes in ambient temperatures of 25 to 35 C. Reverse leakage of the cell is a maximum 20 ma at rated peak inverse volts and maximum temperature. Maximum operating junction temperature is 190 C.

For cell 303, the forward voltage drop will not exceed 1.2 v at

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A pioneer in the field of panoramic instruments since 1938, Panoramic Radio Products, Inc., now brings to the service of American industry the result of a long-established and far-sighted program. It is the new and modernly-equipped plant shown above—designed and built for advanced engineering and ultra-efficient production.

Throughout industry from coast to coast Panoramic instruments for measurement and visual analysis are simplifying and speeding analyses . . . eliminating slow, less-certain methods of measurement . . . aiding research and development . . . clearing production test bottlenecks.

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But industry's need for instruments of advanced design is never static. And as the need expands, both for quality and quantity, Panoramic will continue to meet it with its new and modern facilities.

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is the leader

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RESEARCH • DEVELOPMENT • PRODUCTION

a forward current of 10 amperes in an ambient temperature of 25 to 35 C. Reverse leakage is a maximum 10 ma at rated peak inverse volts and maximum temperature. Maximum operating junction temperature is 190 C.

On both cells, the plated rectifier case is the positive (cathode) terminal and has a threaded ¼—28 stud for through mounting. Each cell, weighing 0.65 oz, is shipped with hex nut, lock washer and flat washer, two 0.003-in. thick mica washers and an insulating bushing. **Circle 412 on Reader Service Card.**

HIGH POWER DIODE
for long trouble-free use

INTERNATIONAL TELEPHONE AND TELEGRAPH CORP., Components Division, 100 Kingsland Road, Clifton, N. J., has introduced a high power, high vacuum diode, for use in charging, shunt or rectifier applications.

Designated the F-7030, the new tube has a maximum peak inverse voltage of 25 kv. Under shunt conditions, maximum peak plate current of 75 amperes and average plate current of 200 ma are obtainable. In rectifier applications the ratings are 30 amperes maximum peak plate current and 6 amperes maximum average plate current, respectively. Tube impedance at 250 plate volts is within the range of 65 to 80 ohms.

The external anode of the F-7030 is forced air cooled and is capable of dissipating 2.5 kw at 2.5 in. of water, static air pressure, and 150 cu ft per minute air flow. The tube is also obtainable

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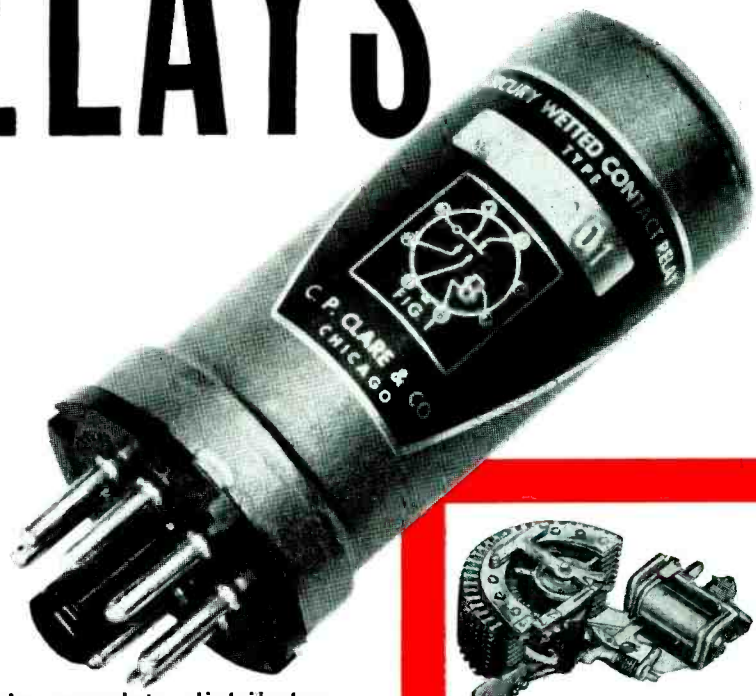

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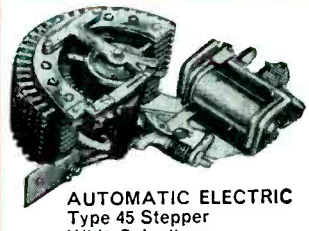

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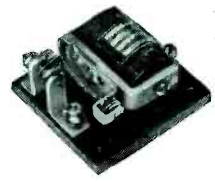
Type 45 Stepper
Wide Selection



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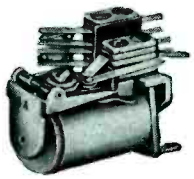
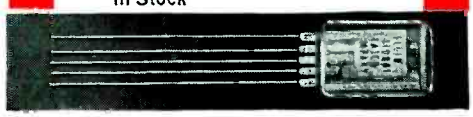
Keying Relay
Many Types in Stock



PHILLIPS CONTROL
9QA Midget for Sub Chassis Mounting. Many Others in Stock



(Actual Size)
NEOMITE-ELGIN
Sub Miniature Hermetically Sealed Relay. All Advance Types in Stock

Write or Phone for Same Day Shipment

Phone: West Chicago 1100

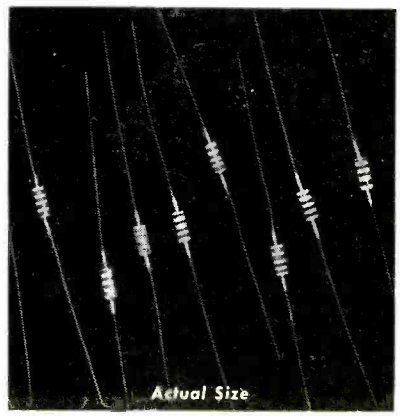
RELAY SALES, INC.

P.O. BOX 186-A **West Chicago, Ill.**

Circle 206 Readers Service Card

with the anode liquid cooled with plate dissipation ratings up to 6 kw. Filament excitation requirements are 13 and 13.75 v for rectification and shunt applications respectively, at approximately 36 amperes.

Maximum overall length and width are 7 in. and 3 17/32 in. respectively. Approximate weight is 6 lb. **Circle 413 on Reader Service Card.**



MOLDED RESISTORS
for miniature apparatus

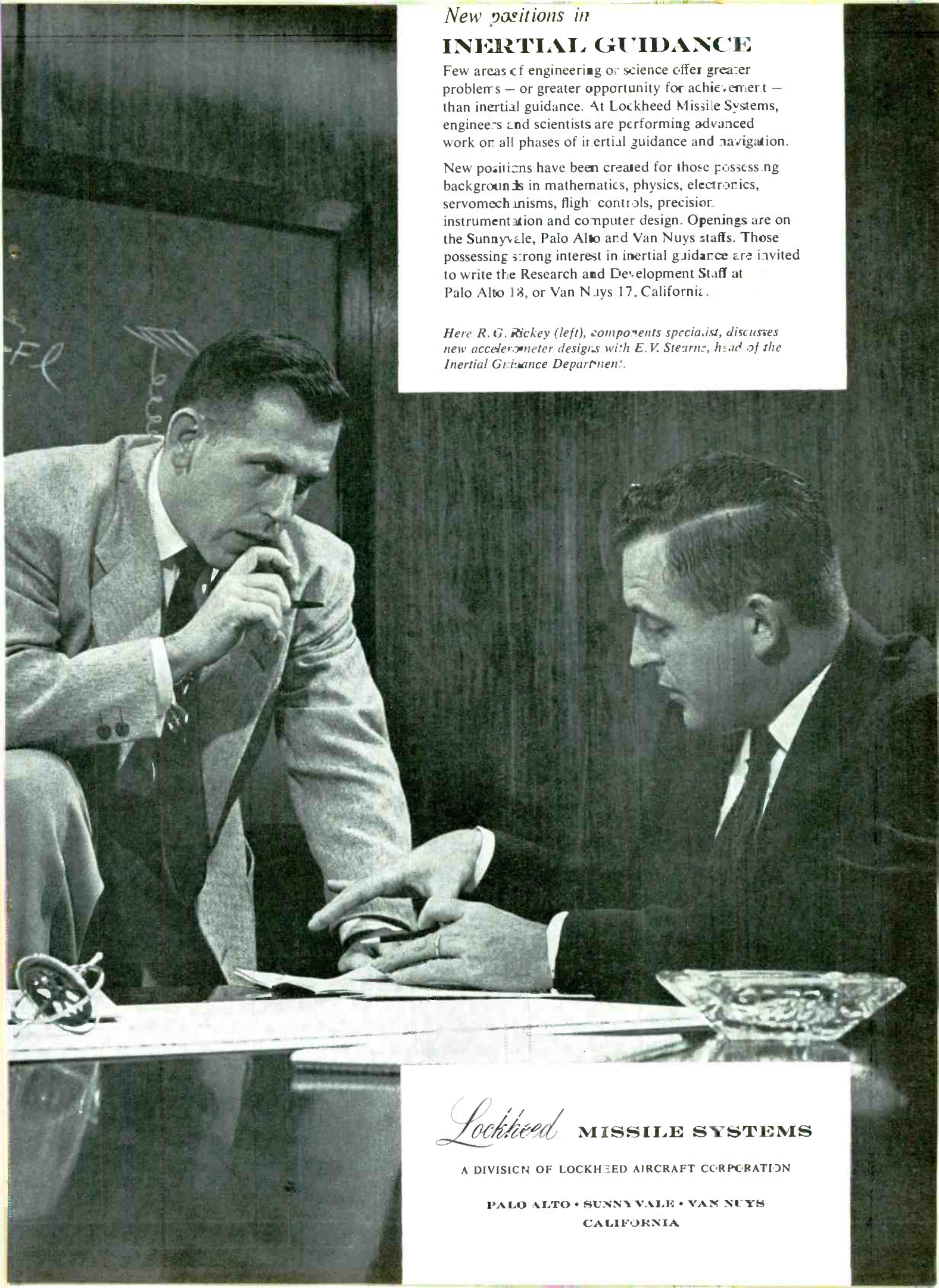
OHMITE MFG. CO., 3631 Howard St., Skokie, Ill. Molded composition resistors in a tiny 1/10 w size have been added to the company's line of ½, 1 and 2 w "Little Devil" units. These new resistors, only 0.067 in. in diameter and 0.140 in. long, are intended for use in miniaturized assemblies where small size is mandatory.

The lead wires are molded solidly into the resistance material for a mechanically superior, reliable electrical connection. Lead wires are hot-solder-coated for rapid soldering.

Used within their ratings, these units maintain their resistance values consistently under long use and are available in RETMA values from 100 ohms to 1.0 megohm, ±10 percent tolerance. Bulletin 150 is available. **Circle 414 on Reader Service Card.**

CERAMIC TRIODE
high-temperature type

EITEL-MCCULLOUGH, INC., San Bruno, Calif., has announced a new premium quality ceramic planar



New positions in

INERTIAL GUIDANCE

Few areas of engineering or science offer greater problems — or greater opportunity for achievement — than inertial guidance. At Lockheed Missile Systems, engineers and scientists are performing advanced work on all phases of inertial guidance and navigation.

New positions have been created for those possessing backgrounds in mathematics, physics, electronics, servomechanisms, flight controls, precision instrumentation and computer design. Openings are on the Sunnyvale, Palo Alto and Van Nuys staffs. Those possessing strong interest in inertial guidance are invited to write the Research and Development Staff at Palo Alto 18, or Van Nuys 17, California.

Here R. G. Rickey (left), components specialist, discusses new accelerometer designs with E. V. Stearns, head of the Inertial Guidance Department.

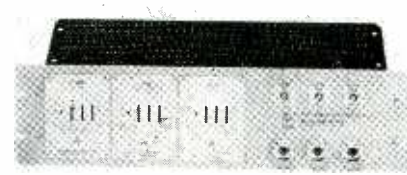
Lockheed **MISSILE SYSTEMS**

A DIVISION OF LOCKHEED AIRCRAFT CORPORATION

PALO ALTO • SUNNYVALE • VAN NUYS
CALIFORNIA

triode. Designated the 3CX100A5, this high temperature ceramic triode has been designed to overcome all disadvantages of the 2C39 types, and is mechanically and electrically interchangeable with that series.

Among the advantages achieved over the 2C39 family are: longer life, 10 percent more power output at 2,500 mc, full ratings to 60,000 ft, lower interelectrode leakage and sustained performance at temperatures to 300 C. It can be employed to 3,000 mc. High quality and close tube-to-tube uniformity are achieved by a series of rigid production tests, including a long pulse cathode evaluation test and a positive grid voltage-current division test. **Circle 415 on Reader Service Card.**

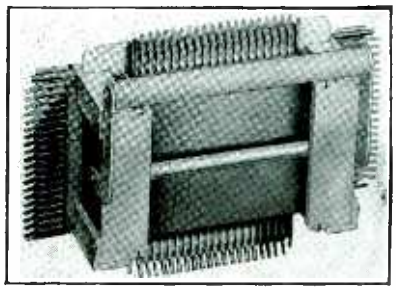


INSTRUMENT AMPLIFIER
general purpose type

ENDEVCO CORP., 161 East California St., Pasadena, Calif. Designed for impedance matching of piezoelectric transducers or other high impedance signal sources to the direct driving of galvanometers or meters, the new model 2616 amplifier features 3 channels with indi-

vidual gains of 1, 3 or 10. A three-decade shunt capacitor is built into each channel to make possible standardization of each transducer to the desired exact sensitivity, such as 10.0 mv/g. Addition of capacity in steps of 10 $\mu\mu$f to 10,000 $\mu\mu$f is also used to attenuate large signal voltages from piezoelectric transducers.

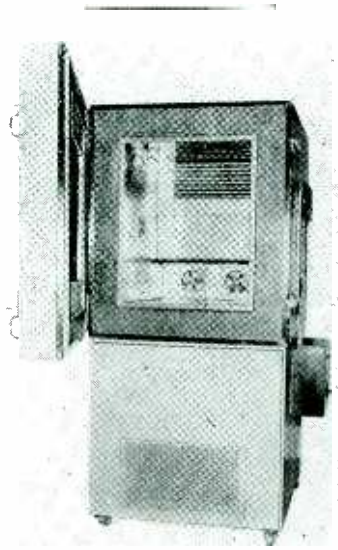
Input conditions may be selected as 1,000 megohms, with or without d-c isolation, or 22 megohms. Output will drive a 2,500-ohm or higher load, or a 25-ohm load such as galvanometer recorders. Model 2616 features extremely low noise levels and gain linearity of 1 percent. Frequency response is ± 1.5 percent, 2 cps to 15 kc. This compact unit mounts in standard rack and is only 5 in. high. **Circle 416 on Reader Service Card.**



PUNCHED CARD READER
simplifies circuit switching

CINCH MFG. CORP., 1026 S. Homan Ave., Chicago 24, Ill. This punched card reader is a simplified circuit switching device having great versatility, which provides a substitute for patch cord panel systems used in the changing of circuit connections at random intervals. It features a molded block with 400 floating contacts passing from one face to the other. This block is sandwiched between two printed wire boards having strip conductors in various grill-like formations. The contacts make connections between groups of conductors on one of these printed wire boards to other groups on the other, except where a card interposes an insulation. Perforations in the card permit connections to be made where desired, and to be changed by substituting a new card.

Ordinary 3 in. by 5 in. cards are used, containing the 400 hole positions, in a 20 by 20 array. In use, a card is inserted in the slot at the top and the lever closed. Safety features include means for insuring that the card is inserted in the correct position, and that closure is not made while a card is missing. Provision is also made so that the circuits are disconnected before the contacts are opened. This insures that all circuits are dead when closures are made or opened. Due to the wide variety of configurations possible with the printed wiring boards, this reader will find applications in the most complicated circuit switching. **Circle 417 on Reader Service Card.**



TEST CHAMBER
has 10-cu ft work space

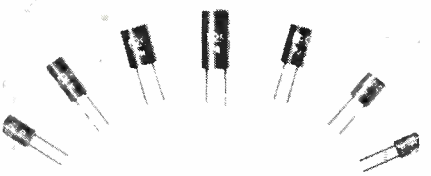
TENNEY ENGINEERING, INC., Environmental Division, 1090 Springfield Road, Union, N. J. A new temperature test chamber, the series 10, has a full 10-cu ft work space.

The low-cost chamber incorporates single stage and cascade refrigeration systems with fully hermetic compressors and fitted with air-cooled condensers. Compactly arranged, they require no installation service other than single plug-in electrical connections.

Four standard assemblies are offered with low temperature ranges of −40 F, −85 F, −100 F and −120 F; high temperature ranges of +240 F, and +350 F. Optional relative humidity could be

20 to 100 percent (limited by +35 F dewpoint) and 5 percent at +160 F.

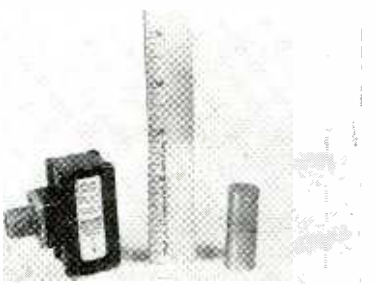
Interior dimensions measure 2 by 2 by 2½ ft high, covering floor space of 3¼ by 3¼ by 6½ ft high. Positive seal is guaranteed by a dual door gasket. **Circle 418 on Reader Service Card.**



FLAT-TOP RESISTORS
for printed circuits

RESISTANCE PRODUCTS CO., 914 South 13th St., Harrisburg, Pa., has introduced a new flat top, encapsulated wire wound precision resistor design for easy, rapid mounting on printed circuit panels with no support required other than the wire leads.

This new type P resistor is a single ended, miniature series available in 7 sizes—from ¼ in. diameter by $\frac{5}{16}$ in. long, up to ⅜ in. diameter by ¾ in. long. It features resistance values to 3 megohms, ratings from $\frac{1}{10}$ w to 0.4 w. The units can be operated in ambient temperatures up to 125 C. Tolerances are from 1 percent to 0.02 percent. Type P resistors will withstand all applicable tests of MIL-R-93A, Amendment 4. **Circle 419 on Reader Service Card.**



INERTIA SWITCH
with Automatonic operation

SAFE LIGHTING INC., 527 Lexington Ave., New York, N. Y. A new

miniature inertia switch operates by a radically new, simple principle. It is designed to eliminate usual "stiction" (causing unreliable function), costly, complicated mechanisms, and waste space.

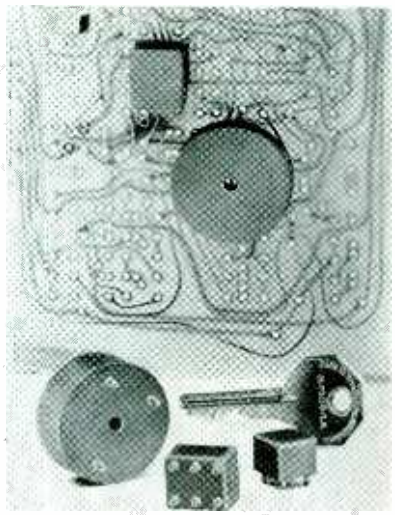
One single moving part, frictionless in operation, momentarily closes electrical contacts, following impact or acceleration above a preset value. Switch setting is easily adjustable from 1.5 g up, tolerance ±0.15. Volume is ½ cu. in., weight ¾ oz.

The switch is used now for aircraft, missiles, electronic and automatonic components. Special designs are available to specifications. **Circle 420 on Reader Service Card.**

CRYSTAL FILTER
priced at $44.50

HYCON EASTERN, INC., 75 Cambridge Parkway, Cambridge 42, Mass., has introduced a standard line of i-f band-pass crystal filters for improved design of single conversion receivers in the h-f and vhf bands.

Model 2215 KA is designed for voice utilizing a 2,800 cycle 6 db bandwidth. Model 2215KB has a band of 250 cycles and is of primary interest in c-w reception. The units are electrically and mechanically interchangeable and may be cascaded in any combination to achieve selectable selectivity. They may be incorporated between the mixer and i-f amplifier of a single conversion receiver. No padding or transformation networks are required between the two filters since they are designed to operate at the same impedance level. Complete instructions including mixer and i-f circuitry are supplied with the filters. **Circle 421 on Reader Service Card.**

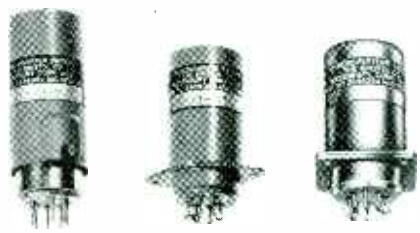


TRANSFORMERS
use new sealing method

TRIAD TRANSFORMER CORP., 4055 Redwood Ave., Venice, Calif., announces a new method of epoxy molding called Tri-Seal. The process provides all the advantages of hermetic sealing plus greater ease of handling and installation.

The transformers illustrated possess the additional advantages of (1) holding close tolerances on terminal positioning for use in printed circuitry, and (2) hollow goldplated terminal pins which rivet over for better mechanical and electrical connections.

Tri-Seal transformers are designed to exceed MIL-T-27A requirements. **Circle 422 on Reader Service Card.**



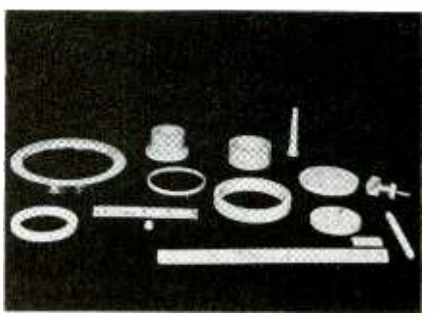
CHOPPERS
for top application utility

THE BRISTOL CO., Waterbury 20, Conn. The company's Syncroverter

switch, a precision, non-resonant inverter, is now being offered in over 75 optimized variations for low power and dry circuit applications. These different models were designed primarily to meet customer requirements for specific applications.

Wide variations in contact ratings, vibration and shock resistance, and frequency ranges are available to fit specific circuit requirements. Special low-noise and high temperature units are available where needed. Mounting arrangements to meet particular conditions are offered, including standard 7-pin plug-in bases or solder lug connectors with mounting flanges.

The chopper can be furnished in either spdt or dpdt switching action. Miniature and larger sized unit are available. **Circle 423 on Reader Service Card.**



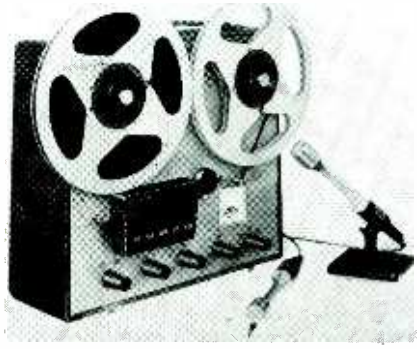
HIGH PURITY ALUMINA
for microwave applications

KEARFOTT CO., INC., 1378 Main Ave., Clifton, N. J., has available high-purity, aluminum oxide ceramics for use in radomes, waveguide components, v-t envelopes and for applications where high resistance to radiation is required.

This alumina has unique dielectric properties in the microwave region. At 50 kmc its loss factor is only 0.000093; X-band and Ku-band loss factors vary from 0.0017 at room temperature to 0.00017 at 1,000 F. Most significantly its dielectric constant of 9.38 ±1 percent remains stable over the entire temperature range, up to 1,000 F. Kearfott's high purity alumina ceramics have a low frequency loss at high temperatures.

Electrical properties, along with high mechanical strength and di-

mensional stability at high temperatures, recommends the use of this material as microwave insulators and windows. **Circle 424 on Reader Service Card.**



TAPE RECORDER
for audio-visual field

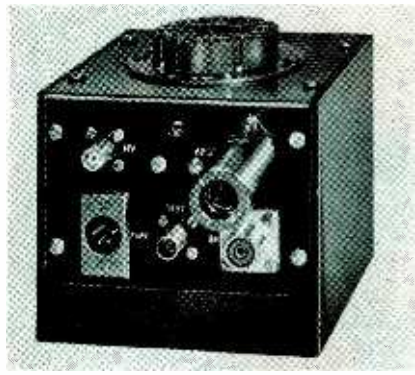
AUDIO DIVISION OF AMERICAN ELECTRONICS, INC., 655 W. Washington Blvd., Los Angeles 15, Calif. Series AV lightweight recorders, for half track or stereophonic record and playback, are of die-cast construction with three integral motors—one for tape drive and two for take-up.

With push-button operation and safety erase interlock, the recorders accommodate reel sizes up to 10½ in. and are built to operate in either a vertical or horizontal position. All recorders are designed for standard 3¾ and 7½ ips, 60 cycle operation; 50 cycle units are also available. **Circle 425 on Reader Service Card.**

AMPLIFIER
for proportional counting

BAIRD-ATOMIC, INC., 33 University Road, Cambridge 38, Mass. Model 255S amplifier is a nonoverloading, stable instrument designed for use with gas flow counters operating in the proportional region. It is designed to receive power from an associated scaler. High voltage for the instrument's detector can be supplied from a scaler or separate h-v supply. The unit measures 9½ by 4 by 2 in. plus tube height; weight is 4 lb; shiping weight is 10 lb.

Gain is approximately 300; input, from proportional counter; minimum output, 6 v negative, 2 μsec duration. It has a built-in delay line for pulse shaping. **Circle 426 on Reader Service Card.**



PREAMPLIFIER
photomultiplier type

HAMNER ELECTRONICS CO., INC., P. O. Box 531, Princeton, N. J. The N-352 photomultiplier preamplifier is designed to achieve greater flexibility and wider application in the field of scintillation spectroscopy.

The preamplifier is particularly suitable for driving long coaxial cables with characteristic impedances between 65 and 78 ohms, such as RG6, RG11, RG12, RG59 and RG81. A slight modification will permit a match for 51 ohm cable. **Circle 427 on Reader Service Card.**

SAMPLING SWITCH
in hermetically sealed case

GENERAL DEVICES, INC., P. O. Box 253, Princeton, N. J. Series 300 high speed sampling switch has up to two poles with 30 nonshorting channels per pole. The switch is driven by either a 28 v d-c motor equipped with a governor, arc-suppression and an r-f filter, or an 115 v, single phase, 400 cps hysteresis synchronous

motor. The company's constant force perma brushes and lifetime semi-molded contact plates insure long service free life.

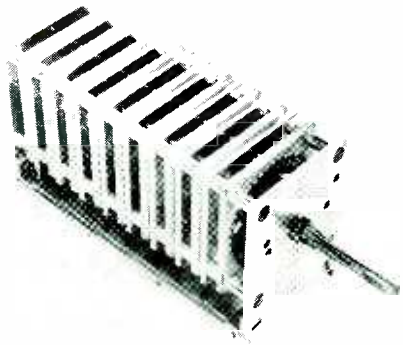
Approximate dimensions are 2.750 in. by 4.940 in. by 3.870 in. Typical applications include high altitude telemetry systems, multichannel data systems and error indicating systems. Current models include single or multiple pole, stacked, concentric, opposed, raised contact, segmented or printed circuit design. A brochure is available. **Circle 428 on Reader Service Card.**

PNP TRANSISTOR
features high gain

BENDIX AVIATION CORP., Red Bank Division, 201 Westwood Ave., Long Branch, N. J., announces the 2N285A high gain germanium *pnp* audio power transistor. Current gains are up to 250 at 0.5 ampere collector current, 125 at 2 amperes collector current, and 50 at 3 amperes collector current. It has a maximum collector dissipation of 25 w and a maximum junction temperature of 95 C.

Because of its very high gain the transistor is especially useful in feedback circuits to provide superior performance. There are also numerous applications to high current switching circuits such as static inverters and power

oscillators, and to servo amplifiers and motor control circuits. **Circle 429 on Reader Service Card.**



R-F SWITCH
for use up to 60 mc

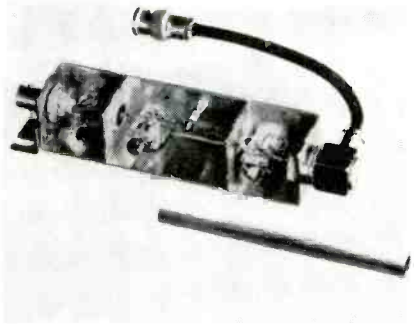
THE DAVEN CO., Livingston, N. J., announces the availability of a new miniature r-f switch, No. 6034. This rotary switch is a miniature unit for use up to 60 mc. It consists of 9 completely shielded decks with 10 position—one pole per deck. All contacts and wipers are of coin silver and all metal parts are silver plated brass. The wiring of this switch is all done with Micro-dot cable and all leads are terminated in Micro-dot connectors. The special feature of this switch is its extremely small size. The entire switch exclusive of shaft is held to 3 in. by 3 in. by 6 in. in depth.

The use of sectional shielding and r-f grounding fingers in conjunction with the outer case results in exceptionally good r-f characteristics. **Circle 430 on Reader Service Card.**

LOW PASS FILTER
uses tiny trimmer capacitors

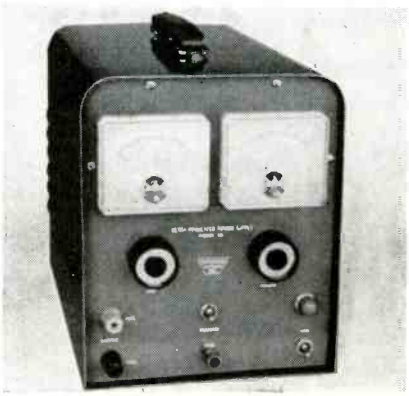
RADIO CONDENSER CO., Davis & Copewood Sts., Camden 3, N. J. A new 400-mc low pass filter measures just 1 in. by 1 in. by 4 in. It combines a low maximum insertion loss from 200 to 400 mc of 0.75 db with rapid attenuation above the passband. Minimum attenuation above 450 mc is 45 db; and at 1,000 mc, 60 db.

Originally designed for a specific application in the defense



effort, the filter is now in volume production, and may easily be modified to meet special requirements.

Maximum rated power handling capacity of the miniature filter is 100 w. Pass band standing wave ratio is 1.5 to 1, and input and output impedance are both 50 ohms. Complete technical data are provided in engineering bulletin FL-462, available on request. **Circle 431 on Reader Service Card.**

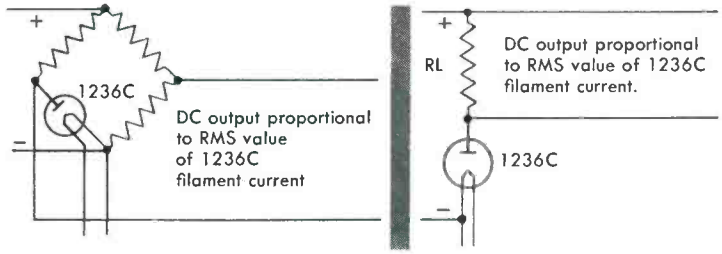


D-C POWER SUPPLY
uses ultrasonics

OPTIMIZED DEVICES, INC., Box 38, Gedney Station, White Plains, N. Y. A new ultra-regulated low voltage d-c power supply utilizes an ultrasonic carrier system to achieve optimum performance consistent with light weight, compactness and efficiency. It can produce 0 to 7.0 v at up to 1.5 amperes. Typical uses are for strain gages, d-c filaments, transistors, precision electroplating, bias supply, and for a precision laboratory reference even under load.

Weight of the unit is 23 lb. Efficiency is pointed out by the fact that the unit draws only 70 w from the a-c line at full output. The instrument features a floating

temperature limited DIODE type 1236C



Temperature limited DIODE type 1236C is designed for service as an RMS detector for a-c voltage and current stabilizers . . . as a detector for d-c voltage and current stabilizers . . . as an RMS detector for differential voltmeters and in other similar applications.

Rigid test conditions and rugged construction assure long dependable tube life under all conditions.

characteristics

ELECTRICAL

	AVERAGE	MAXIMUM
CATHODE (Tungsten)		
VOLTAGE	1.9 Volts A-C or D-C	2.3 Volts A-C or D-C
CURRENT	440 MA	520 MA
PLATE		
VOLTAGE	600 Volts D-C	700 Volts D-C
CURRENT	0.7 MA D-C	1.0 MA D-C

MECHANICAL

MOUNTING POSITION	Any
MAXIMUM OVER-ALL LENGTH	3 3/8 inches
SEATED LENGTH	2 13/16 inches ± 1/8 inch
MAXIMUM DIAMETER	1 17/64 inches
WEIGHT (APPROXIMATE)	1 ounce
BULB	T9 with bakelite base
BASE	Locking-in type D8-1, 8 pin

Ask for DIODE type 1236C at your local distributor or write for complete technical data.

Be sure to see SUPERIOR ELECTRIC'S Mobile Display when it is in your area

Offices: Los Angeles, California • San Francisco, California • Miami, Florida Chicago, Illinois • Baltimore, Maryland Detroit, Michigan • New York, New York Cleveland, Ohio • Dallas, Texas Seattle, Washington

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Have your representative call.

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Company.....

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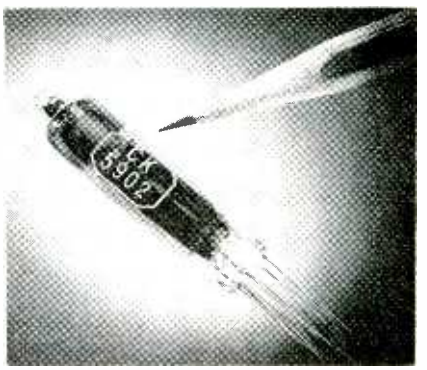
Circle 221 Readers Service Card

output, less than 1.0 mv noise, and response time under 20 milliseconds. **Circle 432 on Reader Service Card.**



SUBMINIATURE TUBE
beam power pentode

RAYTHEON MFG. CO., 55 Chapel St., Newton 58, Mass. Type CK5902 has been added to the company's line of reliable subminiature tubes. This is a high perveance beam power pentode for use as an audio power amplifier, series regulator or in other functions requiring a tube capable of more current and power dissipation than available with other Raytheon subminiature types. The CK5902 has a 6.3 v, 450 ma heater, a 4.1 w plate dissipation, a 165 v plate rating and a maximum plate current of 30 ma in addition to meeting the requirements for military reliable subminiature tubes for guided missile and other critical applications. **Circle 433 on Reader Service Card.**

ISOLATION AMPLIFIER
has selectable bandwidths

KEITHLEY INSTRUMENTS, INC., 12415 Euclid Ave., Cleveland 6, Ohio. Model 102B serves as either a general purpose preamplifier or

Circle 222 Readers Service Card→

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(2) Print your name, title, address, and firm name carefully. It is impossible to process cards that are not readable.

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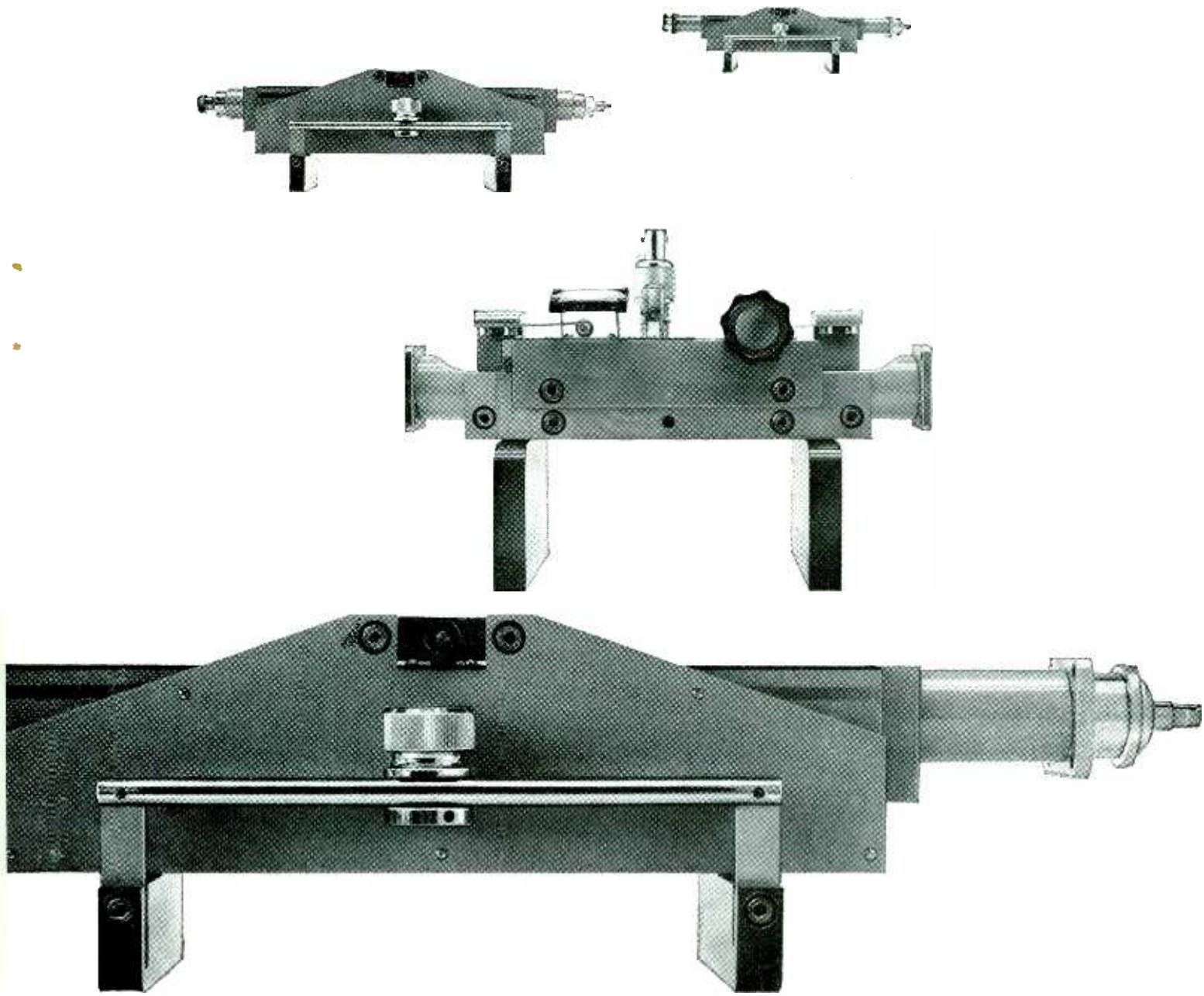
581	582	583	584	585	586	587	588	589	590	591	592	593	594	595	596	597	598	599	600

INSIDE FRONT COVER INSIDE BACK COVER BACK COVER



FINEST, MOST COMPLETE LINE of Precision Slotted Sections

TYPICAL SPECIFICATIONS

Model	Line Size	Equivalent Wave Guide Type	Frequency Range kmc/sec	Insertion Length
200-C	7/8"		1.0 to 4.0	17"
215-A	3/8"		1.0 to 4.0	14 3/8"
203-E		RG-52/U	8.20 to 12.4	7 1/8"
210-A		RG-91 U	12.4 to 18.0	8 1/8"

For full technical details on the complete line of PRD Slotted Sections, or for consultation on the particular model best suited to your needs, call your local PRD Engineering Representative; or write to Applications Engineering Group F.

Be sure to take in the PRD Exhibit at the NEC Show, Booth 162-163.

Ready for IMMEDIATE Delivery!

Whether you are working up VSWR or impedance data in the design or testing of new transmission line components, or are designing an impedance matching device for monitoring antenna and transmission line VSWR in communications systems . . . PRD Slotted Sections provide the superlative answer for precise and accurate information with simplicity and dependability of use.

They have no equal in providing precise standing wave and impedance measurements. PRD Slotted Sections are built of precision-machined "micro-finished" transmission line.

The probe is secured to a ball-bearing carriage that travels in precision-ground, hardened grooved runways. Thus the probe travels in a path exactly parallel to the axis of the transmission line. A marked advantage of PRD Slotted Sections is their permanent adjustment, at the factory, to zero slope—there is no need for adjustment to correct for changing slope characteristics. PRD Slotted Sections are designed to mate with standard MIL type connectors and flanges. Low reflection adaptors are available where additional types of connectors are used.

The ultimate in precision measurements is achieved when PRD accessory items such as Type 250-A Broadband Probe and Type 218-K Accessory Kit are used.

POLYTECHNIC RESEARCH & DEVELOPMENT CO., Inc.

202 Tillary Street, Brooklyn 1, N. Y.

as an excellent isolation amplifier covering both audio and ultrasonic frequencies. It has a 5-v, 50-ohm output to drive oscilloscopes, sound level meters and pen recorder power amplifiers. Frequency response is from 2 cps to 150 kc or to 1.7 mc with selectable bandwidths and accurate decade gains of 0.1 to 1,000.

Other features include a high impedance input of 400 megohms, 3 $\mu\mu$f to reduce circuit loading errors; noise below 10 μv with 150 kc response; and two accessory probes for low-capacitance connection to the circuit being measured.

Typical uses include work with accelerometers and hearing aids, pulse amplification, and vibration and noise studies. **Circle 434 on Reader Service Card.**

CIRCULAR POT
for missile systems

HUMPHREY INC., 2805 Canon St., San Diego 6, Calif., has introduced a new circular potentiometer ruggedly designed for missile systems. Designated type CP05-0101-1, the instrument is moisture-proof and will meet explosion-proof requirements.

It has $1\frac{3}{4}$ in. square base and $\frac{1}{4}$ in. diameter stainless steel shaft with Graphitar bearings. The temperature range is −65 F to 400 F; vibration, 10 g to 2,000 cps. The 10,000 ohm winding can be furnished with taps. **Circle 435 on Reader Service Card.**

EPOXY COATINGS
for printed circuits

HOUGHTON LABORATORIES, INC., Olean, N. Y., has announced full

Individual Initiative in Research and Engineering

The Jet Propulsion Laboratory has brought together an outstanding staff of engineers of exceptional talent and ability. Working individually within the group these men now comprise a highly progressive and productive entity.

A recent survey of this staff indicated that the most important reason for their preference of JPL as a work center is the high degree of responsibility and freedom given the individual to pursue his own assignments. The intriguing nature of the work, challenging problems, professional association, fine residential location, pay scales and opportunities for career development were also important considerations.

This appreciation, from within, of the Laboratory's principle of recognizing ability and talent and allowing it to operate with freedom and confidence under its own initiative is a gratifying tribute in itself.

Working for the U.S. Army on a research and development contract with many ramifications, JPL has broad interests and constantly searches for new approaches to modern technical problems. This provides exceptional career opportunities for those qualified individuals who are interested.

Career Opportunities Now Open in These Fields

ELECTRONICS · PHYSICS · AERODYNAMICS · MATHEMATICS

MECHANICAL ENGINEERING · CHEMICAL ENGINEERING

jpl

JET PROPULSION LABORATORY

California Institute of Technology

PASADENA · CALIFORNIA

commercial production and use of their Hysol modified epoxy coatings for printed circuits.

Hysol 6231 and Hysol 6232 series of compounds, developed for military use, are designed to protect printed circuits against high humidity and low temperature shock conditions. The strong bond produced between the components and the base laminate protects the circuits against mechanical shock and vibration.

Hysol 6231 can be applied by brush or spray and Hysol 6232 by dipping and brushing. No special cleaning is required prior to coating to either system. Both are two component systems.

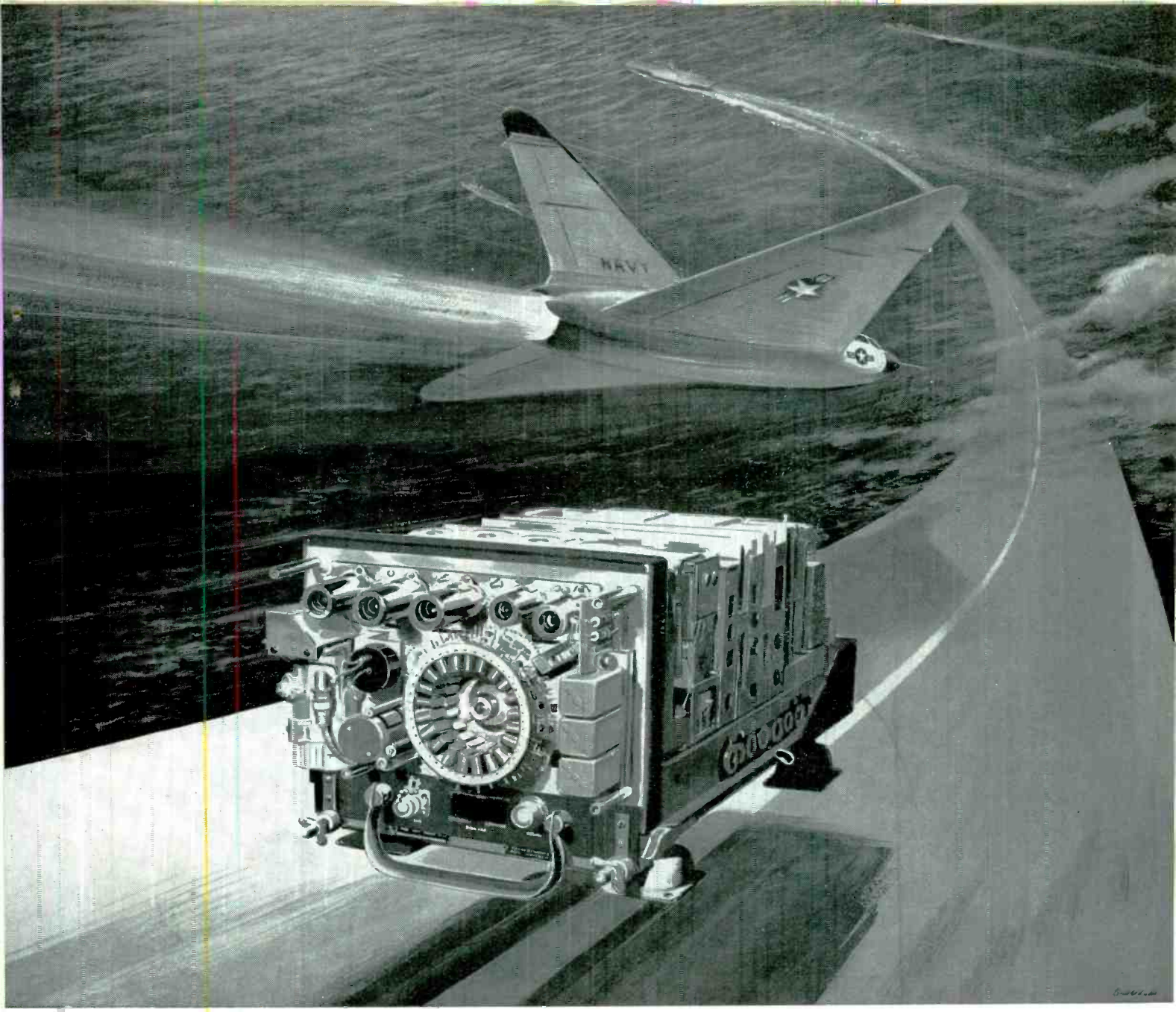
These coatings exceed the specifications of military standard MIL-STD-202A, test methods for electronic and electrical component parts. Write for technical data bulletin 6230 for detailed information and specifications. **Circle 436 on Reader Service Card.**

TRANSDUCER
measures linear displacement

JONES-PORTER INSTRUMENT CO., INC., Box 666, Riverdale, N. J. Model LD-20 linear displacement transducer features an all stainless housing and waterproof connector. It is used to measure linear displacement of 2 in. over distances of 1,000 ft or more.

The device functions with manufacturer's model LD-1 linear displacement indicator using a 60-cycle bridge input, eliminating the necessity for an oscillator and amplifier. It is easily used with a simple bridge circuit. Both the transducer and the indicator are

Circle 225 Readers Service Card→



TACAN unit shown with covers removed; plane is a composite model.

78-~~page~~ tube road map for jets

An 800-foot carrier may be as hard to find as a needle in a haystack, when the plane seeking it is at 20,000 feet and the time is 0200 hours.

To make the homing plane a homing pigeon, we build the "ARN-21" TACAN equipment illustrated above. Its 78 tubes and associated components add up to a self-contained transmitter and receiver, rugged in its ride-resistance and accurate to pin-point tolerances.

The manufacture of equipment as important and complicated as this demands *perfection*, and nothing less. On the military as well as the home front, Stromberg-Carlson has long displayed the ability to take such problems in stride.

STROMBERG-CARLSON

A DIVISION OF GENERAL DYNAMICS CORPORATION

General Offices and Factories at Rochester, N. Y.—West Coast plants at San Diego and Los Angeles, Calif.

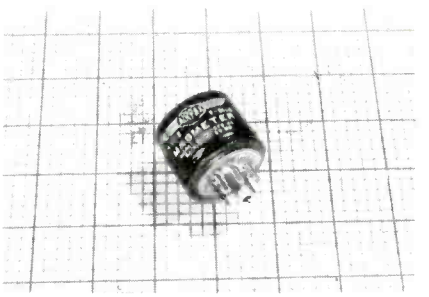
temperature compensated. **Circle 437 on Reader Service Card.**

A-C MOTORS
with outputs up to 1 hp

INDUCTION MOTORS CORP., 570 Main St., Westbury, N. Y., has announced new a-c motors designed for induction, torque or hysteresis synchronous applications, with outputs up to 1 hp.

The 3800 Frame series is available with input voltages of from 26 to 230 v a-c, one, two and three phase; input frequency from 25 to 400 cycles. For induction applications, units in this series are offered in outputs to 1 hp; torque motors 10 to 200 oz in. stall torque; hysteresis synchronous 1/200 to ⅛ hp. Motors can be wound for single, dual or three speed, and can be supplied as self cooled with internal fan.

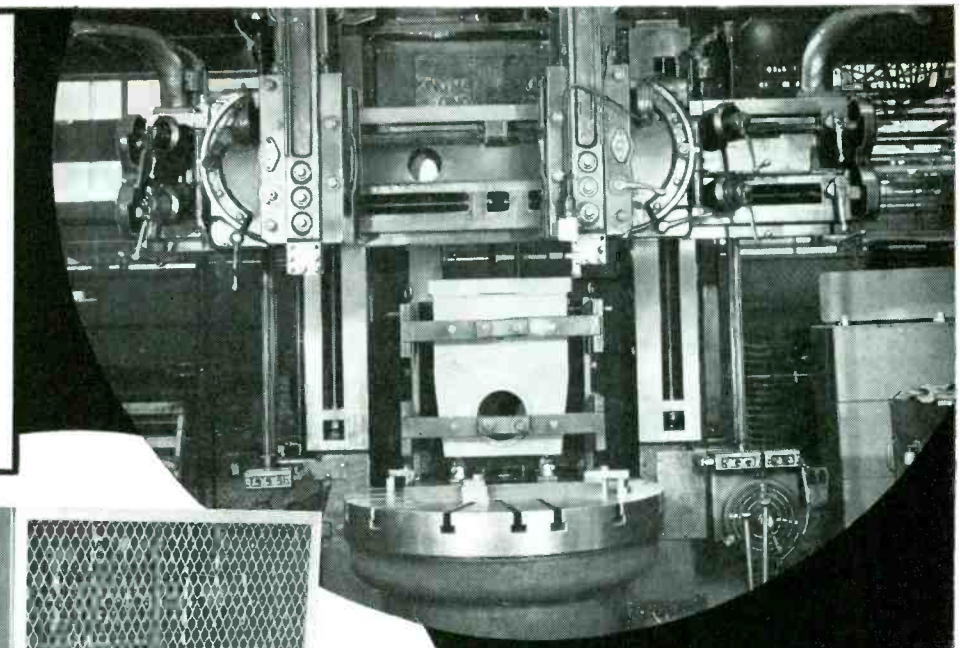
Units in this frame series vary in weight from 8 to 11 lb. All can be supplied for use as fan and blower motors and as p-m generators. **Circle 438 on Reader Service Card.**

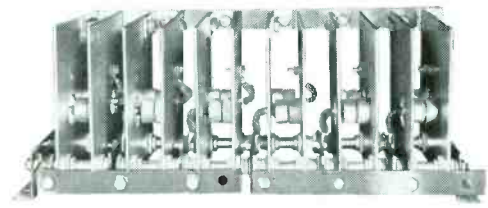


FREQUENCY DETECTOR
range extended to 10 kc

AIRPAX PRODUCTS CO., Fort Lauderdale, Florida. Frequency range of

WESTINGHOUSE SILICON RECTIFIER WN-5082, with maximum peak inverse voltage ratings of 50-400 v. (300 to 5000 amperes in bridge assemblies.)





WESTINGHOUSE SILICON RECTIFIER
6-2-1-B BRIDGE ASSEMBLY

Westinghouse SILICON(Si) RECTIFIERS put more muscle in DC power converter!

Successfully proven in rigorous welding, aircraft and guided missile applications, Westinghouse Silicon Power Rectifiers offer many advantages for power supplies.

Used in the Westinghouse 50KW Power Converter to drive the boring mill above, the WN-5082 bridge assembly supplies greater power and higher efficiency in less space. The 3-phase 60-cycle 440 v. power supply operates with a full load efficiency of 90% and an even higher half load efficiency. Regulation is approximately 8% from no load to full load with a Power Factor of 96 to 97.

Especially rugged for varying duty cycles, the WN-5082 withstands heavy loads of constant on-off operation, high-voltage transients, alternate heating and cooling.

Westinghouse can supply single diodes or complete bridge assemblies built to your specifications. For full information on how Westinghouse Silicon Rectifiers can bring new efficiency and economy to your applications, mail the coupon today.

YOU CAN BE SURE...IF IT'S

Westinghouse

WESTINGHOUSE ELECTRIC CORPORATION
P. O. Box 868, Pittsburgh 30, Pa.

Please send me data on the new Westinghouse WN-5082 Silicon Rectifier.

Please send me data on other Westinghouse Silicon Rectifiers. (Describe types or applications)_____

_____

NAME_____

TITLE_____ **FIRM**_____

ADDRESS_____

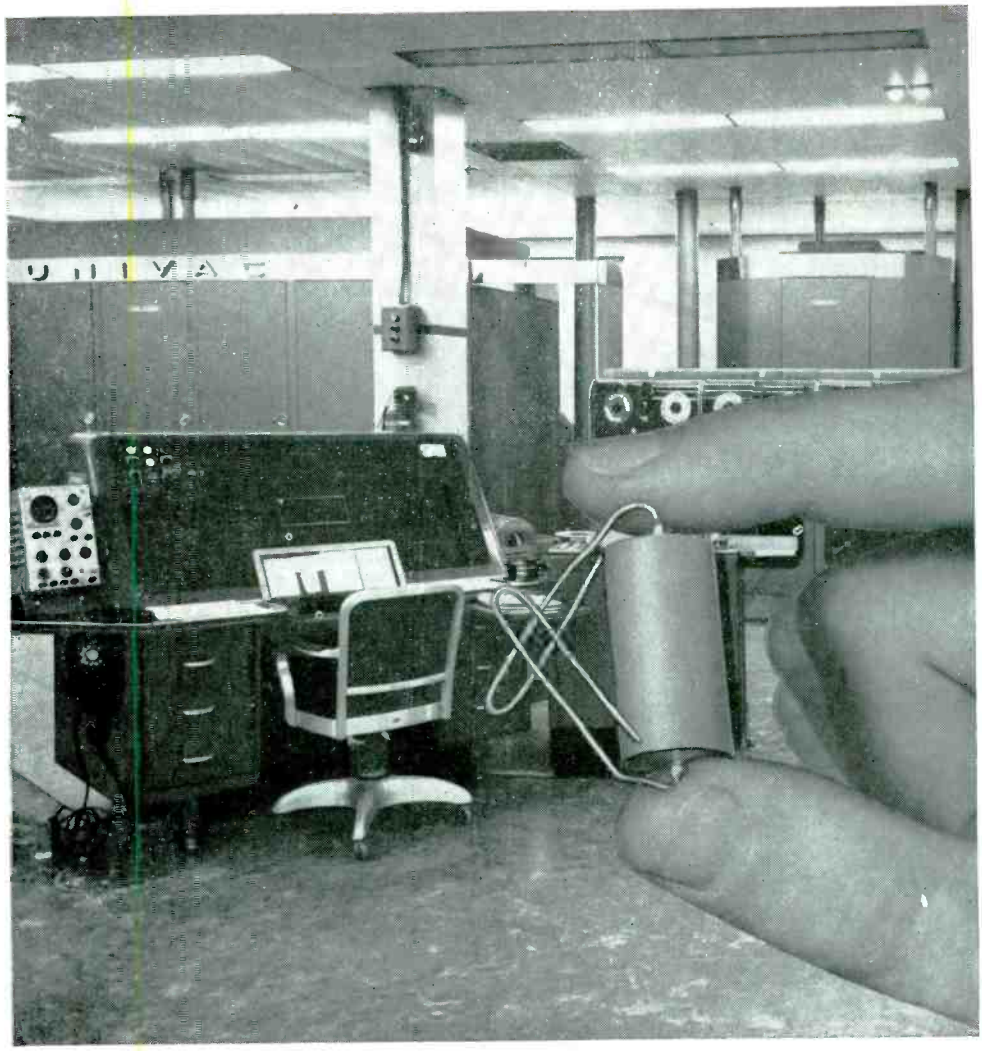
CITY_____ **ZONE**_____ **STATE**_____

Magmeter type frequency detectors has been extended to 10 kc, twice the frequency range heretofore available. These detectors are used in instantaneous pulse rate indicators, electronic tachometers, direct-reading frequency meters, and automatic speed controls. Type F-5116 operates from 0 to 10 kc producing 1 ma full-scale output. It is, therefore, suitable for feeding recorders to provide a permanent record of frequency changes. Changes in input voltage from 105 to 135 v produces only about 1 percent change in indicated frequency. Output current is linear within 1 percent of full scale. The unit operates directly from a 115-v line or from a vacuum tube driver. Narrower frequency ranges can be provided down to as little as 5 percent either side of any center frequency up to 10 kc. **Circle 439 on Reader Service Card.**

TRIODE MODULATOR
for instrumentation radar

INTERNATIONAL TELEPHONE AND TELEGRAPH CORP., Components Division, 100 Kingsland Road, Clifton, N. J., has developed a new hard tube triode modulator, the F-6920, for use in instrumentation radar.

The tube has a peak plate current and hold-off voltage of 150 amperes and 35 kv respectively. The F-6920 is intended for switching applications within the range of 0.002 duty factor and 15 μsec pulse length. The anode is forced



TESTS BY REMINGTON RAND PROVE . . .

Du Pont MYLAR® provides greater reliability, longer life for capacitors used in Univac®

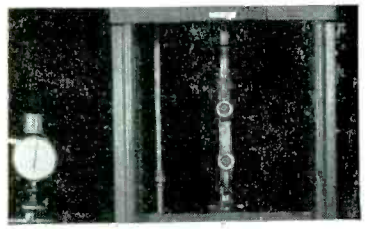
PROBLEM: The Remington Rand Division of the Sperry Rand Corp. had to find a capacitor of high reliability that could meet the requirements of extra-sensitive circuits found in UNIVAC* Data Automation Systems.

SOLUTION: In a series of accelerated tests by Remington Rand, various types of capacitors were exposed to conditions more exacting than those found in normal operation of UNIVAC Systems. These tests proved that capacitors made with "Mylar"† polyester film offered greater reliability and longer life, with an extra margin of safety in moisture resistance. The tests documented the fact that "Mylar" provides excellent insulation resistance at high temperatures . . . "Mylar" does not deteriorate with age or voltage stresses within normal operating ranges.

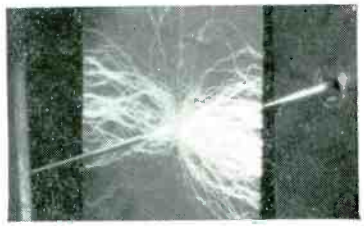
RESULTS: By using capacitors made with "Mylar", Remington Rand has improved the performance of another component in UNIVAC Systems . . . has helped improve the performance of UNIVAC Systems themselves.

HOW CAN "MYLAR" HELP YOU? Whether you make guided missiles or tiny components, it will pay you to investigate the unique advantages of using "Mylar" film . . . or products made with "Mylar". Send for a copy of our new booklet containing detailed information on properties and applications.

"MYLAR" offers a unique combination of properties valuable for electrical design



HIGH TENSILE STRENGTH. "Mylar" is the strongest plastic film. Instron tester shows an average strength of 20,000 lbs. psi.



HIGH DIELECTRIC STRENGTH. Average of 4,000 volts per mil . . . average power factor of 0.003 at 60 cycles . . . dielectric constant above 3.0 at 72°F., 1,000 cycles.

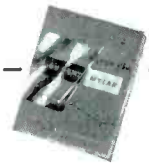
THERMAL STABILITY. Tests prove "Mylar" has an effective operating range, -80°F. to 300°F. . . . won't brittle with age.

DU PONT
REG. U. S. PAT. OFF.

BETTER THINGS FOR BETTER LIVING
. . . THROUGH CHEMISTRY

DU PONT
MYLAR®
POLYESTER FILM

*UNIVAC *is a registered trademark of Sperry Rand Corporation.*
†"MYLAR" *is Du Pont's registered trademark for its brand of polyester film.*



E. I. du Pont de Nemours & Co. (Inc.)
Film Dept., Room E-8, Wilmington 98, Del.

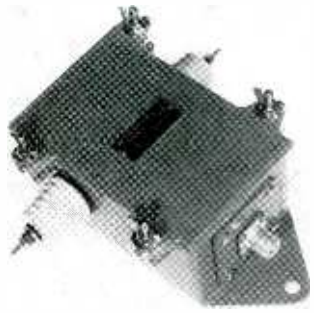
Please send your booklet listing properties, applications and types of "Mylar" polyester film available (MB-11).

Application_____
Name_____ Title_____
Company_____
Address_____
City_____ State_____

Circle 229 Readers Service Card

air cooled and is capable of dissipating 10 kw at ambient air temperatures of 50 C. The filament is designed to operate over a voltage range of 11.0 to 11.9 v depending on the peak plate current requirements. Filament current is approximately 300 amperes.

The F-6920 has a maximum overall length of 24 in., a maximum overall width of 8 in. and an approximate weight of 60 lb. Its high temperature gettering qualities protect it against overloads throughout the tube's life and its specially treated grid minimizes primary and secondary grid emission. **Circle 440 on Reader Service Card.**



ANTENNA COUPLING
or matching transformer

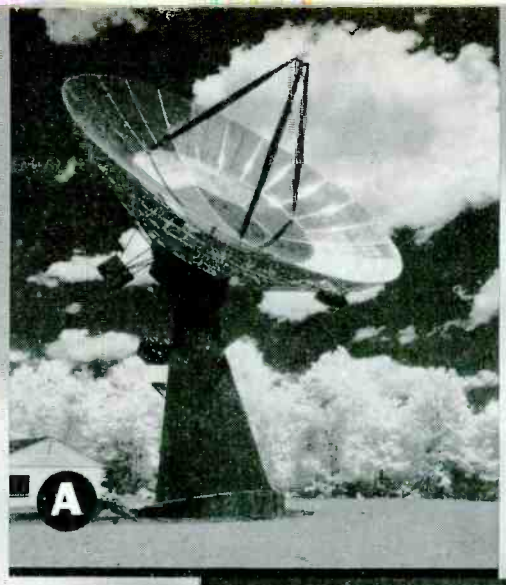
NEMS-CLARKE INC., 919 Jesup-Blair Drive, Silver Spring, Md. Type 803 antenna coupling or matching transformer is designed to match a 700 or 200-ohm receiving antenna balanced transmission line to a 72 or 52 ohm coaxial line with a minimum transmission loss over the range of 1 to 50 mc.

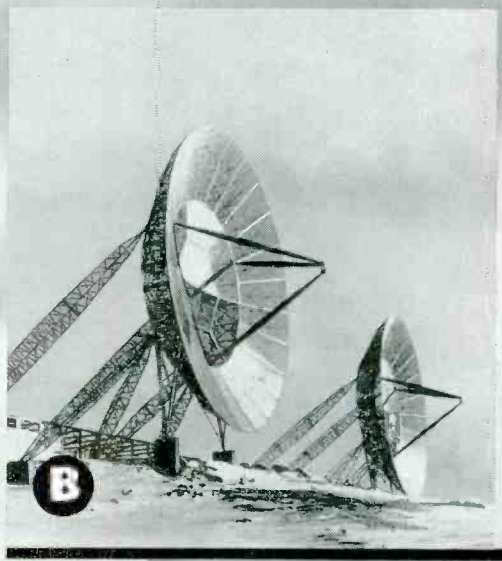
This transformer employs the use of a new type core material which extends its frequency response considerably beyond that of former units. The insertion loss has also been kept quite low, less than 1 db at mid-band. A spark gap arrangement has been provided for protection against the effects of lightning.

The transformer and circuitry have been arranged to provide d-c continuity through the antenna for checking purposes. The transformer has been designed with an octal plug to allow easy replacement. Printed circuitry is

ANTENNA PROBLEMS?

Ask Kennedy!





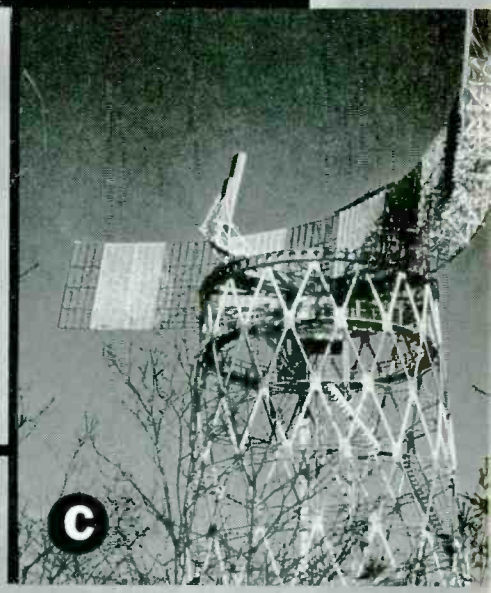
A *60' Radio Telescope*
Harvard University

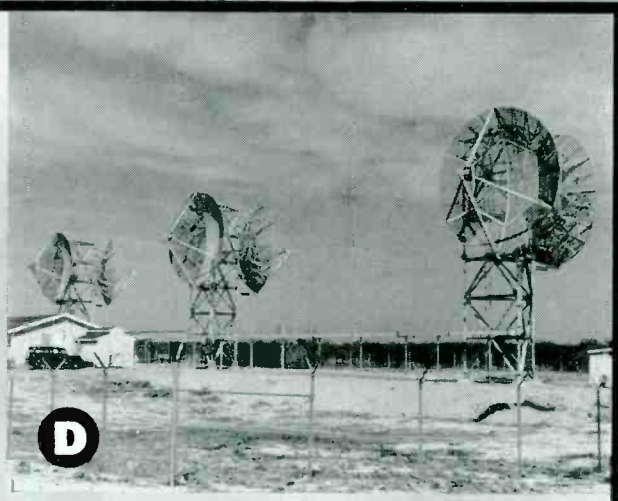
B *60' Trans-horizon Antennas*
Northern Europe

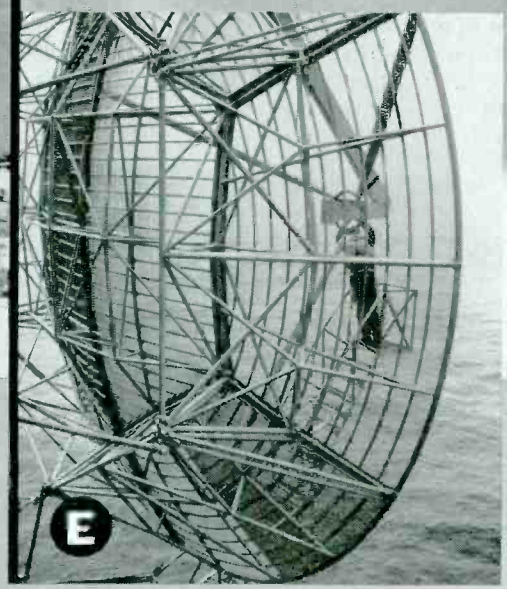
C *120' Radar Antenna*
Maine

D *28' Trans-horizon Antennas*
Cape Cod

E *28' Trans-horizon Antenna*
Texas Tower







The solution to antenna problems begins when someone says: "Let's ask Kennedy!"

A few of the many reasons why are shown on this page. These Kennedy antennas are setting new standards for all-weather reliability and versatility wherever they serve throughout the free world.

Kennedy antennas come in many shapes, many sizes (the world's largest scatter antenna is being built here). But whatever the type, and whatever the conditions under which it must serve, Kennedy can offer a design that fully measures up to specifications. And there are additional advantages in Kennedy's advanced construction techniques — like the extra ease in shipping and handling made possible by sectionalized aluminum construction, for example.

Kennedy engineers are available to supervise installations anywhere in the world. It's a part of the complete, integrated service that is still another reason why more and more people in communications are "asking Kennedy" about antenna problems.

ANTENNA EQUIPMENT

D. S. KENNEDY & CO.

COHASSET, MASS. — TEL: CO4-1200

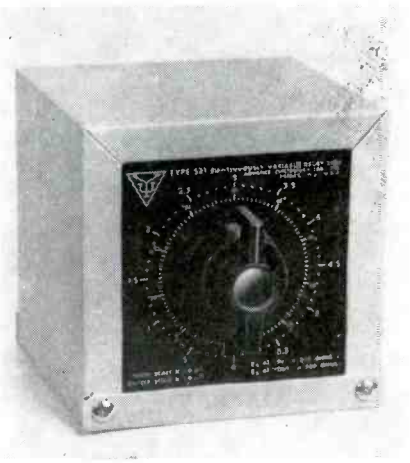
Down-To-Earth **SOLUTIONS** *to*
Out-Of-This-World **PROBLEMS**

Tracking Antennas
Radio Telescopes
Radar Antennas
Tropospheric Scatter
Ionospheric Scatter

used to assure uniformly high performance. Overall dimensions are 5¼ by 7 in. by 4½ in. **Circle 441 on Reader Service Card.**

D-C BRIDGE
and calibrator

ALLEGANY INSTRUMENT CO., INC., 1091 Wills Mountain, Cumberland, Md. The BC-1 is a companion component for any amplifier. It provides an input circuit for conveniently connecting one, two or four active wire strain arms into Wheatstone Bridge form. Means for bridge balancing, automatic 4-step signal calibration, and event or phenomenon initiation are provided along with terminals for external bridge power. **Circle 442 on Reader Service Card.**



DELAY LINES
continuously variable

ADVANCE ELECTRONICS LAB., INC., 249–259 Terhune Ave., Passaic, N. J. Type 521 series was developed to meet an increasing need of continuously variable time delay

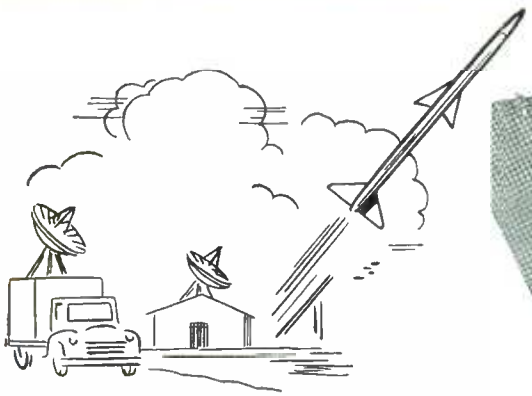
Circle 232 Readers Service Card

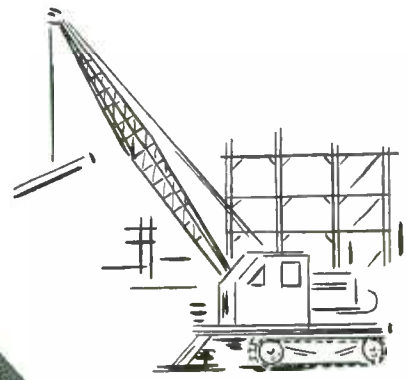
Circle 233 Readers Service Card →

MISSILES to MACHINERY

Century MODEL 420 ELECTROGRAPH

covers the oscillograph recording field





TELEMETRY APPLICATIONS

- QUICK-LOOK monitoring in the telemetry ground station permits continuous observation of missile in-flight programing results.
- ON-THE-SPOT monitoring permits making in-flight function corrections in controlled missiles or piloted aircraft.
- A NATURAL for mobile telemetry vans . . . compact, rugged, low power consumption, record is PERMANENT, no fading or fogging when exposed to direct sunlight.

INDUSTRIAL APPLICATIONS

- STRESS-STRAIN RECORDING with "first-hand" read-out during test.
- PERMANENT record obtained at test site may be stored indefinitely for purpose of future data reduction.
- PORTABLE — extremely useful for field test applications where a "multiplicity" of data must be collected with the least amount of instrumentation.
- No amplifiers required for many applications.

USES a variety of tubular mirror galvanometers pioneered by Century

ENGINEERS . . .

Check your requirements against these FEATURES!

- Permanent continuous record produced within recorder.
- Developed record may be viewed an INSTANT after exposure.
- HIGH CONTRAST photographic qualities . . . black intelligence traces are recorded on light colored background.
- As many as 24 intelligence channels may be recorded on the 8-inch x 200-foot record roll.
- Record is REPRODUCIBLE without loss of contrast by Ozalid, Bruning, etc., processes . . . NO deterioration due to ultra-violet exposure.
- Eliminates need for costly darkroom facilities.

COSTS NO MORE THAN OLD-FASHIONED METHODS

Century

Century Electronics & Instruments, Inc.

1333 NO. UTICA, TULSA, OKLAHOMA

For further information, call on our nearest representative:

EXPORT OFFICE: 149 BROADWAY, NEW YORK CITY — TEL.: BARCLAY 7-0562

PHILADELPHIA, PA.
TEST EQUIPMENT SALES CO.
4447 N. BODINE ST.
TEL.: MICHIGAN 4 1822

DALLAS, TEXAS
ARNOLD BARNES CO
5526 DYER ST
TEL.: EMERSON 1 6716

REDWOOD CITY, CALIF.
G. S. MARSHALL CO.
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E. G. HOLMES & ASSOCIATES
309 PHARR ROAD, N. E.
TEL. CEDAR 7-7801

DAYTON, OHIO
ELECTRO SALES ASSOCIATES
512 ORANGEWOOD DRIVE
TEL. WALNUT 5426

CHICAGO, ILL.
CARLSON SALES CO
6677 NO. NORTHWEST HIGHWAY
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TEL.: EAST 7 3501

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BARNHILL ASSOCIATES
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TEL.: HARRISON 4-7733

CLEVELAND, OHIO
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TEL. REDWOOD 2 7414

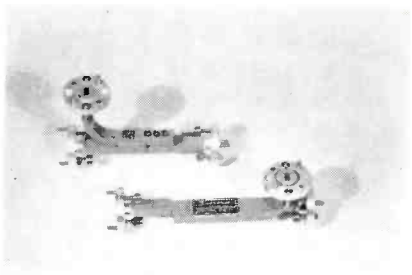
ORLANDO, FLORIDA
E. G. HOLMES & ASSOCIATES
56 W. COLUMBIA ST.
TEL. 3 3524

SEATTLE, WASH.
TESTCO
RM. 105 BOEING FIELD
TEL. LANDER 9000

EXPORT
NEW YORK CITY
149 BROADWAY
TEL. BARCLAY 7-0562

with maximum delay over 15 μsec. It consists of two parts: (1) a continuously variable delay line, which is essentially a condensed r-f cable with one conductor changed into a long thin coil and the other conductor spaced closely to the first producing a large amount of time delay, yet maintaining low attenuation at high frequencies; (2) a step variable delay line, which consists of 60 sections of LC m-derived networks and a 1-pole, 60-position rotary switch.

The unit features a coaxial shaft. It measures 4 in. by 4 in. by 4 in., and weighs approximately 2½ lb. There are three models available, and complete specifications may be had for the writing. **Circle 443 on Reader Service Card.**



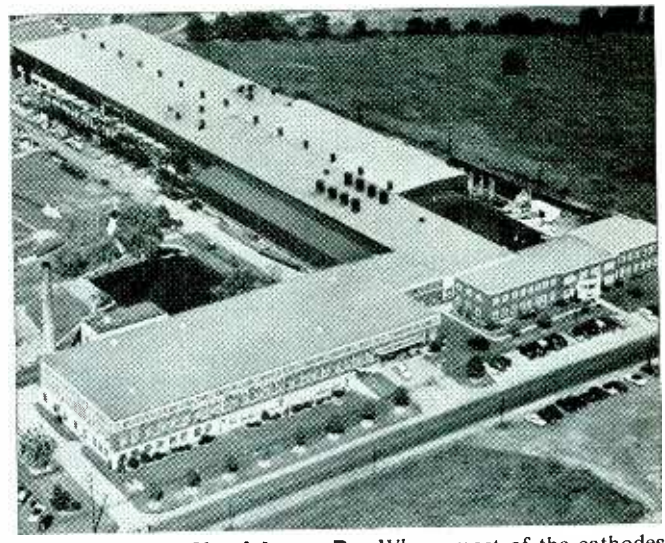
DIRECTIONAL COUPLERS
cover 68 to 73 kmc

MICROWAVE ASSOCIATES, INC., Burlington, Mass., has announced the MA-668A and B side wall directional couplers for the 68 to 73 kmc range. Nominal coupling values are 20 db and 30 db respectively. Directivity is 25 db minimum while maximum vswr in the main arm is 1.1 and in the auxiliary arm 1.15 for both the MA-668A and B. These measurements are performed at mid-band and at specified band extremes. The coupling accuracy is within ±¼ db.

The value and frequency of calibration is stamped on each unit. UG-385/U coupling flanges are used on all arms of both the MA-668A and B. Overall length is 3$\frac{5}{32}$. Height from the center line of the main arm to the auxiliary arm flange surface is $\frac{13}{16}$ in.

Each coupler is fabricated from coin silver waveguide. Mating surfaces are flat and mirror smooth to prevent r-f leaks. All

New 65,000 sq. ft. plant at Wapakoneta, Ohio. Completely modern in every respect. Close to the Mid-U.S. electronics industry.



Main plant at Norristown, Pa. Where most of the cathodes used in this country for more than 20 years have been made.

Two Modern Plants

FOR SEAMLESS NICKEL CATHODES

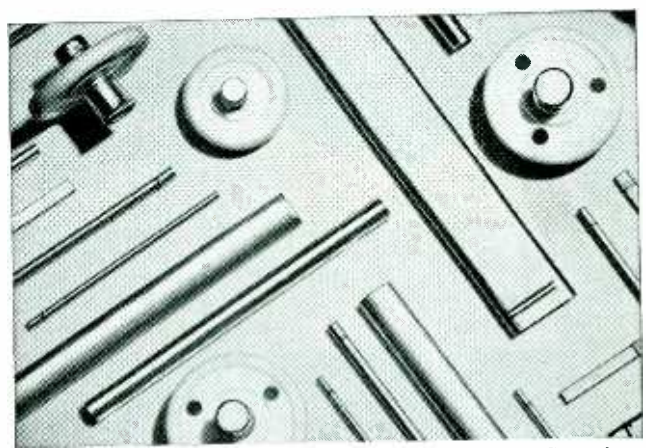
OFFER YOU DOUBLE DELIVERY ASSURANCE

Just like a second source of supply for every cathode order you place—without the inconvenience of dealing with two suppliers or worrying about product uniformity.

Each of these two big Superior Tube cathode plants follows exactly the same manufacturing methods and quality control procedures. Each employs the same laboratory checks on materials and finished cathodes. So cathodes can be produced at either plant and exactly meet the specifications.

Now there's more reason than ever to make Superior Tube your regular source for electron tube cathodes. Get complete technical information in the new Catalog 51. Write Superior Tube Co., 2500 Germantown Ave., Norristown, Pa.

*Manufactured under U. S. patents



Superior Tube cathodes. Typical examples. Seamless, Lockseam,* and Weldrawn® cathode sleeves are available in a wide variety of lengths and cross-section shapes. New CATHALOY® cathode materials offer new properties and superior performance.

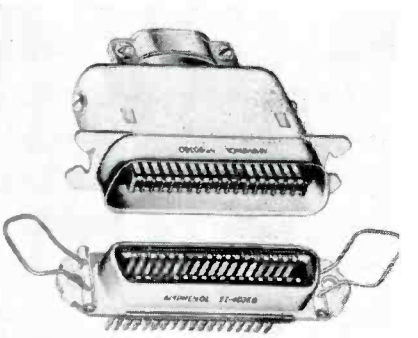
Superior Tube

The big name in small tubing

NORRISTOWN, PA.

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

surfaces are silver plated. A coat of blue-gray lacquer is applied to external noncontacting surfaces. **Circle 441 on Reader Service Card.**



LITTLE CONNECTORS
cable-to-chassis types

AMPHENOL ELECTRONICS CORP., Chicago 50, Ill. Cable-to-chassis types have been added to the company's Micro-Ribbon series of connectors. Available in 14, 24, 36 and 50 contacts, these new types feature cadmium-plated brass shells with clear chromate treatment, gold-over-silver plated contacts and diallyl phthalate dielectrics. Truly miniature in size, a mated pair of largest 50 contact size types occupy only 3.7 cu in.

At 5 amperes Micro-Ribbon connectors are rated at 700 v d-c at sea level, and at 200 v d-c at 70,000 ft.

IRIS-FOCUS UNIT
is remotely controlled

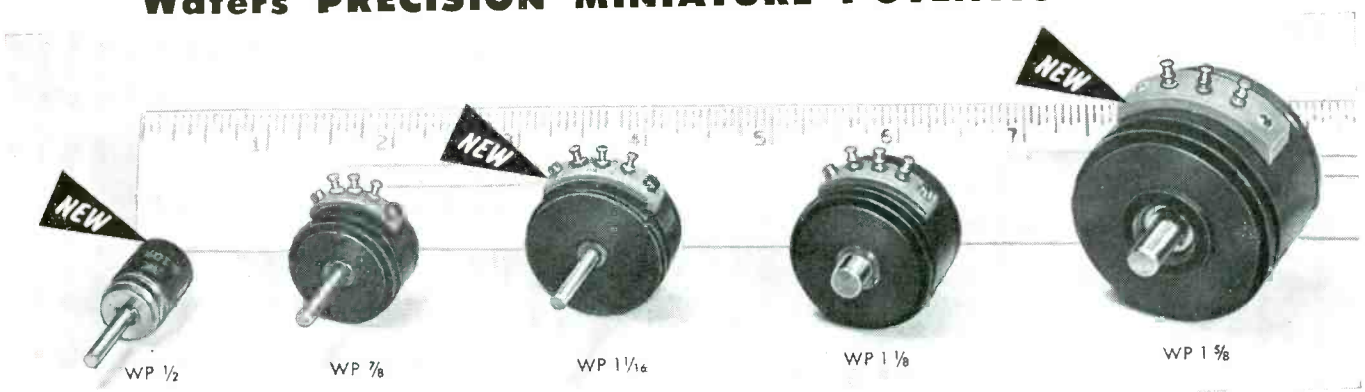
KIN TEL (formerly Kay Lab), 5725 Kearny Villa Road, Box 623, San Diego 12, Calif. Model ARC-1 provides vibration-free remote control of tv camera lens aperture and focus. Both operations may be accomplished simultaneously from

NOW! A complete single-turn-pot line from Waters

Built, tested, and *certified** to such rigid specifications as AIA, RETMA, JAN-R-19, MIL-E-5272A, and other applicable military specifications, this new line of pots packs reliable performance into tight spots.

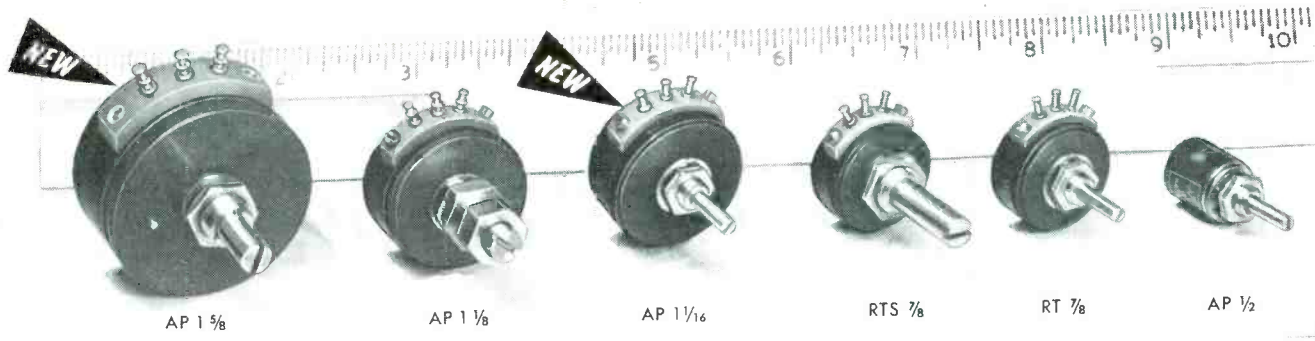
**Complete test data available on request.*

Waters PRECISION MINIATURE POTENTIOMETERS



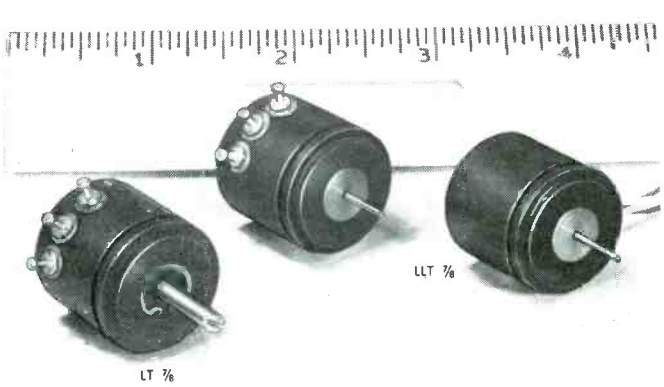
Sizes from ½" to 1⅝" . . . values from ½ ohm to 500K ohms . . . high-precision linear and non-linear . . . write for catalog that describes the complete line.

Waters ROTARY TRIMMER POTENTIOMETERS



. . . include the most compact half-inch pot on the market . . . resistances to 500K . . . non-linear models . . . bushing, servo, or 3-hole mount . . . solder terminals or wire leads . . . write for complete catalog.

Waters LOW-TORQUE PRECISION POTENTIOMETERS



Ball-bearing and jewel-bearing models for ultra-low torque . . . servo or 3-hole mounting . . . solder terminals or wire leads.

Check Waters first for all your single-turn-pot needs.

Big-pot performance in miniature-pot size.

Waters MANUFACTURING, inc.

MFG. INC.

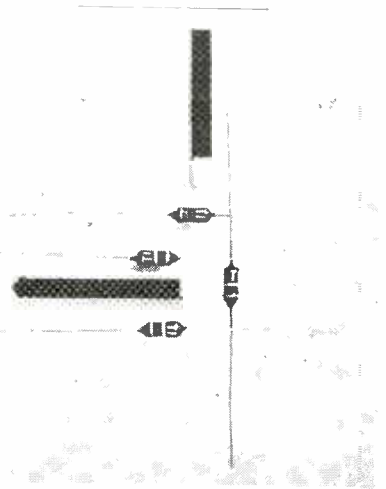
Wayland, Massachusetts

APPLICATION ENGINEERING OFFICES IN PRINCIPAL CITIES

a small modular control panel. The control panel may be mounted in the Kin Tel model ARM-14R 14-in. rack mountable tv monitor or in an ARP-1 remote control mounting panel. Both the ARM-14R and the ARP-1 mounting panel fit standard 19-in. racks.

Interconnection is provided by a model AC-3 cable, and the camera unit may be positioned several thousand feet from the remote control panel. No permanent attachments are made to the camera lens.

This industrial tv camera with iris-focus attachment may be mounted inside explosion-proof, dust-proof, weatherproof, or acoustical housings made by Kin Tel. **Circle 445 on Reader Service Card.**



DIFFUSED SILICON DIODES
increased power capacity

TEXAS INSTRUMENTS, INC., P. O. Box 312, Dallas 21, Texas has initiated full-scale production of a new line of diffused silicon diodes in glass packages.

The 11N649, largest of the series of five, features a 400 ma average rectified forward current and a 600-v peak-to-peak inverse voltage rating. The recurrent peak-forward-current rating is 1.25 amp; 3 amp surge current may be tolerated for one second. Other ratings are 600-mw power dissipation and 720-v breakdown voltage.

The four other diffused silicon glass devices, the 1N645, 1N647 and 1N648 differ from the 1N649 only in peak inverse voltage (225 to 500 v), breakdown voltage (275

NEW IRC®

Distributed Parameter Delay Lines

FEATURE UNIFORMITY, STABILITY AND LOW COST

IRC's extensive mass production experience and technique in the manufacture of continuous lengths of wire wound resistive elements have now been utilized to produce a uniform high-quality, low-cost, distributed-constant delay line. Simplicity of design permits close control of electrical characteristics even to providing, in many applications, unusual phase characteristics to meet customers' special requirements.

Encapsulation in phenolic impregnated rigid tubes with axial leads assures good stability under adverse environmental conditions. These delay lines are well suited for either point-to-point wiring or printed board applications.

If you have an application for distributed constant delay lines, we will be pleased to review your requirements. Send coupon for full details.

Features

TIME DELAY 0.2 to 1.0 microseconds

IMPEDANCE 500 to 2500 ohms standard; higher and lower are available on special request

BANDWIDTH 3.5 MC and greater as required

TEST VOLTAGE 300 volts

OPERATING TEMPERATURE 65°C

Insulated Composition Resistors • Deposited and Boron Carbon Precistors • Power Resistors • Voltmeter Multipliers • Ultra HF and Hi-Voltage Resistors • Potentiometers

Wherever the Circuit Says

Low Wattage Wire Wounds • Resistance Strips and Discs • Selenium Rectifiers and Diodes • Hermetic Sealing Terminals • Insulated Chokes • Precision Wire Wounds • Attenuators

IRC®

INTERNATIONAL RESISTANCE CO.

Dept. 238, 401 N. Broad St., Phila. 8, Pa.

In Canada: International Resistance Co., Ltd., Toronto, Licensee

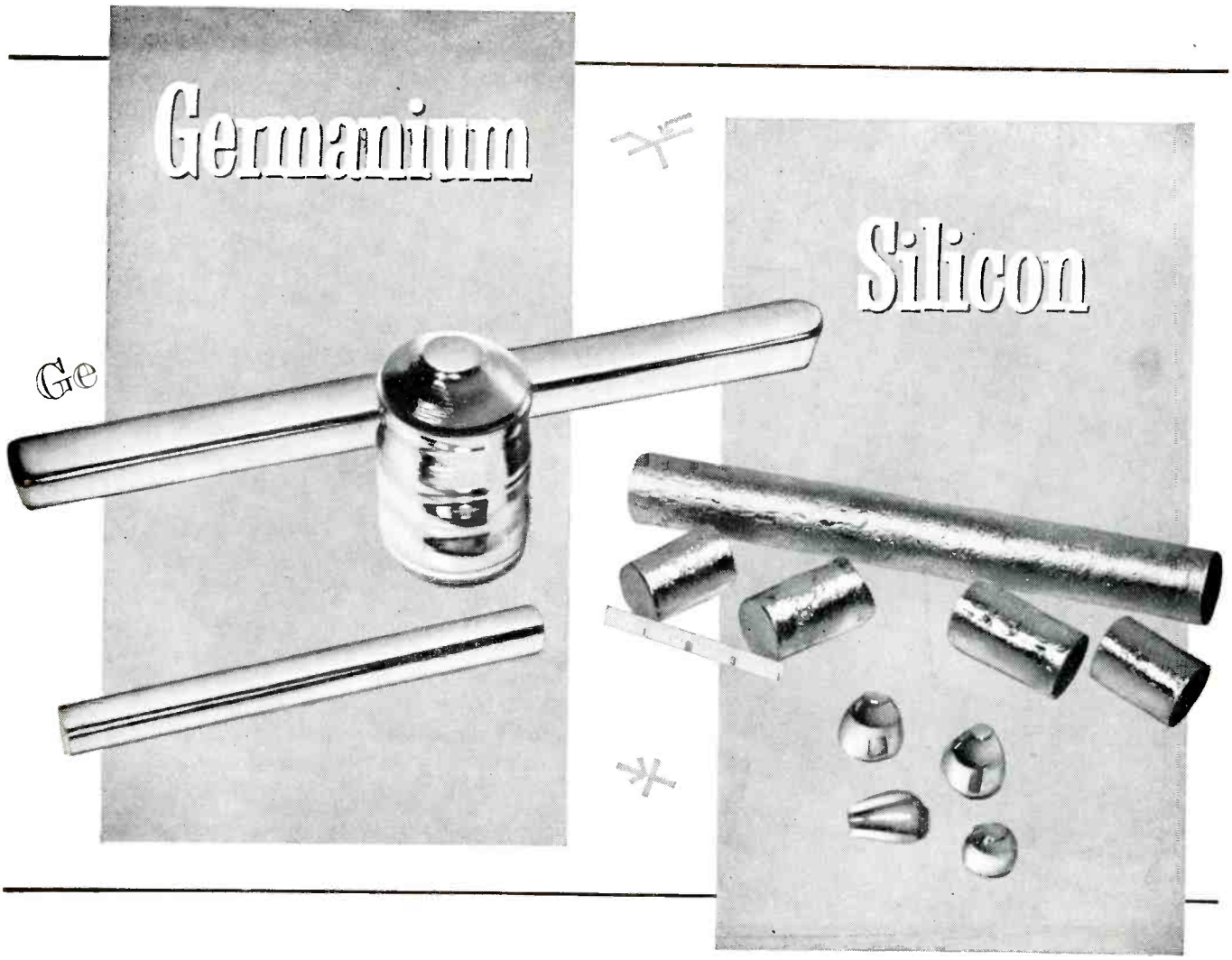
Send technical data and prices on the new IRC Distributed Parameter Delay Lines.

NAME _____

COMPANY _____

ADDRESS _____

CITY _____ ZONE ____ STATE ____



Sylvania...your only source for both semiconductor materials

If you need materials for transistors, diodes, or other semiconductor devices ... Sylvania is your only dependable source of both germanium and silicon.

The following forms of Sylvania germanium products are available; spectrographically pure germanium dioxide; polycrystalline as-reduced ingots; polycrystalline purified ingots; and undoped single crystals. All Sylvania germanium is n-type, and—in the purified ingot or single crystal form—has a resistivity greater than 40 ohm cm.

Diode and transistor manufacturers report that Sylvania germanium makes it possible for them to use the same doping schedule from shipment to shipment. They report higher yield in the growth of doped single crystals. For growing doped crystals horizontally, Sylvania germanium ingots are purified in five standard shapes, or to your specification. Cut pieces, which require no further cutting or etching, are supplied to fit your crucible for vertical crystal growing.

Sylvania silicon is available in the form of polycrystalline stalagmitic rod; average density is 2.2 g/cc. The standard diameter for stalagmitic rod is 1½ in., and it is available in pieces or crucible charges to your specification.

If you have special requirements, our engineering department will gladly consult with you. Send for technical literature on Sylvania germanium and silicon. Write to:

Sylvania Electric Products Inc.
Tungsten and Chemical Div., Towanda, Penn.

TUNGSTEN · MOLYBDENUM · CHEMICALS · PHOSPHORS · SEMICONDUCTORS

SYLVANIA

LIGHTING · RADIO · ELECTRONICS · TELEVISION · ATOMIC ENERGY

to 600 v), and reverse current ratings at elevated temperatures. **Circle 446 on Reader Service Card.**

HEART MONITOR
a medical electronic unit

ALLEN ELECTRIC AND EQUIPMENT Co., Kalamazoo, Mich., has announced a new electronic instrument that lets us hear and see every pulse beat of the heart with controllable sound and large flashing light. The new heart monitor frees the anesthesiologist's hands from continuous pulse checking. The anesthesiologist can take systolic blood pressure audibly or visibly—without a stethoscope. A bulletin containing operation information and chief features is available. **Circle 447 on Reader Service Card.**

RELAY
in dust-proof enclosure

LINE ELECTRIC Co., 271 South 6th St., Newark 3, N. J., has available the SM series relay, in a plug-in, transparent, dust-proof enclosure. Utilizing standard octal and 11-pin bases, this relay comes in contact arrangements up to 3 pdt. Contacts are rated at up to 10 amperes at 115 v a-c, noninductive. Coils in all standard a-c and d-c voltages are also available for plate circuit applications.

These units are extremely com-

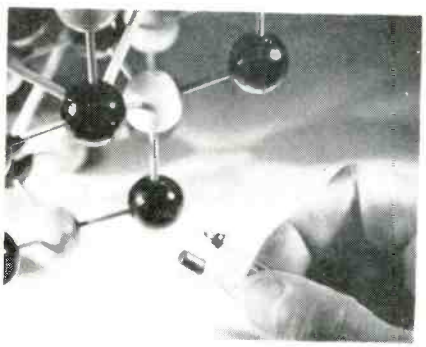
pact. Dimensions are 1 7/16 by 1 7/16 by 2 1/8 high. The relay wiring diagram is clearly printed on the enclosure. **Circle 448 on Reader Service Card.**

TRANSDUCER
ultrasonic type

GULTON INDUSTRIES, INC., 212 Durham Ave., Metuchen, N. J. A new ultrasonic transducer, model UT-2-42, for ultrasonic cleaning, degreasing, and processing is announced.

Using Glennite piezoelectric ceramics, the ultrasonic transducer is designed for modular assembly to cover large areas with non-focusing and uniform sound field. It has a high conversion efficiency and a frequency for many types of processing.

Hermetically sealed in stainless steel housing, model UT-2-42 is completely immersible in organic solvents, aqueous solutions of normal detergents, mild alkalis or acids. **Circle 449 on Reader Service Card.**



FOUR-LAYER DIODE
bistable type

SHOCKLEY SEMICONDUCTOR LABORATORY, Beckman Instruments, Inc., 125 San Antonio Road, Mountain View, Calif., has announced a new low-power four-layer switching

Circle 242 Readers Service Card

Circle 243 Readers Service Card →

MINIATURIZED SEALED RELAYS

VIBRATION...yet normal operation

No—we don't use paint mixers to measure the vibration resistance of General Electric miniaturized sealed relays. But, it is a dramatic illustration of the punishment G-E hermetically sealed relays can —and do—withstand.

The best of laboratory equipment is used to measure this vibration resistance, and the results prove—General Electric voltage-calibrated Micro-miniature relays withstand vibration of *20 G's acceleration from 55 to 2000 cycles* (.125 inch excursion from 10 to 55 cycles).

Excellent vibration resistance is just one of the many "plus" features—such as high- and low-temperature operation, high shock resistance, and rugged construction—you get with *all* Miniature, Sub-miniature, and Micro-miniature G-E sealed relays. Today, General Electric relays are proving their reliability on a variety of military and industrial electronics applications.

What's more, you get all of General Electric's complete line of standard-listed relays on *only 3-week shipment from receipt of order*—plus—immediate service on samples and prototypes.

For further information, contact your G-E Apparatus Sales Office—or—write to General Electric Co., Sect. 792-7, Schenectady 5, N. Y., for complete relay data. *Specialty Control Dept., Waynesboro, Va.*

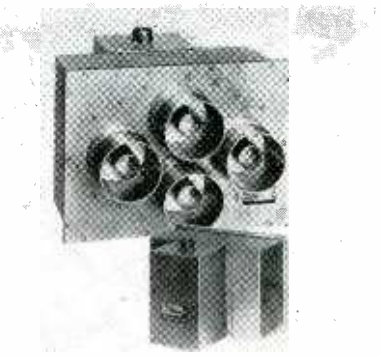
Progress Is Our Most Important Product

GENERAL ELECTRIC

diode. It is a two-terminal silicon device which can exist in either of two states: an open or high-impedance state (1 to 100 megohms) and a closed or low-impedance state (1 to 10 ohms). The diode is switched from one state to the other through control of the voltage and current values. It is driven to its closed state by application of a voltage greater than the critical breakdown point, and it will continue conductive so long as a current greater than a critical holding current is maintained. When the current is reduced below the holding value, the device regains its open state.

While the parameters are controllable over some breadth in manufacture, typical ranges of values are as follows: firing voltage ranges from 20 to 60 v; holding currents, 25 ma or somewhat less at about 1 v. The switched-current capacity is in the order of 100 ma, and maximum power dissipation is on the order of 100 mw. Switching rates are on the order of 1 mc.

Characteristics of the four-layer diode suggest a versatile range of circuit applications with some of the more immediate probabilities including self-excited saw-tooth oscillator, pulse generators of various types, bistable memory circuits, and ring circuits for counter and computer use. **Circle 450 on Reader Service Card.**



COAXIAL SWITCH
remotely controlled

ANDREW CORP., 363 E. 75th St., Chicago 19, Ill. Type 6710 switch provides four-second switching of 3⅛ in. coaxial transmission line to standby equipment at frequencies up to 1,000 mc. It can be used in

APPROVAL DATA

STODDART & MILITARY TYPE	FREQUENCY	MIL-I-16910 (Ships)	MIL-I-6181	S.A.E.	A.S.A.	C.I.S.P.R.
NM-40A (AN/URM-41)	30cps-15Kc	CLASS '1'	Not Req'd	Not Req'd	Not Req'd	Not Req'd
NM-10A (AN/URM-6B)	14Kc-250Kc	CLASS '1'	Not Req'd	Not Req'd	C63.2 (Proposed)	Not Req'd
NM-20B (AN/PRM-1A)	150Kc-25Mc	CLASS '1'	CLASS '1' *CATEGORY 'A'	Not Req'd	C63.2 (Proposed)	**
NM-30A (AN/URM-47)	20Mc-400Mc	CLASS '1'	CLASS '1' *CATEGORY 'A'	APPROVED	C63.3 (Proposed)	**
NM-50A (AN/URM-17)	375Mc-1000Mc	CLASS '1'	CLASS '1' *CATEGORY 'A'	Not Req'd	C63.3 (Proposed)	Not Req'd

*MIL-I-6181C (Proposed)
**Can be supplied to C.I.S.P.R. Recommendations
S.A.E. (Society of Automotive Engineers)
A.S.A. (American Standards Association)
C.I.S.P.R. (Comite International Special des Perturbations Radioelectriques) (International Special Committee on Radio Interference)

STODDART'S **5** self-contained Radio Interference Measuring Equipments, each designed for its specific frequency range, provide:
5 instruments, which can be used by—
5 engineers, to measure over—
5 different frequency ranges, at—
5 different locations, at—
1 time.

FEATURES:

- Each equipment performs Quasi-Peak, Peak, and Average (Field Intensity) measurement functions.
- Approved for use by all Departments of the U. S. Department of Defense.
- Commercial and military equipments are identical.
- Precision laboratory equipment with rugged all-weather design for field use.
- **Immediate delivery from stock.**

— Serving 33 countries in radio interference control —

STODDART

AIRCRAFT RADIO CO., INC.

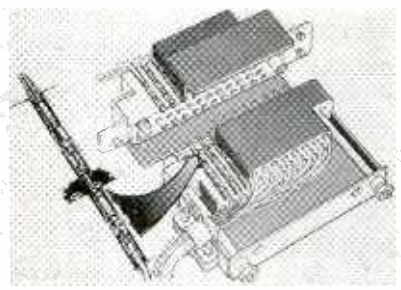
6644 Santa Monica Blvd., Hollywood 38, California HOllywood 4-9294

Circle 245 Readers Service Card

high power communication systems, as well as uhf and vhf tv stations.

Use of these switches eliminates time-consuming manual changes of coaxial transmission line connections. Standby equipment may be quickly and easily checked under actual operating conditions. In the event of main equipment failure, the spare equipment is switched in with negligible off-the-air time.

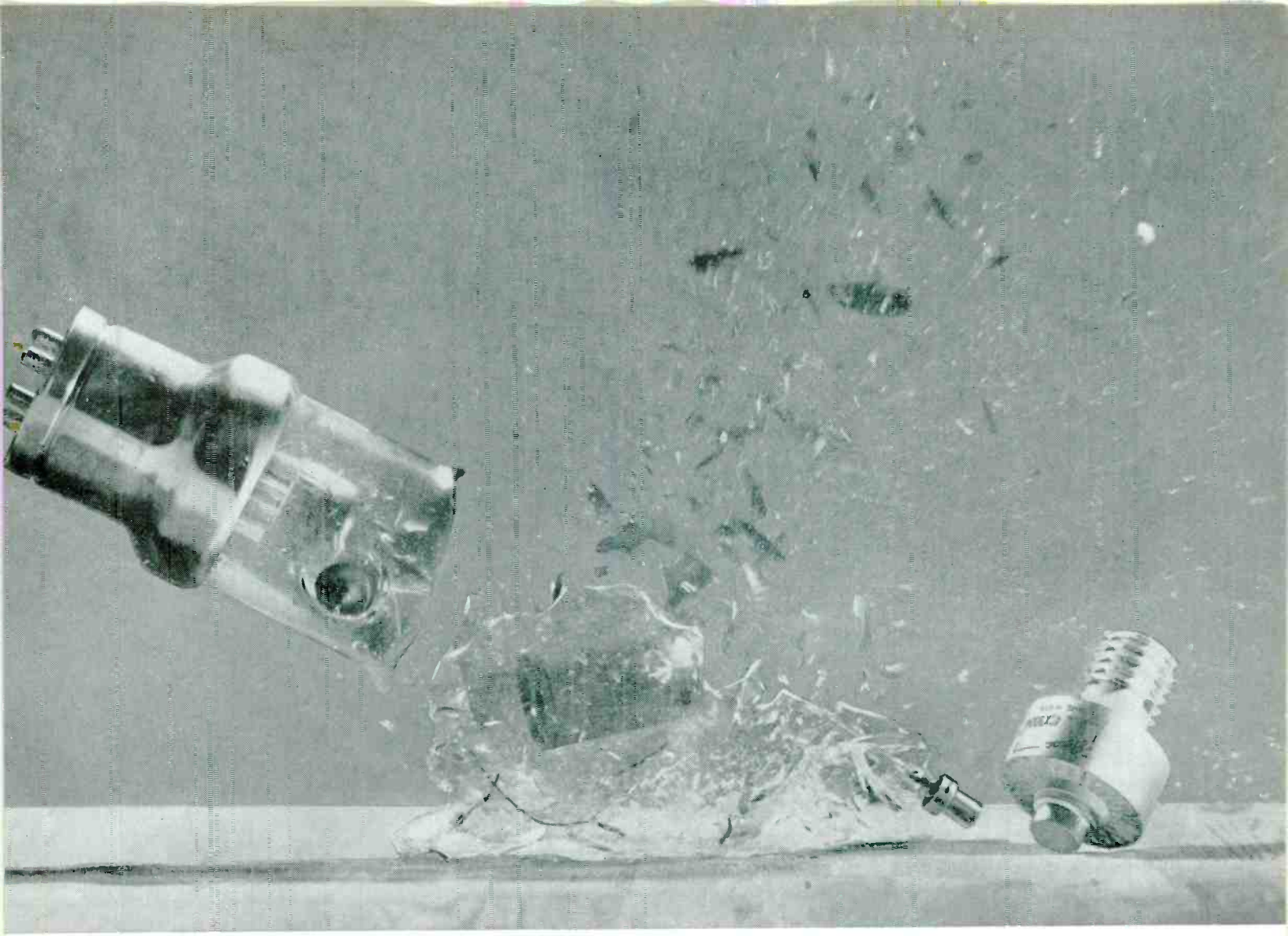
This remotely controlled switch is operated by a dependable, long-life motor. The a-c motor normally supplied operates on 115 v, 60 cycle a-c. Other motors are available on special order. Control circuitry includes a wafer switch for use in remote position indication circuits. The micro-switch is mechanically linked to the switching mechanism so that transmitter power is removed before switching and is reapplied only after new contact is made. **Circle 451 on Reader Service Card.**



CONNECTORS
with snap-in contacts

CONSOLIDATED ELECTRODYNAMICS CORP., 740 Salem St., Glendale, Calif., has announced a new series of rectangular electrical connectors featuring removable snap-in contacts. The specially made contacts have retention springs which permit attachment of the contacts to the wires prior to installation in the connector body. This feature also allows easy insertion or removal for replacement or rearrangement. The contacts are not of the usual tapered design. Neither do they require soldering. This cuts time in the assembly and field maintenance of the connectors.

A split-hood design is another exclusive feature. The hood is



Surviving Impact is an Eimac Ceramic Tube Extra

Aeronautical electronics demands extras from vacuum tubes. Among them is the ability to withstand heavy impact without impairing electrical characteristics. The photograph dramatically shows what happens to a 250 watt glass envelope tube and an Eimac 300 watt ceramic tube when both are dropped from a height of seven feet. The ceramic tube "took it."

Other advantages of Eimac ceramic tubes are: resistance to damage by vibration and temperature; smaller size without sacrificing power; ability to undergo optimum processing techniques that lead to tube reliability and longevity.

The small Eimac ceramic 4CX300A, shown above, will withstand 50G shocks of 11 millisecond duration. It will operate in airborne or ground station service at full ratings up to 500mc.

In its new line of ceramic tubes, Eimac has the answer for the aeronautical engineer who needs a tube that will deliver full output under extreme environment.

EITEL-McCULLOUGH, INC.
SAN BRUNO · CALIFORNIA
Eimac First with Ceramic Tubes that can take it

Eimac

4CX300A MAXIMUM RATINGS TO 500MC

	FM	AM	SSB
D-C Plate Voltage	2000	1500	2000
D-C Screen Voltage	300	300	400
D-C Grid Voltage	—250	—250	—
D-C Plate Amperes	.250	.200	.250

	FM	AM	SSB
Plate Dissipation, watts	300	200	300
Screen Dissipation, watts	12	12	12
Grid Dissipation, watts	2	2	2

made in two parts to facilitate assembly, inspection and contact replacement or rearrangement.

The new series of connectors equals or exceeds the specifications for rectangular connectors contained in MIL-C-8384A. They will be available in 34, 42, 50 and other standard contact capacities. Any of the new connectors will mate with existing, ordinary connectors having similar contact arrangements. **Circle 452 on Reader Service Card.**

TINY A-C VOLTMETERS
with expanded scales

INTERNATIONAL INSTRUMENTS INC., P. O. Box 2945, New Haven 15, Conn., announces a new line of a-c voltmeters using D'Arsonval type movements. Accuracy on all meters is ±5 percent of the expanded portion of the scale; for example, ±1.5-v on a 90 to 120-v a-c scale.

Standard ranges are 90-120, 90-130 and 90-140 volts a-c. Special ranges are available however; minimum scale span is 30 v and lowest scale starts at 80 v. Scales are linear with black markings on a white background.

All meters, except Model 1145, are for use on nonmagnetic panels. Watertight seals can be included, if required. **Circle 453 on Reader Service Card.**

SWEEP OPERATED RELAY
for studying transients

ENGELHARDT ENGINEERING CO., 38 Burritt Ave., South Norwalk, Conn. In the study of single transient phenomena with an oscilloscope, the sweep operated relay will be found useful by initiating the tran-

How to keep informed on the "with what" part of your business

AT YOUR FINGER TIPS, issue after issue, is one of your richest veins of job information – advertising. You might call it the "with what" type – which dovetails the "how" of the editorial pages. Easy to read, talking your language, geared specifically to the betterment of your business, this is the kind of practical data which may well help you do a job quicker, better – save your company money.

Each advertiser is obviously doing his level best to give you helpful information. By showing, through the advertising pages, how his product or service can benefit *you* and *your* company, he is taking *his* most efficient way toward a sale.

Add up all the advertisers and you've got a gold mine of current, on-the-job information. Yours for the reading are a wealth of data and facts on the very latest in products, services, tools . . . product developments, materials, processes, methods.

You, too, have a big stake in the advertising pages. Read them regularly, carefully to keep job-informed on the "with what" part of your business.

McGRAW-HILL FOR BUSINESS

McGRAW-HILL PUBLICATIONS

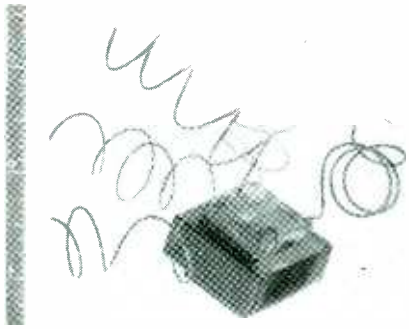
sient at a convenient preset portion of the trace on the face of the crt. Many transients and disturbances such as inrush current into inductive and capacitive circuit elements, recovery time of voltage regulated systems, time constants of magnetic amplifiers, operating time of electromechanical devices, and the like, can be studied easily and with a minimum amount of effort on the part of the operator. Complete specifications are given in a single-sheet bulletin. **Circle 454 on Reader Service Card.**

SOLDERLESS CONNECTORS for solid sheathed cable

ENTRON, INC., Bladensburg, Maryland has begun production of the first group of a series of a compression-type fittings and adapters for use on Foamflex solid sheathed cable. The couplings feature very low vswr's, corrosion resistant finishes, and a flared seal for the cable end. Units of the same series have interchangeable bodies allowing extension cables or connectors to be readily changed.

A combination gaged sheath cutter, ferrule wrench, and counterboring and flaring tool has been especially designed for the installation of these connectors. Both

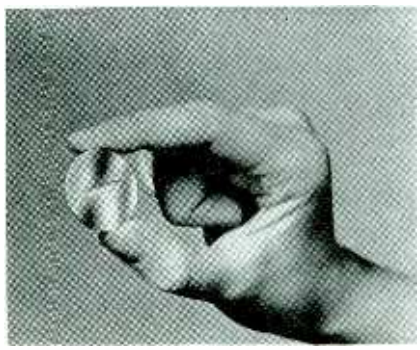
tools and connectors are made for ½ in. and ⅜ in. cables. **Circle 455 on Reader Service Card.**



FLEXIBLE LEADWIRE
Teflon insulated

HITEMP WIRES, INC., 1200 Shames Drive, Westbury, Long Island, N. Y., has available a Teflon insulated flexible leadwire that has had its surface so treated that it will provide adequate adhesion with impregnated and casting materials. Heretofore, the lack of adhesion caused serious moisture paths, which greatly degraded the hermetic seal.

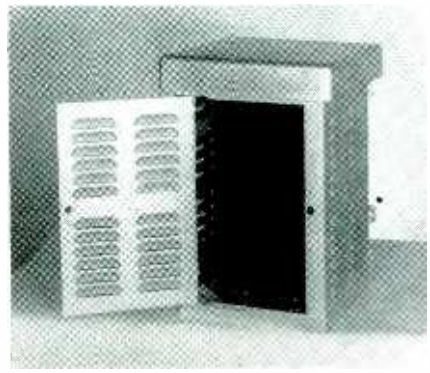
With Hitemp's new, specially treated Teflon lead wire, the nonstick properties have been completely alleviated. The treated Teflon wire exhibits the same outstanding thermal and electrical characteristics as conventional Teflon insulated conductors. It can be provided in all the available color codings. **Circle 456 on Reader Service Card.**



PRESSURE WINDOW
for half-X waveguide uses

MICROWAVE ASSOCIATES, INC., Burlington, Mass., has developed a new flange-mounted waveguide pressure window for use in half-X waveguide applications.

Designated the MA-1339, the new window covers the frequency range from 9.5 to 10.1 kmc with maximum vswr of 1.10 at the band edges. Resonant frequency is 9,800 mc. It is used in 0.2 b-- 0.9 i.d. waveguide applications. Window flange thickness is 0.060 in. Maximum power rating of the MA-1339 is 20 kw. Maximum pressure handling capability is 45 lb on the glassed side of the window. Pressure-handling capability in the reverse direction is 30 psi. The windows are constructed of kovar and glass. All metal surfaces are silver plated. **Circle 457 on Reader Service Card.**

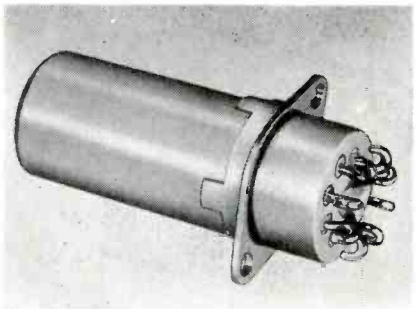


PREAMPLIFIER
weatherproof, pressurized

NEMS-CLARKE, INC., 919 Jesup-Blair Drive, Silver Spring, Md., announces a new design in preamplifiers for use with their telemetering receivers. The unit is weatherproof and pressurized so that location at the antenna can be made without encountering moisture problems. Line losses as high as 6 db will not decrease the sensitivity of the receiving system by more than a few tenths of a db when this preamplifier is used.

The pass band has a uniform response of 3 db over a frequency range of 215-245 mc. The PR-200 will improve the noise figure of the type 1400 or 1401-A receivers by approximately 1 db assuming lossless connecting cables. The unit has a self contained power supply which is controlled from a 1¾ in. power control panel designed for mounting in the relay rack with other receiving equipment. Similar units are available

having a uniform response within 3 db over a frequency range of 225-260 mc. **Circle 458 on Reader Service Card.**



SUBMINIATURE RELAY
for low-level circuits

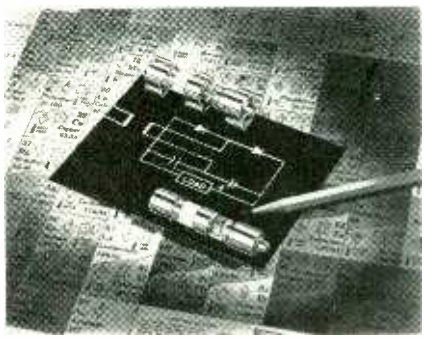
PRICE ELECTRIC CORP., Frederick, Md., announces production of the new Husky subminiature relay—style 506—to meet the requirements of MIL-R-25018 (USAF).

Style 506 relay is available in two designs: for critical applications in low level circuits, and for general purpose use on aircraft and missiles. Both types are hermetically sealed. The low level circuit design permits isolation of all organic materials from the contact chamber. To positively eliminate contamination, each relay is assembled and adjusted under ideal conditions in the company's pressurized room. The general purpose design does not have the isolation feature.

These continuous duty relays, d-c operated, have a mechanical life expectancy of 20 million cycles. Each relay weighs 1.5 oz. Bulletin No. 5 gives more detailed information and a schematic presentation. **Circle 459 on Reader Service Card.**

VOLTAGE DOUBLERS
silicon cartridge type

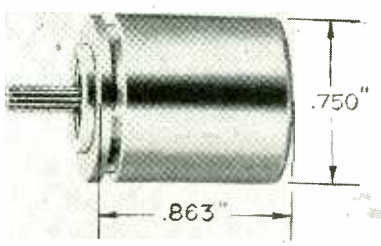
INTERNATIONAL RECTIFIER CORP., 1521 E. Grand Ave., El Segundo, Calif., announces compact, dual purpose silicon cartridge voltage doubler rectifiers. The small size, light weight, and rectifying characteristics of these silicon cartridges make them especially applicable to airborne military equipment, and industrial equip-



ment operating in high ambient temperatures (−55 C to 150 C). Hermetic sealing in metallized ceramic housings permits their use in corrosive atmospheres.

Each of these cartridge rectifiers is a voltage doubler having a maximum rating per leg of 3,200 piv. Therefore, two units can be connected as a single-phase, full-wave bridge, capable of delivering 1,900 v d-c at 90 ma for an input voltage of 2,240 v rms at 75 C. Measuring $\frac{3}{4}$ in. in diameter, the rectifiers are available in two standard lengths: $2\frac{1}{2}$ in. and $4\frac{5}{16}$ in. The cartridge design permits mounting in standard 30-ampere fuse clips.

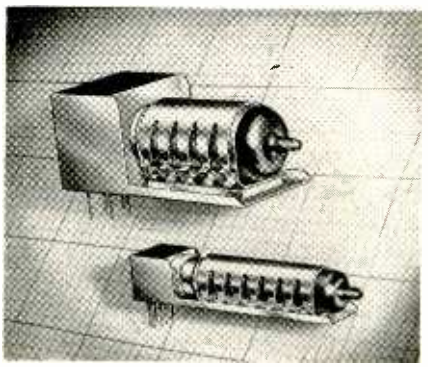
They are well suited to applications such as: mounting in d-c relay housings to eliminate the need for separate power supplies; replacing a-c relay units where hum is objectionable; providing d-c power for solenoids, counters, variable speed controls and for the supply of power to the fields of small d-c motors. **Circle 460 on Reader Service Card.**



SERVO MOTOR
high temperature type

JOHN OSTER MFG. CO., Avionic Division, 1 Main St., Racine, Wisc. A new smaller lighter high temperature continuous duty servo motor for transistorized operations has been announced. Type

8-5001-02 measures only 0.863 in. long by 0.750 in. o.d., weighs only 1.2 oz, has an operating temperature range of −65 C to +125 C and meets MIL-E-5272. Voltage is 40/20 on control phase and 26 on fixed phase 400 cycle. No load speed is 6,500 rpm and stall torque 0.15 oz in. It is furnished with synchro mount and pinion type shaft. **Circle 461 on Reader Service Card.**



TUBE SHIELD
for printed circuit use

INTERNATIONAL ELECTRONIC RESEARCH CORP., 145 West Magnolia Blvd., Burbank, Calif. A new miniature and subminiature series of right-angle heat-dissipating tube shield clamps for printed circuit application are announced.

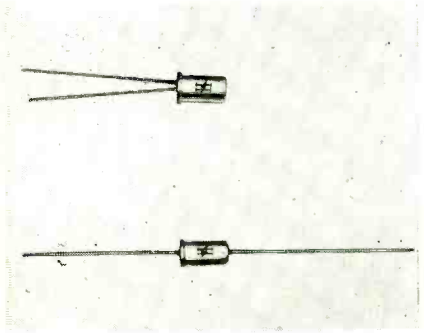
The shields contain integral sockets for miniature and subminiature tubes. Subminiature shields have flat press and round button base sockets and miniature shields are available with 7 and 9 pin sockets. All sockets are of a standard Mica filled type cast on to the shield assembly in a Mica filled epoxy resin of good electrical and mechanical properties. The epoxy resin withstands continuous operating temperatures of 175 C.

Bulb temperature of the tube is maintained to within 5C of the heat sink temperature per watt of heat dissipation and gives excellent retention, shock and vibration protection in extreme environmental conditions.

With the IERC right-angle printed circuit design the base of the shield attaches directly to a metal heat sink which lies adjacent to the printed circuit board. Socket leads extending

from the right-angle epoxy resin head fit through holes near the edge of the printed circuit board and are affixed by hand or automatic dip-soldering.

Installation illustrations and engineering data are available for the asking. **Circle 462 on Reader Service Card.**



RECTIFIERS
for h-v applications

HOFFMAN SEMICONDUCTOR DIVISION, Hoffman Electronics Corp., 930 Pitner Ave., Evanston, Ill., has announced the HDMP series of h-v medium power silicon diffused junction rectifiers. Designed for applications requiring up to 1,000 peak inverse working volts, these rectifiers are finding wide application in both commercial and military equipment.

Rated for operation in free air with no external heat sink, there is a choice of axial or single ended body construction. Maximum dimensions are only 0.220 in. diameter by 0.360 in. length. The line of HDMP rectifiers includes ten different models at the present time.

Charts, technical information and literature are available for the writing. **Circle 463 on Reader Service Card.**

INDUSTRIAL RELAY
general purpose type

WHEELOCK SIGNALS, INC., Long Branch, N. J. A new general purpose relay incorporating such design features as interchangeable coils and a removable multiposition base is now being offered to the equipment manufacturer and industrial user. Contacts rated

MICRO-BEARING ABSTRACTS

by A. N. DANIELS, *President*
New Hampshire Ball Bearings, Inc.

BEARING FITS AND FITTING PRACTICES

As shown in *Fig. 1*, the fitting of Micro-Bearings, like the fitting of larger ball bearings, chiefly involves the clearances between the inside diameter of the housing and the outside diameter of the bearing; the bore of the bearing and the shaft diameter.

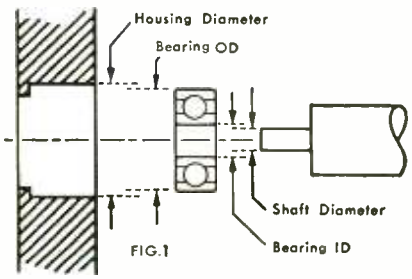


FIG.1

The achievement of the desired fit by dimensioning is illustrated in *Fig. 2*. The bearing ID is represented by the top blocks and the shaft OD is represented by the lower blocks. Such a block diagram could also be applied to housings and bearing outside diameters. In this block diagram, it will be noted, the bearing ID is represented by a .00015 tolerance with a similar tolerance for the shaft. A resulting fit of line to line to .0003 loose is shown.

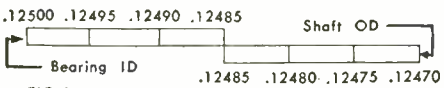


FIG.2

An interference fit not tighter than line to line is suggested for the following reasons:

1. *Difficulty in assembly.*
2. *Difficulty in disassembly. This is often more hazardous than the assembly operation and may result in total bearing destruction.*
3. *Reduction in radial play.*
4. *Danger of bearing ring conforming to possible poor geometry of mating shaft or housing.*

TOLERANCE DISTRIBUTION

The maximum .0003 loose condition shown in *Fig. 2* may be excessive in some applications. The fitting problem then resolves itself to reducing this extreme, and yet maintain the maximum tight fit of line to line. The looseness may be reduced by redimensioning the shaft to .12490/.12475 as shown in the block diagram, *Fig. 3*.

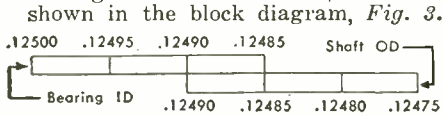


FIG.3

If the frequency distributions of shaft and bearing ID sizes were statistically normal, the modal fit of all parts would be 0.0001 loose. Accordingly, an insignificant percentage of parts would be mated to the extreme values, and for practical purposes could be ignored.

With regard to bearings' outside diameters and bores, however, normality of the distribution curve cannot be assumed. During the grinding operation, the "most metal tendency" tends to skew the frequency distributions for bearing ID's and OD's in the direction of most metal.

In grinding and finishing shafts and housings, similarly skewed distributions occur.

Operating on a modified probability distribution of tolerance is possible if the volume of parts is sizeable. But the approximate distribution of shaft and housing sizes must be verified if this method is to be used.

MATERIALS and SURFACE FINISHES

The ease of assembly is also affected by materials and finishes. The following factors must be considered:

1. *The galling characteristics, hardness and ductility of the materials involved.*
2. *Finish lay patterns produced by various tools and techniques used.*
3. *R M S surface finish values achieved.*
4. *Geometry of shafts and housings as regards out-of-roundness, taper, etc.*

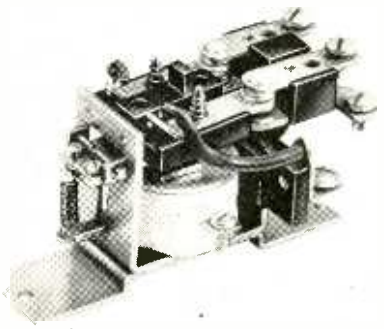
The possible combinations of these elements in any single application are so numerous that their gross effect can only be ascertained by trial and error, or by a detailed study of operations on individual applications. A more complete discussion of fitting practices, including sizing methods and coding, is found in our design handbook.

DESIGNERS HANDBOOK FREE TO ENGINEERS

If you work with miniature bearings, you'll find this new, 70 page authoritative publication a great help in solving problems in designing instruments or small electro-mechanical assemblies.

It will be sent free to engineers, draftsmen and purchasing agents Write to:

NEW HAMPSHIRE BALL BEARINGS, INC., PETERBOROUGH 1, NEW HAMPSHIRE



at 20 amperes, 115 v 60 cycle a-c or 24 v d-c, are single-and-double pole, single-and-double throw. Mounting arrangements are provided for auxiliary spdt contacts if desired. The relay is 2 7/16 in. high with a base measuring 1 in. by 3 3/8 in.

Small size and compactness, choice of mounting base (metal strap or Bakelite), choice of coil voltages (a-c—6 through 230 v, or d-c—6 through 115 v), and choice of terminal connections combine to make the relay truly versatile.

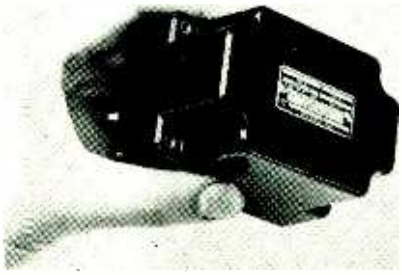
Typical applications include: motor control circuits; as a starter for fractional h-p motors; operation of signalling devices; as a relay in circuits controlled by thermostats, pressure switches, float switches, photoelectric devices, and the like. **Circle 464 on Reader Service Card.**

RELIABLE RELAYS
for printed circuits

MAGNECRAFT ELECTRIC CO., W. Grand Ave., Chicago 51, Ill., has announced adaptation of the versatile miniature class 11 relay series for printed circuit application. These relays are especially

adaptable to low-voltage sensitive applications where reliability is important and for requirements where one relay must perform a number of switching functions with minimum input power. They can be furnished with great resistance to shock and vibration and to withstand wide temperature variations in compliance with military specifications.

The relays are available for d-c operation, any voltage to 230, also with full wave rectification for operation from 20 to 400 cps. They are furnished with a great variety of contact combinations: snap action contacts, time delay, and heavy current contacts. Descriptive literature is available on request. **Circle 465 on Reader Service Card.**



MAGNETIC AMPLIFIER
sensitive and reliable

MAGNETIC CONTROLS CO., 6405 Cambridge St., Minneapolis 16, Minn. Type PA3C-1 magnetic amplifier is designed specifically to provide proportional temperature control of a heating element in response to a change in resistance of a temperature sensor.

Power output is proportional from 0 to 100 w, 400 cps, as the temperature sensing element resistance changes by approximately 1 ohm. Nominal output load is 130 ohms.

The two-stage amplifier combines a high degree of sensitivity and reliability. It is designed to operate in ambient temperatures of −55 C to 100 C and to exceed all other environmental conditions of MIL-E-5272. Internal circuitry design is such that open or short circuit sensing elements will cause the output voltage to automatically reduce to zero. The ampli-

fier may be mounted directly to the airframe in any position. **Circle 466 on Reader Service Card.**

COMMUTATOR
for airborne telemetry

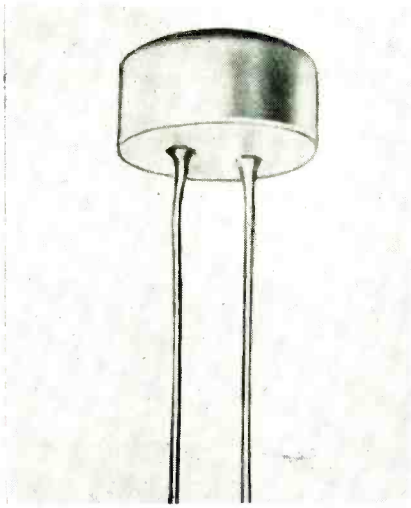
ARNOUX CORP., 11924 W. Washington Blvd., Los Angeles, 66, Calif. Series ETC-30 electronic commutator is offered with any sampling rate from 75 to 900 points per second. The unit meets all IRIG requirements for PAM and PDM commutated telemeter and magnetic tape systems under MIL-E-5272A environment. It may be used as a direct replacement for mechanical commutators in 0-3 v and 0-5 v systems. Errors due to drift, crosstalk and nonlinearity are less than 0.50 percent.

The unit is designed to give noise-free operation, without maintenance of any kind, for at least 5,000 hours. The ETC-30 series features 27 information channels and one master pulse. A built-in limiting feature eliminates the necessity for signal limiters elsewhere in the telemeter system.

Power required is 150 v d-c at 12 ma. Size is 3 in. diameter by 5 in. long. Total weight is less than 2 lb. **Circle 467 on Reader Service Card.**

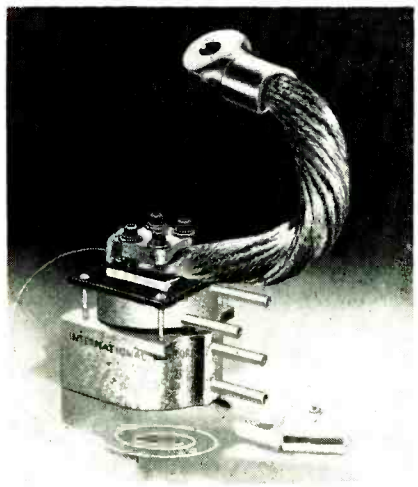
TINY TOROIDS
for printed circuits

TOROTEL, INC., 11505 Belmont, Hickman Mills, Missouri. A new series of printed circuit subminiature toroids, designed and built for use with automatic production techniques, is now available with



inductance values up to 4 hy.

These toroids are round case type, as pictured; 0.675 o.d. by 0.312 high with Q values of 45 at 5 kc to 165 at 5 mc, and test-proved to meet successfully the requirements of government specifications. Transistor transformers are also available in the same package. **Circle 468 on Reader Service Card.**



POWER JUNCTIONS
liquid-cooled germanium type

INTERNATIONAL RECTIFIER CORP., 1521 E. Grand Ave., El Segundo, Calif., has introduced highly efficient, liquid-cooled germanium power junctions, rated at 670-ampere rectified d-c, specifically engineered for heavy power conversion.

Six junction types are available in the range of 20 to 66 v rms. The 1-v junctions provide 98.5 percent efficiency, and will lower the power consumption of rectifier equipment. Connected in a three-

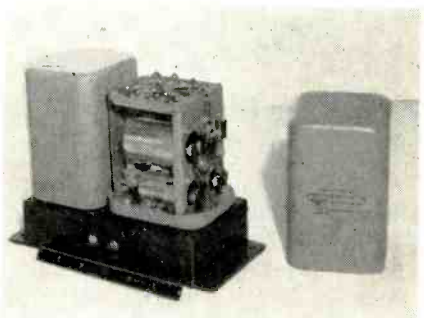
phase bridge circuit, six of these junctions will deliver 170 kw.

The junction measures 5 in. by 3¾ in. by 3⅜ in.; features a copper housing cast around special alloy steel tubing for maximum cooling. **Circle 469 on Reader Service Card.**

DELAY LINE
lumped constant type

PCA ELECTRONICS INC., 16799 Schoenborn St., Sepulveda, Calif., has developed a highly miniaturized 120-μsec delay line with a rise time of 1.4 μsec. Taps can be supplied as desired with the tolerance in delay of 0.25 percent at taps and output. This line offers the low attenuation of 3 db and has a temperature coefficient of less than 25 ppm from −40 C to +105 C.

The units can be supplied with pin terminals recessed for plug-in to printed circuit board or with conventional hooked terminals. All units are hermetically sealed in a metal case measuring 17 in. by 4½ in. by 1½ in., plus studs and terminals. **Circle 470 on Reader Service Card.**

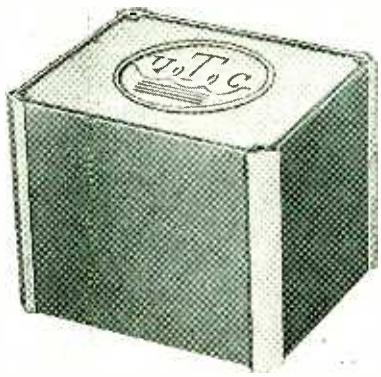


D-C POWER SUPPLIES
are transistor regulated

RAMSEY ENGINEERING CO., 2451 University Ave., St. Paul 14, Minn., announces a line of transistor regulated d-c power supplies having line regulation better

than 0.05 percent, load regulation better than 0.1 percent, and ripple less than 5 mv rms. Present models are for 115 v, 50-65 cps line, with output voltages from 2 to 200, adjustable ±5 percent of specified value, at 30 w. Custom design is readily available.

Special features are size, absolute short circuit protection, adjustability, stability, ease of custom design, and design to military specifications. **Circle 471 on Reader Service Card.**



OUTPUT TRANSFORMERS
two high fidelity types

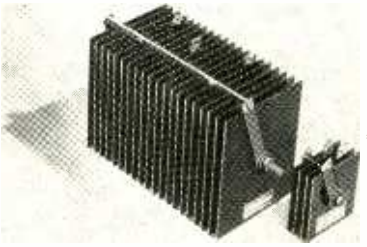
THE UNITED TRANSFORMER CORP., 150 Varick St., New York 13, N. Y., announces two new high fidelity output transformers in its linear standard series. Type LS-35 has a 5,000 ohm center tapped primary with 43 percent screen taps for use with EL-34 tubes in AB-feedback. Secondary impedances are 4, 8, and 16 ohms; frequency response, 1 db from 7 to 50,000 cps, 35 w level.

The LS-65 transformer is a similar unit of 60 w rating, providing a 3,300 ohm center tapped primary with 40 percent screen taps for 6550's in AB_1 feedback.

Both units are furnished with a recommended circuit which provides maximum fidelity and stability. **Circle 472 on Reader Service Card.**

SELENIUM RECTIFIER
for industrial applications

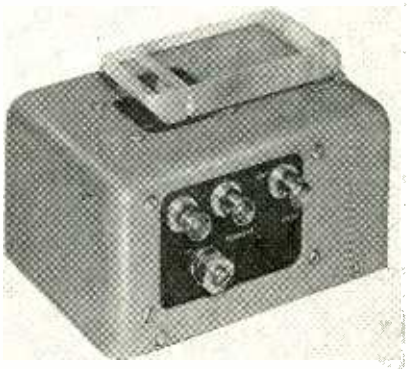
INTERNATIONAL RECTIFIER CORP., 1521 E. Grand Ave., El Segundo,



Calif., has announced high current density selenium rectifiers for high temperature industrial applications.

Individual rectifier plates are capable of handling twice the current of conventional plates of the same dimensions, and feature input voltages up to 36 v per plate. The low forward drop and h-v capacity resulting from the new Dualtron process reduces the number of plates required to provide the same output as other selenium rectifiers available to this date.

Rectifiers of all circuit types will be available in plate sizes ranging from 1 in. square to 6¼ by 7¼ in. **Circle 473 on Reader Service Card.**



TEST JIG
for magnetic cores

BURROUGHS CORP., Electronic Instruments Division, 1209 Vine St., Philadelphia 7, Pa., has announced development of a new test jig designed for precision testing of magnetic tape wound bobbin cores. The jig provides a means of applying either positive or negative current driving pulses to the core being tested and incorporates circuits permitting direct viewing on an oscilloscope of the current

pulse at the point of application to the core and also the output pulse induced by the switching of the core.

The jig is available in two models, types 8040 and 8041, the difference between models being the size of bobbin flange each will accommodate. In operation the two models are identical. The core is inserted into the jig by placing it between two pairs of sensing pins. When the cover arm is pulled down, the two pins in each pair are connected, thus forming a tight, single-turn winding on each side of the core; one for the input, the other for the output. In both models the pin spacing is adjustable in order to assure a tight loop around the core for different size bobbins.

Types 8040 and 8041 test jigs have been designed as part of Burroughs core tester BCT301, a complete system for individually testing tape wound cores. **Circle 474 on Reader Service Card.**

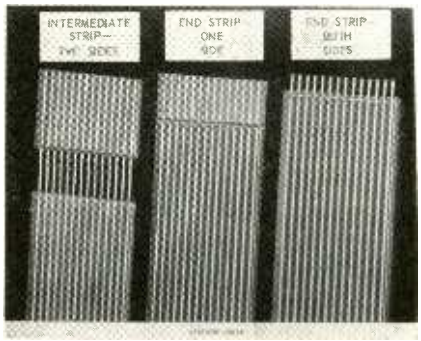
WIRE WRAP TERMINALS
for printed circuit assembly

MALCO TOOL AND MFG. CO., 4025 West Lake St., Chicago 24, Ill. A recently developed line of wire wrap terminals is presently being used by electronic, tv and radio manufacturers to speed up assembly and cut production costs. Available in loose or chain form, this terminal features a clinch-type design which holds the individual terminal firmly in the printed circuit board during additional assembly operations and until permanently soldered.

When used in chain form and in conjunction with the Malcomatic lug inserter, the new terminals make possible a fully automatic assembly of 20 wire wrap termi-

nals into printed circuit boards, in any pattern, at rates up to 20 boards per minute. For semiautomatic operation, they can be used in chain form for rapid insertion by means of the Malco single terminal inserter.

The new wire wrap terminals are engineered to meet the rigid specifications required for automatic wire wrap connections. Variations in designs can be quoted on request. **Circle 475 on Reader Service Card.**

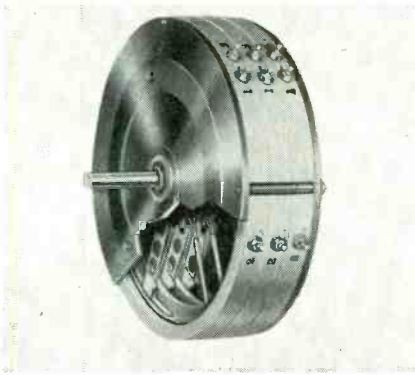


CABLE BELT
for printed wiring

TAPE CABLE CORP., 790 Linden Ave., Rochester 10, N. Y. has introduced a transparent flexible polyester film in which are imbedded flat copper conductors 0.0015 in. thick. A saving of 85 percent in copper over conventional cable having round conductors of the same current-handling capacity is claimed. Each conductor is rated at 1 amp in free air at 300 v, with an interconductor capacitance of less than 5 $\mu\mu$f/ft. Tensile strength is 80 lb/in. of width. Other advantages include reduced assembly and maintenance costs due to high-speed stripping, soldering and insulating. **Circle 476 on Reader Service Card.**

PRECISION POT
five-in. type

DEJUR AMSCO CORP., 45-01 Northern Blvd., LIC 1, N. Y. Series HP-500 potentiometers are an extension of the characteristics of the HP-300 series (3-in.) for use where resolution and linearity requirements are more important than physical considerations. The HP-



500 series uses a 14 in. long Kohlrausch cylindrical resistance element, resulting in linearities of ±0.3 percent (std) to ±0.05 percent (on order) and in very high resolution.

Depending on the spacing required, up to 32 taps can be provided. Resistance tolerances are ±5 percent (std) to ±1 percent (on order) at 12 watts. Mechanical rotation is 360 degrees. Aluminum end-plates have three tapped mounting holes. All contact materials are precious metals with terminals and slip rings gold-plated. **Circle 477 on Reader Service Card.**

WINDING MACHINE
for toroidal coils

DONALD C. Harder Co., 3710 Midway Drive, San Diego, Calif. has added the Model M-24 toroidal coil winding machine to its line of products. The M-24 is a heavy duty machine designed to wind toroids from 2 in. to 8 in. outer diameter such as those used in magnetic amplifier and control systems.

Wire sizes 18 to 36 are wound up to a maximum speed of 500 turns per minute. An electronic system using a thyratron pulsing circuit counts the turns. Footage of wire loaded is registered by means

of a 1-ft circumference measuring wheel.

The grooved 24 in. diameter winding ring operates in conjunction with a circumferential retaining coil spring. A maximum of 1½ lb of wire may be loaded. The feed is manual, resulting in a random winding. Total price is $1,250. **Circle 478 on Reader Service Card.**

TAPE ERASER
priced at $20

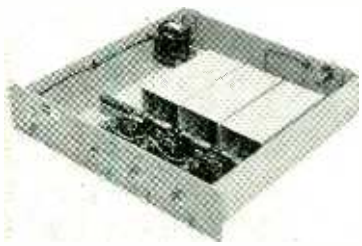
MICROTRAN CO., INC., 145 E. Mineola Ave., Valley Stream, N. Y., has introduced a magnetic tape bulk eraser. Model HD-11 erases recorded signals and noise from magnetic tape below level of standard erase heads. Spindle mounting of reel permits rapid, thorough, coverage without missed spots.

The eraser is usable with magnetic tape reels from 5 in. through 10 in. diameter. It may also be used for demagnetizing record-playback-erase heads, tools, and other metal objects. Size is 3 in. by 5 in. by 8 in. Weight is 8½ lb. **Circle 479 on Reader Service Card.**

TUBE ANALYZER
an automatic unit

RHEEM MFG. CO., 7777 Industry Ave., Rivera, Calif. The REL-1001 is an automatic tube analyzer incorporating new concepts of design for faster, more accurate, highly flexible and extremely simple operation. The unit provides 17 test positions, which can be set up to perform any combination of 19 basic tests, utilizing the "programmer" principle con-

sisting of individual, easily inserted patch panels, each unique to a particular tube type. Tests may be conducted singly or in sequence, and may be accomplished automatically, semiautomatically, or manually at the rate of 3,000 tests per hour, to ±3.0 percent accuracy. The analyzer tests practically all basic tube types. The unit will accommodate new types and is adaptable for special tests. A bulletin giving complete specifications is available. **Circle 480 on Reader Service Card.**



TRIPLE POWER SUPPLY
for strain gages

KIN TEL, 5725 Kearny Villa Road, San Diego 11, Calif., Model PSG-3 supplies three independent 6 or 10 volt sources for 120 or 350 ohm strain gages. A single front panel switch sets all three channels to either 6-v or 10-v. A screw-driver control for each channel allows ±1-v adjustment on both voltage settings. Adjustment resolution is 0.05 percent.

Output noise is less than 5-μv with supply ungrounded and feeding a grounded 350 or 120 ohm bridge. Ripple is 2-mv peak-to-peak. Resistance to ground is greater than 1000 megohms and capacity to ground is less than 500$\mu\mu$f per channel. Nominal load resistance is 120 or 350 ohms, while internal impedance is less than 15 ohms.

Pushbuttons on the front panel allow voltage measurement of each channel by an external voltmeter. The chassis requires 3.5 in. vertical space in a standard 19-in. rack. Including space for cable and connector, 19.5-in. is required behind the front panel. **Circle 481 on Reader Service Card.**

New Literature

L-V Relay Service. Pyramid Instrument Corp., 630 Merrick Road, Lynbrook, N. Y. Now that the company has made its Remcon low-voltage relays available to manufacturers of original equipment, it has published a service bulletin (RT-100) which gives full engineering specifications on this silent, modern relay with its own built-in transformer. **Circle 501 on Reader Service Card.**

Energy Cartridge. Associated Spring Corp., Bristol, Conn. To describe its new compact energy cartridges—which consist of preassembled stacks of multiple Belleville spring washers held together by pins or rivets passing through the washers at or near their neutral axis—the company has published a six-page bulletin.

Exploded views show how the washers are assembled, and schematic drawings illustrate several typical applications for the cartridges. A few of the possible applications listed are: as a shock absorber, in vibration-isolation mounts for such products as airborne electronic equipment, in aircraft, missiles and ordnance projectiles; in machinery such as impact presses; and in spring mountings for punches and dies in industrial and powder metal compacting presses. **Circle 502 on Reader Service Card.**

Rotary Transducer. Crescent Engineering & Research Co., 5440 North Peck Road, El Monte, Calif. A one-page bulletin gives description and data on the 3-oz model RT-22A-120 rotary transducer. The unit discussed is an electromechanical instrument designed to sense angular position or rotary displacement and to transmit a proportional signal to measurement apparatus or control circuitry. **Circle 503 on Reader Service Card.**

Distributed-Constant Delay Lines. International Resistance Co., 401 North Broad St., Philadelphia 8, Pa. Catalog data bulletin S-2 covers distributed-constant delay lines. It contains comprehensive data on functions, applications, principal equipment uses, characteristics, specifications, nomenclature, time delay, bandwidth and rise time. The four-page bulletin includes detailed graphs and illustrations. **Circle 504 on Reader Service Card.**

Precision Electronic Equipment. The Industrial Test Equipment Co., 55 E. 11th St., New York 3, N. Y., has recently made available a short form catalog of their precision electronic equipment. The brochure includes in a precise form the description and specifications of various instruments, such as a phase meter, null meter, impedance comparators, precision power oscillators, a frequency standard, an automatic hi-pot tester and others. **Circle 505 on Reader Service Card.**

Magnetic Hum & Electrostatic Shielding. Magnetic Shield Division, Perfection Mica Co., 1322 North Elston Ave., Chicago 22, Ill., has issued data sheet 129 with 14 photographs and captions which illustrate and describe how to wrap audio transformers, chokes and other square or rectangular components using newly developed Co-Netic flexible foil to prevent magnetic hum. **Circle 506 on Reader Service Card.**

Tube Tester Roll Charts. Sylvania Electric Products Inc., 1891 East Third St., Williamsport, Pa., has available three new electronic tube tester roll charts. Designed for use with Sylvania tube testers, the new charts feature approximately 100 new tube types.

Chart PC15845-N is for use with tube testers 139 and 140. Chart PC18325-K can be used with tube testers 219 and 220. Chart PC25700-C is designed for use with tube tester 620.

The charts are priced at $1.50 each. **Circle 507 on Reader Service Card.**

Linear Transducers. Automatic Timing & Controls, Inc., King of

Prussia, Pa., has announced a handbook completely treating the theory and most advanced application of differential transformers. Characteristics of various differential transformers are described, tabulated and charted. Basic circuits are shown and described. Fifteen typical applications are completely covered.

The 32-page, plastic-bound handbook provides necessary data for design engineers who wish to apply linear magnetic transducers in replacing precision potentiometers and syncros as well as develop new low impedance automatic circuitry of high precision and great reliability.

Text includes 22 circuits, 37 diagrams and 12 charts. Price is $2. **Circle 508 on Reader Service Card.**

Power Supply. B. M. Harrison Laboratories, Inc., 80 Winchester St., Newton Highlands 61, Mass., has announced a descriptive bulletin covering a new fixed or variable frequency regulated power supply. The model No. 5014 described can be used for supplying power requirements up to 125 w at exact frequencies of 60, 400 or 1,000 cycles ±0.01 percent. In addition to these fixed frequencies it can be driven by an external signal generator to supply 125 w over a range of 50 cps to 2,500 cps.

The power supply discussed is recommended for use as a prime laboratory source of regulated voltage and frequency for the testing of equipment in the fields of missile controls, servomechanisms and gyro instrumentation. **Circle 509 on Reader Service Card.**

Instruments Catalog. Beckman-Berkeley Division, 2200 Wright Ave., Richmond 3, Calif. Seventeen new instruments are described in short form catalog C704.

New instruments include preset EPUT meters with variable time base for direct digital readout without conversion and a series of moderately priced portable EPUT meters. Expanded scale volt and frequency meters, transformation ratio meters, and resist-

ance bridges are also covered.

The catalog also covers new nuclear scales, recorders and readouts, and the EASE 1100 analog computer with digital input and output. **Circle 510 on Reader Service Card.**

Calibration With Frequency Standard Broadcasts. Specific Products, 21051 Costanso, Woodland Hills, Calif. Calibration of r-f and a-f signals with standard frequency transmissions is described in an informative 4-page folder.

Designated bulletin 557, the literature details a number of methods for utilizing the standard transmissions from stations WWV and WWVH, National Bureau of Standards. It discusses with diagrams, such topics as calibration of low f-f sources, upward extension of standard frequencies, a-f comparisons, and the use of 1,000 cycle time pulses. The bulletin includes a discussion on code symbol notices of propagation disturbances, as well as the conditions necessary for obtaining various levels of signal accuracy. **Circle 511 on Reader Service Card.**

Epoxy Encapsulation. Rue Products, 1628 Venice Blvd., Venice, Calif. A new bulletin offers encapsulation service, engineering, development and production of all types of electronic components, assemblies and circuitry. Units discussed are designed and produced to meet the most exacting requirements of the design engineer for his specific applications. Properties of the epoxy offered are noted. Pointed out is the featured low-cost molding technique for short-run requirements. **Circle 512 on Reader Service Card.**

Power Supplies & Converters. Kepco Laboratories, Inc., 131-38 Sanford Ave., Flushing 55, N. Y., has published the new condensed brochure, No. B576. It introduces the new lines of: semiconductor voltage regulated power supplies; semiconductor d-c to d-c converters; and magnetic amplifier voltage regulated power supplies.

This literature also lists the latest improved specifications on both the company's side range and

narrow range electronic type voltage regulated power supplies. **Circle 513 on Reader Service Card.**

Digital Voltmeter Application. Non-Linear Systems, Inc., Del Mar Airport, Del Mar, Calif., announces the availability of a new 28-page booklet which describes the company's full line of digital voltmeters, digital ohmmeters, a-c/d-c converters and complete data logging systems. The book, profusely illustrated with charts, diagrams, and photos of instruments, is available free upon request. **Circle 514 on Reader Service Card.**

Logarithmic Count Rate Meter. The Victoreen Instrument Co., 5806 Hough Ave., Cleveland 3, Ohio, has announced a bulletin on the model 727 logarithmic count rate meter.

The new two-page, two-color, illustrated bulletin outlines suggested uses and applications and gives complete specification data such as range, accuracy, dimensions, shipping weight and the like.

Copies of Form 3002-7 are available on request. **Circle 515 on Reader Service Card.**

Germanium Power Transistor. Clevite Transistor Products, 241 Crescent St., Waltham 54, Mass. A 4-page technical data sheet covers the type 2N297 military specified germanium power transistor. Included are a general description and mechanical and electrical specifications. **Circle 516 on Reader Service Card.**

All Transistor Amplifier. Beckman Instruments, Inc., 325 Muller Ave., Anaheim, Calif., has available a 4-page brochure on the company's all transistor amplifier. The unit discussed is a high gain, broad band, chopper stabilized, precision amplifier designed specifically for use in analog computation and amplification for low level d-c signals such as strain gage transducers or thermocouple output. High reliability over conventional amplifiers is due primarily to its being fully transistorized, light weight, cool and free of microphonics, plus a built-in

power supply that will accept inputs up to ±15 v and has an output capability of ±15 v at 100 ma.

This brochure is very descriptive, utilizing complete diagrams, block diagrams and photographs explaining operation, typical applications and operations specifications. **Circle 517 on Reader Service Card.**

Electronic Components Guide. International Resistance Co., 401 N. Broad St., Philadelphia 8, Pa. Comprehensive data on IRC's complete line of resistors and other electronic components (including those of its subsidiary, Circuit Instruments Inc. and the Hycor Division of IRC) are listed in the 1957-1958 Electronic Components Guide. Data given include JAN or MIL equivalent, rated wattage, standard tolerance, temperature rise, temperature coefficient, maximum operating temperature, ohmic values available and dimensions. **Circle 518 on Reader Service Card.**

Electronic Timer. G. C. Wilson & Co., 1915 Eighth Ave., Huntington, W. Va. A new 4-page bulletin describing the manufacturer's line of electronic timers is now available. This bulletin provides specifications, applications and operation of 11 timers of the repeat cycle, interval and delay types. **Circle 519 on Reader Service Card.**

Protective Closures. Shurclose Seal Co., 3,000 East Grand Blvd., Detroit 2, Mich., has issued a new 4-page catalog on its caps and plugs. Complete specifications are given for both rubber and plastic closures for the protection, sealing or masking of threaded parts, pipe ends or tubing. Seven styles of stock sizes are covered by the specifications. **Circle 520 on Reader Service Card.**

Operational Mixer. Hoover Electronics Co., 3906 Liberty Heights Ave., Baltimore 7, Md. A four-page brochure describes the model 10022 operational mixer, developed for use in summing the outputs of up to 18 subcarrier oscillators. A high-gain amplifier is used with a large feedback factor, insuring

drift-free operations with a minimum of intermodulation distortion. The unit discussed weighs 9 oz and measures 1 13/64 by 2 5/16 by 4 3/64 in. overall, including connector. **Circle 521 on Reader Service Card.**

Thyratron-Rectifier Catalog. Continental Electric Co.-Taylor Tubes, Inc., 6 North Michigan Ave., Chicago 2, Ill., has published a fully illustrated 12-page catalog on thyratrons and rectifier tubes. Included are charts, wiring schematics, cross-reference replacement data and descriptive matter on the Cetron-Taylor product line. A copy of catalog No. 557 is available for the writing. **Circle 522 on Reader Service Card.**

X-Ray Inspection of Electron Tubes. Philips Electronics, Inc., Instruments Division, 750 South Fulton Ave., Mount Vernon, N. Y. A new bulletin gives details on methods used for automatic x-ray inspection of subminiature electron tubes.

Illustrated with photos and radiographs, the bulletin describes mass quantity inspection of components for missiles and aircraft systems. The text deals with x-ray work that involves welds on wire stock measuring 0.003 to 0.015 in. in diameter. The bulletin also treats x-ray examinations which determine spacing of parts and discover loose metallic particles, defective heaters and distorted grids.

The new literature discusses details of the new x-ray method including the special disk of spherical section on which tubes and film are positioned. The technique discussed permits 18,000 tubes to be checked daily and the inspection involves lead, glass, nickel, barium, aluminum, iron and many other materials which exist in alloys and chemicals of subminiature tubes. **Circle 523 on Reader Service Card.**

Phase Sensitive Demodulator. Hoover Electronics Co., 3906 Liberty Heights Ave., Baltimore 7, Md. A 4-page brochure describes the model 10019 phase sensitive demodulator, and associated 400-

cycle power supply, which serves as the link between a guidance system and a telemetering system. Compact and lightweight, the unit described supplies subcarrier oscillators with signals proportional to the position of three gyros, synchros or other position sensing devices. In addition, it supplies a signal representing the a-c reference voltage in the system. **Circle 524 on Reader Service Card.**

Tantalum Wire Capacitors. Ohmite Mfg. Co., 3634 W. Howard St., Skokie, Ill. Bulletin 148B supplement describes two very small "Tan-O-Mite" series TW capacitors (tantalum wire electrolytic capacitors). This release also reviews the now expanded line of "Tan-O-Mite" units, gives the maximum capacities and voltages for each of the six case sizes, and lists the stock values immediately available from Ohmite. Technical information and data concerning Mylar-sleeve insulated "Tan-O-Mite" capacitors is also given. **Circle 525 on Reader Service Card.**

Cycling Timer. Cramer Controls Corp., Centerbrook, Conn. Complete technical information on a new motor driven cycle timer, type 571, is available in bulletin No. PB-571. Application and operation data are presented in detail together with time ranges, ratings, material and construction specifications.

Several nonstandard arrangements for special applications are suggested. A set of graphic instructions on specifying program schedules is also included. **Circle 526 on Reader Service Card.**

Telephone-Type Relay. Phillips Control Corp., 59 W. Washington St., Joliet, Ill. A comprehensive report on the type 8 multicontact telephone-type relay is available.

The four-page engineering bulletin, complete with photographs and dimensional drawings, provides detailed descriptions of characteristics, special features and general technical data. Standard stock and special contact listing plus in-stock relay listing is included for the type 8, which is

available enclosed or hermatically-sealed.

This bulletin and others in the series are available in an attractive three-ring, looseleaf binder by writing the company. **Circle 527 on Reader Service Card.**

Time Interval Measurements. Beckman/Berkeley Division, 2200 Wright Ave., Richmond, Calif. Data File 112 discusses time interval measurements and how to make them. Among the subjects covered in this nine-page booklet are a description of time interval meters, measurement of pulse width and elapsed time, low-frequency period measurements, timing relay operations, testing camera shutter speeds with a time interval meter, and measuring velocity with a time interval meter.

Profusely illustrated, the literature contains diagrams, photos, and schematics describing techniques for using time interval meters. **Circle 528 on Reader Service Card.**

Computer Bibliography. Remington Rand, Division of Sperry Rand Corp., 315 Fourth Ave., New York 10, N. Y., has announced a new bibliography of computer literature for those interested in learning more about this absorbing subject. Booklet EL335 has been prepared with emphasis on scientific and engineering use of computers. **Circle 529 on Reader Service Card.**

Hermetic Seal Single Terminals. Hermetic Seal Corp., 29 South 6th St., Newark 7, N. J. Drawings and specifications for a large variety of standard hermetic seal single terminal feed-throughs and stand-offs are contained in a new 12-page supplementary catalog No. 657-B. Single terminals are produced in Vac-Tite seals constructed by the company's glass-to-metal chemically bonded compression process and in matched seals with metal and glass of matching coefficients of thermal expansion. Seals are listed in groupings according to types and sizes easily identified with specific part numbers. All are available

hot tin dipped or in precious metal finishes. **Circle 530 on Reader Service Card.**

Components Catalog. Merit Coil and Transformer Corp., 4427 North Clark St., Chicago 40, Ill. Form No. 409 is a 128-page catalog containing a comprehensive and accurate listing of a wide line of i-f and r-f coils, components, transformers, flybacks and yokes found in practically every tv set produced up to early 1956. **Circle 531 on Reader Service Card.**

Physical Limitations of Magnetic Tape. Minnesota Mining and Mfg. Co., 900 Bush St., St. Paul 6, Minn. The effects of heat, humidity and tension on magnetic tape are discussed in "Sound Talk" bulletin No. 35, now available on request from the company.

The three-page bulletin is illustrated with three graphs which show stress characteristics of the different types of "Scotch" brand magnetic tape. It points out that where magnetic tape is used under abnormal or extreme conditions—as in recording instrumentation data at tape speeds as high as 100 inches per second in conjunction with high head pressures and high environmental temperatures—certain properties of the recording media may become critical. **Circle 532 on Reader Cervice Card.**

Electro-Hydraulic Valve Actuator. Askania Regulator Co., 240 East Ontario St., Chicago 11, Ill. Bulletin 38.3 describes the new electro-hydraulic valve actuator. The actuator discussed is designed for use with low level a-c or d-c signals from electronic controllers and measuring elements or remote positioning devices. It can be mounted on valves having ½ to 1½-in. stroke, requiring less than 200 lb thrust. **Circle 533 on Reader Service Card.**

Electronic Megaphone. Kaar Engineering Corp., P. O. Box 1320, Palo Alto, Calif. Bulletin MA-4-1-7 illustrates and describes the Loudhailer, a transistorized megaphone of tremendous power adaptable to practically all commercial, industrial and sporting activities. Spe-

cifications and many applications are listed. Price of the unit discussed is $125. **Circle 534 on Reader Service Card.**

Coolant Fluid for Electronic Equipment. Monsanto Chemical Co., 800 N. 12th, St. Louis 1, Mo. Technical bulletin No. O-123 covers OS-45 coolant fluid for electronic equipment, especially the aircraft type. The fluid described is a silicate ester-based material which performs over a wide temperature range—from −80 F to 400 F—and has excellent service life. Major features, properties, handling information and availability are discussed. **Circle 535 on Reader Service Card.**

Precision Soldering Irons. American Electrical Heater Co., 6110 Cass Ave., Detroit 2, Mich. Bulletin 218-CP shows the latest development in American Beauty electric soldering irons. The irons discussed are designed and intended primarily to do fine precision soldering on miniature and subminiature electronic components and similar assemblies. Features and specifications are included. **Circle 536 on Reader Service Card.**

Interval Timer. Cramer Controls Corp., Centerbrook, Conn. Catalog and technical data on new manually set, motor driven interval timer, type 271, are now available in bulletin No. PB-271. Details of construction, operation, and application are included.

The bulletin also shows time range selections, ratings, switch capacity, and special accessory information. **Circle 537 on Reader Service Card.**

Miniature Composition Potentiometers. Ohmite Mfg. Co., 3638 Howard St., Skokie, Ill. The smallest, molded composition potentiometer available is described in bulletin 149 recently released. The reasons for the superior reliability of molded composition construction are outlined in detail. Complete specifications, resistance values, dimensions and prices are included on this dusttight, splashproof, fungus-resistant unit in-

tended for small or miniature apparatus in domestic and military applications. **Circle 538 on Reader Service Card.**

Pulse Calibrator. Burroughs Corp., Electronic Instruments Division, 1209 Vine St., Philadelphia, Pa. The type 1810 pulse calibrator, a new instrument designed for accurately measuring current and voltage pulse amplitudes, pulse durations and rise time, is now fully described in a technical brochure.

The four-page brochure shows how the calibrator operates, illustrating and explaining actual waveforms obtained from different applications of the unit. Complete theory of operation of the two sections of the calibrator, the chopper section and the calibrator section, along with the specifications, is included. **Circle 539 on Reader Service Card.**

Mobile Air Monitor. The Victoreen Instrument Co., 5806 Hough Ave., Cleveland 3, Ohio. A new two-page, two-color bulletin describes the model 900-2 mobile air particle monitor for continuously monitoring and recording beta and gamma levels.

Stating that the unit conforms to ORNL specification Q-1740, bulletin 3004-7 outlines special design features, gives a block schematic showing applications, and lists detailed specification data. **Circle 540 on Reader Service Card.**

Five-Inch Precision Pots. DeJUR-Amsco Corp., 45-01 Northern Blvd., Long Island City 1, N. Y. A two-page illustrated catalog sheet gives specifications, diagrams and general information on a new five-inch high resolution precision potentiometer. **Circle 541 on Reader Service Card.**

Variable Transformer. The Superior Electric Co., 83 Laurel St., Bristol, Conn. A four-page bulletin SE-L3578 is now available giving illustrations, outline drawings and technical rating data on the new Powerstat variable transformer type LW136. The new double wound Powerstat with an isolated secondary on a single

core is fully described in the bulletin.

Connection diagrams and ratings are given for the Powerstat when used as a source of adjustable low voltage isolated output, a limited range line corrector, or as a limited range buck-boost variable transformer. **Circle 542 on Reader Service Card.**

Electronic Typer. Shepard Laboratories, Broad St. & Park Ave., Summit, N. J. A four-page folder illustrates and describes the model 190 electronic highspeed typer. Specifications are included. **Circle 543 on Reader Service Card.**

Miniaturized Self-Locking Nuts. Elastic Stop Nut Corp. of America, 2330 Vauxhall Rd., Union, N. J. A new 36-page illustrated brochure, bulletin 5711, presents the company's progress and status in the field of miniaturized self-locking nuts for electronic units and avionic equipment.

Major sections cover size and weight reduction and fastener configuration and the relative importance of each factor in choosing the right fastener for the particular job. Comparison charts show weight, size, temperature, and material for nuts in ESNA's hex and clinch series. Standard AN parts and NAS miniatures are graphically compared in chart form. **Circle 544 on Reader Service Card.**

Production Equipment for Electronics. United Shoe Machinery Corp., 140 Federal St., Boston, Mass. Producers of electronic equipment who are using or planning to use printed wiring can receive help in determining if they can profitably mechanize their component trimming, inserting and clinching operations from a new 12-page booklet.

The booklet illustrates presently available models of Dynasert component inserting machines including both fully automatic conveyor systems and individual bench machines. Representative case histories are used to illustrate applications in high, medium and low volume situations. **Circle 545 on Reader Service Card.**

Plants and People

Edited by WILLIAM P. O'BRIEN

Electronics manufacturers expand plants and facilities by acquisition, leases or new construction. Top engineers and executives in the industry are promoted and move to new responsibilities. Standards Conference hosted by Moscow

Burnell Moves to Large Pelham Manor Plant

BURNELL & CO., INC., manufacturer of toroidal coils, filters and communications network components, located in Yonkers for the past nine years, has moved to Pelham Manor, N. Y.

The new Pelham Manor plant has undergone extensive remodeling and modernization. The office and production control area occupies 11,000 sq ft, and the factory space 22,000 sq ft. Equipped with an air-control system throughout, the plant employees will enjoy an air-conditioned cafeteria-style lunchroom, a large parking space in the rear of the plant, and a highly advanced assembly layout.

Because of the highly specialized nature of Burnell's products, the company instituted an on-the-job training system several years ago which has resulted in the elevation of numerous workers from the ranks into positions of responsibility.

Burnell's new location in Pelham Manor, New York

It is expected that the present roster of Burnell & Co. employees, which now numbers between three and four hundred, will be increased sharply within the near future, since the new plant production potential has been increased by new equipment and larger space.

Boscia Named Chief Product Engineer at Kin Tel

APPOINTMENT of Archie F. Boscia as chief product engineer for Kin Tel Division of Cohu Electronics, Inc., has been announced by William S. Ivans, Jr., vice president for engineering.

Boscia formerly was associated with Stromberg-Carlson Div. of General Dynamics as section head of communications and navigation at the Rochester, N. Y., plant. In this post he had project supervision of the program for production of airborne units for Tacan, the tactical air navigation system built for the armed forces.

At Kin Tel in San Diego, Boscia will supervise all engineering phases of production design on the Kin Tel line of instruments for communication, measurement and control. These include wide-band d-c amplifiers, microvoltmeters, industrial and broadcast tv and other electronic instruments.

Archie F. Boscia

Microwave Engineering Labs Has New Quarters

ANNOUNCEMENT has been made by Microwave Engineering Laboratories, Inc., of its completed move into a new 3,500 sq ft research and development facility at 943 Indus-

Three voltage ranges:
0-200, 125-325, 325-525 VDC

1.5 AMPERE MODELS NEED ONLY 8¾" OF PANEL HEIGHT!

(metered)		(unmetered)	
MODEL C-1580M:	0-200 VDC, 0-1500 MA....580.00	MODEL C-1580:	0-200 VDC, 0-1500 MA....550.00
MODEL C-1581M:	125-325 VDC, 0-1500 MA....605.00	MODEL C-1581:	125-325 VDC, 0-1500 MA....575.00
MODEL C-1582M:	325-525 VDC, 0-1500 MA....680.00	MODEL C-1582:	325-525 VDC, 0-1500 MA....650.00

800 MA MODELS NEED ONLY 7" OF PANEL HEIGHT!

(metered)		(unmetered)	
MODEL C-880M:	0-200 VDC, 0-800 MA....370.00	MODEL C-880:	0-200 VDC, 0-800 MA....340.00
MODEL C-881M:	125-325 VDC, 0-800 MA....345.00	MODEL C-881:	125-325 VDC, 0-800 MA....315.00
MODEL C-882M:	325-525 VDC, 0-800 MA....390.00	MODEL C-882:	325-525 VDC, 0-800 MA....360.00

400 MA MODELS NEED ONLY 5¼" OF PANEL HEIGHT!

(metered)		(unmetered)	
MODEL C-480M:	0-200 VDC, 0-400 MA....289.50	MODEL C-480:	0-200 VDC, 0-400 MA....259.50
MODEL C-481M:	125-325 VDC, 0-400 MA....274.50	MODEL C-481:	125-325 VDC, 0-400 MA....244.50
MODEL C-482M:	325-525 VDC, 0-400 MA....289.50	MODEL C-482:	325-525 VDC, 0-400 MA....259.50

200 MA MODELS NEED ONLY 5¼" OF PANEL HEIGHT!

(metered)		(unmetered)	
MODEL C-280M:	0-200 VDC, 0-200 MA....214.50	MODEL C-280:	0-200 VDC, 0-200 MA....184.50
MODEL C-281M:	125-325 VDC, 0-200 MA....189.50	MODEL C-281:	125-325 VDC, 0-200 MA....159.50
MODEL C-282M:	325-525 VDC, 0-200 MA....199.50	MODEL C-282:	325-525 VDC, 0-200 MA....169.50

LAMBDA
Electronics Corp.

11-11 131 STREET, COLLEGE POINT 56, NEW YORK

For all power supply needs through 1.5 amperes:

LAMBDA
COM-PAK®
POWER SUPPLIES

Less space! Improved performance!

Long, trouble-free service!

Transient free output!

Fills the need for compact, regulated DC power supplies. Economy of panel space, functional simplicity, new quick-service features.

Wiring, tubes and other components readily accessible. You can reach them easily, service them fast.

400 MA, 800 MA, and 1.5 ampere models include new, high-efficiency, long-life, hermetically-sealed semi-conductor rectifiers. All Com-Pak models are constructed with hermetically-sealed transformers, chokes and capacitors.

Condensed Data

LINE REGULATION . . . . . Better than 0.15% or 0.3 Volt, whichever is greater.

LOAD REGULATION . . . . . Better than 0.25% or 0.5 Volt, whichever is greater.

INTERNAL IMPEDANCE

C- 200 Series . . . . . Less than 6 ohms.
C- 400 Series . . . . . Less than 3 ohms.
C- 800 Series . . . . . Less than 1.5 ohms.
C-1500 Series . . . . . Less than 0.75 ohms.

RIPPLE AND NOISE . . . . . Less than 3 millivolts rms.

POLARITY . . . . . Either positive or negative may be grounded.

AMBIENT TEMPERATURE . . . . . Continuous duty at full load up to 50°C (122°F) ambient.

AC OUTPUT
(unregulated) . . . . . 6.5 VAC (at 115 VAC Input).

C- 200 Series . . . . . 10 AMP
C- 400 Series . . . . . 15 AMP
C- 800 Series . . . . . 20 AMP
C-1500 Series . . . . . 30 AMP

AC INPUT . . . . . 105-125 VAC, 50-400 CPS

OVERLOAD PROTECTION . . . . AC and DC fuses; built-in blown-fuse indicators.

Send for complete **COM-PAK** *data*

LAMBDA Electronics Corporation
11-11 131st Street, College Point 56, New York

By return mail, send complete specifications on Lambda Com-Pak Power Supplies.

Name_____ Title_____

Company_____

Address_____

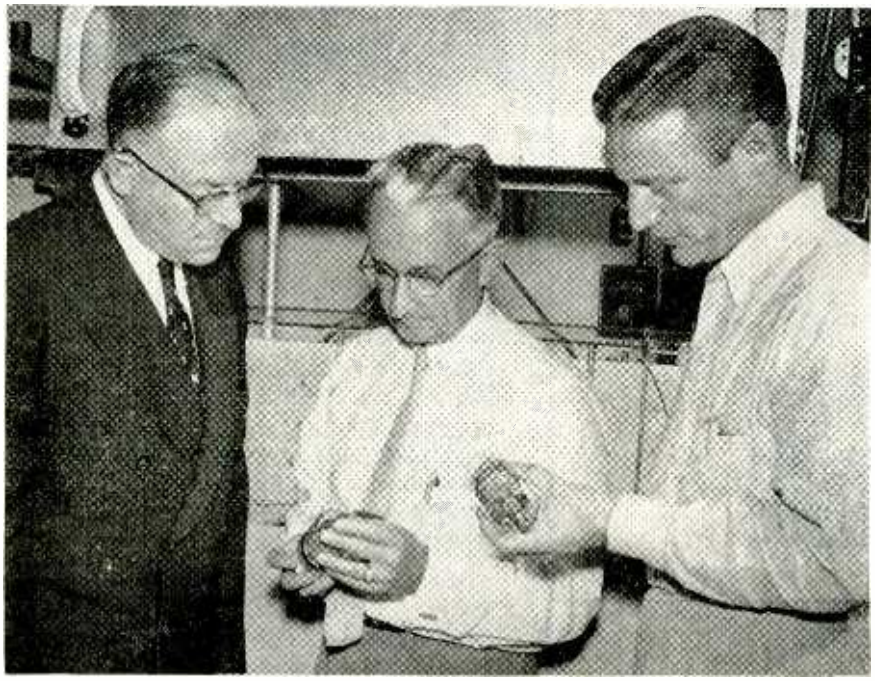
City_____ Zone____ State_____

Circle 315 Readers Service Card

trial Ave., Palo Alto, Calif.

The organization is engaged in research and development on microwave components and systems. Research in the field of solid state masers is being performed under Air Force sponsorship. The maser, a new microwave solid state amplifier, promises to offer low noise amplification for applications where extreme sensitivity is required. Research under Signal Corps sponsorship is also being performed by MELabs in the field of millimeter wave generation in ferrites. In addition, the company has a broad microwave receiver development program. MELabs also develops specialized ferrite components for use in military and commercial microwave systems.

Kaufman of IGC Appointed to ODM Key Position



Jack Kaufman (left), newly appointed executive reservist in telecommunications to the ODM, discusses electron-tube production at the Los Gatos plant of Lewis and Kaufman, Ltd., Div. of International Glass Corp. with general manager Frank Mansur (center) and chief engineer Ray Clinton (right)

JACK KAUFMAN, International Glass Corp. executive vice-president and cofounder of the corporation's Lewis and Kaufman electronic division in Los Gatos, Calif., has been appointed as an executive reservist in telecommunications by Gordon Gray, director of the Office of Defense Mobilization.

Kaufman is one of a selected group of executives in the United States to receive this appointment. In the event of an emergency, he would, under the direction of the Federal Government, assume a key government position for the purpose of insuring the greatest national benefit from the United States telecommunications complex.

While specific plans have not been made public, it is assumed that he would be called upon to act for the Seat of the Federal Government in regulating communications on the Pacific Coast in the event of a national emergency.

Varian Forms Systems Group

VARIAN ASSOCIATES, Palo Alto, Calif., has announced formation of a Systems Group, headed by Dr. William McBride.

The company has been doing some systems work in its Systems Development and Linac departments, and initially the new group will consist of these two departments. Long range plans call for the Systems Group to accommodate new products which do not fall into the company's tube and instrument product lines.

Systems Development has been developing and building prototypes of advanced microwave systems to illustrate new applications and demonstrate workability. It also has built large, complex or unusual power supplies and microwave instrumentation systems for use in its tube engineering and manufacturing operations when such systems were unavailable commercially.

The Linac department designs, develops and builds linear electron accelerators.

Ohmite to Build Plant Addition

CONSTRUCTION of a sizeable addition to the Ohmite Mfg. Co. plant in Skokie, Ill., was recently begun.

The new addition will increase manufacturing facilities by 42,000 sq ft. The expansion is the third in 15 years for this company, a leading manufacturer of electrical and electronic components.

The increased space provided by the new addition will be used for expanding production on the standard Ohmite products and for manufacturing new products recently developed by the company.

Brush Electronics Promotes Ralph Little

RALPH V. LITTLE, JR., has been named manager of the Product Engineering Department of Brush Electronics Co., Cleveland, Ohio.

Most recently, Little served as assistant manager of Brush's Product Engineering Department, and prior to that, was associated with the Univac Division of the Remington Rand Corp., first as a project engineer, and later as engineering manager of its Product Design De-

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Ralph V. Little, Jr.

partment. Earlier in his business career, he was for many years with RCA, where he became engineering group leader in the design and development of television equipment for the corporation's Victor Division.

In his new post, he will be responsible for the development of basic new products to be manufactured and sold by Brush Electronics.

Printed Circuit Outfit Acquires More Space

TECHNIQUES, INC., announces the acquisition of additional space for its Printed Circuit Division at 52 Jackson Ave., Hackensack, N. J. The new space will be devoted primarily to increasing facilities for sample and short run production on etched circuits.

Additional personnel and equipment have been added to enable shipment of small orders within 24 to 48 hours. Production facilities continue to supply medium and long runs on short notice.

Philco Builds on West Coast Again

PHILCO CORP. has bought a 24-acre site in Palo Alto, Calif., where it

will build a research facility.

The Philco government and industrial division's Western Development Laboratories, now quartered in nearby Redwood City, will move to the Palo Alto establishment.

Classified government work in electronic research will be done at the new facility. The project is slated for a construction start late this year.

Instruments For Industry Hires Engineer

Selig Lenefsky

SELIG LENEFSKY recently joined the engineering staff at Instruments for Industry, Inc., Mineola, N. Y.

Lanefsky was formerly employed with Sperry Gyroscope and while with the U. S. Army worked at the Ballistic Research Laboratory on atomic research at the Aberdeen Proving Grounds.

Brunetti Joins FMC

FOOD MACHINERY AND CHEMICAL CORP. has announced the appointment of Dr. Cledo Brunetti as executive assistant to James M. Hait, FMC executive v-p and manager of the company's Ordnance Division, San Jose, Calif.

Dr. Brunetti has been managing

Dr. Cledo Brunetti

director of engineering, research and development for General Mills, Inc., Minneapolis, since 1953. From 1949 to 1953 he was associate director of Stanford Research Institute, Menlo Park, Calif.

In his new position Dr. Brunetti will be responsible for formulation of long-range objectives and coordination of development in new product lines in other than present areas of the division's activities.

Tracerlab Establishes New European Branch

IN ADDITION to its offices in Paris, France, Tracerlab, Inc., has opened a new subsidiary with offices in Amsterdam, Holland. The subsidiary company, wholly owned by Tracerlab, will be called Tracerlab (Holland) N.V.

The new branch will maintain a stock of the most frequently used Tracerlab instruments in order to facilitate delivery to the company's growing European market.

Missile Research and Networks Electronic Merge

CHAIRMAN Patrichi and president Mock recently announced the merger of Missile Research Mfg. Corp. into Networks Electronic Corp.

No changes in ownership, man-

agement, products or policies are involved. Headquarters remain in Van Nuys, Calif. The purposes are to feature one name, Networks Electronic, in advertising the rapidly expanding program of new electronic components, and to simplify the financial structure in preparation for a public stock issue.

Twenty acres of land have been purchased for a new plant in the Canoga Park-Chatsworth area, where building will start this winter on the first unit, 25,000 sq ft of precision manufacturing and laboratory space. Five acres have also been purchased for a Tucson, Arizona, facility. Current volume exceeds a rate of $1½ million per year.

Systron Ups Perlmutter To Vice President

Norman Perlmutter

NORMAN PERLMUTTER has been named vice-president of Systron Corp., Concord, Calif. His responsibilities will include overall administration and planning of the company's technical development activities.

Perlmutter has served as chief engineer of Systron Corp. for the past six months. In this capacity he has been very largely responsible for the company's entry into an entirely new field of instrumentation based upon the use of magnetron beam switching tube techniques.

Prior to his affiliation with Sys-

tron he was chief engineer and assistant general manager of the systems department of Beckman Instruments, Inc., and before that, in charge of the special products department of Berkeley Scientific Co.

Magnetic Core Moves to Larger Quarters

JOHN C. WEBB, president of Magnetic Core Corp., has announced the move of this company's general and executive offices from Ossining, N. Y., to their expanded manufacturing plant at John and Lawrence St., New Windsor, Newburgh, N. Y.

For many years this company has specialized in the manufacture of electronic powder metallurging.

CEC Establishes New Division

ESTABLISHMENT of a new division to specialize in the engineering, design and manufacture of a standard instrumentation line of magnetic-tape recording and reproducing equipment has been announced. It is being called the Data Tape Division.

Philias H. Girouard

Philias H. Girouard, formerly assistant director of engineering, has been appointed director of the new division. Prior to joining CEC last

year, Girouard was for 13 years chief engineer of the U. S. Navy Bureau of Ordnance.

Saunders Rejoins NBS Staff

CLARENCE J. SAUNDERS, an electronic scientist, has rejoined the staff of the National Bureau of Standards. A member of the Data Processing Systems Division, he will be working on the design and development of electronic circuits to be utilized in the Division's work. This program includes not only the design, development, construction, procurement, and evaluation of advanced digital and analog computers, but also the development of new electronic control systems utilizing these computers.

Prior to returning to the Bureau, Saunders was with the Mine Fuze Laboratory of the Diamond Ordnance Fuze Laboratory. He first joined the NBS staff in 1941 and was a member of the NBS ordnance electronics group when that group was reorganized under the Department of the Army as the Diamond Ordnance Fuze Laboratory in 1953.

Electra Mfg. Gets Engineering Director

RAY W. KIDDER has been named director of engineering for Electra Manufacturing Co., Kansas City, Mo., manufacturer of deposited

Ray W. Kidder

carbon resistors and ceramic disk capacitors. He was formerly with Texas Instruments, Inc., and a consulting engineer immediately prior to joining the Electra staff.

Eicher Joins Tobe Engineering Labs

Jerry G. Eicher

THE Tobe Deutschmann Corp. recently announced the appointment of Jerry G. Eicher as a project engineer at the company's Engineering Laboratories in Venice, California.

Eicher will be responsible for the design and manufacture of electronic components such as pulse-forming networks, pulse capacitors, high-voltage capacitors, delay lines and band pass filters.

He comes to Tobe Deutschmann from Hughes Aircraft in Culver City, Calif., where he has been on the engineering staff since 1954.

Moscow Host to Standards Conference

CLOSER scientific and engineering liaison between the Soviet Union and the West is indicated by the recent meeting in Moscow of the 32-nation International Electrotechnical Commission.

Significance of Russia's invitation this year to all member nations lies in the fact that the IEC aims to provide common terminology and standards in lighting, power, communications and electronics to aid

international trade.

The U. S. sent 24 delegates from the U. S. National Committee of the IEC, an arm of the American Standards Association. The conference lasted from July 2-12, with 16 technical committees holding meetings on semiconductor rectifiers, lightning arrestors, switch gear and control gear, rotating machinery electric traction equipment, cables, lamps, lighting and bushings.

The U. S. delegation was headed by R. C. Sogge, manager Standards Engineering, General Electric Co., who is president of the U. S. national committee of IEC. It included national committee officers H. Blackmon of Westinghouse, S. David Hoffman and G. F. Hussey Jr. of ASA.

Gulton Industries Acquires CG Electronics

ACQUISITION of CG Electronics Corp., Albuquerque, N. M., by Gulton Industries, Inc., has been announced.

The company will retain its corporate identity, operating as the CG Electronics Corp., a wholly-owned subsidiary of Gulton Industries, Inc.

Maxson Instruments Hires Leeds

IRVING LEEDS has joined Maxson Instruments, Division of The W. L. Maxson Corp., Long Island City,

Irving Leeds

N. Y., as manager of transformer engineering.

Prior to joining Maxson, he was assistant chief engineer at American Bosch Arma Corp., and chief engineer of Ferranti Electric, Inc.

Continental Connector Corp. Move Completed

DEJUR-AMSCO CORP. recently announced that Continental Connector Corp. has completed its move into a three-story building located at 34-63 56th St. in Woodside, L. I., N. Y. This new location represents an increase of over three times the space previously available for the design, development and production of precision miniature electrical connectors. Increased business and anticipated future requirements prompted the expansion move of assembly operations, engineering staff, model and machine shops, and molding department.

Neely Enterprises Promotes Two

ROBERT L. BONIFACE, vice-president and general manager of Neely Enterprises, Western electronic manufacturers' representatives, has announced the appointment of Michael Z. Laslo and George A. Phillips to the position of field engineer.

Laslo joined the Neely organiza-

Michael Z. Laslo

George A. Phillips

tion in 1954 as an engineer on the Mobile Lab operation.

Phillips has been with Neely Enterprises as a staff engineer since 1956.

CEC Changes Division Name

CONSOLIDATED ELECTRODYNAMICS CORP., Pasadena, Calif., has changed the name of its Electronic Industries Division to the Alectra Division. Hugh F. Colvin, president, said the name was changed to eliminate confusion caused by the existence of several other companies with names similar to Electronic Industries.

The Alectra Division, formerly Electronic Industries, Inc., of Burbank, Calif., was acquired by CEC in June 1956, and moved to a new Pasadena facility in November.

Products of the division include portable test instruments, printed wiring, transistor circuitry, and specialized electronic components. Division manager is George B. Clark.

Weston Announces Expansion

THE Vamistor manufacturing division of the Weston Electrical Instrument Corp., Newark, N. J., is

now occupying expanded quarters in a new building recently completed in Union, N. J. Weston is a subsidiary of Daystrom, Inc.

The Vamistor is the precision metal film resistor which has a special resistance alloy fused into the inner surface of a moisture sealed ceramic tube in a dispersed form. The unit, which will handle a full half watt loading at 125 C, is virtually impervious to the effects of abrasion, thermal shock and temporary overloads; and in addition to having a temperature coefficient better than ±50 ppm per deg C, it is noise free with excellent high frequency performance.

E. V. Roberts & Associates Open San Diego Office

OPENING of a San Diego office at 4379 30th St. has been announced by Ernest V. Roberts, president of E. V. Roberts and Associates, electronics representatives. Headquarters of the firm is in Los Angeles.

Richard B. Blayney

Manager of the new EVRA branch is Richard D. Blayney, who was formerly an electronic engineer with Amelco, Inc., Santa Monica.

Bomac Announces $1 Million Expansion

BOMAC LABORATORIES, INC., Beverly, Mass., is building a new, million dollar plant at its Route 128 site which will virtually double the company's present engineering and

manufacturing facilities.

The new building will house complete manufacturing and assembly facilities, engineering offices and a modern cafeteria. The plant will be used principally for magnetron production.

Richards Electrocraft Gets New Location

DUE to an increased demand for their electronic components, Richards Electrocraft, Inc., are tripling their manufacturing area in a new location at 4432 North Kedzie Ave., Chicago, Illinois. With new, modern production equipment they will be in a position to give better service on their present line and facilitate the production of many new items.

Cohu Doubles Plant Facilities

PRESIDENT LaMotte T. Cohu has announced that Cohu Electronics Inc., will double its plant facilities in the San Diego area.

Cohu Electronics, successor to Kay Lab, will begin construction of a 50,000 sq ft production building to cost approximately $250,000 late this year on a seven-acre tract in San Diego's Kearney Mesa industrial area. The site adjoins seven acres where Cohu Electronics and its Kin Tel division occupy two leased buildings totaling some 50,000 sq ft.

Lockheed Promotes Jatras

STEPHEN J. JATRAS has been appointed to the newly-created position of assistant to the director of Lockheed Missile Systems division's research and development branch in Palo Alto.

Jatras, formerly manager of the research and development coordination division, will act in behalf of the branch director in administrative and financial matters. He also will handle special assignments given him by Dr. Ridenour, branch director.

Before joining Lockheed, Jatras

was vice-president and research engineer with Mid-Western Instruments in Tulsa, Oklahoma.

Lindquist Joins Andrew Corp.

J. R. Lindquist

APPOINTMENT of J. Rilee Lindquist as sales engineer, Andrew California Corp., was recently announced.

Lindquist joined Andrew Corp. of Chicago in 1953. Engaged in design and development engineering of antennas, coaxial cables and waveguide, he was transferred to the company's sales department in 1956 as sales engineer for communication antenna equipment.

SRI Names Eldredge to Key Post

DR. KENNETH R. ELDREDGE has been appointed assistant director of the Engineering Research Division of Stanford Research Institute, Menlo Park, Calif.

Eldredge, who set up and managed SRI's Control Systems Laboratory, has done outstanding work in high-speed mechanical paper handling techniques, printed circuitry and electronic control systems for industry. He was basically responsible for developing systems for electronically reading arabic

numerals and symbols, which have been adopted as the standard of the banking profession by the American Bankers Association.

He spent 10 years with Standard Oil Co. of Calif. as supervisor of special electronic instrumentation development. From 1946 to 1953 he was employed in the London branch of the U. S. Office of Naval Research. He joined the SRI staff in 1953.

New laboratory manager is Dr. Manning Hermes, who has headed the Basic Sciences Group since 1956.

Topp Mfg. Appoints Baddorf Chief Engr.

ROBERT LEE BADDORF has been appointed chief engineer of Topp Mfg. Co., Los Angeles, a Division of Topp Industries, Inc., Beverly Hills, Calif.

He joined Topp Mfg. after service as chief engineer and works manager of Mechaponents Division, Servomechanisms, Inc., El Segundo, Calif., prior to which he was chief engineer and general manager of Electro, Inc., Los Angeles.

Northeast Electronics Has New Home

A RECENTLY occupied new home at Concord Municipal Airport, Concord, N. H., has been announced by Northeast Electronics Corp. The building answers an acute need for increased space for office, laboratory and manufacturing facilities.

Completion of Northeast's new home will permit further expansion of the corporation's activities, previously limited by lack of space.

Ericksons Joins Daystrom

WILBUR ERICKSON, formerly with the Ampex Corp., has joined the Daystrom Systems Division of Daystrom, Inc., as a systems engineer specializing in input-output equipment.

At the Ampex Corporation,


Wilbur Erickson

Erickson supervised systems testing in the special products engineering department. He has also designed the electronics for a low-frequency loop recorder-reproducer for use in the Distant Early Warning line.

Westinghouse Promotes Brandt

DR. W. H. BRANDT has been named director of advanced systems engineering at Westinghouse Electric Corp.'s Sunnyvale, Calif., plant. With Westinghouse since 1936, he served most recently as engineering manager of the director systems department.

In his new post he will direct work on studies related to handling and launching systems for the Polaris, the Navy's new intermediate range ballistic missile.

Calidyne Co. Moves to New Quarters

A GROUNDBREAKING ceremony was recently conducted at The Calidyne Company's new 12-acre manufacturing site in Woburn, Mass. A modern plant will occupy 46,000 sq ft of floor space on the property and will house all Calidyne Company operations now carried on in four buildings located in Woburn and Winchester, Mass.

At an estimated construction cost of one half million dollars, the new

plant facilities should be ready for occupancy in early 1958.

The Calidyne Company manufactures vibration test equipment used in the design and production of many types of industrial, military and commercial products.

CBS TV Announces Several Appointments

WILLIAM B. LODGE, vice-president of station relations and engineering at CBS Television, recently announced the following appointments:

A. B. Chamberlain, formerly chief engineer, becomes director of engineering.

Howard A. Chinn, formerly chief engineer, Audio-Video Division, assumes the new title of chief engineer, CBS Television.

Richard S. O'Brien, formerly chief project engineer, becomes assistant director for Audio and Video Engineering.

At the same time Lodge said that J. D. Parker would continue as assistant director for Radio Frequency Engineering.

Schultz Joins Ramo-Wooldridge Corp.

PETER REDFIELD SCHULTZ, electrical engineer, has joined the Guided Missile Research Division, The Ramo, Wooldridge Corp., Los Angeles, Calif.

While at MIT Schultz participated in the cooperative course in electrical engineering with the General Electric Co. His work on cooperative assignments included testing aircraft compass systems, designing test equipment for aircraft components and the development of pulse circuitry for nuclear instrumentation.

Collins Radio Constructs New Plant

COLLINS RADIO CO. has begun construction of a 235,000-sq ft manufacturing plant in Cedar Rapids,

Iowa, at an estimated cost of $2,750,000. The new facility, which upon completion will house the company's fabrication activities, will be located on a 90-acre tract opposite the Collins Engineering Laboratory.

Occupancy of the new plant is scheduled for early 1959.

The company's Dallas officials have announced construction at Richardson, Texas, of a 128,000 sq ft Engineering Laboratory, at a cost of $1,700,000. Both projects are the initial phases of the company's long range plans for facilities expansion and consolidation.

Amphenol Forms British Subsidiary

AMPHENOL ELECTRONICS CORP., Chicago, Ill., recently announced the formation of Amphenol Great Britain Ltd. The new subsidiary, which began immediate operations in Alperton, England, is owned jointly by Amphenol and by Gas Purification and Chemical Co. Ltd. Amphenol Great Britain Ltd. will manufacture and sell the entire line of Amphenol products under an exclusive license in the United Kingdom and other Commonwealth nations, with the exception of Canada, where Amphenol Canada Ltd. has successfully operated for many years.

Gas Purification and Chemical Co. Ltd., is a specialized investment company with seventeen subsidiary companies intimately connected with the English electronics industry. Similarly, Amphenol serves the electronics industry in the U. S.—manufacturing electronic components for aircraft, communications, computer projects and other applications.

Perkin Appoints Engineering Supervisor

FRED LILIENSTEIN was recently named engineering supervisor of the Advanced Development Laboratory of Perkin Engineering Corp., El Segundo, Calif. Perkin manufactures d-c power supplies and a-c line regulators of the tubeless

Fred Lilienstein

magnetic amplifier type.

Lilienstein was previously associated, for many years, as a group leader in charge of development for the Federal Telephone and Radio Co. of Clifton, N. J. He was also earlier with Kidde Mfg. Co., Tung Sol Lamp Works.

Eimac Plans New Facilities

A MORTGAGE loan of $1,675,000 was recently acquired by Eitel-McCullough, Inc., manufacturers of Eimac electron tubes, for new facilities in San Carlos, Calif. Cost of the new plant will be approximately $2 million.

The new 150,000 sq ft facility will house the company's administrative offices and production of some tube types, including ceramic receiving tubes. The company will maintain its two present plants in San Bruno, Calif., and Salt Lake City, Utah.

Construction is to start shortly and will take approximately nine months to complete.

Electronics Systems Takes Larger Quarters

DUE to expansion of the organization, Electronics Systems, Inc. has moved to larger quarters in downtown Boston. The new address is 105 Chauncy St., Boston 11, Mass.

New Books

Microwave Principles

By H. J. Reich, J. G. Scalnik, P. F. Ordung and H. J. Krauss
D. Van Nostrand Company, Inc., New Jersey, 1957, 427 *p*, $8.75.

In response to a definite need for a more elementary text aimed at senior level students the authors have abridged their earlier volume, "Microwave Theory and Techniques", into one of about one-half the original size. The authors have accomplished this successfully by eliminating the details that belong to a more advanced book, without sacrifice of adequate treatment of fundamental principles. To help simplify matters for students not familiar with vector notation, the scalar forms of Maxwell's equations have been used.

▶ **Microwave Devices** — The authors have succeeded outstandingly well in covering the details of a wide variety of microwave devices. About one-half of the book is devoted to a description of transmission lines, wave guides, components commonly used in passive microwave circuits, impedance matching techniques, measurements, antennas and microwave resonators. The remaining half consists of an excellent description of microwave amplifier and oscillator fundamentals, and tubes such as microwave triodes and tetrodes, klystrons, magnetrons, travelling-wave tubes and electron-wave tubes.

The coverage of each subject is necessarily brief, since books could be written about the subject matter of most of the chapters. The presentation is such that a complete overall picture of the important aspects of the microwave engineering field can be obtained. An excellent feature of the text is that equal emphasis has been placed on the active microwave elements, such as amplifiers and oscillators, as has been given to the passive circuit elements.

The authors have made no attempt to cover all of the recent work in the microwave field. This is understandable since this field is rapidly changing and it is often difficult to evaluate the ultimate value of the newer ideas and devices. The reviewer feels, however, that for completeness, material on the important and well-established field of nonreciprocal microwave devices, such as ferrite isolators, should have been included in the text.

▶ **Text Use**—The material in the book is supplemented by a large number of problems at the end of each chapter and an outline of practical laboratory experiments is included in an appendix, which makes it particularly useful as a college text.

The authors have written a remarkably good text, well unified and carefully developed. It is highly recommended as a senior-level text book and as a reference to practicing engineers needing a review of fundamentals of microwave devices.—C. G. Dalman, *Professor, Cornell University, Ithaca, N. Y.*

Transistor Circuits and Applications

By John M. Carroll
McGraw-Hill Book Company, New York, 1957, 283 *p*, $7.50.

By gathering together some of the most important work accomplished in applied transistor circuitry, Mr. Carroll has compiled a valuable reference to the circuit designer and engineer.

"Transistor Circuits and Applications" consists of 106 technical articles that appeared in Electronics during the years 1950 to 1956. The book covers the wide field of transistor circuits, from principles of design through linear amplifiers, oscillators and pulse circuits. Many illustrations of applied transistor circuitry are described, covering the fields of home entertainment, military, broadcasting, communications, computing (digital and analog), control, industrial, scientific and medical equipment. In many cases complete

circuit schematics are presented.

▶ **Context**—The two major themes of design and application are covered in eight chapters. The first four chapters consist mainly of articles on transistor characteristics and their effect in designing amplifiers, oscillators and pulse circuits. The latter chapters of the book emphasize applications in commercial and military equipment.

▶ **Design**—Chapter I is given over to articles on transistor characteristics, design equations, feedback analysis and techniques, noise and transient behavior of amplifier circuits. Here the transistor is concerned at an active element in design of amplifiers. Here temperature stabilization and feedback are featured at techniques in multistage amplifier designs. Illustrations of power, high frequency, and video, as well as tuned amplifier designs are presented.

Various types of linear oscillators are the topics discussed in Chapter 3. Colpitts, Hartley, bridge and crystal controlled, oscillators typify the circuits presented in this chapter.

Chapter 4 illustrates the use of transistors in pulse circuits. Here flip flops, counters and pulse forming circuits typify the designs discussed.

▶ **Applications** — The remaining four chapters deal with transistor applications. Chapter 5 describes the application of transistors to home entertainment devices (radios, phonographs and television).

In Chapter 6, military and communications equipment, such as telemetering, radar, transmitters and missile applications, are reviewed. Application of transistors to digital and analog computers, as well as servo-amplifiers is the concern of Chapter 7.

The concluding chapter, slightly smaller than the others though not less important, covers industrial, scientific and medical devices.

▶ **Index** — The complete Table of Contents as well as the index will aid the reader in quickly finding topics of particular interest.

▶ **Value**—Due to the prescient edi-

torial judgment of the staff of ELECTRONICS, the choice of articles, presented over the past six years, gives a fairly complete picture of the work being done in the field of transistor circuitry. The reviewer felt that including the date of publication of each article would have been a valuable additional fact. Despite this minor omission the book will be of value to anyone engaged in transistor circuit design.

For the novice in the field this book provides a guide to practical transistor circuitry when accompanied by a basic book on transistor circuit design.—F. BRONSTEIN, *Design Engineering Dept., Ford Instrument Co., Long Island City, N. Y.*

Frequency Modulation Receivers

BY J. D. JONES
Philosophical Library, Inc., New York, 1957, 111 *p*, $6.00.

MIXED in with some good discussion on practical design problems in f-m and f-m/a-m receivers is a jumble of incorrect formulas (dimensionally incorrect), incorrect, incomplete, improperly labeled diagrams and a host of errors that can best be ascribed to a total lack of editing. To the man in the field the book might provide experience in locating the errors; for the neophyte it can only be confusing.—JOHN BOSE, *Columbia University, New York, N. Y.*

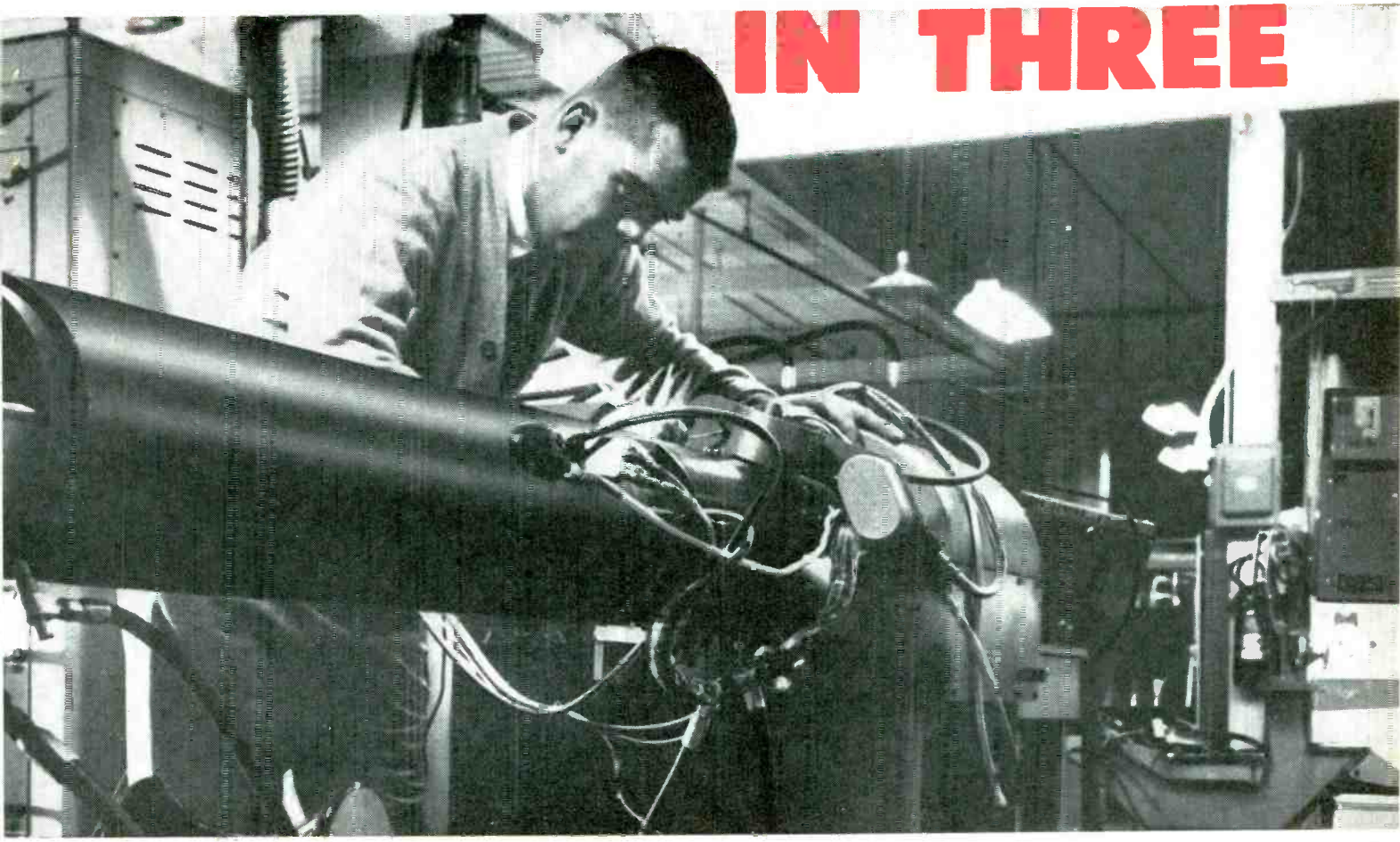
Principles and Techniques of Applied Mathematics

BY BERNARD FRIEDMAN

John Wiley & Sons, New York, 1956, 315 *p*, $8.00.

THE rapidly expanding field of electronic engineering is turning more and more to mathematics for the basic tools of its development. Mathematics, in turn, has been evolving into two diverging realms —the pure or abstract, and the applied. This book constitutes an attempt to relate these two realms in

TO THE ONE MAN IN THREE



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Continued ▶

the subject of ordinary and partial differential equations and as such, is of interest to engineers.

▶ **Linear Spaces**—The text opens with a discussion of linear spaces and the relation of operators to these spaces. The properties of both matrices and differential operators are then discussed with a consideration of the two important methods of obtaining solutions of equations involving such operators. These methods are (1) the use of an integral operator to invert a differential operator where the kernel of this integral operator is the Green's function and (2) the use of the eigenfunctions and the spectral representation of the differential operator whereby the solution of the differential equation is obtained as an expansion in terms of these eigenfunctions.

Before considering the Green's function in detail, the author considers the theory of delta functions, symbolic functions and distributions as developed by Laurent Schwartz. This topic is especially of interest to electronic engineers who have been using delta functions in such fields as circuit theory or information theory without having a rigorous mathematical justification for their use. However, many of the results of this theory of distributions is presented without proof and the reader is referred to the original work of L. Schwartz if he desires such proofs.

Not only are the methods of mathematical physics systematized in this fashion but also many specific examples are considered which are applicable to specific physical problems. In this manner the propagation of waves, such as sound or electromagnetic waves, through discontinuous media are considered. Similarly, the transmission line equations and their solution with such concepts as characteristic impedance and reflection and transmission coefficients are introduced and related to the abstract mathematical point of view.

▶ **Partial Differential Operators**—The book concludes with a brief discussion of partial differential op-

erators. The methods used previously to solve ordinary differential equations are found to apply in this case also. Moreover, the separation of variables method is introduced and some common partial differential equations are solved. These are the potential equation, the heat equation and the wave equation. Problems on the various topics that are discussed are distributed throughout the body of the text so this book is suitable as a textbook for a course on this subject.

The book has been written mainly for the mathematician. The engineer who is not throughly familiar with the techniques of mathematical physics may have trouble following the discussion. However, it is a well-written account of the applications of the powerful methods of abstract mathematics to the types of problems that concern physicists and engineers and as such it may be very useful as a reference source for the mathematically inclined electronic engineer. — ARMEN H. ZEMANIAN, *College of Engineering, New York University, New York, N. Y.*

"Impulse und Schaltvorgaenge in der Nachrichtentechnik" ("Pulses and Transients in Communications Circuits")

By HEINRICH KADEN.

R. Oldenburg, Munich, 1957, 304 *p*, *DM*32.

THIS book represents an attempt to combine the classical theory of Fourier and Laplace transforms as it applies to impulses, pulses and transients, with modern communications theory. That the author has done a really conscientious job in his attempt to present the modern applications integrally with the basic mathematical tools is evident in the organization of the subject matter.

▶ **Fourier Concepts** — The first

chapter deals with the basic concept of the Fourier integral, presented as an extension of Fourier series. This chapter is immediately followed by an introduction to statistical methods, i.e., a treatment of the autocorrelation function and its relationship to the power spectrum.

A long applications chapter for the Fourier transform uses the transmission of signals through cables as its principal illustration. A chapter on the Laplace transform is then presented. This is followed by a Fourier analysis of the distortion encountered in the transmission of telegraph signals.

The concluding chapters of the book deal with the transmission of signals in the presence of noise in wide band systems, the sampling theorem and related topics.

► **Mathematical Treatment**—While the examples which are chosen to illustrate the theory are particularly interesting because of their intrinsic importance, the general style of the book emphasizes the mathematical treatment. As a result of this preoccupation with technique, the discussions of the meaning and interpretation of solutions are generally too brief.

The author assumes that the reader has background in the theory of functions of a complex variable and some acquaintance with the transformations since the former is not treated per se at all and the latter is presented in the form of a review type resumé.

This reviewer is slightly mystified by the presence of the chapter on Laplace transform. It appears to be a rather hasty presentation which serves no purpose relative to the rest of the book since the Fourier methods are (quite appropriately) used in the bulk of the volume.

Readers with a reasonable acquaintance with the German language will have no difficulty with this book. The sentences are quite short and the style, though concise, is quite lucid.

In summing up, one is inclined to commend the author for taking a much needed step in the direction of tying together the classical

theory of transient analysis with the modern statistical approach to communications problems so that this volume is a worthwhile contribution to the engineering library.—EGON BRENNER, *The City College of New York.*

Thumbnail Reviews

Electronic Computers. Edited by T. E. Ivall. Philosophical Library, New York, 1956, 164 p, $10.00. A collection of tutorial articles which appeared in *Wireless World*, this book is an up-to-date and clear exposition of analog and digital computers for technically trained persons with no previous experience in this field.

The Industrial Chemistry, Properties, and Application of Silicones. By Charles E. Reed, American Society for Testing Materials, 1916, Race St., Philadelphia, Pa., 1957, $1.50, 47 p. Chemical properties and applications of silicones.

Wave Propagation. Edited by Alexander Shure, John F. Rider Pub., Inc., New York, 1957, 56 p, $1.25. Elementary explanation of electromagnetic wave propagation for technicians and amateurs discussing interrelation of wave theory and natural phenomena.

Semiconductor Abstracts — Vol. 3, 1955. Compiled by Battelle Memorial Institute, John Wiley & Sons, Inc., New York 1957, 322 p, $10.00. Abstracts of the literature on semiconducting and luminescent materials and their applications.

Glossary of Terms in Nuclear Science and Technology. American Society of Mechanical Engineers, 29 W. 39 St., New York, N. Y., 1957, 188 p, $5.00. Glossary prepared under the auspices of the National Research Council based on former "preliminary editions."

Transistors—Circuits and Servicing. By B. R. Bettridge, Trader Publishing Co., Ltd., 1957, 23 p, 2s.8d. Introduction to transistors for servicemen and technicians including applications and servicing.

Electric Circuits and Machines, 2nd Ed. By B. L. Robertson and L. J. Black, D. Van Nostrand Co., Inc., New York, 1957, 456 p, $6.75. General text covering circuit constants and circuits through machines and concluding with

four chapters on electronics. Material is presented briefly, but competently, with ample supply of problems and has been designed to form basis for conventional one-year course for students not majoring in electrical engineering.

Energy. By Oliver Lodge, John F. Rider Publisher, Inc., New York, 1957, 64 p, $1.25. Modernized reprint of classic has newly added illustrations to dramatize and emphasize important concepts.

Antennas. By Alexander Schure, John F. Rider, Publisher, Inc., New York, 1957, 88 p, $1.50. Fundamental concepts of antenna theory on the technical level covering basic types, input impedance, radiation resistance, etc.

Scientific German. By George Condoyannis, John Wiley & Sons, Inc., New York, 1957, 164 p, $2.50. Intended for students of engineering and science, with no previous knowledge of German, this book provides the briefest explanation of the structural aspects of technical German that will permit translation of papers of normal difficulty accurately and completely into English with the aid of a dictionary.

The Icosahedron. By Felix Klein, Dover Publication, Inc., New York, 1956, 289 p, $1.85. New edition of classical mathematical work which was first published in 1884. Of interest mainly to pure mathematicians, it considers the fundamental problem of the solution of quintics and will serve as a source book on those properties of the icosahedron which were known prior to 1884.

Elements of Pure and Applied Mathematics. By Harry Lass, McGraw-Hill Book Co., Inc., New York, 1957, 491 pages, $7.50. This survey of linear equations, reactor and tensor analysis, function theory, differential equations, integral transformations, group theory and probability theory is written for applied mathematicians on the graduate level and includes many problems and examples. It may serve as a good reference book for the research physicist or engineer.

Introduction to Electrical Engineering, 3rd ed. By George V. Muller, McGraw-Hill Book Co., Inc., 1957, 466 p, $7.50. Introductory level textbook deals with electric and magnetic fields, dielectric and magnetic circuits, Kirchoff's laws and circuit theorems, nonlinear elements, electronics and elementary transient circuit analysis.

Scientific French. By William N. Locke, John Wiley & Sons, Inc., New York, 1957, 112 p, $2.25. Intended for students of science and engineering, with no previous knowledge of French, this book provides the briefest ex-

planation of the structural aspects of technical French that will permit them to translate papers of normal difficulty accurately and completely into English with the aid of a dictionary.

Auto Radio Service Manual, Vol. 6. Howard W. Sams & Co., Inc., Indianapolis, Ind., 1957, 225 p, $3.95. Service data for 1955 and 1956 models of auto radios.

Alternating Current Bridge Methods. By B. Hague, Pitman Publishing Corp., N. Y., 1957, 650 p, $12.50. Thorough text on bridge measurements in the frequency range from d-c to 3,000 cps, with emphasis on fundamentals and references to early original literature. An invaluable aid to the experimenter interested in precise physical measurements on surface and barrier-layer phenomena when unusual and difficult bridge measurements at low frequencies are quite useful.

RCA Transistors and Semiconductor Diodes. RCA Commercial Engineering, 415 S. Fifth St., Harrison, N. J., 1957, 24 p, $.25. General explanation of transistor theory and operation including eight pages of circuit applications.

1957 Directory of German Machinery and Machinery Manufacturers. Nordeman Publishing Co., Inc., 14 E. 62 St., New York 21, N. Y., 1957, 800 p, $3.50. Listing of 20,000 manufacturers of all types of machinery, precision instruments and industrial equipment, classified in 9,000 product categories.

Digital Computer Programming. By D. D. McCracken, John Wiley & Sons, Inc., New York, 1957, 253 p, $7.75. Fundamentals of computer programming for people with no previous knowledge of computing on how to prepare detailed instructions for the computer.

An Introduction to the Cathode Ray Oscilloscope. By Harley Carter, Phillips Technical Library, Eindhoven, Holland, 1957, 100 p, $1.95. Operating principles, construction and applications of cro for technicians include complete circuits of four oscilloscopes of varying complexity. This book may be ordered directly from the publisher.

Who's Who in Electronics. Electronic Periodicals, Inc., 2775 South Moreland Blvd., Cleveland, Ohio, 1957, 495 p. Purchasing index to supply sources of electronic components and equipment lists manufacturers by purchasing, geographical, field salesman, trade name and indexes. Representatives roster is listed geographically and alphabetically; distributors are listed geographically.

Backtalk

Crazy Ideas?

DEAR SIRS:

ABOUT a year ago I received a form from ELECTRONICS asking for suggestions for improving service to the readers. One suggestion I made was to establish a "crazy idea" department in which those interested could publish ideas which seem rather fantastic or considerably ahead of current developments. I still think that this is a good idea and I believe that this department would be of interest to readers.

I have filed more than 1,000 inventions in the patent office relating to an extreme variety of devices in many different fields. In many cases I have not prosecuted these patents through to completion, in some instances because the ideas seemed rather theoretical and in other cases because I did not recognize the real value.

It has been something of a surprise to me to see many of these inventions brought out by others years later and demonstrated to be of considerable value or usefulness. As examples of these I will cite the fog dissipation system used in England, some polarized light development, ionic propulsion of aircraft, certain reproduction papers, pelleted fertilizer, improvements in magnetic recording, anlyzing metals by contact potentials, suppression of electrolytic action by magnesium rod counter emf, several improvements in television, pumping by varying magnetic fields, magnetic rubber, etc.

I am enclosing also a copy of patent No. 2,584,641 relating to ground speed indicators and inertial guidance. This patent discloses broad principles which apparently are used in one recently announced inertial guidance system.

You may be interested in the second modification in which voltages developed by cutting the earth's field are used. The usual stumbling block has been avoided in that there is not a closed circuit to balance out the emf's.

Another very important feature is that a compensator is provided to take care of any variations in

either strength or direction of the earth's magnetic field. This feature should make this type of instrument practical.

If you ever set up the department of futuristic ideas I would be glad to contribute some if you wish.

A. G. THOMAS
Butler, Pennsylvania

Special Items

DEAR SIRS:
I WOULD like to add our little vote to that of Mr. Anderson of Brown University. (*Backtalk*, p 400, May 1, 1957).

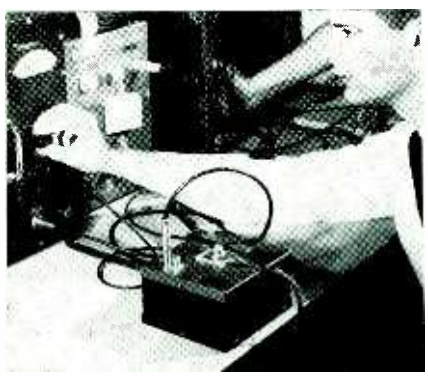
Although we are not engaged in research and development as are a number of similarly small firms; we do occasionally have need of small runs of special components. On several occasions we have discovered that after redesigning our project to use something else, exactly what we needed was available. An exchange ground such as Mr. Anderson suggested is a good start along the right line.

I will also go along with the idea of an idea exchange too. Again we have occasionally worked to the point of frustration on a project, and then stumbled on the solution, or a lead to the solution, quite by accident.

Again, we would like to commend Mr. Anderson on his suggestion, and we hope that it is favorable received by the editors.

DAVID B. TENNISON
Electronics Design
Enid, Oklahoma

Power Transistor for 10 MC



Experimental 5-watt silicon transistor developed by Bell Laboratories operates as oscillator or amplifier at 10 mc

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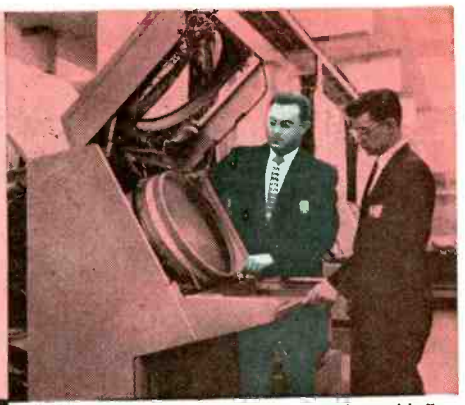
Associate Engineer Donald A. Patterson demonstrates a problem in pluggable unit layout.



Field Engineering Instructor Joseph Rechloff explains basic display console functions at IBM, Kingston, N. Y.

Associate Engineer Robert M. Blake points out a feature of an advanced magnetic tape circuit development.

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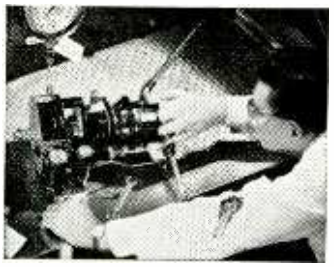

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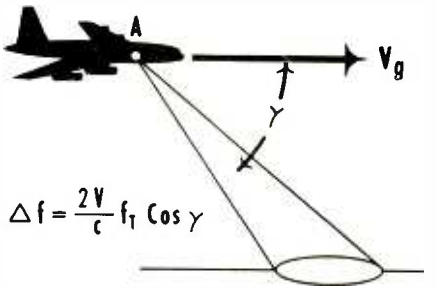

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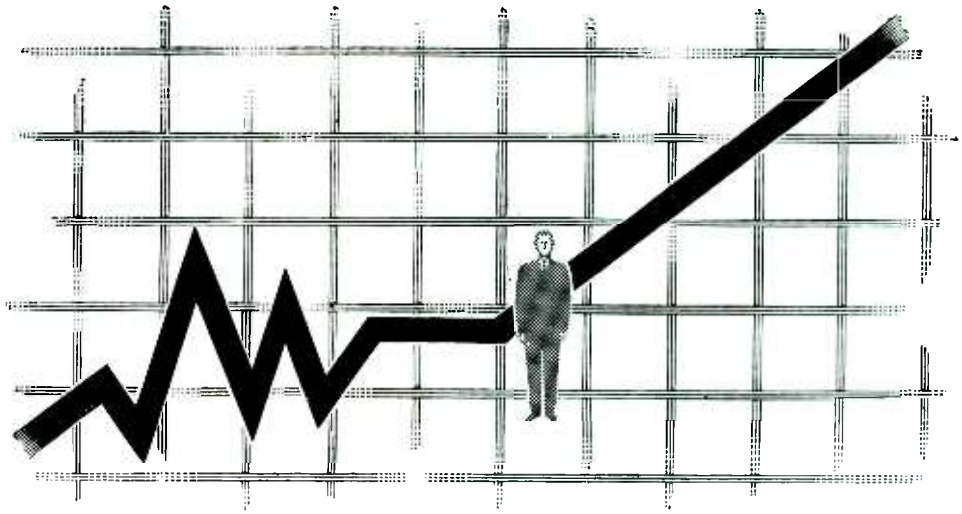

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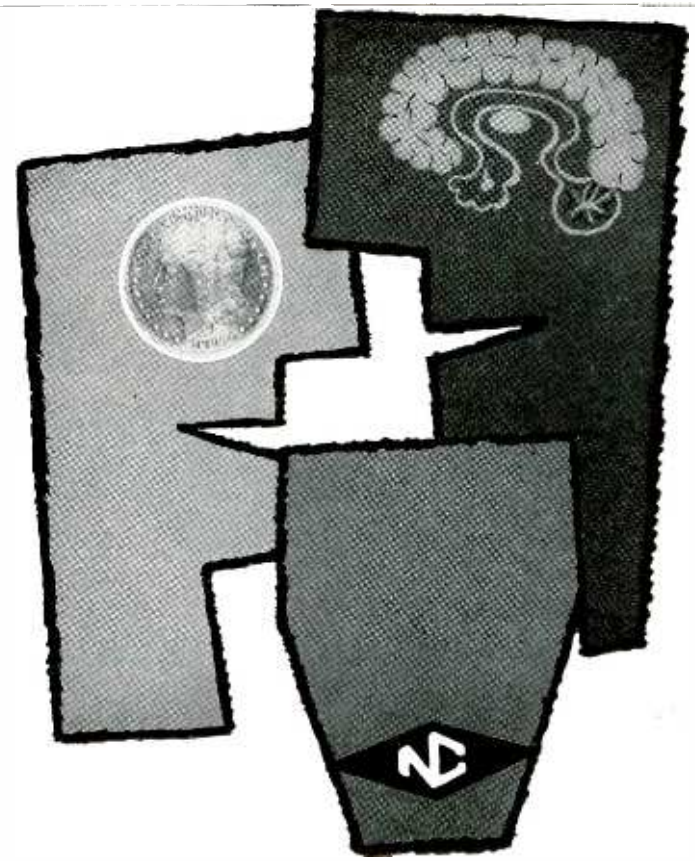

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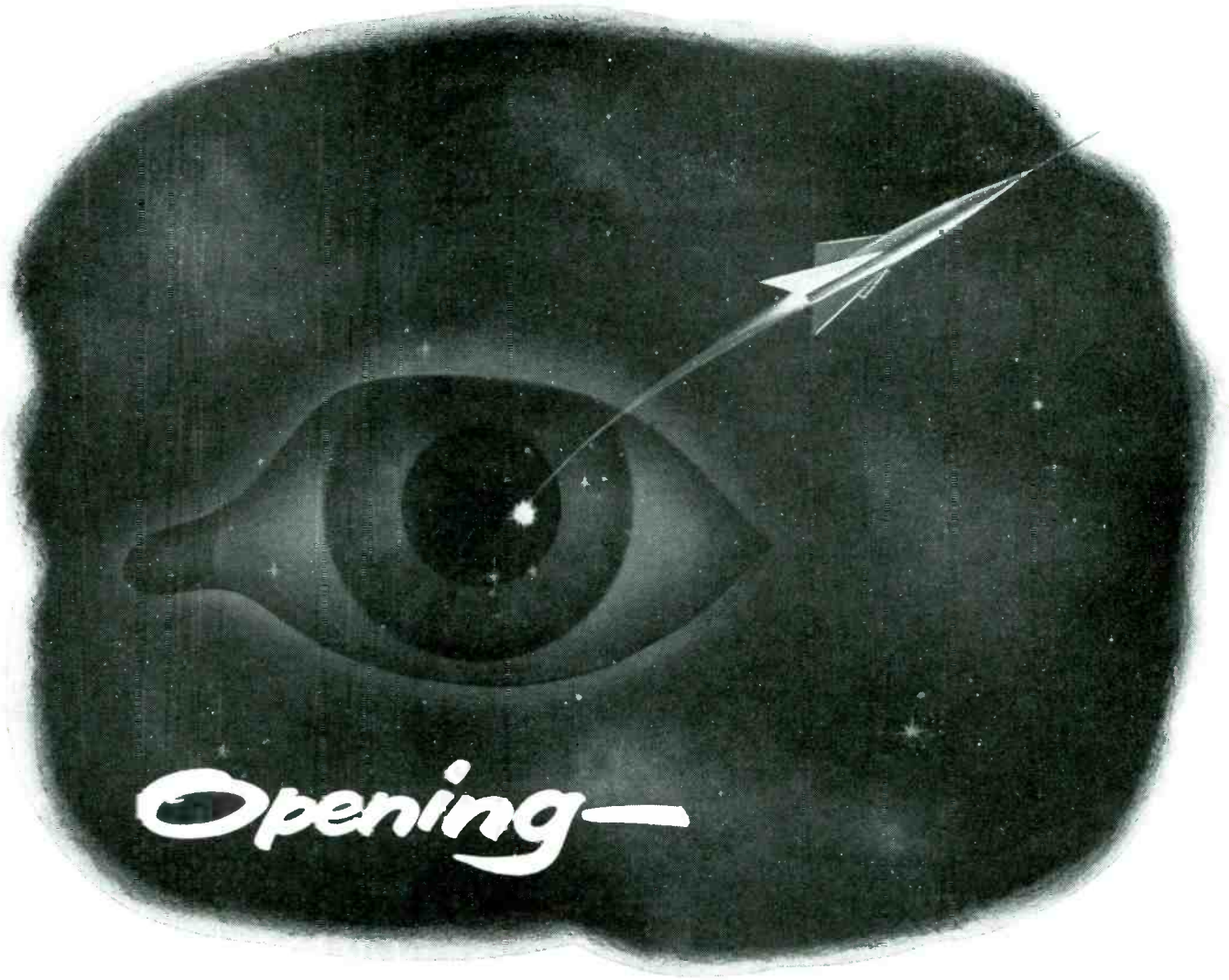

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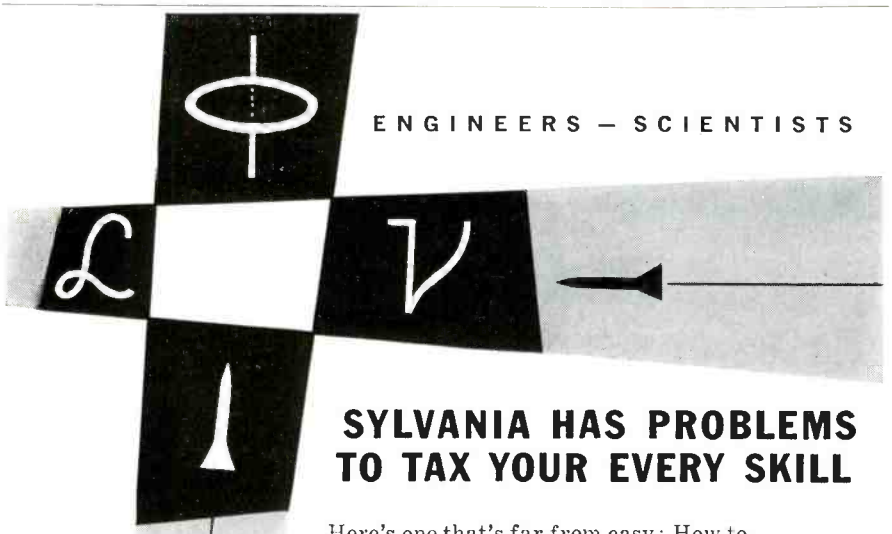

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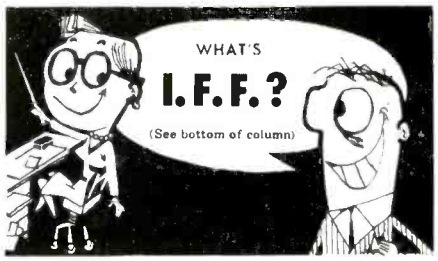

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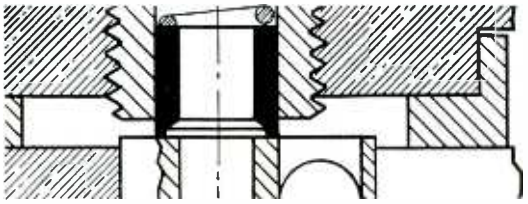

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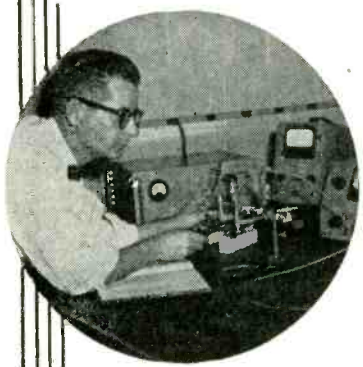

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TOPWALL HYBRID JUNCTION. 8500-9600mc 1x.5 wg size. Broad banded better than 16%. Aluminum casting. $15.00 new. Crossover output for use with junction $5.00 new.

BROAD BAND BAL MIXER using short slot hybrid. Pound type broad band dual balanced crystal holder, 1x.5 wg size. $25.00 new.

BENDIX GYRO SERVO UNIT. Combined horizon gyro, Autosyn & tilt correction motor. Maintains tilt stabilization of radar antenna, etc. Pioneer 12800-1-B (APS-15). New $75.00.

F-28/APN-19 FILTER CAVITY

Jan. Spec: 2700-2900mc, 1.5db max. loss at ctr freq over band. Single tuned filter for freq channelling in radar beacon. New. $37.50

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VARIAN KLYSTRON VA6312/V57. 8.5-10kmc 15mw output, shaft tuner. Factory new with spec. sheet. $125.00.

RT39/APG-5 10CM RADAR. Complete S band RF package. Lighthouse 2C40 xmtr. 2C43 rcvr, TR, 8293 pulser, miniature 6AK5 1F strip. Press. 12" dia., 24" lg. Brand new with all tubes $275.00.

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VARIAN V-1100 PRESS. FLANGE. Std. 1 x ½" window. $5.00.

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TAPER. RG51 to RG52 (1¼ x ⅝" to 1 x ½") Smooth Electroform Standard Flanges. $16.50.

MINIATURE 60MC IF STRIP uses 6 ea. 6AK5 tubes, with synchronous single tuned interstage coupling networks realizing an overall gain of 100db for a band width of 2mc. 9 ounces, $12.50

3KW 400 CYCLE SOURCE

Complete generator set. 115V 60CY AC 3HP speed regulated, motor. Generator output 115 volts, 400 cycle, single phase 17.4 amp. continuous duty (easily converted to 3 phase by transformer). Output electronically regulated. Built to rigid U. S. Navy spec. A perfect source 115 volt 400 cycle. $385.00 each. Like new.

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250-2C40	6.25	800-830B	.95	1,000-9003	1.25	800-5Z4M	.92	1,000-6SJ7M	.48	1,000-12AX7	.57
1,000-3BP1	1.00	150-851	4.75	50-AX9903/		5,000-6A8G	.50	500-6SN7WGt	.95	600-12AY7	1.35
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1,500-6AS6	1.00	500-872A	1.10	RECEIVING TYPES		4,000-6AN8	.68	3,900-7B6	.34	3,000-12Q7Gt	.30
1,300-10Y	.09	100-902P1	1.50	5,000-1A3	.15	3,500-6B8G	.25	1,000-7C6	.40	20,000-19	.07
100-100TH	6.45	2,000-1625	.19	11,750-1D5GP	.15	1,000-6C4	.22	10,000-7H7	.18	1,000-35L6Gt	.46
10,000-VR150	.38	7,000-1629	.16	10,000-1H5Gt	.32	5,000-6K7G	.22	4,000-7Q7	.42	5,000-35Y4	.40
100-GL434A]	4.75	2,000-5676	.60	3,000-1J6G	.26	1,000-6P5Gt	.35	2,850-7Y4	.32	4,000-35Z4	.30
3,000-446A	.38	2,000-5787	2.25	10,500-1U4	.38	5,000-6Q7G	.40	1,000-12AT7	.70	1,500-77	.19

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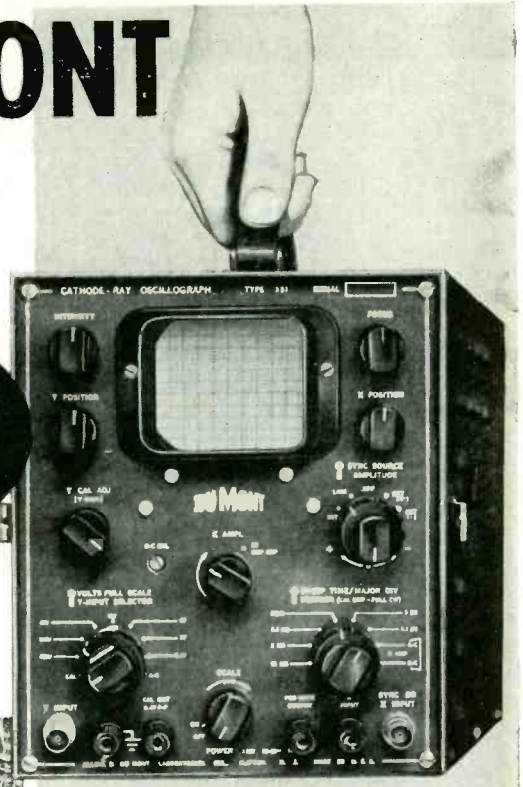

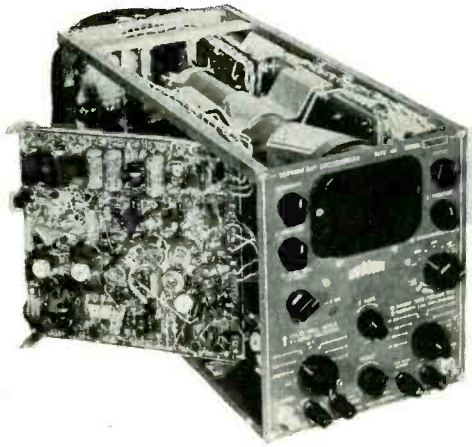

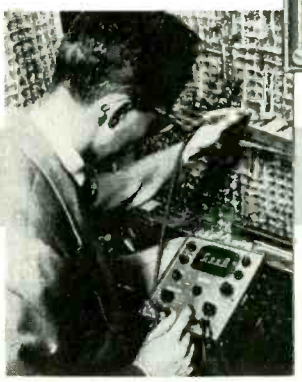

NO. 331 OSCILLOSCOPE COMPLETE VERSATILITY in Portable Instrumentation

Now you can have a precision laboratory Oscilloscope for your use at the price of a simple serviceman's unit. A program change on the part of one of the nation's largest computer manufacturers makes available a quantity of "like new" current model DuMont Type 331 portable Oscilloscopes, with accessories, at a fraction of their present selling price. Each instrument has been individually tested and is guaranteed to meet DuMont published specifications. The Type 331 Oscilloscope is NOT military surplus. It IS NOW a current model with a manufacturer's selling price of $645.00. Cramer Electronics is able to offer this unit *COMPLETE* with instruction manual, probe, and protective front cover at the amazing low price of $329.50, f.o.b. Boston. Cramer Electronics, Inc. has also made arrangements for maintenance and repair service on these instruments through a DuMont factory authorized Service Laboratory.

The DuMont Type 331 Oscilloscope is a miniature, portable instrument featuring DC amplifiers with a bandwidth to 4.0 megacycles and driven sweeps. Precise calibration of both vertical and horizontal amplifiers and driven sweeps make possible rapid, accurate measurement of time and amplitude.

SPECIFICATIONS

Vertical Deflection
Bandwidth—0-4 Mc.
Sensitivity (amp)—0.2 volts peak/major division
Input Impedance—2 megohms, 30 uuf (max.)

Horizontal Deflection
Bandwidth—0-400 Kc.
Sensitivity—0.5 volts peak/major division
Input Impedance—100 kilohms, 60 uuf (max.)

Calibrated Sweep (Driven Sweep Only)
Rate—0.5 seconds-0.5 microseconds/major division
Expansion—Available on all ranges approx. 3 times
Amplitude—2.25 inches (expanded, approx. 6.75 inches)
Accuracy—Within ±5%

Gate Output
Polarity—Positive
Voltage—15 volts peak open circuit

Synchronization
Internal—From signal of one minor division
External—From signal 10 cps-1.0 mc at 0.5 volts p.p.
Line Frequency—Either polarity from internal supply

Calibrating Voltage
Output—0.4 volts peak to peak ±2% (for sensitivity adjustment)

Intensity Modulation (On front panel)
Polarity—Positive signal decreases intensity
Input Impedance—10,000 ohms, 50 uuf.

Size — 7⅞" x 9" 19½"

Weight — 19¼ lbs.

Accessories (Included)
Illuminated Scale
Protective Front Cover
Instruction Manual
Probe (Type 2613)—10:1 attenuator
Filter—Green

Cathode-ray Tube
Type 3WP—operating at 1500 volts

OPTIONAL ACCESSORIES

Viewing Hood (Type 2621) permits viewing in high ambient lighting, flexible rubber. Price $6.50 list.
$3.95

Probe (Type 2607) 20:1 attenuator flat dc to 10 mc with pulse adjustment and mount. Price $22.50 list.
$10.95

Sync Cable with BNC fitting, coax cable and insulated clips. Price
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MAGNETRON PULSE TRANS. #964; Prim. imp. 30 ohms, 1600 v. pulse. Secondary imp. is 1250 ohms, 12 KV pulse. Turns ratio sec:pri. is 7.5:1. Duty ratio is 0.001 at 1.2 usec. Bifilar winding 1.2A..... $8.50

RAYTHEON WX 4298E: Primary 4KV., 1.0 USEC. SEC. 16K-16 AMP DUTY RATIO: 001 400 CYCLE FIL. TRANS. "BUILT-IN"..... $17.50

GE #K-2499A Primary: 9.33 KV, 50 ohms imp. Secondary: 28 KV, 450 ohms. Pulse length: 1.05/5 usec @ 635/120 PPS. PK Power Out: 1,740 KW Bifilar; 1.5 amps $62.50

GE #K-2748-A, 0.5 usec @ 2000 Pps. Pk. Pwr. out is 32 KW impedance 40:100 ohm output. Pri. volts 2.3 KV Pk Sec. volts 11.5 KV Pk Bifilar rated at 1.3 Amp. Fitted with magnetron well..... $24.50

K-2745 Primary: 3½.8 KV. 50 ohms Z Secondary: 14/12.6 KV 1025 ohms Z. Pulse length: 0.25/1.0 usec @ 800/600 PPS. Pk. Power 200/150 KW, Bifilar: 1-3 Amp. Has "built-in" magnetron well....$32.50

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(All Primaries 115V. 400 Cycles)

RA6405-1	800VCT/65MA, 5VCT/3A	$3.69
T-48852	700VCT/80MA, 5V/3A, 6V/1.75A	4.25
352-7098	2500V/6MA, 300VTC/135MA	5.95
KS9336	110V/50 MA TAPPED 625V 2.5V/5A	3.95
M-7474319	6.3V/2.7A, 6.3V/.66A, 6.3VTC/2IA.	4.25
KS80984	27V/4.3A, 6.3V/2.9A, 1.25V/.02A	2.95
52C080	650VCT/50MA, 6.3VCT/2A, 5VTC/2A	3.75
32332	400CT/35MA, 6.4V/2.5A, 6.4V/.15A	3.85
68G631	1150 0-1150V 2MA	2.75
80G198	6VCT/.00006 KVA	1.75
302433A	6.3V/9.1A, 6.3VCT/6.5A, 2.5V/3.5A, 2.5/3.5A	4.85
KS9445	592VCT/118MA, 6.3V/8.1A, 5V/2A	5.39
KS9685	6.4/7.5A, 6.4/3.8A, 6.4/2.5A	4.79
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70G30G1	600VCT/56MA	2.65
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X-BAND—RG, 52/U WAVE GUIDE

PARABOLOID DISH, 18" diam. Spun Aluminum 8" Focus. For AN/APS-6 ..... $4.50

3 CM. DIPOLE and Feed Assembly (May be used with above dish.) 8 inches long..... $5.00

FLEXIBLE SECTION 9 in. long, Cover-to-Cover $5.50

ROTARY JOINT (APS-6) Sperry PT #658275, 180 deg. rotation, choke to choke. Has "Built-in" Di-Coupler. 20 DB, with "N" Takeoff..... $17.50

3 CM. DIPOLE FEED, 45° L for APS-15..... $14.50

MITERED ELBDW, Cast aluminum, 1¼" x ⅝" W.G. W. E. Flanges. "E" Plane..... $3.50

3 CM. ANTENNA ASSEMBLY; Uses 17" paraboloid dish, operating from 24 vdc motor. Beam pattern: 5 deg. in both Azimuth and elevation. Sector Scan; over 160 deg. at 35 scans per minute, Elevation Scan, over 2 deg. Tilt. Over 24 deg..... $35.00

Cross-Guide Directional Coupler, UG-40 output flange. Main Guide is 6" Long, with 90 Deg. "E" Plane bend at one end, and is fitted with Std. UG 39/UG 40 flanges. Coupling figure: 20 db Nominal....$22.50

Bulkhead Feed-thru Assembly..... $12.00

Pressure Gauge Section with 15 lb. gauge..... $10.00

Directional Coupler, UG 40/U take off 20db....$15.00

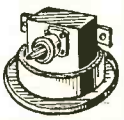
MAGNET AND STABILIZER CAVITY For 2J41 Magnetron $24.50

90 degree elbows, "E" Plane 2½" radius..... $8.50

Beacon/receiver unit. Complete with dual klystron mount, TR/ATR section, duplexer, and 30 mc IF/-Mixer unit. Originally designed for 9000 mc receiving using 723A/B. New, less tubes..... $22.50

Klystron mount for 723A/B. Front end of microwave receiver (SO-3), with balanced mixer crystal mt. and iris coupling for AFC, less tube..... $15.00

10 CM.—RG48/U Waveguide



Waveguide-to Coax, adapter. Matches RG48/U. waveguide to RG 44/U rigid coax. Complete with flanges, "T" match $15.00

10CM ECHO BOX: Tunable from 3200-3333 Mc. For checking out radar transmitters, for spectrum analysis, etc. Complete with pickup antenna and coupling devices $17.50

POWER SPLITTER for use with type 726 or any 10 CM Shepherd Klystron. Energy is fed from Klystron antenna through dual pick-up system to 2 type "N" connectors $12.50

LHTR, LIGHTHOUSE ASSEMBLY. Parts of RT39 APG 5 & APG 15, Receiver and Trans. Cavities w/ assoc. Tr. Cavity and Type N CPLG. To Recvr. Uses 2C40, 2C43, 1B27, Tunable APX 2400-2700 MCS. Silver Plated $15.00

McNally Klystron cavity for 2K28 or 707B, tunes 2700-2900 mc. Complete with tuning vanes..... $5.00

3000 MC WAVEMETER

Mfd. by G.E. for Armed Services 3000-3700 MC. Comes furnished with variable attenuator, coax. adapter cord, Cal. chart and pickup antenna. Has output jack for external meter or other monitor device. Reasonance indicator is 3½ 20 microamp meter. Brand new, in portable wooden carrying case..... **$75.00**

TEST EQUIPMENT

TS 102 Radar Range calibrator. Rep. rates are 400/800/1600/2000 PPS. Operates from 115, 60-1600 cy. Used, exc..... $95.00

RCA WR 39A TV Calibrator, 20-240mc, with crystal on 2.5 or .25 mc. Used, exc..... $65.00

RCA WR 53A. FM Sweep Generator covers 88-108 mc and 8.5-10.7 mc*..... $49.00

RCA WR 67A. Test oscilator, 100kc-30 mc. internal or external mod.*..... $43.00

RCA 710A Signal Generator, 380-560 mc..... $70.00

Kay Marka-Sweep. Model RF-P. TV alignment generator, channels 1-12, plus LF freq. Markers at pix and audio. Output 0.5v across 70 ohms. *$125.00

P4E Synchroscope: 4 mc. bandwidth with a gain of 100. 5-inch display, includes 2-stage video amplifier. Writing speeds 0.04/0.166/0.5/2 in. per microsec*..... $75.00

TS/28/UPM Synchroscope. Uses 5CP1 tube, and may be used as a regular scope with repetitive sweeps. Signal gain is 100 with a bandwidth of 5mc. Triggered sweeps range from 1 to 6 microsec. per inch*..... $135.00

PULSE EQUIPMENT

MIT. MOD. 3 HARD TUBE PULSER: Output Pulse Power 144 KW (12 KV at 12 Amp). Duty Ratio: .001 max. Pulse duration: 0.5, 1.0, 2.0 microsec. Input voltage: 115 v, 400 to 2400 cps. Uses: 1-715B, 1-829B, 3-'72's, 1-'73. New. Complete with pressurized housing $135

10 CM R.F. HEAD

Complete R.F. Head and Modulator delivers 50 K.W. Peak R.F. at 3000 MC. Pulser delivers 12KV pulse at 12 Amp. to magnetron of .5, 1 or 2 microsec. duration at duty cycle of .001. Unit requires 115V, 400-2400 Cycles, 1 phase @ 8.5A. Also 24-28 VDC @ 2A. External sync. Pulse of 120 V Req'd. Brand New. Complete with magnetron, magnet, plumbing and all tubes $275

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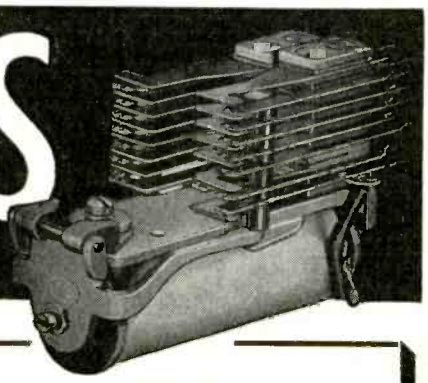

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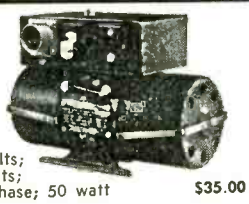

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Output: 6 volts; 400 cycles, 6 volt amperes, 1 phase. Input: 24 VDC; 1 amp. **$15.00**

12121 Bendix
Input: 24 volt D.C. 18 amp. 12000 r.p.m. Output: 115 volts, 400 cycle, 3-phase. 250 volt amp, 7 pf. **$49.50**

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Output: 125.5 VAC; 1.5 amps. 400 cycles single phase, 141 VA. Input: 20-30 VDC. 18-12 amps. Voltage and frequency regulated. **$49.50**

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Output: 115 VAC, 400 cycles; single phase. Input: 24-30 VDC; 8 amps. **Price $39.50 each**

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Output: 115 volts AC; 750 VA, 3 phase, 400 cycle, .90 pf and 26 volts. 50 VA single phase, 400 cycle, .40 pf. Input: 27.5 VDC 60 amps. cont. duty, 6000 rpm. Voltage and frequency regulated. **$59.50**

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Output: 115 VAC; 400 cycles; 3-phase; 175 VA; .80 pf. Input: 27.5 DC; 12.5 amps.; cont. duty. **$70.00**

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Output: 115 VAC; 400 cycle; 3-phase; 115 VA; 75 pf. Input: 28.5 VAC; 12 amps. **$35.00**

F16 Jack & Heintz
Output: 115 volts, 400 cycle, 1 or 3 phase, 250 VA pf. 9. Input: 27.5 volts, 20 amp. Electronic frequency and voltage regulated. **$99.50 each**

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Output: 115 VAC, 400 cyc.; single phase; 1.53 amp.; 8000 rpm. Input: 13.5 VDC; 29 amp. **$50.00**

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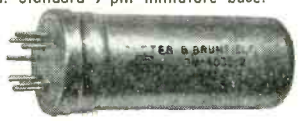
Input: 24 VDC; 52 amps. Output: 115 volts —400 cycles, 3-phase, 750 VA. Voltage and frequency regulated. **$95.00**

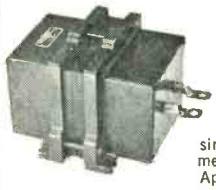
AN 3499 Eicor, Class "A"
Input: 27.5 volts at 9.2 amps. AC. Output: 115 volts, 400 cycles; 3 phase, 100 voltamp; continuous duty. **Price $39.50 each**

POTTER & BRUMFIELD RELAY

#5M5LS. SPDT 8,000 ohm 11/16" dia. x 1 11/16" long. Approx. weight 1 oz. Hermetically sealed. Standard 7-pin miniature base.

Price **$3.00** each





$14940 TRANSFORMERS

Mfgd. by Kenyon. Output: 5 volts, 115 amps. Input. 105/125 volts, 60 cycle, single phase. Overall dimensions: 10" x 7" x 6". Approx. weight: 30 lbs.

$15.00

SELSYNS-SYNCHROS

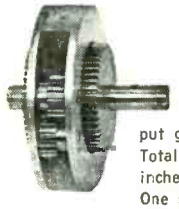
1CT cont. Trans. 90/55V 60 cy.	$37.50
1DG Diff. Gen. 90/90V 60 cy.	37.50
1F Syn. Mtr. 115/90V 60 cy.	37.50
1G Gen. 115V 60 cy.	37.50
1SF Syn. Mtr. 115/90V 400 cy.	12.50
2J1F1 Gen. 115/57.5V 400 cy.	7.50
2J1F3 Gen. 115/57.5V 400 cy.	10.00
2J1FA1 Gen. 115/57.5V 400 cy.	7.50
2J1G1 57.5/57.5V 400 cy.	5.00
2J1H1 Diff. Gen. 57 5V 400 cy.	7.50
2J5D1 Cont. Trans. 105/55V 60 cy.	17.50
2J5F1 Cont. Trans. 105/55V 60 cy.	17.50
2J5H1 Gen. 115/105V 60 cy.	17.50
2J15M1 Gen. 115/57.5V 400 cy.	17.50
5C Cont. Trans. 90/55V 60 cy.	34.50
5D Diff. Mtr. 90/90V 60 cy.	34.50
50DG Diff. Gen. 90/90V 60 cy.	34.50
5F Syn. Mtr. 115/90VAC 60 cy.	34.50
5G Syn. Gen. 115/90VAC 60 cy.	34.50
5HCT Cont. Trans. 90/55V 60 cy.	42.50
5SDG Diff. Gen. 90/90V 400 cy.	12.50
60G Diff. Gen. 90/90V 60 cy.	25.00
6G Syn. Gen. 115/90VAC 60 cy.	34.50
7G Syn. Gen. 115/90VAC 60 cy.	42.50
R110-2A Kearfott Cont. Mtr. 115V 400 cy.	17.50
R200-A Kearfott Cont. Trans. 26/11.8V 400 cy.	15.00
R210-1-A Kearfott Trans. 26/11 8V 400 cy.	20.00
R220-T-A Kearfott Receiver 26/11.8V 400 cy.	20.00
R235-1A Kearfott Resolver 26/11 8V 400 cy.	22.50
C55701 Type 11-4 Rep. 115V 60 cy.	20.00
C69405-2 Type 1-1 Transm. 115V 60 cy.	20.00
C69406 Syn. Transm. 115V 60 cy.	20.00
C69406-1 Type 11-2 Rep. 115V 60 cy.	20.00
C76166 Volt. Rec. 115V 60 cy.	10.00
C78248 Syn. Transm. 115V 60 cy.	12.50
C78249 Syn. Diff. 115V 60 cy.	5.00
C78863 Repeater 115V 60 cy.	7.50
C79331 Transm. Type 1-4 115V 60 cy.	20.00
851 Bendix Autosyn Mtr. 22V 60 cy.	7.50
4C3 Kollsman Autosyn. Mtr. 32V 60 cy.	7.50
FFE-25-11 Diehl Servo Mfr. 75/115V 60 cy.	19.50
FFE-43-1 Resolver 400 cy.	25.00
FJE-43-9 Resolver 115V 400 cy.	19.50
999-0411 Kollsman 26V 400 cy.	15.00
13770410 Kollsman 26V 400 cy.	10.00
1515B-0410 Kollsman 26V 400 cy.	20.00
1C047-2A Bendix 26V 400 cy.	12.50
2500 Transicoil 115V 400 cy.	15.00
15CX4a Synchro Transmitter MK 22 MOD 1	15.00 ea.

DIFFERENTIAL

Size 2-11/16" long 1-11/16" dia. 1-1 reverse ratio. ¼" shaft on each end; one shaft 25/32" long, one shaft 15/32" long. Input and output gear 1-23/32" dia. 53 teeth.

Stock No. 150 **$3.50 ea.**

SIMPLE DIFFERENTIAL



1 to 1 reverse ratio; 48 teeth on input and output gear, 1-1/32 inch diameter. Total outside diameter 1-25/32 inches. Shaft size is ¼ inch. One shaft is 9/16" long; other shaft is 3/16" long.

Stock No. 151 **$5.00**

400 CYCLE MOTOR GENERATOR

Output: 115 volts, 400 cycle, single phase, 2 kva. Input: 115 volts D.C., 4 h.p., 3450 r.p.m. Motor and generator in separate frames. Dimensions mounted: 48" long; 17½" wide.

$100.00 each

3800 CYCLE INVERTER

Mfgd. by Eclipse-Pioneer #12144-1-A. Input: 24-30 volts DC, 10 amps AC. Output: 115 volts, .95 amps, 3800 cycle, single phase. Approx. weight 2½ lbs. **Priced at $39.95**

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".

No. 145
$17.50 ea.

(All Shafts on Both Ball Bearing Supported)

SMALL DC MOTORS

(approx. size overall 3¾" x 1¼" dia.:)

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.
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 R.P.M.	15.00
206-1001 PM Planetary Gear Reduced Motor with Magnetic Brake. Mfgd. by Air Equipment 26 volts 600 ma 145 rpm	17.50
5BA10FJ33, G.E., 12 VDC, 56 R.P.M., reversible	15.00
806069 Oster series reversible 1/50 h.p. 10,000 rpm. 27.5 VDC 1⅝" x 3½"	5.00
C-28P-1A 27 VDC 1/100 h.p. 7,000 rpm	3.00
7100-B-PM Hansen 24 VDC 160 rpm	7.50
SSFD-6-1 Diehl PM 27.5 VDC 10,000 rpm	4.00
6-volt PM motor mfgd. by Hansen 5,000 rpm 1¼" in dia., 2" long overall	4.00

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OA3/VR-75	.90	4C35	15.00	FG-57	7.50	726A	4.00	5686	1.75
OA4G	.75	4D32	23.00	RK-61	2.25	726B	9.50	5687	2.25
OA5	3.50	4E27	7.00	RK-65/5D23	6.50	750TL	30.00	5687WA	4.00
OB2	.60	4J45	35.00	FG-67	7.50	802	2.00	5691	4.25
OB2WA	2.50	4J46	35.00	HY-69	2.50	804	7.00	5692	4.50
OB3/VR-90	.80	4J52	50.00	FG-81A	8.50	805	3.00	5693	3.75
OC3/VR-105	.50	4J61	125.00	FG-95	13.50	807	1.10	5702	1.40
OC3W	2.50	4PR60A	25.00	100TH	5.00	807W	1.25	5703	.85
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OD3W	2.50	4X500F	42.50	121A	2.50	810	10.00	5719	1.50
EL-C1A	6.00	5A6	2.00	122A	2.50	811	3.00	5720	15.00
EL-1C	1.50	5AP1	5.00	123A	2.50	812	2.50	5725	2.00
1AD4	.90	EL-5B	4.00	124A	2.50	813	9.50	5726	.75
1AE4	1.00	5BP1	2.50	FG-172	15.00	814	1.25	5727	1.25
1AF4	2.50	5BP1A	7.50	FG-190	10.00	815	1.25	5728	7.50
1AG5	2.00	5BP2A	3.00	CE-203	5.00	816	1.35	5734	13.25
1B24	5.00	5C22	25.00	203A	2.50	826	.75	5740	50.00
1B35	3.25	5CP1	2.50	207	50.00	828	8.00	5749	1.15
1B35A	7.50	5CP1A	7.50	CE-235A	5.00	829B	8.50	5750	2.00
1B37	6.50	5CP7A	8.00	FG-235A	55.00	832A	4.85	5751	2.00
1B63A	15.00	5CP12	10.00	242C	10.00	834	5.00	5755	6.50
1B83	7.50	5FP14	5.00	QK-243	40.00	835	2.50	5763	1.00
1P21	28.50	5HP1	1.75	244A	3.50	836	1.20	5771	250.00
1P22	5.00	5JP1	7.50	245A	6.00	837	1.25	5783	3.00
1P25	25.00	5JP2A	5.00	249B	3.00	845	2.50	5784	4.50
1P28	7.50	5JP4	3.50	249C	2.50	850	7.50	5787WA	6.00
1Y2	5.00	5JP5A	7.50	250R	4.00	866A	1.15	5796	10.00
2AP1	2.00	5JP11A	7.50	251A	42.50	866 JR	1.35	5798	12.50
2AP1A	4.00	5LP1	12.50	252A	7.50	868/PJ-23	1.50	5801	3.50
2BP1	3.50	5LP2A	7.50	253A	2.00	869B	50.00	5803	5.00
2C36	35.00	5R4GY	1.25	254A	2.25	872A	1.00	5814	.75
2C39	4.00	5R4WGY	2.50	257A	10.00	874	.75	5814A	1.50
2C39A	10.00	5RP1A	15.00	FG-258A	75.00	884	.95	5814WA	3.00
2C40	6.50	5RP11A	75.00	259A	10.00	885	.65	5819	25.00
2C42	8.00	5SP1	40.00	262B	5.00	913	17.50	5827	4.00
2C43	8.00	5SP7	40.00	FP-265	12.50	917	1.40	5828	6.00
2C44	.25	5UP7	12.50	267B	3.50	918	1.50	5829	.85
2C46	5.00	5X3	2.00	268A	5.00	920	2.00	5830	85.00
2C50	5.00	5XP1	50.00	271A	5.00	922	1.75	5839	7.50
2C52	2.75	5XP11	50.00	272A	6.00	923	1.25	5840	2.85
2D21	.75	EL-C6J	10.00	274B	.50	927	1.00	5842	12.00
2D21W	.85	EL-C6L	5.00	275A	3.50	929	1.00	5847	12.00
2E22	2.00	6AC7W	.50	276A	10.00	931A	3.75	5854	.85
2E24	2.00	6AD4	2.50	279A	150.00	959	1.15	5881	3.00
2E26	3.25	WE-6AK5	1.25	282A	2.00	CK-1006	2.25	5886	3.25
2J47	50.00	6AK5W	1.00	282B	3.75	1237	4.50	5894	16.50
2J51	175.00	6AL5W	.75	283A	3.25	HY-1269	3.00	5899	3.50
2J52	50.00	6AN5	2.25	285A	4.50	1274	2.50	5902	4.00
2J54	25.00	6AN5WA	4.50	286A	3.25	1614	1.50	5902A	5.00
2J59	50.00	6AQ5W	1.75	287A	2.00	1620	3.50	5915	.50
2J61	8.50	6AR6	1.35	293A	8.00	1624	1.10	5932	3.25
2J62	3.00	6AR6WA	6.00	300B	6.00	1846	50.00	5933	1.25
2J64	75.00	6AS6	1.25	304TH	10.00	2050	1.00	5933WA	5.00
2K25	10.00	6AS6W	2.00	304TL	12.50	2050W	3.00	5948/1754	100.00
2K26	32.50	6AS7G	2.50	310A	3.50	ZB-3200	75.00	5949/1907	75.00
2K28	27.50	6AU6WA	2.00	311A	3.50	5528	5.00	5962	4.00
2K29	35.00	6BA5	3.00	313C	2.50	5550	30.00	5963	1.25
2K30	75.00	6BA6W	1.15	316A	.50	5552	55.00	5964	.85
2K33A	50.00	6BE6W	2.00	323A	7.50	5553	75.00	5975	3.00
2K34	85.00	6BL6	22.50	323B	3.50	5556	10.00	5977	3.00
2K35	150.00	6C4W	4.00	328A	3.50	5557	4.50	5979	7.50
2K41	75.00	6C21	15.00	336A	3.50	5558	4.50	5980	6.50
2K45	27.50	6F4	2.25	338A	3.50	5559	7.50	5981/5650	50.00
2K48	50.00	6J4	1.25	339A	9.50	5560	13.50	5993	8.00
2X2A	.75	6J4WA	2.00	347A	2.50	5584	3.00	5998	4.00
3ABP1	50.00	6J6W	.85	350A	2.50	5591	2.75	6005	1.75
3AP1	1.50	6K4	2.00	350B	2.00	5610	1.00	6012	3.50
3AP11A	5.00	6K4A	2.50	352A	15.00	5632	8.50	6021A	4.00
3B24	.75	6L4	2.00	354A	8.50	5633	5.00	6028	2.00
3B24W	4.50	6L6WGA	3.25	355A	8.50	5634	5.00	6037	40.00
3B24WA	7.50	6L6WGB	3.50	388A	1.00	5635	5.00	6038	7.50
3B25	4.50	6Q5G	2.00	393A	3.50	5636	2.50	6073	1.25
3B26	2.75	6SJ7WGT	2.00	394A	2.50	5636A	3.00	6080	3.50
3B28	4.00	6SK7W	.85	403A	1.35	5637	3.50	6087	4.00
3B29	5.00	6SK7WA	2.00	403B	2.75	5638	3.00	6098	6.00
3BP1	2.00	6SL7WGT	1.25	404A	12.00	5639	5.00	6100	2.00
EL-C3J	8.50	6SN7WGT	.75	407A	3.00	5639A	5.50	6130	5.00
EL-C3J/A	10.00	6SU7GTY	2.00	408A	2.00	5640	5.00	6134	3.50
EL-3C	3.50	6X4WA	2.00	409A	4.25	5641	4.50	6136	2.00
3C23	3.00	7MP7	15.00	417A	12.00	5642	1.10	6137	2.00
3C24	2.00	7YP2	50.00	418A	15.00	5643	3.00	6146	4.50
3C30	3.00	VX-10	4.00	420A	6.50	5644	5.75	6189	2.50
3C33	6.00	12AT7WA	2.75	421A	4.00	5645	5.00	6201	2.85
3C45	5.00	12AU7WA	2.50	429A	8.00	5646	3.00	6263	10.00
3D22	9.50	FG-17	4.50	GL-434A	7.50	5647	4.00	6264	10.00
3E22	4.00	HK-24	2.00	446A	.50	5650	50.00	6328	4.85
3E29	8.50	HK-24G	2.00	446B	1.00	5651	1.25	6463	1.50
3GP1	2.00	26C6	1.00	450TH	38.50	5651WA	3.00	6626	2.50
3J21	50.00	26E6WG	2.25	450TL	38.50	5654	1.25	6627	2.50
3J31	30.00	26Z5W	3.00	464A	1.75	5656	4.00	6655	35.00
3JP1	7.50	FG-27A	10.00	GL-575A	10.00	5663	.95	8005	4.50
3JP2	2.50	FG-32	4.50	631-P1	5.00	5667	100.00	8012A	3.50
3JP7	7.50	FG-33	15.00	701A	1.50	5670	2.00	8013A	4.50
JP12	7.50	VX-33A	3.50	707B	2.00	5670WA	4.00	8020	1.25
KP1	7.50	35T	3.00	715C	10.00	5672	1.00	9001	.75
X2500A3	150.00	35TG	2.00	719A	10.00	5675	8.00	9002	.50
-65A	13.50	VX-41	5.00	721A	.50	5676	.75	9003	1.00
B31	20.00	FP-54	50.00	721B	7.50	5678	.75	9005	2.00

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S-370D Fixed Attenuator 1½ x 3"—6DB	52.50
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TYPE 1623B - 0410120 - Motor 26V-400 Cy.-2Ph. 6500 RPM 4.5 Watts Output GEN. 0.34V/1000 RPM. $42.50 Ea.

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GR 434B Audio Freq. Meter	*95.00
GR 475-BS2 Frequency Monitor AND GR 681-AS2 Frequency Dev. Meter	*300.00
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GR 700P1 Voltage Divider	27.50
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GR 720A Het. Freq. Meter	275.00
GR 723C VT Fork 1 KC	*89.50
GR 724B Precision Wavemeter	160.00
GR 726A VTVM	*85.00
GR 727A VTVM (Battery Oper)	*105.00
GR 814-P2 Filter	*15.00
GR 830A Low Pass Filter	*20.00
GR 1110A Freq. Standard with GR 1110P1 Multivibrator	*475.00
GR 1176A Freq. Meter 25-60,000 cy.	*170.00
GR 1535B Contactor	*75.00
GR 1861A Megohmmeter	*75.00
Boonton 152A FM Signal Gen. 20-28 MC & 1-5 MC w/150R Pwr Supply	*185.00
Dumont 185 Electronic Switch	*57.50
Dumont 208 Oscilloscope	*89.50
Dumont 248 Oscilloscope	*375.00
Esterline Angus-20 Pen Operation Recorder Portable type	320.00
Hewlett-Packard 325B Distortion Analyser	*220.00
Hewlett-Packard 337B FM Monitor 25-175 MC	*465.00
Kay Megasweep 50 KC-1000 MC	*200.00
Lavoie LA-239A Oscilloscope	*850.00
Measurements 62 VTVM	99.50
Measurements 78E Std. Signal Gen. 50-75MC	115.00
Measurements 79B Pulse Gen.	165.00
Rubicon 1168 Resis. Std. .001 ohms	85.00
Rubicon 1169 Resis. Std. .001 ohm, 500 amp	150.00
Rubicon 1171 Resis. Std. .0001 ohms	150.00
Sperry Microline Model 291A Cavity Freq. Meter 2575-3780 MC—Accur. 0.15 MC	*395.00
Victoreen 247 AY Radiation Survey Meter 0-2.5/25/250/2500 milliroentgens/hr	$115.00
Weston Model 1 Direct Reading Ohmeter 0-2.5/25/50 ohms ¼%	120.00
Weston 45 DC Voltmeter 0-15V-½% Acc	*35.00
Weston 695 Power Level Meter	30.00
Weston 785 Industrial Circuit Tester	95.00
Weston 796 Megohmeter. 0-20/200 megohms 500V. Battery Operated	*42.00
AN/UPM-2 Wavemeter 80-1220 Mc Accur. 1 MC	*97.50
AT-48/UP3 CM Pickup Horn Antenna	9.95
AT-105/AP K Band Pickup Horn Ant.	12.95
BC-221 Frequency Meter 125 KC-20,000 KC-Accur. .01%	*115.00
I-126 Signal Generator 15-25 MC & 195-225 MC-Int. Mod	115.00
I-138A 10CM Signal Generator 2700-2900 MC	*125.00
LAE-1 UHF Signal Generator 510-1500 MC Accur. 1%	*225.00
LAF VHF Signal Generator 90-600 MC. Accur. 1%	*325.00
LAJ Audio—Oscillator-20-20,000 cy. Mfd. by Hewlett-Packard	*85.00
LP Std. Signal Generator 9.5 KC-50 MC-2V. Output	*375.00
ME-11A/U. R.F. Wattmeter	*80.00
TS-33/AP 3 CM Frequency Meter 8700-9500 MC Accur. .03%	*145.00
TS-34/AP Oscilloscope 30cps-1 Mc Portable	*195.00
TS-46/AP Wave Meter 3000 MC	49.50
TS-100/AP Oscilloscope-A. J. R. & X Indication-Freq. video to 3 MC	89.00
TS-174/U Freq. Meter 20-230 MC Accur. .05%	385.00
TS-311A/UP Precision Echo Box 3730 to 8910 MC—Measures frequency, power, spectrum analysis. 2 Incl. Crystal mixer tester	*225.00
STODDART TS-587/U Noise and Field Intensity Meter 15-400 MC	1200.00
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SS5 Minor Switch 10 steps and off. Contacts: Nos. R960, 975, 976 Gold plated brass; Bridging wiper; Others beryllium-copper, Nonbridging wiper; Net Wt. 1 lb.

Volts DC	1 level Stk# Price*	2 level Stk# Price*	3 level Stk# Price*
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24- 36	R975..10.50	R978..11.50	R600..12.50
48- 60	R976..11.50	R979..12.50	R645..13.50
100-125	R643..12.50	R644..13.50	R646..14.50

SS6 Western Electric Co.; 22 step; 5 levels; Bridging wipers; Contacts; Gold plated brass. Interrupter Switch: 1 Break-Make; Net Weight: 2 lb. 2 oz. "Homing" type; 180° Wipers; Step in One Direction.

	ea*
#R926; 6 to 12 VDC	13.75
#R980; 24 to 36 VDC	14.75
#R981; 48 to 60 VDC	15.75
#R615; 100 to 125 VDC	16.75

SS7 Western Electric Co.; 44 step; 2 levels Bridging Wipers; Contacts: Gold plated brass; Interrupter Switch: 1 Break-Make; Net Weight: 1 lb. 14 oz. "Homing" Type; 360° Wipers; Step in One Direction.

	ea*
#R927; 6 to 12 VDC	13.75
#R982; 24 to 36 VDC	14.75
#R983; 48 to 60 VDC	15.75
#R616; 100 to 125 VDC	16.75

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50 step; Five levels; Non-Bridging wipers. Contacts: Beryllium Copper. Break-Make Interrupter; Break-Make Off—Normal Springs.

#R893 6- 12 VDC	27.50
#R894 24- 36 VDC	28.50
#R895 48- 60 VDC	29.50
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#R1310 With Rectifier for 110 V AC Operation 35.00

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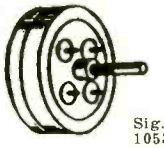

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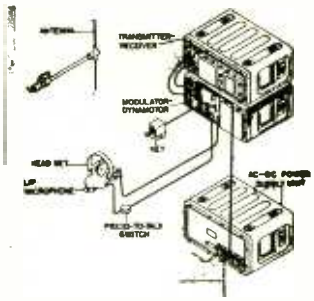
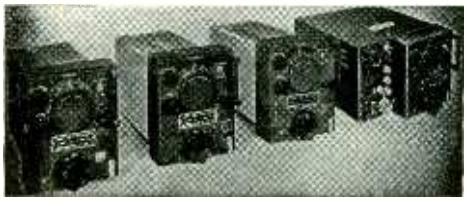


AN/APR-4
38-4000 MC RECEIVER



RDO
NAVY SEARCH RECEIVER

The RDO is a very elaborate radar search receiver greatly improved over the APR-4. The set uses APR-4 tuning units, but is much more versatile, having input metering, D.B. output meter, automatic noise limiter and greater selectivity and sensitivity. The RDO is recommended when only the very best will do. Input 110/60 cyc.

AN/ASQ-1 AIRBORNE MAGNETOMETER

This is an airborne chart recording magnetometer. The set consists of an amplifier, oscillator, detector head, chart profile recorder, power supply. The equipment has a sensitivity of 2 gamma. The AN/ASQ-1 records on an Esterline angus recorder disturbance in the earth's magnetic field. An indicator is provided that gives a bearing on a magnetic disturbance. Input is 28v DC. Weight about 130 lbs.

SHORAN
AN/APN-3-AN/CPN-2

The AN/APN-3 and AN-CPN-2 are Precision distance measuring installations. This equipment operates on 225 mc. The range is 250 miles with an accuracy of 25 feet. This equipment is widely used by geological companies for prospecting and mapping. Power input is 110v 400 cyc and 28v DC.

AN/GSQ-1 SPEECH SCRAMBLER

This is a unit designed to be attached to either a radio or telephone circuit to scramble speech or code. This equipment utilizes coded cards in each terminal equipment. Unless the properly numbered card is inserted on the receiving end the speech can not be unscrambled. This provides an excellent privacy system. 24 VDC input. Mfg. Western Electric.

COUNTER MEASURES EQUIPMENT

SEARCH DETECTION

AN/APR-4 38-4000 MC
AN/APR-2 300 1000 MC
AN/APR-5 1000-3100 MC
AN/APR-6 1,000-10,000 MC
RDO 38-4000 MC
SCR-616 145-600 MC

DIRECTION FINDING

AN/APA-17 300-10,000 MC
AN/APA-24 100-750 MC
AN/APA-48 140-300 MC

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AN/APA-6 Pulse Analyzing
AN/APA-11 Pulse Analyzing
AN/APA-10 Panadaptor
AN/APA-38 Panadaptor
AN/ARQ-5 18-80 MC Receiver Indicator
AN/ARQ-8 25-105 MC Barrage Rec-Trans Indicator
AN/ARQ-10 1.5 MC-50 MC Receiver-Trans. Jammer Indicator
AN/ARQ-1 Thru 12 also avail.
AN/APA-23 Signal and Time Recorder

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AN/APQ-1 thru 20
AN/SPT-Series
SCR-596 1.5-30 MC Barrage Ground Jammer
TDY, MRQ, SPT, SPQ-TPQ-1AN/UPT-TI-T3, T4
Many other countermeasures equipments avail. both hi and low power. These equipments can be used to test new radar and computer systems for susceptibility to jamming and other countermeasures. We can supply complete setups covering any freq. from 100 KC 10,000 MC, with power supplies for mobile operation.

MAR POINT TO POINT RADIO SET

Portable 225-398 mc point to point 10 chan. crystal controlled voice and mcw radio set. This is a very late radio set used for point to point and ground to air communication. The transmitter output is 8 watts on 10 pre-set crystal controlled channels instantly selected by a band switch. The REC is also crys. controlled on the trans. freq. The set is inclosed in 3 water proof shock proof cabinets that may be set up in a few minutes on location. This equipment is ideal where a reliable radio link easily transported is needed. Power input is either 24 VDC 115/230V AC or DC. Complete sets avail. Write

GROUND INSTRUMENT LANDING SYSTEM

This set consists of an AN/CRN-10 localizer and a AN/CRN-2 glide path ground station. This equipment can be set up at an airport to provide a complete I.L.S. that will operate with the AN/ARN-5 and RC-103 airborne I.L.S. system to provide blind approach facilities. This system can be installed permanently or transported. Each station has complete monitoring facil. Input power is 110V 60 cyc.

AN/TRC-1-3-4
100 MC RADIO-RELAY EQUIPMENT

The AN/TRC series is a mobile portable set for duplex or simplex radio telephone point to point communication. This set will operate with the CF series carrier systems to provide multi channel operation. The TRC operates on 100 MC with an output of 10 50 watts. The set is crystal controlled. Complete sets avail. Input 110v 60 cys.

SCR-399-499

Mobile and fixed station high power radio sets: the SCR-399 is mounted in a HO-17 shelter. The SCR-499 is transoorted in carrying cases to be set up for field operation. Freq. of the sets is 2-18 mc. pwr output is 350w. Phone and C.W. 2 communication receivers are provided. Input is 110v 60 cyc.

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OD3	.60	2K55	12.00	6BM6A	44.50	QK247	150.00	813	12.00	5676	.85	6101	4.00
C1B/A	10.00	2K56	55.00	EL6CF	9.00	249B	5.00	814	10.00	5687	2.50	6115	72.50
C1J	10.00	3AP1A	12.00	6D21	135.00	250TH	25.00	815	5.00	5691	5.50	6115A	85.00
1B37	7.00	3B24	2.00	6L6GA	2.00	261A	18.00	828	12.50	5693	4.25	6116	120.00
1B60	17.00	3B24W	4.50	6SK7W	1.00	QK278	275.00	829B	9.00	5720	23.50	6140	8.50
1D21	5.50	3B25	5.00	6X5WGT	1.50	GB302	4.00	832A	8.00	5721	140.00	6146	4.25
1P22	9.00	3B26	6.00	7F8W	2.50	304TH	22.50	833A	35.00	5725	2.00	6152	7.00
1P24	1.00	3B29	5.00	8D21	850.00	304TL	32.50	872A	6.00	5734	12.50	6161	55.00
1P25A	44.50	3C45	8.50	SRC12	160.00	311C	9.00	931A	5.50	5736	155.00	6167	35.00
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1P41	2.00	3D23	7.00	12AU7WA	2.25	316A	.50	CK1026	3.00	5749	1.75	6187	4.75
1Z2	2.50	3E22	8.75	FA15	33.00	323A	7.00	CK1037	7.00	5750	3.00	6189	2.25
2BP1	6.00	3E29	10.00	EL16B	19.00	339A	6.00	R1111	3.00	5764	50.00	6199	35.00
2BP11	8.00	3J31	100.00	RK20A	11.00	QK351	72.50	R1131C	12.00	5768	38.50	6201	2.75
2B22	4.50	SKP1	10.50	T21	4.00	QK404	65.00	1236	6.00	5777	165.00	6229	210.00
2C33	1.50	KC4	135.00	B25	12.50	GL414	75.00	1247	3.25	5787	4.00	6280	40.00
2C37	40.00	SN4	5.50	FG27A	13.00	GL415	35.00	K1303	45.00	5793	10.00	6291	57.50
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2C39B	28.00	4C28	15.00	V57	375.00	575A	15.00	1636	.90	5819	35.00	6347	82.50
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2C46	7.00	4C35	14.50	RK71	135.00	579B	13.00	R4340	10.00	5825	10.00	6383	70.00
2C50	13.00	4E27	15.00	BL77	10.00	UE583	17.50	5516	5.50	5830	185.00	6437	7.00
2C52	3.00	4J52	55.00	83V	1.00	592	24.00	5527	110.00	5838	6.50	6485	1.50
2D21	1.00	4X150A	25.00	FG97	20.00	NL600	8.00	5550	35.00	5839	5.75	6524	8.50
2E24	3.25	4X150G	38.00	100TH	7.00	NL602	10.00	5551	55.00	5851	4.00	6587	40.00
2E41	3.00	4X250B	45.00	101L	4.00	GL627	11.00	5552	75.00	5854	1.50	6655	44.50
2G21	2.00	4X500A	95.00	QK103	90.00	629	13.00	5558	6.75	5857	35.00	6816	52.00
2J36A	90.00	5AXP4	20.00	FG105	20.00	KX641	12.50	5563	32.50	5865	110.00	6838	14.00
2J51	200.00	5C22	20.00	TW150	17.50	GL672A	29.00	5593	180.00	5876	8.00	8000	10.00
2J55	60.00	5FP14	15.00	152TL	27.50	705A	15.00	5607	475.00	5894	17.50	8003	11.00
2J56A	90.00	5J26	200.00	QK159	62.00	707B	13.00	5622	12.50	5931	5.00	8005	6.00
2K25	24.50	5JP2A	10.00	FG172	15.00	709A	1.00	5625	135.00	5937	45.00	8008	5.00
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2K33	150.00	6AS6W	2.00	QK201	165.00	802	4.00	5643	5.50	6012	6.00		
2K40	90.00	6AS7G	3.25	QK202	200.00	803	2.50	5647	6.00	6029	2.00		
2K41	100.00	6BA6W	1.75	CE206	24.75	804	12.00	5650	65.00	6032	75.00		
2K45	50.00	6BE6W	3.00	RX212	32.00	805	4.50	5654	1.75	6034	7.00		
2K48	60.00	6BL6	28.00	CE213A	12.50	807	1.35	5657	150.00	6037	125.00		
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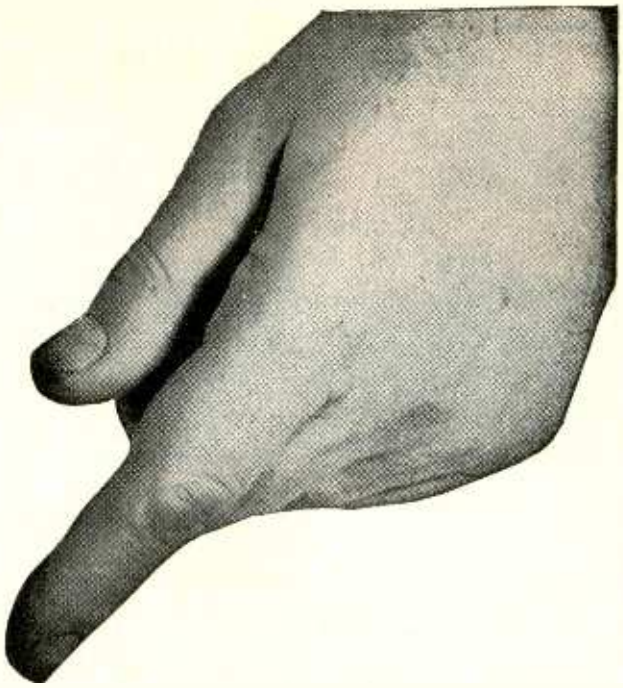

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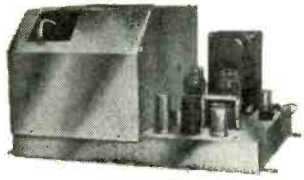

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(Additional Wanted advertising on page 407)

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1AD4	1.10	4J37	70.00	250R	7.95	927	.95	5814	1.00
1B24	5.00	4J78	150.00	249B	2.75	954	.10	5819	23.95
1B24A	15.00	4PR60A	30.00	HK253	5.00	957	.30	5829WA	3.00
1B26	1.00	4X150A(surp)	19.00	HK-257B/4E27	7.40	958/958A	.35	5840A	4.50
1B32/532A	.25	4X500A(surp)	45.00	274B	.80	CK1007	.45	5876	7.00
1B35	3.35	4X500F	40.00	287A	2.20	CK1026	2.35	5879	1.20
1B40	2.00	EL5B/4B22	5.50	FP265	20.00	R1130B	10.50	5933/807W	1.40
1B63A	19.00	5BP4	3.00	304TL	12.50	HY-1269	3.35	5981/5650	50.00
1N21	.10	5C22	24.00	307A	.60	1622	1.60	5998/421A	4.00
1N23	.10	5CP1A	6.50	311A	5.50	1626	.15	6004	2.00
1N48	.40	5D21	5.50	311C	1.50	1635	1.60	6021	3.00
1N52	.65	5D23/RK65	7.50	313C	2.50	1654	2.00	6073	1.50
1N65	.85	5HP1	2.25	313CD	2.50	†1740(W.E.)	3.00	6096	1.40
1N70	.65	5J23	Write	QK319	100.00	†1760(W.E.)	3.00	6108/BS213	6.00
1P23	1.75	5FP7	.75	328A	3.50	†1768(W.E.)	3.00	6109/BS404	6.00
1P24	1.35	5J30/Z666	4.00	338A	3.75	†1821(W.E.)	3.00	6100/6C4WA	2.00
1P25A	20.00	5JP2	3.50	339A	9.00	†1847(W.E.)	3.00	6130/3C45	4.75
1P30	1.25	5JP5	5.50	350A	2.35	1850A	Write	6136/AU6WA	2.50
1P37	3.50	5LP1	12.50	350B	2.35	5517	1.35	6187	4.00
1P41	2.50	5R4WGY	3.00	354A	2.25	ZB3200	65.00	6189	2.50
1U4	.38	5Y3WGT	1.00	355A	10.00	5528/C6L	5.00	6201	2.50
1Z2	1.25	6AK5W	1.00	359A	1.50	5599/FG57	8.50	6211	1.10
CE2C	2.00	6AS6	1.00	371B/VT166	.75	5638	2.75	6264	10.00
CL-2	10.00	6B4G	.75	375A	10.00	5639	5.75	6278/C5F14	20.00
2BP1	3.95	6BA6W/5749	1.25	393A	4.50	5642	1.00	6288(Taylor)	12.50
2C39A	10.00	6BL6	28.00	396A/2C51	3.00	5654	1.25	6485	1.30
2C39AM	10.00	6BM6	30.00	401A/5590	2.75	5656	4.00	6655	39.95
2C43	7.50	6C4W	4.00	403A/6AK5	.90	5670	1.30	8005	3.95
2C51/396A	2.75	C6L/5528	5.00	403B/5591	2.90	5672	.85	8008/872A	3.25
2C53	9.75	6C21/450TL	13.50	404A/5847	12.50	5676	.65	8020	1.00
2D21W	.95	6SN7WGT	1.75	407A	2.50	5678	.75	AX9903/5894	17.50
2E24	2.25	7E5/1201	.20	408A	2.75	5693	4.50	†Transistors	
2E25	3.50	7A7	.20	412A	3.50	5721	125.00		
2E26	2.95	8D21	Write	416B	30.00	5725	1.50	AND MANY OTHERS IN STOCK. WRITE FOR LATEST TUBE LISTINGS.	
2E35	1.80	12AT7WA/6201	3.00	417A/5842	12.00	5726/6AL5W	.65		
2J21A	3.50	12DP7	10.00	421A/5998	4.00	WL5736	110.00		
2J22	3.50	12DP7A	20.00	422A	7.00	5744	1.00		
2J37	9.00	27	.20	GL434A	5.00				
2J54	25.00	FG-27A	8.00	GL502	1.50				
2K25	13.50	28D7	.80	UE578	7.00				
2K30/410R	115.00	FG-32A	4.25	KU-610	3.50				
2K45	35.00	33	.20	Z666/5J30	5.00				
†2N155(CBS)	3.75	RK34	.10	GL-673	12.50				
†2N255(CBS)	2.90	35TG(surp)	2.00	724B	.60				
2V3G	.65	VC50/32(cap)	8.00	726A	5.00				
3B24	1.50	56	.20	726B	14.00				
3B24WA	10.50	QK60	20.00	726C	12.00				
3B25	5.00	QK61	21.50	750TL(surp)	30.00				
3B26	3.95	RK65/5D23	7.50	803	1.50				
3B28	3.75	FG81A	3.10	806	7.50				
3B29	4.75	100R/451	1.75	805	4.00				
3C22	59.50	100TH(surp)	6.25	807W/5933	1.50				
3C23	3.95	100TL(surp)	11.00	809	2.50				
3C24/24G	1.70	FG-105	15.00	813	7.75				
3C33	6.00	120	.50	814	2.50				
3C45	6.75	F-128A	10.00	826	.50				
3D23	4.00	VXR-130	1.00	829B	8.00				
3E29	8.00	R161	35.00	830B	.35				
3J30	25.00	FG-166	12.00	832A	6.75				
3K200000LK	Write	FG-172	13.50	833A	36.00				
4-65A(surp)	15.00	FG-178A	9.50	837	1.25				
4-125A	30.25			869B	Write				

TERMS: 25% Deposit with Order, Balance C.O.D.—or Send Full Remittance with Order. Well Rated (D&B) Firms, Net 10. All Items Subject to Stock Depletion and Price Variation Without Prior Notice. All Merchandise Fully Guaranteed for Cost of Merchandise Only. Minimum Order $10.00.

2-COLOR TUBE CARTONS

Keeps your tube stock neat. New safety partition prevents tube breakage. Distinctively lithographed in glossy red and black. The most distinctive tube carton available today. Minimum quantity: 100 of fany one size. Write for case lot prices.

SIZE FOR TUBE	PER 100
Miniature ..6AU6, etc.	$1.00
GT ....6SN7, etc.	1.25
Large GT ....1B3, etc.	1.50
Large G ....5U4G, etc.	2.00

WHITE GLOSSY BOXES

Completely blank, No printing or color. Otherwise same as above. Same high quality, same low prices. Specify "WHITE" when ordering. When color is not stated, 2 color cartons will be shipped.

TUBE STACKERS

White glossy only. Ministacker holds 10 Mini. tube cartons; "GT" stacker holds 10 "GT" cartons.

SIZE	PER EACH
Ministacker	11¢
GT	.02

All cartons & stackers f. o. b. NYC.

WAlker 5-7000

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Telegrams: Barry, Fax, NYC

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WRITE FOR "BARRY'S GREEN SHEET" OF EQUIPMENT BARGAINS.

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Let us quote on your requirements.

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WOrth 4-2490-1-2

Cadmium or olive drab finish.

"TAB" THAT'S A BUY

STEVENS ARNOLD PRECISION DC-AC CHOPPER TYPE CH365

SPDT/COIL 26VDC800. Ω IMP 60Cys/830 Ω 400Cys/1100 Ω. Use as Chopper Rectifier, DEMODULATOR, Sq. Wave Generator or SPECIAL........$2@; 4for$10; 25for$37

450MA CHOKE $3 @ *Quantities 3*

W.E. Mfgr for U.S.N. Rated 4Hy 450ma/3KV/27 ohms hermetic Sealed & Cased 4½x3⅛x4¼"x10 Lbs. #CH1001 SPECIAL $2/$7@.

TRANSFORMERS all 115V/60cy/ 1Φ PRIMARYS VAC H'Sealed PWR&FIL/U.S.N. 6V@8A/ 5V@3A&1200VCT @ 200ma. Tapped pri. 5H7L6"W............$7@. 5for$30
TP502/5500VCT@550ma/WST/USN........$39
TPF52/778VCT@200ma/5V@3A, 6.3VCT@5A $4@, 3for$11, 25for$70
TPF53/270VCT @ 50ma/6.3V@2A, $2@....4/$7
TPF54/150V @ 30ma/6.3V @ 1A, $1.49@...3/$4
TPF55/4.5KV@10ma/650VCT@275ma/ 6.4V @ 10A&5V @ 8A/2.5V @ 3A $7@, 2for$12
TPF56/900VCT@35ma/2x2.5V @ 2A $3@, 2for$5
TPF57/2500@10ma/2.5V@2A.....$4@, 3for$10
TPF58/5850, 5400, 5000VCT @ 40ma......$8@
TF01/2.5V@2A $1@ TF02/2.5VCT @ 10A/5KV $4@, 2for$7, 10for$29
TF05/7.5VCT/12A/15KV KENYON.....$7.50@
TF06/2X12V@2A/or 24V@2A $4@.......2for$7
TPHI Isolation 110to220&440VAC/150W $4@.
MIL-T-27 TRANSF Hermetic Sealed
TFM10/6.3V/1.2A/$2; TFM11/5VCT@3A/ 6.3VCT@5A.....................$5@, 2for$9
TFM12/2x5V@3A/&2x5V@2A......$5@, 2for$9
TFM13/2x2.5V@6A at 3KV.......$5@, 2for$9
TFM14/6.3VCT@9A/&2x6.3@1.2A.$6@, 2for$11
CHOKE 1000 Hys @5 ma/12KV Insulation $3@
TF1A/W.E. Pulse 35Mu Sec, Min $3@, 4/$10

SPECIALS! TEST EQUIPMENT!

G.E. Time Interval Meter measures elapsed time From .1/1000 to 3 seconds in 8 ranges .001, .003 .01, .03, 0.1, 1 & 3 secds........$149
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RAL5/USN RADIO RECEIVER 0.3 to 23 mcs. NEW with Power Pack................ $129
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ANCRW3/UHF Radio Transmitter........ $3
XMitter/Citizens band 200 to 550 mcs.... $4
30mcs IF STRIP less tubes Higain.........$3@
EE65 Telephone Test Set.............. $9
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DUMONT 241 LAB Scope.................$200

HI & LO VOLTAGE REGULATED SUPPLY

"SOLA" 3% REGLTD 420VDC@350ma & 20to30KV HiV TUBE REGULATED & ADJUSTABLE HiV & 6.3VAC@6A filament; 13 Tubes 2/5U4, 2/6SN7, 2/6AL5, 2/6BG6, 2/1B3, OA3, 6W6, 6SJ7; 3 sens Relays & protection ckts. Input 117VAC/60cys./1Φ DUMONT RA119 for 30" T.V. EXCELLENT LAB, TV, HiFi, RADAR POWER SUPPLY Cost $200. supplied with Diagram SPECIAL......$24@, 2for$45, 5/$100

R.F. INTERFERENCE FILTERS
One KC to 1000 MCS/MIL SPEC'S
SPRAGUE, CD, TOBE, FILTRON

10amp @ 130vac..$1.49@, 7for$10
100amp & 50vdc $1.49@, 8for$10
15amp @ 115vac/400cys $1.29 @
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FA446 Filtron 200amp@130vac. CP556; $15@, 2for$25, 10for $100

NEW VIBRATORS 6&12VDC Gtd.

FOUR PIN 6 or 12 volt $1.39@, 6for$7. 12for$15. 100for$110
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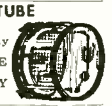

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AC—MINFAN—6&12V QUIET

COOL THAT TUBE EQUIPMENT or TRANSISTOR. TAPPED for 6&12VAC/60cy. Also on 400 cys as well. BARBER COLEMAN Mfgr. $1@, 6 for $5......... 50for$35
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60mcs/85DB Gain IF STRIP W.E. Dsgn mfrd by MOTOROLA contains 8/6AK5 & 1/6AL5 Less Tubes $6@, Compact $14@;

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HELIPOT, G.R., MULTIPOT, MICROPOT TIC, BOURNS, DEJUR.

HELIPOT, MULTIPOT Ten Turn/ 0.5% ohms 100, 1000, 5000, 20K, 30K, 100K $6.98@, 2 for $12
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GR#314/50,000 ohm/8Watt.............2.45@
GR#214/20 ohm/10 Watt..............1.35@
Muter 0214/500 ohm/10Watt...........1.50@
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Fairchild 748/20K $6; #746/2X40K $6; #736/ 3X10K & 10K & sw. $4; TIC #RV1¼ 10K $3@, #RV1. #S117—3 section 12.7K, 1.62K, 45.55K ....$12@

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***FULL WAVE BRIDGE & †C.T. • DATED & ONE YEAR GTD.**

MAX DC AMP	Single Phase Full Wave Bridge 18VAC 14VDC	36VAC 28VDC	54VAC 42VDC	72VAC 54VDC	130VAC 100VDC	266VAC 217VDC	3-Phase Bridge 3-Phase 16VAC 20VDC	3-Phase 30VAC 36VDC	3-Phase 120VAC 150VDC	3-Phase 208VAC 256VDC	3-Phase 240VAC 300VDC	MAX DC AMP
1	$1.50	$2.30	$3.75	$5.30	$8.75	$27.90	$3.75	$4.90	$21.45	$39.75	$45.90	1
2	2.35	3.35	5.40	6.45	11.70	33.60	4.75	5.95	24.90	47.90	58.80	2
3	3.00	4.15	6.30	9.60	13.45	42.90	5.40	6.85	27.60	63.30	73.95	3
4	3.70	7.50	11.30	16.15	25.00	49.80	6.75	7.95	31.15	69.75	84.15	4
6	4.45	8.85	12.90	19.30	32.85	63.90	7.90	9.30	48.45	81.90	99.90	6
10	6.50	12.60	19.90	27.90	42.30	99.70	9.00	14.25	63.60	117.75	139.50	10
12	8.10	15.90	22.50	32.75	45.90	111.45	10.75	16.15	69.75	137.90	159.60	12
20	13.20	25.40	38.00	52.50	79.45	177.90	16.20	24.75	124.15	165.75	195.90	20
24	16.15	32.40	44.90	63.60	86 35	210.60	18.60	31.70	149.70	279.90	299.70	24
30	19.80	37.80	56.45	78.75	120.75	256.15	21.60	34.95	189.60	363.75	396.90	30
36	24.90	48.45	72.45	95.70	147.60	326.70	24.75	39.30	225.75	399.60	444.40	36
50	33.45	63.75	171.50	135.75	192.75	445.90	31.60	46.75	297.90	591.75	690.90	50

BATTERY CHARGER STACKS VOLTS AC INPUT : CR20R† 10VAC/CT., CR32D†16VAC/CT, BR18R—BR18C*—BN18R*—18VAC.*

Battery Charger Stacks * †
FAN COOLED 6 & 12 VDC
CR20R† $14
6VDC@100AMP
REPLACEMENT OR CONVERSION
6&12VDC 100/150AMP
CR32D† $20
BR18R* $24
BR18C* $26
BN18R* $20
6&12VDC—OUT 80/40AMP

SINCE 1945 CERTIFIED TUBE TESTING AGEING & PRESELECT FACILITIES WRITE!

TUBES

"TAB" TESTED *INSPECTED* GUARANTEED!!!

WRITE FOR COMPLETE TUBE LIST

0Z4	$ .50	2J21A	$4.00	3D23	$6.00	6AG5	$ .69	RK20	$8.00	100L	$11.29	534X	$2.00
C1A	10.50	2J22	3.70	3E29	8.00	6C4	.49	24G	2.00	G104	29.00	536X	1.49
C1B	2.88	2J26	9.29	3J31	35.00	6C21	14.00	25A6	1.19	G105	11.00	538X	1.45
1B3	.78	2J27	4.00	3K23	160.00	6CA7	3.49	25A7	2.19	152L	32.00	539X	2.00
1B21	3.78	2J31	9.00	3K27	150.00	6CB6	.80	25BQ6	1.39	F200	10.25	541X	2.00
1B22A	5.00	2J32	9.00	3K30	200.00	6D4	2.39	25L6	.72	242	12.50	543X	2.00
1B23	5.00	2J33	19.00	3S4	.68	6F4	2.49	25T	7.00	245	14.75	544X	1.45
1B24	5.00	2J34	14.00	3X2500	80.00	6H6	.59	25Z5	.72	249B	3.30	547X	2.00
1B26	1.00	2J36	24.00	4A1	2.00	6J4	1.72	25Z6	.75	249C	4.25	548	2.00
1B27	9.00	2J37	9.00	4A11	2/1.00	6J5	.59	26A7	3.69	250H	19.45	571	1.49
1B29	2.42	2J38	24.00	4B25	15.00	6K6	.59	FG27	8.28	250L	19.45	725A	2.50
1B35	3.00	2J39	50.00	4B26	7.50	6L6	1.19	28D7	.89	252A	14.35	726B	18.00
1B37	12.00	2J48	9.00	4B27	4.70	6N7	.99	FG33	15.00	H254	9.35	726C	12.00
1B38	41.00	2J50	49.00	4B32	8.00	6S4	.59	GZ34	1.54	254A	2.35	805	5.00
1B41	48.00	2J55	50.00	4C35	19.00	6SA7	.69	EL34	3.49	257B	7.40	807	1.19
1B42	4.00	2J56	35.00	4-125	32.00	6SB7	1.19	35T	4.49	259A	21.75	808	.85
1B46	1.88	2K22	13.00	4E27	7.50	6SC7	.89	35Z5	.57	274A	4.75	809	2.40
1B53	25.00	2K23	11.00	4E27A	10.00	6SG7	.79	EL37	2.49	275A	3.40	810	9.40
1B63	19.00	2K25	13.00	4J22	98.00	6SJ7	.69	TZ40	2.00	276A	19.75	811	2.50
1C	1.39	2K28	27.00	4J31	60.00	6SK7	.72	50L6	.69	300B	4.90	812	3.30
1D21	4.70	2K30	125.00	4J50	95.00	6SL7	.89	HK54	3.85	H300	19.45	813	8.00
1R5	.78	2K33A	39.00	4J51	215.00	6SN7	.72	T55	9.00	303A	8.45	814	2.35
1S4	.78	2K39	180.00	4J52	43.00	6SQ7	.74	RK60	1.17	304H	12.50	815	1.85
1T4	.78	2K41	125.00	4PR60	39.00	6T8	.98	RK61	2.50	304L	16.50	826	2/1.00
1U5	.89	2K42	125.00	4-65	15.00	6U8	.98	HY65	2.90	310B	8.50	827R	100.00
1X2A	.68	2K43	125.00	4-125	32.00	6V6	.90	KT66	3.45	313C	2.60	829B	8.00
2C22	5/1.00	2K44	125.00	4X150	19.00	6X4	.39	75T	15.50	322A	57.50	832A	6.00
2C26	5/1.00	2K45	34.00	4-250	36.00	6X5	.49	80	.59	323B	13.25	836	1.20
2C33	.85	2K47	110.00	4X500	45.00	6Y6	.89	EM81	2.39	339A	9.85	837	1.35
2C39A	11.00	2K48	55.00	4-1000	70.00	7C29	69.00	EC81	1.25	349A	4.95	845	3.50
2C40	6.00	2K50	169.00	5AW4	1.10	10Y	3/1.00	EZ81	1.05	350A	2.45	866A	1.20
2C43	7.00	2K55	15.00	5B	4.00	12AT6	.59	EC82	1.05	350B	1.75	872A	.95
2C44	.25	2K56	60.00	5C22	25.00	12AT7	.89	83	.95	351A	12.75	884	1.15
2C51	2.00	2X2	3/1.00	5D21	5.00	12AU6	.63	83V	.89	357B	43.50	889A	75.00
2C52	2.00	3B22	1.25	5D23	7.00	12AU7	.69	EC83	1.19	368AS	4.59	891R	170.00
2C53	9.50	3B23	3.00	5J29	4.00	12AX7	.79	EF86	1.29	387A	3.95	892	237.00
2D21	.68	3B24	1.50	5J33	5.00	12AY7	1.29	EB91	.81	394A	3.45	931A	4.00
2D29	3.00	3B24W	4.00	5R4	1.25	12BA6	.65	EC90	1.26	434A	2.00	954	10/1.00
2E22	2.00	3B27	3.00	5Y3	.59	12BA7	.99	EF94	.96	450H	44.00	955	3/1.00
2E24	2.25	3B28	3.50	6A	18.00	12BE6	.59	EK90	.99	450L	44.00	957	3/1.00
2E25	7.00	3C22	57.00	6J	18.00	12BH7	.99	EZ90	.79	460	11.50	991	5/1.00
2E26	3.00	3C23	3.95	6A5	3.00	12CU6	1.45	EB91	.81	473	165.00	1850A	36.00
2E27	.70	3C24	1.72	6AC5	1.00	12SA7	.69	EC90	1.26	502X	1.50	2050	1.25
2E30	2.00	3C31	1.00	6AC7	.79	12SJ7	.75	EF94	.96	503X	1.00	5654	1.20
2E31	2.00	3C33	6.00	6AD4	3.00	12SK7	.75	EK90	.99	512X	2.00	5691	4.70
2E32	1.22	3C34	6.00	6AD6	1.29	15E	1.19	EZ90	.79	522X	2.00	5692	5.00
2E35	2.00	3C37	19.00	6AD7	1.39	FG17	3.49	EB91	.81	525X	2.00	5693	5.00
2E36	2.00	3C39	80.00	6AE5	1.89	19BG6	2.15	FG95	16.00	531X	2.00	WE417A	12.00
2E43	1.64	3C45	7.00	6AE6	1.89	19T8	1.16	FG98	14.75	532X	2.00	5BP1	1.50
2G21	2.26	3D21A	3.00	6AF6	.99	T20	5.00	100H	6.39	533X	2.00	5BP4	3.50

"TABTRAN" Rectifier Xfmrs

Sec'd Volts (DUAL† 0-9-15-18-&-0-9-15-18 Series Sec'ds 0-3-6-9-12-15-18-21-24-27-30-33-36 Volts

TR4001 @ 1 Amp† ea/sec/w $4.95
TR4002 @ 2 Amp† ea/sec/w 7.20
TR4003 @ 5 Amp† ea/sec/w 9.45
TR4005 @ 12 Amp† ea/sec/w 16.70
TR4006 @ 24 Amp† ea/sec/w 35.65
TR4007 @ 50 Amp†* per ea sec wndg.. 59.65
TR4008 @ 100 Amp†* per ea sec wndg..117.00
† Wndgs in Series at Ratings shown; Parallel 2X Current, Voltage outpt. 0-9-15-18.
*Dual Pri 115 & 230VAC/60cys INPUT

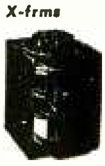
"TABTRAN" Rectifier Chokes

CR6001/ 1 Amp/0.1 HY/1.4 Ohm..........$3.50
CR6002/ 2 Amp/0.1 HY/.67 Ohm.......... 5.45
CR6003/ 5 Amp/.07 HY/.6 Ohm........... 9.45
CR6004/12 Amp/.01 HY/.1 Ohm..........14.75
CR6005/24 Amp/.001 HY/.025 Ohm.......29.75
CR6006/50 Amp/.001 HY/.001 Ohm.......47.85

FILTER CAPACITORS

CE156M 6000MFD 15V....$2@; 2/$3; 10/$12
CE502M 2000MFD 50V....$4 ea, 10 for $30
BRACKET for CE156M or CE502M 25c@,5/$1
CE 2005M 500mfd@200V $6@, 4/$22, 10/$45
Brackets for Capacitors @ 25c each..........

New Variable Voltage X-frms



SUPERIOR-GR-STACO
0-132v-1.25A.................$7.23
0-135V/3A....................10.63
Cased 0-135V/7.5A............19.55
Uncased/0-135V/7.5A..........15.30
Cased/0-270V/3A..............22.10
Uncased/0-270V/3A............17.00
Cased/0-135V/15A.............39.10
Cased/0-270/9A...............39.10
Uncased 0-135V@30A...........44.10
Uncased 0-270V@12A...........44.10
Uncased 0-135V@60A..........113.00
Uncased 0-270V@30A..........113.00
Uncased 0-270V@60A..........189.00
100BU3-3 Φ @ 240/out 0-240/520W/1.2A....$36
300BU3-3 Φ @ 230/out 0-230/1.2KVA/3A.....50
500BU3-3 Φ @ 230/out 0-270/3.5KVA/7.5A...57
1500B3-3 Φ @ 230/out 0-270/7KVA/15A.....132
3000B3-3 Φ @ 230/out 0-270/14KVA/30A....164
8000B6-3 Φ @ 230/out 0-270/28KVA/60A....354
Write For Qty. Prices & Catalog

New 5-Way Binding POSTS

Similar to Superior DF30*, takes plugs, tips, lugs wire, 1/16" to 1/4" panels.
BP30*, 30 Amp, 29c @ 12/$3.25........100/$22
BP10*, 10 Amp, 18c @.................100/$15
BP60*, 60 Amp, 75c @..................50/$30
BP100, 100 Amp, $1 @...................24/$18
Mfrs. write quantity prices

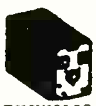
NEW! LOW PRICED HIGH CURRENT BASIC INDUSTRIAL SUPPLIES

Consisting of Transformer & Full Wave Bridge Rectifier mtd and wired, fused, outlet, pilot light & ventilated grill & chassis or cabinet. **Ready to deliver constant DC Power. 1 yr. Gtd. Input 115 VAC/60 cys.**

Stock Number	Continuous Rating	Unit Price
B28V/5A	0-28 WVDC at 5 Amp	$45
B28V/5ACC	5 Amp (1% Ripple)	69
B28V/12A	0-28 VDC at 12 Amp	90
B28V/12ACC	12 Amp (1% Ripple)	135
B28V/24A	0-28 VDC at 24 Amp	139
B28V/24ACC	24 Amp (1% Ripple)	189
B28V/50A*	0-28 VDC at 50 Amp	225
B28V/50ACC*	50 Amp (1% Ripple)	350
B28V/100A*	0-28 VDC at 100 Amp	439
B28V/100ACC*	100 Amp (1% Ripple)	600
B100V1A	100 VDC @ 1 Amp	39
B115V1.5A	115 VDC @ 1.5 Amp	52
B115V5A*	115 VDC @ 5 Amp	120
B220V5A*	220 VDC @ 5 Amp	234
B115V5ACC*	115 VDC @ 5 Amp/1% Rip	169
B115V10ACC*	115 VDC @ 10 Amp/1% Rip	275
B220V10ACC*	220 VDC @ 10 Amp/1% Rip	468

* 115 & 230 VAC/60cy/1Φ Input

New Variable 0 to 6 & 12 Volt D.C. Power Supplies



12 Amp Battery Eliminator, Charger, Model RR, Plater, Aircraft, Marine or any DC Reg. Extra Hvy Duty Selenium Rectifier, 2 Meters V. & A. Dsgnd far Cont. Service and up to 20 Amp. Intermittent overload .10% ripple. **Model T612V12AC $33.00**
T612V12ACC only 0.5% Ripple at 5 Amps $43.00

HEAVY DUTY VARIABLE 0-6&12V

50 & 25 Amp Filtered DC Supply Air-Marine-Police Power Supply for Communications Transmit & Receive. Rugged Design 4" Volt & Amp Mtr. Desgnd for Continuous Service 6V@ 50 Amps & 12V@ 25 Amps Filtered 2% Ripple 115VAC 60cy/1Φ Input, One Year Gtd.
T612SNACC..........................$200

NEW RELAY 24 VDC SUPPLIES
Cased Filtered Ready to Work

B24VAR 24VDC at 1 amp Filtered.........$8
B24VER 24VDC at 2 amp Filtered........$11
B24VJR 24VDC at 5 amp Filtered........$21

TEK-AP TABPAK®
High Current Power Supplies
One Year Guarantee

Variable 0-28 VDC. Completely built. Ready to go. Full Wave Selenium Rectifier, Transformer, Variac, Meters, Pilot Light, 4" Volt & Amp Meters, Switch, Terminals & Fuse, Hvy Duty Steel Cabinet. **Std. 115V/60cy Input or 220V† (3 phase) to order.**

Stock Number	Continuous Rating	With Meters
T28V5A*	0-28 WVDC at 5 Amp	$57
T28V5ACC	5 Amp (1% Ripple)	84
T28V5A2CC	5 Amp 0.1% Ripple	155
T28V12A	0-28 VDC at 12 Amp	138
T28V12ACC	12 Amp (1% Ripple)	168
T28V12A2CC	12 Amp 0.1% Ripple	250
T35V16ACC†	0 to 35V @ 16 Amp/.5% Rip	210
T28V24A†	0-28 VDC at 24 Amp	175
T28V24ACC†	24 Amp 1% Ripple	250
T28V24A2CC†	24 Amp 0.1% Ripple	345
T28V50A†	0-28 VDC at 50 Amp	325
T28V50ACC†	50 Amp (1% Ripple)	450
T28V100A†	0-28 VDC at 100 Amp	550
T28V100ACC†	100 Amp (1% Ripple)	750
T35V25ACC†	0-35V @ 25 Amp (.1% Rip.)	370
T35V50ACC†	0-35V @ 50 Amp (.1% Rip.)	639
T60V1ACC	0-60 VDC @ 1 Amp/0.1% Rip	108
T60V2ACC	0-60 VDC @ 2 Amp/0.1% Rip	139
T60V5ACC	0-60 VDC @ 5 Amp/0.1% Rip	225

Variable 0-130 VDC Completely built. Includes Isolation Transformer, Selenium F.W. Bridge, Rectifier, 4" Rectangular Volt & Ammeter Specify for 115 or 230VAC/1Φ/60cy input.

T130V5A†	0-130 VDC at 5 Amp	$225
T130V5ACC†	5 Amp (1% Ripple)	275
T130V10A†	0-130 VDC at 10 Amp.	275
T130V10ACC†	10 Amp 1% Ripple	369

Includes 4" Meters 2% Acy. *2" Meters

ONE & 3 PHASE 400 CYS SUPPLIES

3Φ 400 cys /115v/750 watt & 1Φ/400 cys 26v @ 250 watts with voltage adjustment. Operates 115 & 230v/ 60CY/1Φ Input, 28VDC @ 60 amps Filtered to inbuilt Inverter. V/adj & Freq/adj & R.F.Filter All in Cabinet.
T4750B Basic Non-Metered...............$475
T4750M DC & AC & Freq Metered..........$563

"TEKAP"® 1Φ/400cys/115v/1500 watts Regulated Power Supply Pckg. Operates 115 or 230v/60cy/1Φ input, 28VDC@100 amps Filtered to inbuilt Regulated Inverter .90Pf. Carbon Pile Voltage Regulator, Freq Adj & Radio Noise Filter. All in one Cabinet.
T41500B Basic Non-Metered Supply......$650
T41500M DC&AC & Freq Metered..........$738

Isolation and Control Transformers

Indoor Power Circuit Type NEMA CASED Primary 230/460V & Secondary 115/230 V 1Φ 60 cys *NEMA Specs.

TPP050/50W.....$10	TPP075/75W.....$12
TPP100/100W....$13	TPP150/150W....$14
TPP250/250W....$17	TPP500/500W....$25
TPP750/750W....$32	TPP1000/1KW...$39
TPP2000/2KW...$59	TPP30000/3KW..$81

230 TO 115 V AUTOFORMERS

For 220v/60cy Input. To 110-120V or Step up. † With Cord Plug & Receptacle.
TPA050/50W*..........$2.55
TPA075/75W†..........3.65
TPA100/100W†.........4.00
TPA200/200W†.........5.75
TPA250/250W†.........6.75
TPA500/500W†.........8.25
TPA750/750W†........11.79
TPA1000/1KW† $16.95; TPA2000/2KW* $22.50
TPA2000/2KW* $34; TPA3000/3KW* $51
**Less Cord, Plug & Receptacle.*

"TEKAP"® 1Φ 400 cys/115v/485 watts Power Supply Pckg. Op/ 115v/60 cys
T4485B Basic Non-Metered..............$299

NEW DC "REGOVAC"® HIVOLTAGE

SUPPLY R200: REGULATED OUTPUT 250 450 VDC AT 200MA: REGULATION 1% MIN TO MAX CURRENT RIPPLE LESS THAN 5MV. IMPED 2 OHMS AND ALSO NON-REGULATED 125VDC@ 100MA. 6.3V/12A. COMPLETE CONTROLS FRONT PANEL SWITCHES, PILOT LIGHT BINDING POSTS, FUSES, 4" VOLT & MILLIAMMETER (2% ACCY) RACK 8-3/4H13D19"W OR CABINET. **R200R RACK MTD $135; R200C CABINET $150**

● ● ● ● ● ● ● ● ● ● ● ● ● ●

W.E. TANTALYTIC NEW 4mfd/60WV CAPACITOR MINIATURE ¼"DX⅛"L SPECIAL .75@, 2for$1, 25for$10
W.E. 100Ma/miniature Silicon Junction Rectifier GA52843 10-6 Reverse Res. SPECIAL.....90@, 3for$2, 20for$11
UG342U CO-AX BN CONNECTOR.....69@, 2for$1, 20/$7
VEEDER ROOT 5/DIGIT COUNTER SMALL $1.49@, 5for$5
GLYPTAL RED #1201/ONE/OZ BOTTLES .35@, 4for$1
GLYPTAL #1202 CLEAR VARNISH PINTS $1@, 4for$3
M&W #480 "NON-FLASH" SPOT CEMENT/ TUBE.............5for$1
WRITE FOR NEW INDUSTRIAL CATALOG

THAT'S A BUY "TAB" THAT'S A BUY
Dept. 9E7 111 Liberty St., New York 6, N. Y., U. S. A. PH. RECTOR 2-6245 CABLE: "TABPARTS"

Money Back Guarantee (Cost of Mdse. Only) $5 Min. Order FOB N. Y. C. Add shpg. charges or for COD 25% Dep. Prices Subject to Change Without Notice.

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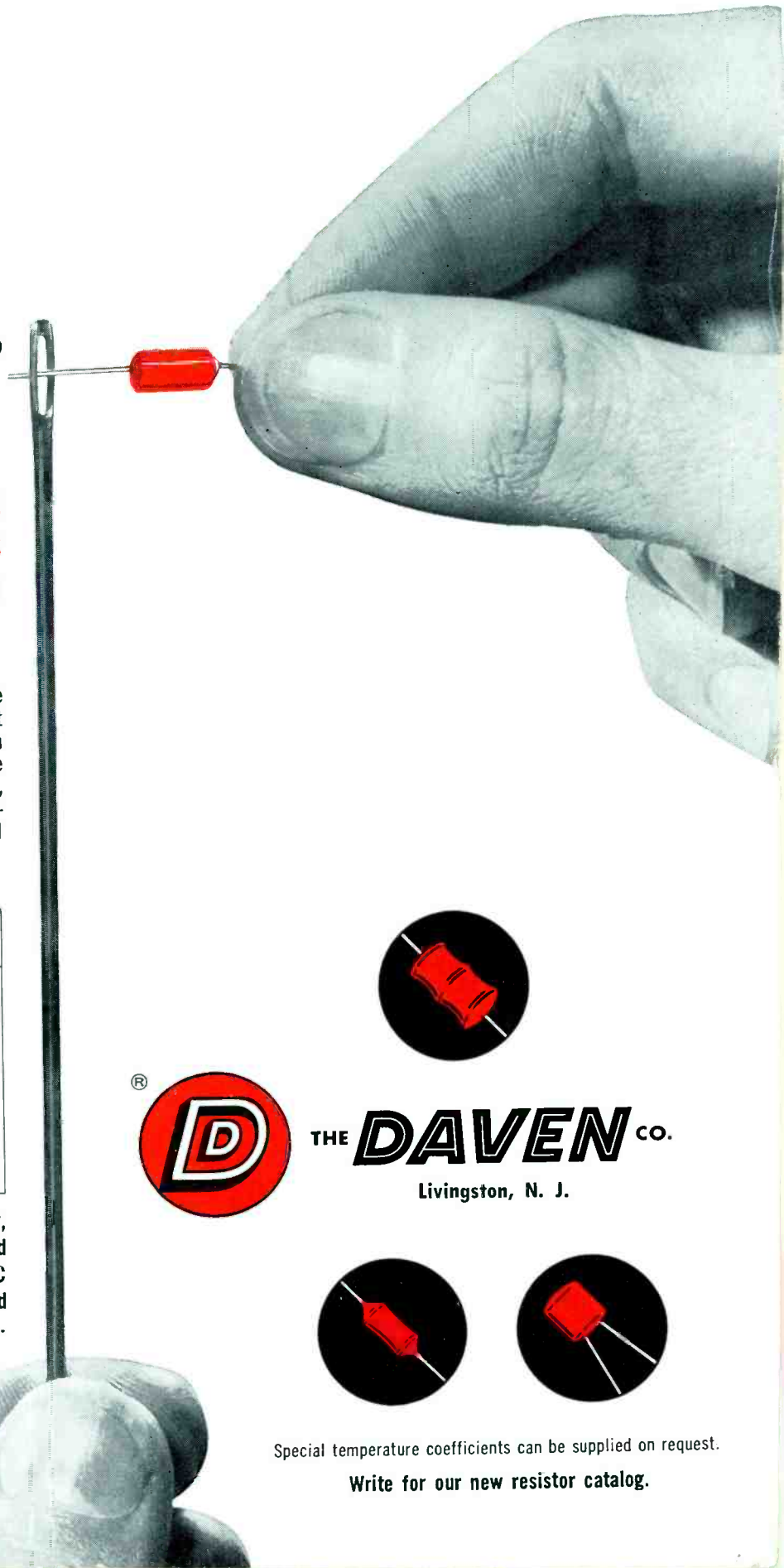
how large is small?



DAVEN'S NEW MINIATURE WIRE WOUND RESISTORS PROVIDE AS MUCH AS 400K RESISTANCE IN 1/4" x 5/16" SPACE

DAVEN's fully encapsulated, miniature, precision wire wound resistors offer the design and development engineer the solution to critical space limitation problems. DAVEN's advanced techniques provide the needed resistance value in a minimum of space, without sacrificing reliability. Where space conservation is a prime factor in your design, specify DAVEN miniature wire wounds.

Types and Specifications

Type	Dia.	Length	Max. Ohms	Max. Watts
1274	3/16	3/8	100K	0.25
1273	1/4	5/16	400K	0.25
1283	1/4	5/16	400K	0.25
1284	1/4	27/64	.5 Meg.	0.25
1250	1/4	1/2	900K	0.33
1170A	7/16	1/2	1.2 Meg.	0.50
1170	1/2	1/2	1.8 Meg.	0.50

• Fully encapsulated • Meet and exceed all humidity, salt water immersion and cycling tests as specified in MIL-R-93A, Amendment 3 • Operate at 125°C continuous power without de-rating • Can be obtained in tolerances as close as ±0.02% • Standard temperature coefficient is ±20PPM/°C.

® THE DAVEN CO.

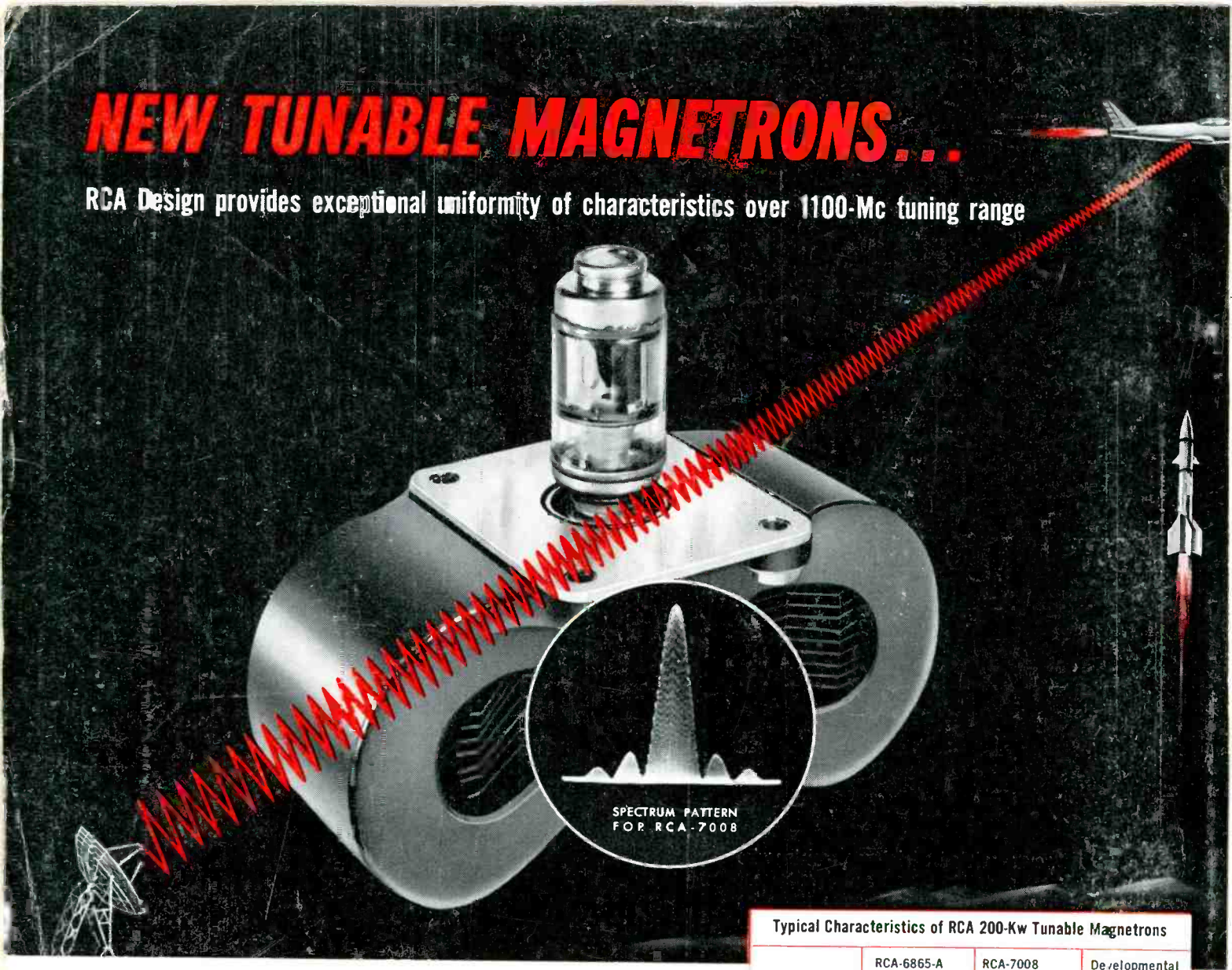
Livingston, N. J.

Special temperature coefficients can be supplied on request.

Write for our new resistor catalog.

NEW TUNABLE MAGNETRONS...

RCA Design provides exceptional uniformity of characteristics over 1100-Mc tuning range



These remarkable tunable X-band magnetrons feature:

(1) exceptional electrical stability at very high rate-of-rise of voltage pulse, (2) virtually constant power output across the entire tuning range, and (3) rugged mechanical construction to meet stringent military requirements.

Available for either servo- or hand-tuned applications, this new family of RCA tunable X-band magnetrons is interchangeable with the 4J50 type magnetron in many systems. All RCA tunable magnetrons are designed for maximum performance throughout warranted life.

If you are working on new designs or modification kits for government end use, investigate RCA's new tunable magnetrons. For additional information on RCA commercial or custom-designed tunable magnetrons, call the RCA Office nearest you:

Typical Characteristics of RCA 200-Kw Tunable Magnetrons

	RCA-6865-A	RCA-7008	Developmental Type*
Tuning Range	8750 to 9600 Mc	8500 to 9600 Mc	8500 to 9600 Mc
Pulse Width	Up to 2.5 μsec at full power	Up to 2.5 μsec at full power	Up to 2.5 μsec at full power
Rate-of-Rise of Voltage Pulse	70 to 180 KV/μsec	70 to 225 KV/μsec	70 to 200 KV/μsec
Stability at Max. Rate-of-Rise of Voltage	less than 0.1%	less than 0.1%	less than 0.1%
Type of Tuner	Hand (with tuner lock)	Gearbox (for servo applications)	Hand (with tuner lock)
Approx. Weight	11.5 lbs.	13 lbs.	11.5 lbs.

*Available with several different tuning mechanisms to meet customer requirements.

Equipment Sales
744 Broad Street, Newark 2, N. J., HUmboldt 5-3900
Suite 1181, Merchandise Mart Plaza, Chicago 54, Ill., WH 4-2900
6355 E. Washington Blvd., Los Angeles 22, Calif., RA 3-8361

Government Sales
415 South Fifth Street, Harrison, N. J., HUmboldt 5-3900
224 N. Wilkinson Street, Dayton, Ohio, HEmlock 5585
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